Dr Tina Aughney, Bat Eco Services

Derryadd Wind Farm,

Lanesborough,

County Longford.

Bat Survey Final (January 2019)

Dr Tina Aughney

2019

Report prepared for:

Bord Na Mona

&

TOBIN Consulting Engineers

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SUMMARY

Site: Bord na Mona, Lanesborough, Co. Longford

Development: Proposed wind farm development

Grid reference: Various – see main body of report

Survey by: Dr Tina Aughney

This Full Season Bat Survey was undertaken from June to November 2016. Table A provides a summary of the surveillance completed on the masts:

Table A: Summary of bat species recorded by sound recording units located on masts

	Lough Bannow Mast (100m) 4m height	Lough Bannow Mast (100m) 50m height	Derryaroge Mast (80m) 4m height	Derryaroge Mast (80m) 50m height
Date	**June**	**June**	**June**	**June**
Species	Soprano pipistrelle, brown long-eared bat, Leisler's bat	Soprano pipistrelle, Leisler's bat	Soprano pipistrelle, brown long-eared bat, Leisler's bat, *Myotis* spp.	No recordings
Date	**July**	**July**	**July**	**July**
Species	Soprano pipistrelle, brown long-eared bat, Leisler's bat, common pipistrelle	Soprano pipistrelle, common pipistrelle, Leisler's bat	Soprano pipistrelle, brown long-eared bat, Leisler's bat, *Myotis* spp.	Soprano pipistrelle, common pipistrelle, Leisler's bat
Date	**August**	**August**	**August**	**August**
Species	Soprano pipistrelle, common pipistrelle, Leisler's bat	Common pipistrelle, Leisler's bat	Soprano pipistrelle, common pipistrelle, Leisler's bat	No bats recorded
Date	**September**	**September**	**September**	**September**
Species	Soprano pipistrelle, common pipistrelle, Leisler's bat	Leisler's bat	Leisler's bat	No bats recorded
Date	**October**	**October**	**October**	**October**
Species	No bats recorded	Leisler's bat, Nathusius' pipistrelle	Leisler's bat, Common pipistrelle	No bats recorded
Date	**November**	**November**	**November**	**November**
Species	No bats recorded	No bats recorded	Soprano pipistrelle	No bats recorded

Additional bat surveying comprised of walking and driving transects. Bat species recorded during Walking and/or Driving Transects: soprano pipistrelle, common pipistrelle, Leisler's bat, Natterer's bat, Daubenton's bats, *Myotis* species.

Bat species recorded during additional static recording sessions (static recording units located a 2m height): soprano pipistrelle, common pipistrelle, Leisler's bat, Natterer's bat, brown long-eared bats, *Myotis* species.

Additional survey work was complete in June 2018 to address gaps in the coverage across the entire survey area. This consisted of walkabout surveys in two sections of the survey area and the placing of five static recording units (2m height) for one night surveillance. The following bat species were recorded: soprano pipistrelle, common pipistrelle, Leisler's bat, Nathusius' pipistrelle and *Myotis* species

1. Introduction

Information in relation bat activity at the proposed wind farm location was requested by Bord na Mona in 2016. Bat Eco Services, was appointed to provide a bat survey of the proposed development site and this was completed in June-November 2016 and June 2018.

The proposed development at Derryadd Wind Farm is comprised of 24 turbines located in three sections of Bord na Mona property (Mountdillon Bog Group). A bat survey was commissioned to provide advice with regard to bat usage of the proposed wind farm location.

Such surveying was completed due to the fact that bats are protected species under the Wildlife Act (1976) and Wildlife [Amendment] Act (2000). Across Europe, they are further protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982), which, in relation to bats, exists to conserve all species and their habitats. The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions. Also, the EC Directive on The Conservation of Natural habitats and of Wild Fauna and Flora (Habitats Directive 1992), seeks to protect rare species, including bats, and their habitats and requires that appropriate monitoring of populations be undertaken. All bat species are protected under Annex IV of the EU Habitats Directive, while the lesser horseshoe bat is listed under Annex II. Member states are required to designate Special Areas of Conservation for all species listed under Annex II in order to protect them.

The general format of this report is in accordance with guidelines recommended by the EPA (2002) *Guidelines on the Information to be contained in Environmental Impact Statements*. Recommendations and evaluation techniques utilised are in general accordance with *Guidelines for Baseline Ecological Assessment* (Institute of Environmental Assessment, UK, 1995), *Wildlife Impact: the treatment of nature conservation in environmental assessment* (RSPB, 1995) and *Guidelines for ecological evaluation and impact assessment* (Regini, M. 2000). Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, August 2017) are also considered.

In relation to bats, the following guidelines have been consulted:

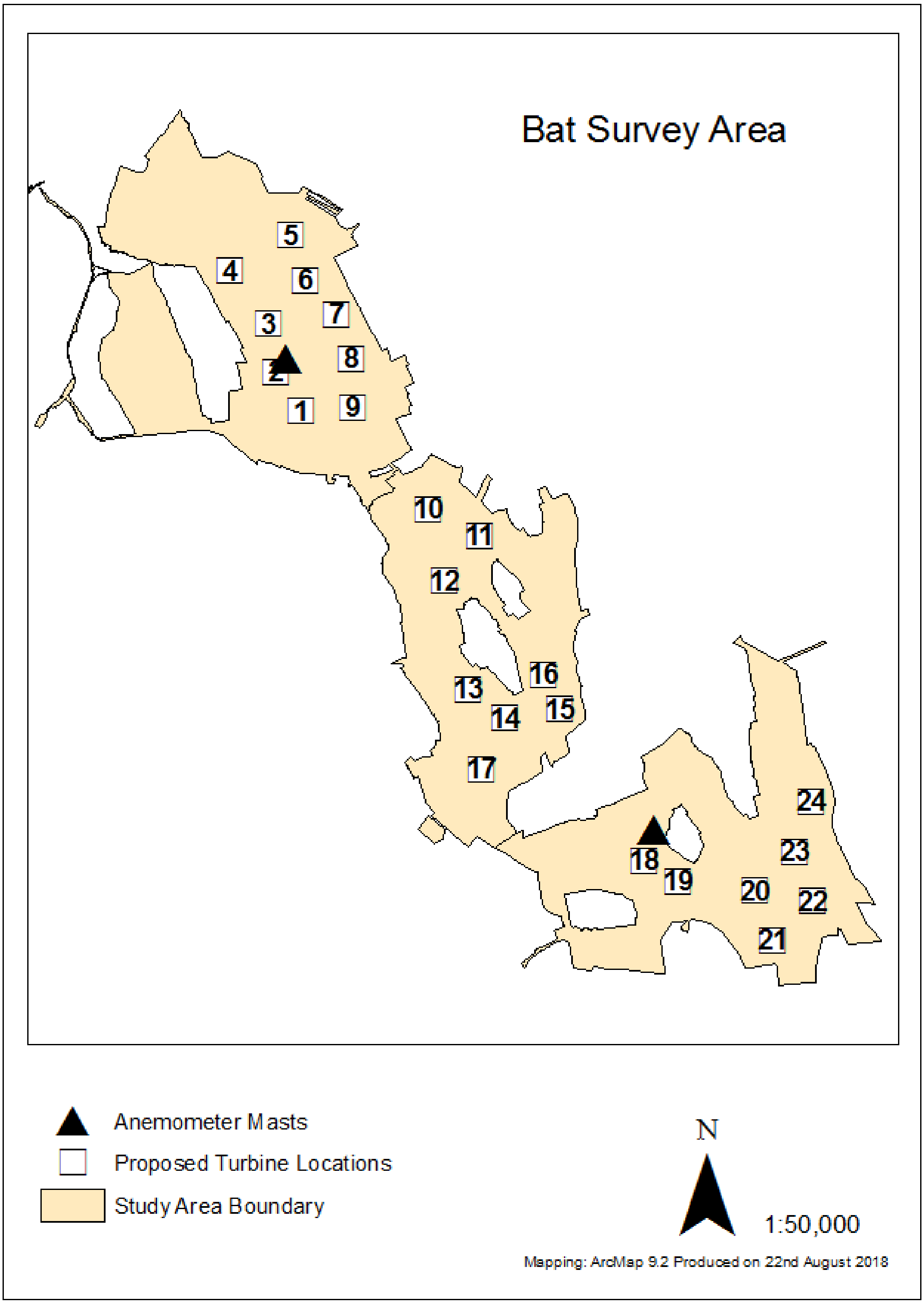
- *UNEP/EUROBATS: Guideline for consideration of bats in wind farm projects, Publication Series No. 3.*
- *Natural England Technical Information Note TIN051: Bats and onshore wind turbines – Interim Report*
- *A conservation plan for Irish vesper bats, Irish Wildlife Manual No. 20 National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.*
- *Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.*
- *Guide to Tubrines and Wind Farms. Bat Conservation Ireland 2012.*
- *Bats and onshore wind turbines: Survey, Assessment and Mitigations. January 2019.*

This bat survey report is a stand-alone document and aims to provide the following information:

- Bat species list for the proposed development area;
- Location of bat presence within the proposed development area;
- Bat activity levels within the proposed development area;
- Analysis and assessment of the potential impact of the proposed development on local bat fauna;
- Recommendations and mitigation measures to reduce the potential impact of the proposed development on local bat fauna.

1.1 Site location and access

The proposed wind farm comprised of 24 turbines as shown below in Map 1.1. This figure also details the location of the two existing anemometers. These masts were the location for static units set to record on specific dates during the full season bat survey (June-November 2016).



Map 1.1: Survey Area illustrating proposed turbine locations and locations of anemometer masts.

2. Literature Review, Guidelines, Legislation & Desktop Study

A large array of publications has been produced to date on the potential impact of wind turbines on bats. As a consequence, there are a number of guidelines that this report draws from in order to provide recommendations and mitigation measures. It is important to be aware of these publications in order to understand the survey protocol, the large degree of bat surveying completed and to address potential impacts of wind turbines on local bat populations. This literature review also provides evidence for accepted bat mitigation measures implemented across Europe.

2.1 Literature Review: Effects of Wind Turbines on Bats

In the last 20 years, wind energy is the fastest growing source of power generation in the world. In Europe, during the last 30 years, wind energy has grown dramatically Wind Europe reporting that a total net installed capacity of 169 GW has been installed making wind energy remains the second largest form of power generation capacity in Europe (Wind Europe, 2018). Among European countries, Germany, Spain, Italy, France, UK and Portugal have shown an extraordinary growth in wind energy in the last decade in particular (WWEA, 2013). Energy produced from renewable sources is a priority in the European Union (EU) agenda, especially after the implementation of the Renewable Energy Directive in 2009 (2009/28/EC). This directive establishes mandatory targets for 2020, imposing a 20% share of energy from renewable sources by 2020 in all member states. As a consequence, several member states have seriously invested in the development of wind energy, as a crucial way to attain this goal. As a consequence, renewable energy is an expanding industry in the Republic of Ireland with wind energy an increasing contributor.

However, in mainland Europe and North America evidence of adverse impacts of wind turbines on bats has become evident leading to concerns about the sitting and operations of wind turbines (Arnett *et al.,* 2008, Bearwald *et al.,* 2008). Bats are nocturnal flying insectivorous mammals. Irish bat species tend to emerge to feed at sunset and return to roosts at sunrise. This mammal group tends to fly in low wind, mild and dry weather conditions. Evidence of bat collisions grew in the late 1990's with a total of 20 species found to suffer collision fatalities in Europe and 21 species are considered to be potentially affected by wind turbines (including the following bat species found in the Republic of Ireland: Nathusius' pipistrelle *Pipistrellus nathusii*, common pipistrelle *P. pipistrellus*, soprano pipistrelle *P. pygmaeus* and Leisler's bat *Nyctalus leisleri*). Wind turbines located in the open can impact of the high flying/aerial feeding bats e.g. Leisler's bats; migratory species e.g. Nathusius' pipistrelles while wind turbines located close to treelines and woodland can impact on edge-feeding species e.g. soprano pipistrelle and common pipistrelle. Research suggests the more bat fatalities in vicinity of wind turbines occur during relatively low-wind periods at particular times of the year (e.g. summer and autumn months). Rydell *et al.* (2010) have documented that 10% of mortality occurs in the spring months while 90% of mortality occur in summer and autumn months (details taken from 40 wind farms across Europe). These two seasons coincide with changes in the behaviour of bats such an autumnal migration or changes in foraging areas in the spring months (Barclay *et al.*, 2017). As a consequence, a four season bat survey is recommended for a wind turbine development.

The principal concerns relate to the following:

- High flying bats/aerial feeding bats colliding with turbine blades;
- Wind turbines sited along migratory routes for bats;
- Impacts on tree roosting bats;
- Wind turbines sited too close to foraging and commuting habitats.

The sitting of wind turbines can lead to habitat fragmentation, loss of roosting sites and impede the movement of commuting and migratory bats, while the operation of wind turbines can cause direct (bats colliding with the blades) and incidental collisions with flying bats. As a consequence the assessment methodology to determine the potential impact of a proposed wind turbine development should consider the habitats within the survey area.

Weather conditions may also influence the degree of bat fatalities at wind energy sites. The highest bat fatalities have been reported by Ahlén (2003) and Arnett (2005) occurred on nights when the wind speed was low (<6 ms^{-1}). Kunz *et al.* (2007) state that the speed at which the tips of turbine blades rotate, even in relatively low-wind conditions, may not be detected by echolocating bats in time to avoid and therefore a collision occurs. Therefore it is important to assess the weather conditions during the bat survey period to determine its potential influence on potential bat activity.

Concerns in relating to the impact of wind farms on bats are relating to the high number of bat fatalities (300,000 per year in Germany as reported by Voigt *et al.,* 2012) but also the concentration of bat fatalities on specific bat species (Barclay *et al.*, 2017). Bats response to variable and seasonal environmental conditions (including food sources) means that the impact on bats is variable from species to species. Table 1.1 provides a summary of the species of bats killed at wind farms in Europe as reported in Table 9.1 of Barclay *et al.*, 2017.

Table 1.1: Extract from Table 9.1 from Barclay *et al.*, 2017 detailing bat species killed at wind farms in Europe.

No. of bat mortalities	Species	% of fatalities	Peak fatality time	Migratory status	High flight / foraging	Roosts in trees
5,108	*Pipistrellus nathusii*	14.8%	Autumn (late July to early October)	Migratory	Yes	Occasionally
	Pipistrellus pipistrellus	20.7%	Autumn (late July to early October)	Sedentary	Yes	Occasionally
	P. pipistrellues / P. pygmaeus	12.1	Autumn (late July to early October)			
	Nyctalus leisleri	8.4%	Autumn (late July to early October)	Migratory, stationary in south	Yes	Occasionally
	Pipistrellus spp.	5.4	Autumn (late July to early October)		Yes	Occasionally
	Myotis daubentonii	0.1		Sedentary	No	Occasionally
	Plecotus auritus	0.1		Sedentary	No	Occasionally

Studies in Germany have shown that the majority of bat activity occurs between 0 and 8 m/s (Beaufort Wind Scale of 0-4) with Nathusius' pipistrelle showing a slightly higher wind tolerance compared to other bat species such as Noctule bat *Nyctalus noctula* and common pipistrelle. This study has also shown that common pipistrelle is tolerant of higher wind speeds in August while Nathusius' pipistrelle tolerates higher wind speeds in September. The results also indicated that the majority of bat fatalities occurred at wind speeds of 4-7 m/s (Beaufort Wind Scale of 3-4). Overall the research study above showed that bat activity was significantly lower at higher wind speeds thereby supporting that the mitigation measure of setting at cut-in speed condition for wind development is a condition that can be considered for wind farm projects.

An additional concern is that the number of turbines at a site, the height of the turbines and the rotor-swept area are increasing with each new generation of turbine design. For example Kunz *et al.* (2007) reported that a turbine rotating at 19 rpm with speeds at the rotor tips 86 ms^{-1} (or 193 mph). Turbine blades are large objects that bats should be able to detect by echolocation. The species of bats most affected by collision are the high flying and fast flying bat species and consequently, this flight style means that such bat species are more likely to be in the wind blade swept area. This means that it is important to undertaken bat surveys at a height to determine what high flying species are present (Barclay *et al.*, 2017).

Kunz *et al.* (2007) recommended that future research and monitoring at wind energy sites should emphasize regions and areas with the highest potential for adverse environmental impacts on bats. Bat Conservation Ireland produced a Landscape Favourability GIS system in relation to Ireland's bats (Lundy *et al.,* 2011) and this was further used by research undertaken by the Centre for Irish Bat Research (CIBR) to determine if it could be used to pin point such regions for Ireland. Nealon *et al.* (2014) recommended in a presentation at the 8th Irish Bat Conference that the mapping system required further bat research of bat usage in upland areas to make the Landscape Favourability map more suitable to assist this process.

In addition, Kunz *et al.* (2007) also recommended that multi-year monitoring is undertaken to determine the bat usage of proposed wind energy sites across the seasons and BCIreland recommends that at least 6 months of survey is undertaken between April and October to collate this information (Bat Conservation Ireland, 2012). Kunz *et al.* (2007) further recommends that a policy framework that encourages wind energy owners/developers to provide full access to such facilities in order to monitor and collate the essential information to make informed policy decisions in relation to wildlife matters.

Gartman *et al.* (2016) review mitigation measures reported in peer reviewed journals, research papers and unpublished papers in order to provide measures that can reduce the impact of wind energy facilities on wildlife. The focus of the paper primarily lies mainly within avoidance and minimisation measures used in wind energy development. This paper categorised 11 mitigation measures which are shown in Figure 1.1 and these were further categorised by the authors as 'recommendation', 'observation', or 'investigation'.

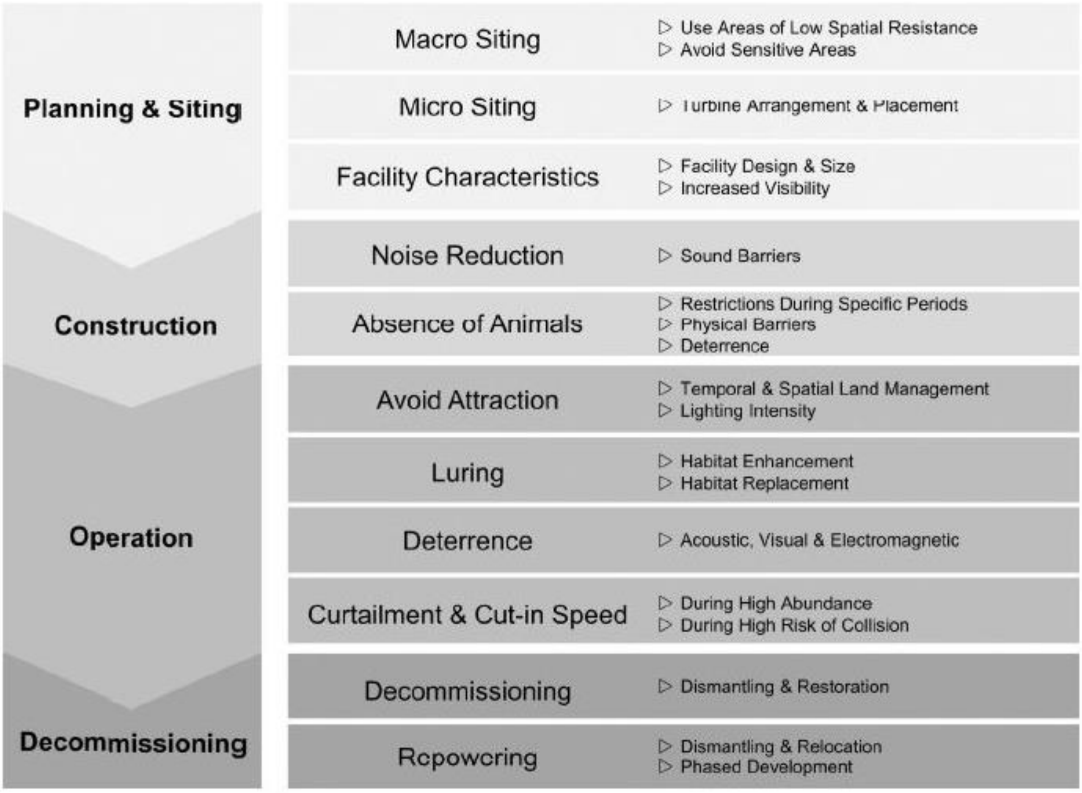


Figure 1.1: Screenshot of Figure 1 from Gartman *et al.*, 2016.

The first stage of ***Planning & Siting*** of a proposed wind energy facility provides the opportunity to make best practices in relation to minimising the impact on wildlife particularly in avoiding high risk areas.

- Macro Siting

This measure refers to the wider topographical and geographical landscape and provides the facility to plan siting of a wind energy facility away from bat roosting sites or areas of high concentration of bat activity (foraging and commuting) and national environmentally designated sites (e.g. SACs). Particular habitats, such as riverine valleys, woodland edges and linear landscape features such as hedgerows should be avoided as these are particularly used by commuting bats.

- Micro Siting

Additional to the geographical and topographical facility location, choosing the turbine layout and design of the facility is just as crucial and this comes under micro-siting of the individual turbines. Local survey results will inform area where bats are active thereby informing where turbines should be located to have the minimum impact on local populations.

- Facility Characteristics

When designing the wind energy facility, Gartman *et al.* (2016) state that there are a number of technical factors to take into account such as the design (i.e. tower type), size (i.e. vertical extent and height of the rotor swept area), and visibility (i.e. lighting and tower colour). *"These factors are factors are dependent upon where the facility is to be developed as weather patterns, wildlife movement, and facility size which determine* *turbine model and design are most appropriate as well as based on country and industry targets".* Some papers reported that shorter turbines have less of an impact on bats as it means that the blade length is less and therefore less likely to collide with flying bats. It was deemed that mitigation measures should be centred on turbine height and blade size when considering facility characteristics, and centred on which at-risk species may fly through the facility.

During the ***Construction Phase***, changes can occur to the receiving environment in preparation and construction of the wind energy facility includes infrastructure and the turbine locations themselves. The most obvious non-lethal impacts are habitat loss, alteration and fragmentation. The amount of land changed/cleared to facilitate the wind farm and it's operation vary from site to site but reports have shown anywhere from 1.23 ha per wind turbine (Zimmerling *et al.,* 2013) to 2.25 ha per wind turbine (Tidhar *et al.,* 2013). Impacts on habitats include clearance and drainage. Therefore the mitigation measures during this phase aims to reduce the impacts of the changing environment on local wildlife.

For bats, EUROBATS (Rodrigues et al., 2006, 2014) recommended local knowledge on the site and species that could become displaced during construction needed to be considered and that construction should only be planned during times of the day or parts of the year when bats are least active and not in hibernation (Rodrigues et al., 2014). As their loss of roost sites would occur during construction, an additional recommendation from English Nature (Mitchell-Jones, 2004) includes establishing alternative roosts for species to return (Rodrigues et al., 2006).

For unavoidable impacts, measures to minimise impacts on bat populations include on-site efforts to remedy the effects of short-term damage. Research on this subject has significantly increased in the last few years, especially on ultrasound emissions as a way to deter bats from approaching wind turbines (Arnett et al., 2013; Horn et al., 2008; Johnson et al., 2012). Radar emissions also seem to negatively affect bat activity (Nicholls and Racey, 2007, 2009). However, currently there is no evidence that such device has been successfully developed or commercialised to meet this aim. Nevertheless, as bat mortality rates seem to be higher during low wind nights (Rydell et al., 2010) the most effective mitigation measure seems to be the increase of wind turbine cut-in speed (the velocity at which turbines start producing electricity) and changes in blade feathering (altering the angle of the blade preventing it from rotating on low wind situations). This measure has been proven to reduce bat fatalities from 30% to 90% (Arnett et al., 2008, 2011; Baerwald et al., 2009).

If an adverse effect on local bat populations cannot be definitely eliminated or even reduced to acceptable levels through the abovementioned measures and thus residual adverse effects on biodiversity still remain, offset or compensatory measures should then be considered.

Mitigation options are primarily associated with increasing cut-in speed of the wind turbines since the vast majority of bat fatalities at wind farms occur in low wind conditions (Arnett, 2005). In low wind conditions, turbine blades can often be freewheeling (spinning) but not generating electricity (Arnett, 2005). But freewheeling blades can still kill bats while non-spinning blades (feathering) do not kill bats (Horn *et al.,* 2008). Hence raising the cut-in speed above that set by the manufacture can reduce the impact of the wind turbine on bats.

Arnett *et al.* (2011) showed that a 50% decrease in bat fatality can be achieved by increasing the cut-in speed by 1.5 m/s with similar results achieved at European sites.

Off-site compensatory measures are also considered to be an option to reduce the overall impact of wind farms on local bat populations, particularly in relation to foraging habitat compensation.

2.2 Guidelines on Wind Farms in relation to Impact on Bats

The UNEP/EUROBATS Resolution urges all signatory countries to develop national guidelines on bat surveys and risk assessment, tailored to the situation in a specific country and reflect the best available evidence at the time. In the Republic of Ireland, due to the lack of research, there is little information available on the potential impacts of wind turbines on bats. Bat Conservation Ireland, the national non-government body for the conservation of bats, has compiled survey guidelines specific for wind turbines proposals. These guidelines were used to design a bat survey protocol:

- *Bat Conservation Ireland Wind Turbine / Wind Farm Development Bat Survey Guidelines*

This guideline provides advice on the survey work required to understand and assess the use of bats of an area proposed for wind energy development. This guideline has been drawn up in consultation with wind energy stakeholders and considered to be in line with UNEP/EUROBATS Secretariat Guidelines. The overall aim of the guidelines is to ensure that bats, their roosts, foraging areas and commuting flight paths are protected from any potential adverse impacts posed by a wind farm development through avoidance, mitigation and/or compensation measures.

All Irish bat species are given a Favourable Status in Republic of Ireland. The principal pressures on Irish bat species, as reported by the NPWS Conservation Status Assessment, are as follows:

- urbanized areas (e.g. light pollution)
- bridge/viaduct repairs
- pesticides usage
- removal of hedges, scrub, forestry
- water pollution
- other pollution and human impacts (e.g. renovation of dwellings with roosts)
- infillings of ditches, dykes, ponds, pools and marshes
- management of aquatic and bank vegetation for drainage purposes
- abandonment of pastoral systems
- spieleology and vandalism
- communication routes: roads
- forestry management
- wind turbines

Bat species present in the survey area and recognition of the different behavioural patterns of different species:

- as some bat species are high aerial flyers and likely to encounter turbine towers and blades;
- bats display a very flexible use of the landscape which is linked to roosts and food availability;
- there is some evidence that bats may investigate turbine towers to feed on insects attracted by heat generated by the turbines (nacelles).

2.2.1 UNEP/EUROBATS Secretariat: Guideline for consideration of bats in wind farm projects, Publication Series No. 3.

This document, published by the UNEP/EUROBATS Secretariat, refers to survey, impact assessment, mitigation and monitoring guidelines that should be considered by developers for the assessment of wind farms on local bat populations. In summary, this document suggests that site selection is the most important consideration for the location of wind farms. Turbines should not be located along bat migration routes, near concentrated feeding habitats and roosting sites. Buffer zones are considered an essential component of mitigation. The UNEP/EUROBATS Resolution proposes that the buffer zones around woodlands should be 200m.

2.2.2 Natural England Technical Information Note TIN051: Bats and onshore wind turbines – Interim Report

This set of guidelines refers to specific guidelines for the UK. English Nature document suggests a buffer of at least 50m from the tip of the rotor blade to a linear habitat feature and provides a formula to calculate the minimum buffer zone required in relation to habitat features present in the landscape. This is an example of difference between generic guidelines for the whole of Europe compared to guidelines for specific guidelines for the UK. There is a larger suite of bat species in Europe compared to the number of bat species in the UK and Ireland. Consequently, individual countries are encouraged to draw up guidelines best suited to the bat species present in individual member states.

- 50m buffer zone

To minimize risk to bat populations, a buffer zone of 50m around any treeline, hedgerow, woodland feature, into which no part of the turbine should intrude. Therefore, 50m should be the minimum distance from the blade tip to the nearest habitat feature.

The following formula should be used (should be undertaken in consultation with the named document as this document provides a greater explanation of the formula which also requires information on the tree heights etc.):

Buffer distance = $\sqrt{(50 + bl)^2 – (hh – fh)^2}$
where bl = blade length, hh = hub height, fh = feature height (all in meters).

Natural England stated that the potential risk from wind turbines for the different bat species which includes the bat groups found in the Republic of Ireland:

Low Risk	**Medium Risk**	**High Risk**
Myotis species	common pipistrelle	Leisler's bat
brown long-eared bat	soprano pipistrelle	Nathusius' pipistrelle
lesser horseshoe bats		

2.2.3 Bats and onshore wind turbines: Survey, Assessment and Mitigation: January 2019

These guidelines provide the most up to-date guidelines from on-going research in the UK. As the UK landscape is similar to the Irish landscape, such guidelines are applicable to Ireland. In relation to previous guidelines, the principal changes relate to the allocation of Common pipistrelle and Soprano pipistrelle to "High Risk" category. This publication also provides recommendations in relation to survey methodology, assessment of static data using the online tool *Ecobat* (http://www.mammal.org.uk/science-research/ecostat/) and risk assessment criteria. The guidelines continues to promote the Natural England 50m buffer zone as described above. It also provides mitigation measures in relation to feathering, curtailment, smart operation of SCADA and buffer zones. *NOTE: this last guideline was published as the final report was completed.*

2.3 Bat species in Ireland

There are eleven recorded bat species in Ireland, nine of which are considered resident. Eight resident bat species and one of the vagrant bat species are vesper bats and all vespertilionid bats have a tragus (cartilaginous structure inside the pinna of the ear). Vesper bats are distributed throughout the country. Nathusius' pipistrelle is a recent addition while the Brandt's bat has only been recorded once to-date (Only record confirmed by DNA testing, all other records has not been genetically confirmed). The ninth resident species is the lesser horseshoe bat *Rhinolophus hipposideros*, which belongs to the Rhinolophidea and has a complex nose leaf structure on the face, distinguishing it from the vesper bats. This species' current distribution is confined to the western seaboard counties of Mayo, Galway, Clare, Limerick, Kerry and Cork. The eleventh bat species, also belonging to the Rhinolophidea, the greater horseshoe bat, was only recorded for the first time in February 2013 in County Wexford and is therefore considered to be a vagrant species.

Irish bat species list:

Common pipistrele *Pipistrellus pipistrellus*
Soprano pipistrelle *Pipistrellus pygmaeus*
Nathusius' pipistrelle *Pipistrellus nathusii*

Leisler's bat *Nyctalus leisleri*
Brown long-eared bat *Plecutus auritus*
Natterer's bat *Myotis nattereri*
Whiskered bat *Myotis mystacinus*
Daubenton's bat *Myotis daubentonii*
Brandt's bat *Myotis brandtii* *(Vagrant)*
Lesser horseshoe bat *Rhinolophus hipposideros*
Greater horseshoe bat *Rhinolophus ferrumerquinum (Vagrant)*

Eight of these bat species are currently recorded in County Longford: common pipistrelle; soprano pipistrelle; Nathusius' pipistrelle; Leisler's bat; brown long-eared bat; Natterer's bat; whiskered bat and Daubenton's bat (www.batconservationireland.org). All of these are Annex IV bat species under the EU Habitats Directive.

2.4 Legal Status and Conservation Issues

All Irish bat species are protected under the Wildlife Act 1975 & 2000 (as amdended) and European Communities (Birds and Natural Habitats) Regulation 2011, in particular, Section 52 (dealing with the protection of Annex IV animals) and Section 54 (dealing with derogations relating to Annex IV species) and the obligation of Local Authorities and the courts to take into account of guidelines (Section 27 (5) (e) (v); Section 63 (2), Section 71 (4), Section 72 (3).

Also, the EC Directive on The Conservation of Natural habitats and of Wild Fauna and Flora (Habitats Directive 1992), seeks to protect rare species, including bats, and their habitats and requires that appropriate monitoring of populations be undertaken.

Marnell *et al,* 2009 provides details with regards to the Red List status for all Irish bat species. The Leisler's bat is given an Irish Status of Near Threatened, the Brandt's bat has an Irish status of Data Deficient while all remaining Irish bat species have an Irish status of Least Concern (See Appendices).

Across Europe, they are further protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982), which, in relation to bats, exists to conserve all species and their habitats. The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions.

All bats are listed in Annex IV of the Habitats Directive and the lesser horseshoe bat is further listed under Annex II.

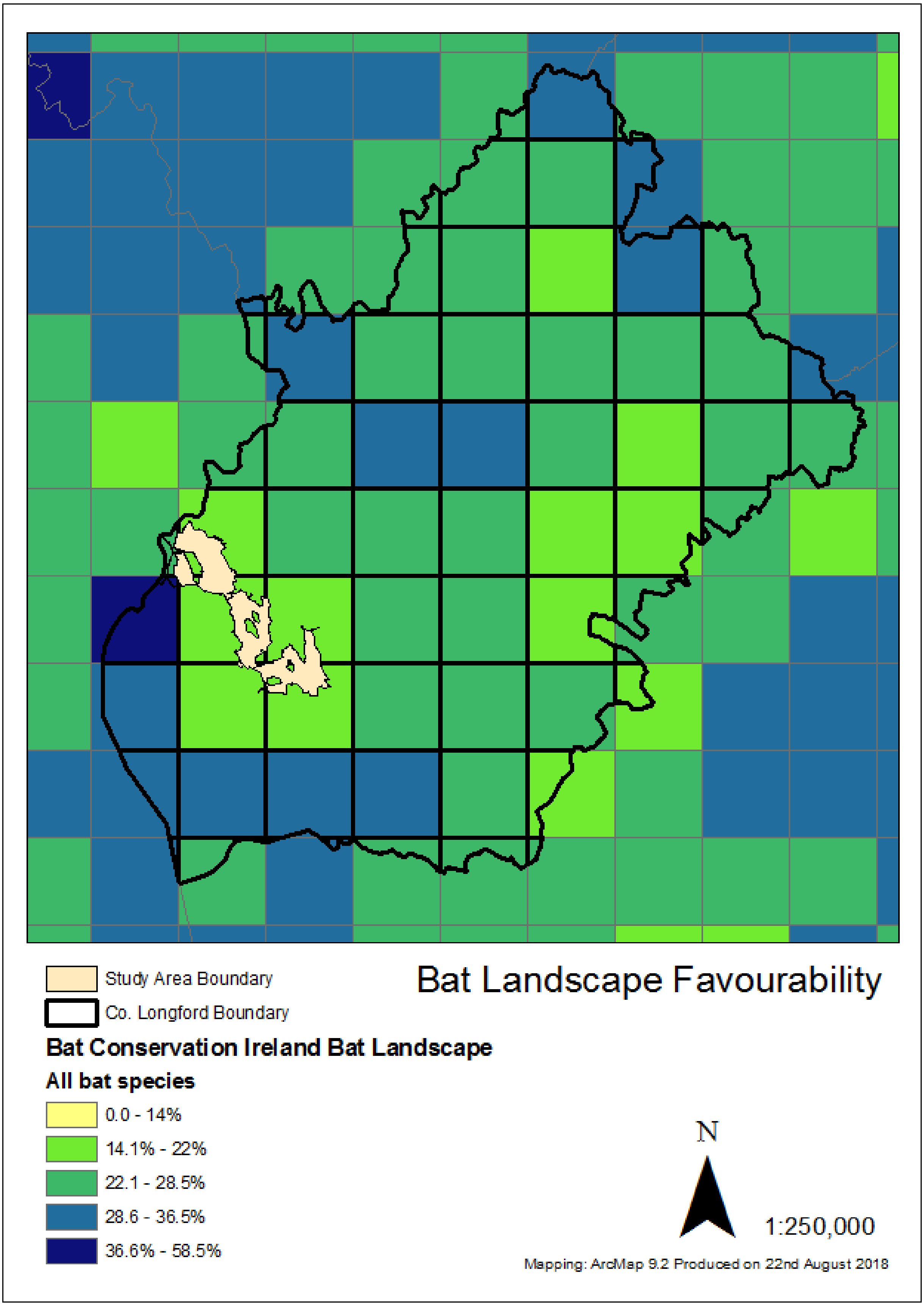
2.5 Desktop Study

2.5.1 Bat Conservation Ireland Landscape Favourability Model

Bat Conservation Ireland produced a landscape conservation guide for Irish bat species using their database of species records collated during the 2000-2009 survey seasons. An analysis of the habitat and landscape associations of all bat species deemed resident in Ireland was undertaken and reported in Lundy *et al.*, 2011. The geographical area suitable for individual species was used to identify the core favourable areas of each species. This was produced as a GIS layer for local authorities and planners in order to provide a guide to the consideration of bat conservation. The island is divided into 5km squares and the landscape favourability of each 5km square for each species of bat was modelled. The degree of favourability is colour coded with lighter colours indicating a low favourability progressing towards a dark colour indicating a higher favourability. The value of favourability ranges from 0 – 100 with 0 indicating unsuitable and 100 deemed as suitable. The values of the grid squares represent the range of habitat suitability values the bat species can tolerate within each individual square. This is divided into five categories using "Natural breaks" (Jenks Natural Breaks Classification - is a data clustering method designed to determine the best arrangement of values into different classes. This is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other groups. The method seeks to reduce the variance within classes and maximize the variance between classes (Jenks, 1967)). As a result of the classification, there are different values (i.e. percentage favourability) for each of the species models shown in the figures below. Each class is represented on a colour ramp to show the difference between 5km squares, where applicable. Therefore, due to the mosaic of land uses in a 5km square, there are no squares where the value a 100. This model is a broad generalisation of the bat species' geographical occurrence.

A caveat is attached to the model and it is that the model is based on records held on the BCIreland database, while core areas have been identified, areas outside the core area should not be discounted as unimportant as bats are a landscape species and can travel many kilometres between roosts and foraging areas nightly and seasonally.

The survey area of the proposed wind farm development is located, primarily, in 5 x 5km squares. The five 5km squares where the majority of the proposed development area is located are considered, in general, to have low-medium landscape favourability for bat species (Map 2.1, bright green – 14.1-22% favourability). It was reported by Lundy *et al.*, 2011 that large expanse of open bog tended to be avoided by bats. Linear landscape features such as treelines and hedgerows are an essential component to many bat species to guide them through the landscape and these habitats are often not present in open peat habitats. The exception to this is Leisler's bats and Nathusius' pipistrelles as these two species are high flying bats and therefore not confined to linear landscape features for guidance.



Map 2.1: Bat Conservation Ireland Landscape Favourability Map for all bat species for Co. Longford. (All bat species (i.e. the entire model generalised to represent all Irish bat species): 0-14% favourable; 14.1-22% favourable; 22.1-28.5% favourable; 28.6-36.5% favourable and 26.6-58.6% favourable).

2.5.1.1 Soprano pipistrelle *Pipistrellus pygmaeus*

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	0.54 to 1.2 million (2007-2012)
Irish Population Trend	2003-2013 ↑
Estimate Core Area (km2) (Lundy *et al. 2011*)	62,020

(Taken from Roche *et al.*, 2014)

Core Area (Lundy et al., 2011)
The modelled Core Area for soprano pipistrelle is a large area that covers much of the island of Ireland (62,020 km2). Strongholds include east Clare, west Galway and the Monaghan/Fermanagh area.

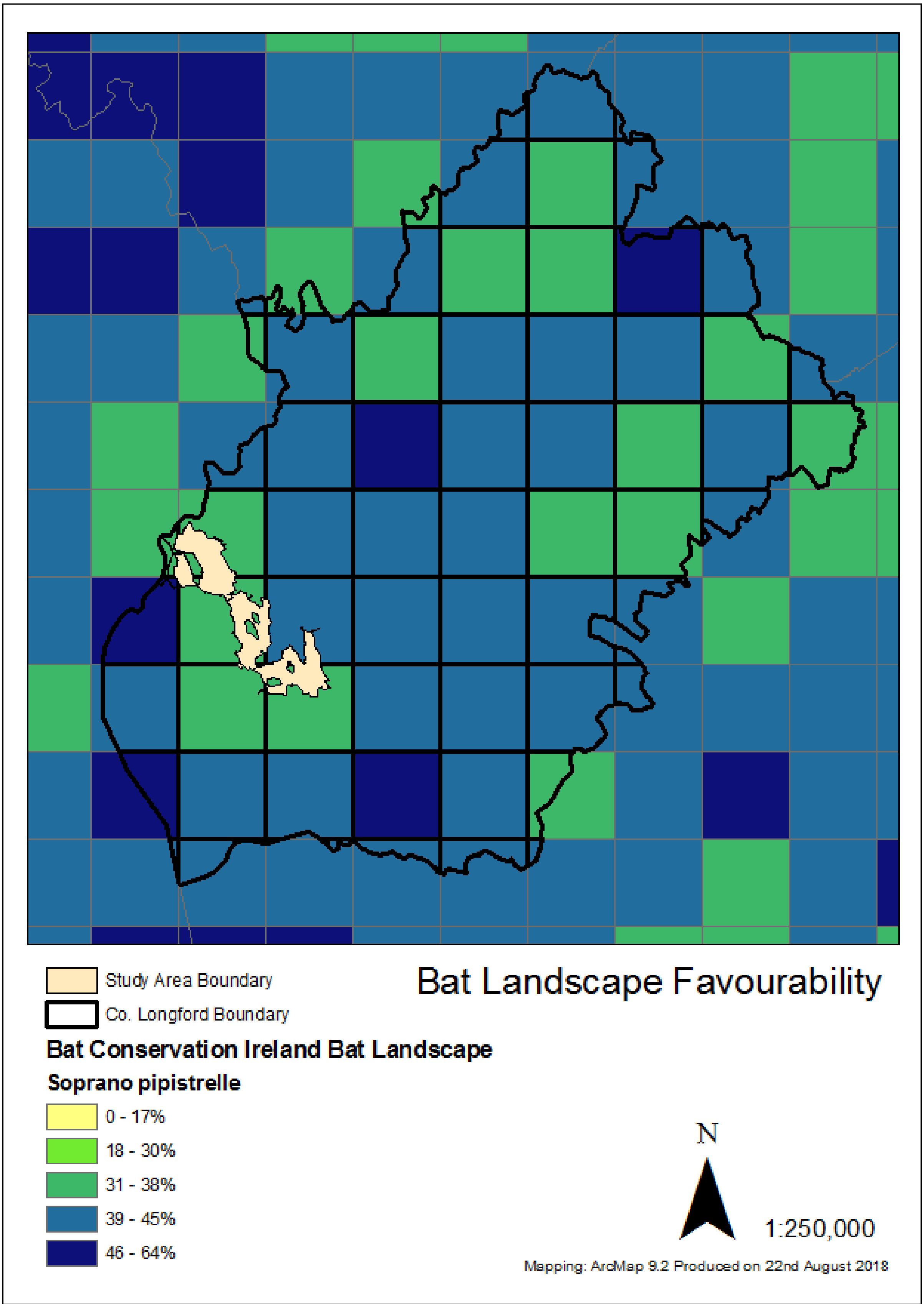
Habitat Preference/Avoidance (Lundy et al., 2011)
The Irish Landscape Model indicated that the soprano pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.*, 2014).

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme has reported a steady incline in the soprano pipistrelle numbers since 2003 as reported by the Car-based Bat Monitoring Scheme was set up.

Concerns (Roche et al., 2014)
Principal concerns for soprano pipistrelles in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosts
- Renovation or demolition of structures
- Tree felling
- Increasing urbanisation (e.g. increase in lighting)

Landscape Favourability (Lundy et al., 2011)
The survey area has a medium favourability (31-38%) for soprano pipistrelles for four of the 5 km squares while the fifth square has a higher favourability (Map 2.2, medium-high favourability). This fifth square is located in the east of the survey area. One 5km square of high favourability (46-64%) is located outside the survey area and to the west of the survey area. This coincides with the location of the River Shannon.



Map 2.2: Bat Conservation Ireland Landscape Favourability Map for soprano pipistrelle for survey area. (Soprano pipistrelles: 0-17% favourable; 18-30% favourable; 31-38% favourable; 39-45% favourable and 46-64% favourable).

2.5.1.2 Common pipistrelle *Pipistrellus pipistrellus*

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	1.2 to 2.8 million (2007-2012)
Irish Population Trend	2003-2013 ↑
Estimate Core Area (km2) (Lundy *et al. 2011)*	56,485

Taken from *Roche et al., 2014*

Core Area (Lundy et al., 2011)
The modelled Core Area for common pipistrelles is a large area that covers much of the island of Ireland (56,485 km2) which covers primarily the east and south east of the area (Roche *et al.,* 2014). Particularly suitable areas include east Clare, Kilkenny, Laois, south Offaly, Galway, Monaghan and east Wicklow.

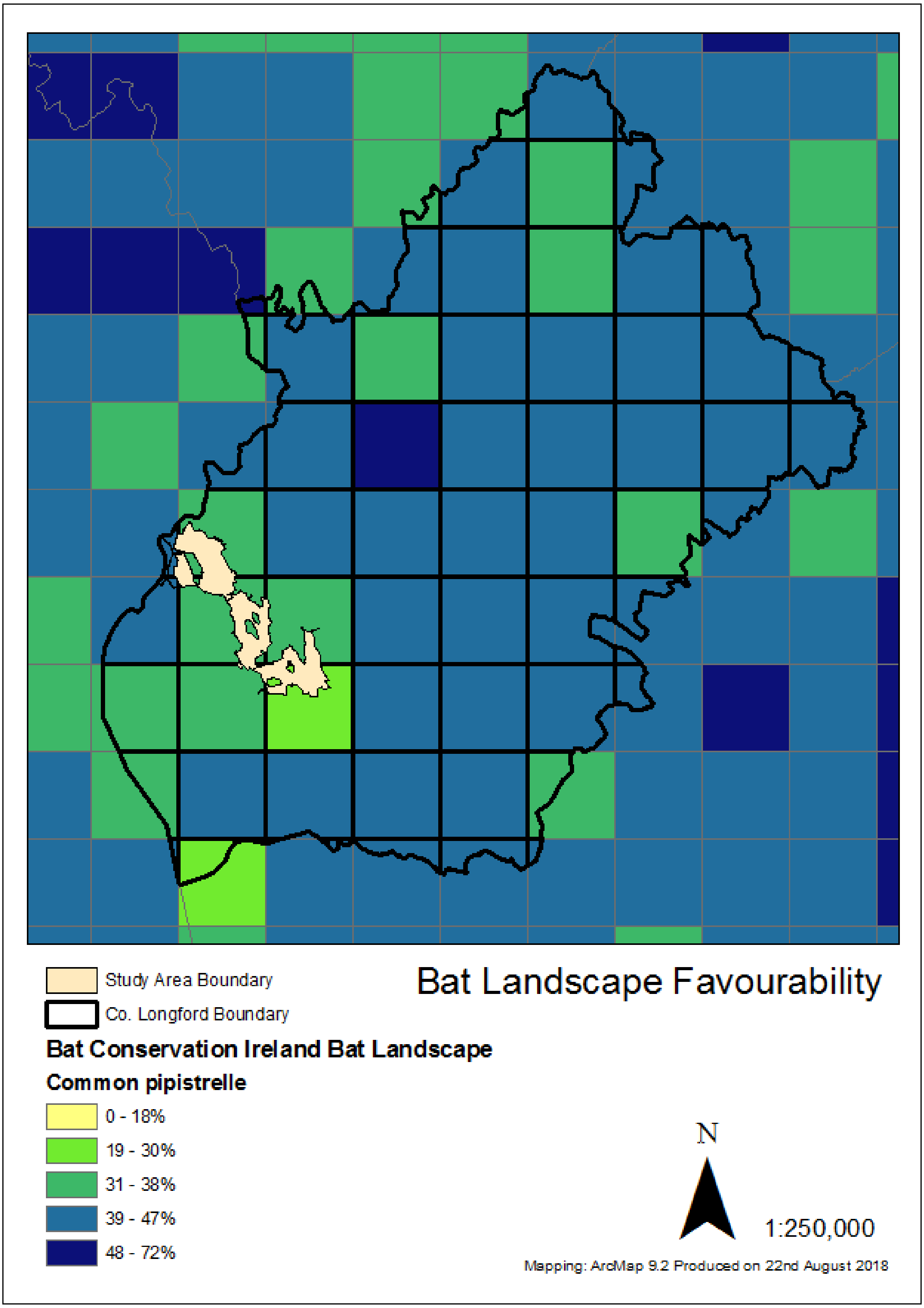
Habitat Preference/Avoidance (Lundy et al., 2011)
The Irish Landscape Model indicated that the common pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanization (<30%) (Roche *et al.,* 2014).

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme has reported a steady incline in the common pipistrelle numbers since 2003 as reported by the Car-based Bat Monitoring Scheme was set up.

Concerns (Roche et al., 2014)
Principal concerns for common pipistrelles in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosting requirements
- This species has complex habitat requirements in the immediate vicinity of roosts. Therefore careful site specific planning for this species is required in order to ensure all elements are maintained.
- Renovation or demolition of derelict buildings.
- Tree felling
- Increasing urbanisation (e.g. increase in lighting)

Landscape Favourability (Lundy et al., 2011)
The survey area has medium favourability for common pipistrelles for four of the 5 km squares while the fifth square has a low-medium favourability (Map 2.3). This fifth square is located in the south-east of the survey area.



Map 2.3: Bat Conservation Ireland Landscape Favourability Map for common pipistrelle for survey area. (Common pipistrelles: 0-18% favourable; 19-30% favourable; 31-38% favourable; 39-47% favourable and 46-72% favourable).

2.5.1.3 Nathusius' pipistrelle *Pipistrellus nathusii*

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	10,000 to 18,000 (2007-2013)
Irish Population Trend	2003-2013 (limited data, probably stable
Estimate Core Area (km2) (Lundy *et al. 2011)*	13,543

Core Area (Lundy et al., 2011)
The modelled Core Area for Nathusius' pipistrelle is a relatively restricted area (13,543 km2) and these areas are primarily associated with large water bodies such as Lough Neagh and the Lough Erne complex.

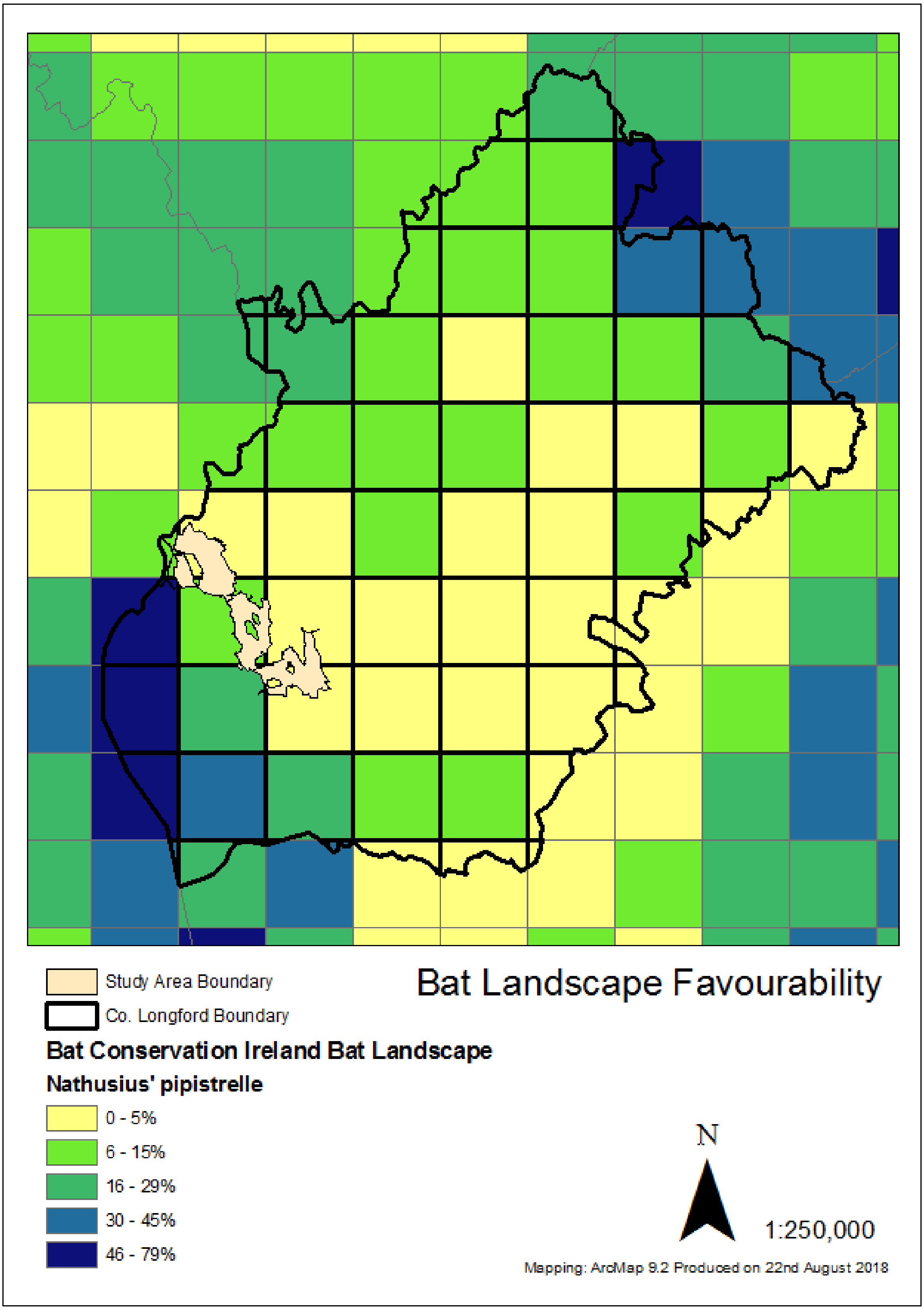
Habitat Preference/Avoidance (Lundy et al., 2011)
The Irish Landscape Model indicated that the Nathusius' pipistrelle habitat preference is large waterbodies (Roche *et al.,* 2014). But due to the paucity of information on this species, the knowledge of this species preference in Ireland is limited.

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme has reported a limited but stable population.

Concerns (Roche et al., 2014)
The principal concerns for Nathusius' pipistrelle is the fact that roosting sites are poorly known in the Republic of Ireland:

- Lack of knowledge of winter sites and whether migration occurs.
- Renovation or demolition of derelict buildings and structures may cause undocumented roost losses.
- Water pollution may be a threat to this species because it is particularly associated with lakes.

Landscape Favourability (Lundy et al., 2011)
The survey area has a low favourability for Nathusius' pipistrelles for three of the 5 km squares while the fourth square has low-medium favourability and the fifth square has medium favourability (Map 2.4). Two 5km squares of high favourability is located outside the survey area and to the west of the survey area. These coincide with the location of the River Shannon.



Map 3.4: Bat Conservation Ireland Landscape Favourability Map for Nathusius' pipistrelle for survey area. (Nathusius' pipistrelle: 0-5% favourable; 6-15% favourable; 16-29% favourable; 30-45% favourable and 46-79% favourable).

2.5.1.4 Leisler's bat *Nyctalus leisleri*

Irish Status	**Near Threatened**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	73,000 to 130,000 (2007-2013) Ireland is considered the world stronghold for this species
Irish Population Trend	2003-2013 ↑
Estimate Core Area (km2) (Lundy *et al. 2011)*	52,820

Core Area (Lundy et al., 2011)
The modelled Core Area for Leisler's bats is a relatively large area that covers much of the island of Ireland (52,820 km2). A large contiguous area spans the east and middle of the island with particular favourable areas in south Clare, east Wicklow, north Monaghan and north Cavan.

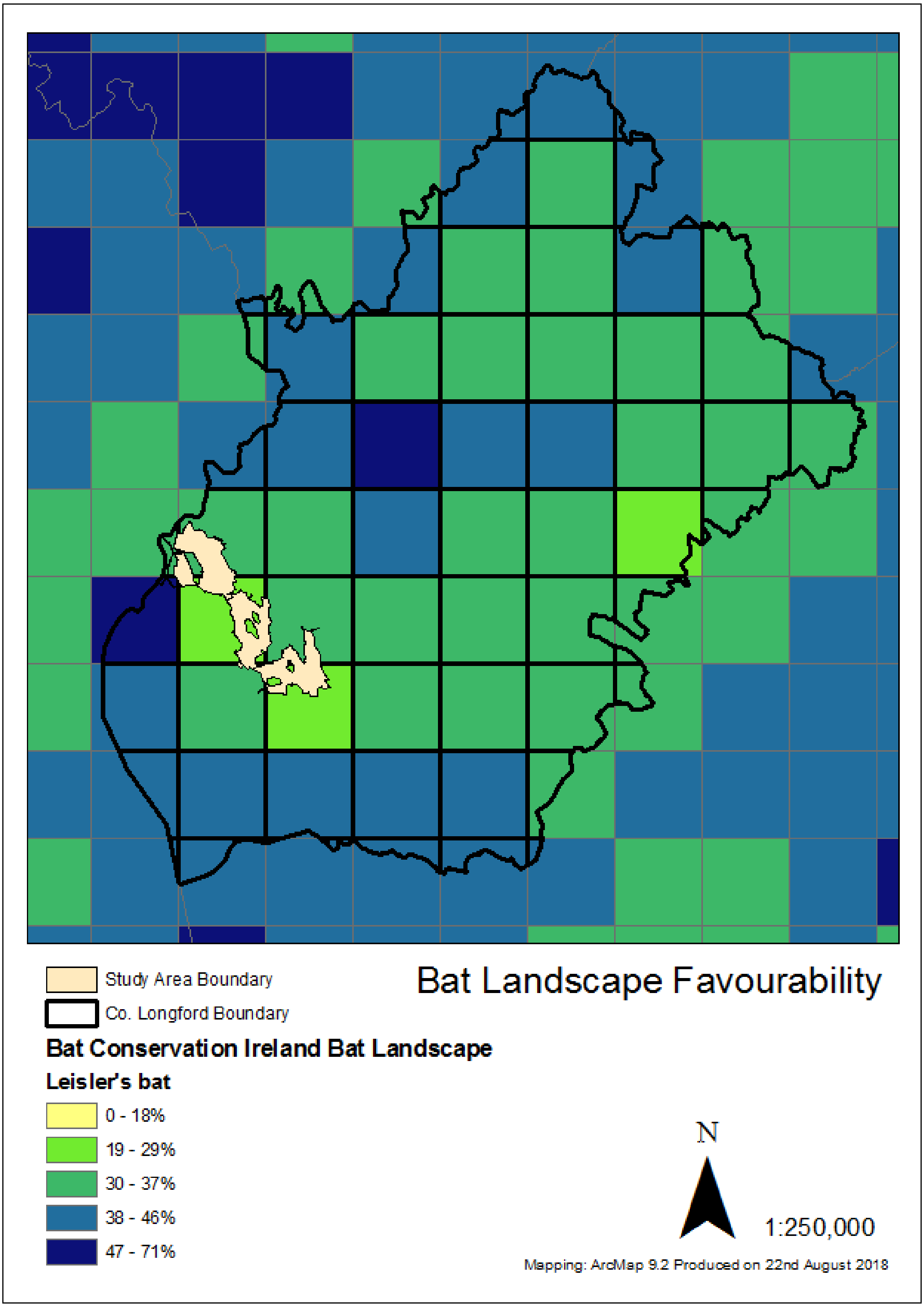
Habitat Preference/Avoidance (Lundy et al., 2011)
The Irish Landscape Model indicated that the Leisler's bat habitat preference has been difficult to define in Ireland. Habitat modelling for Ireland shows an association with riparian habitats and woodlands (Roche *et al.,* 2014). The landscape model emphasised that this is a species that cannot be defined by habitats preference at a local scale compared to other Irish bat specie but that it is a landscape species and has a habitat preference at a scale of 20.5km. In addition, of all Irish bat species, Leisler's bats have the most specific roosting requirements. It tends to select roosting habitat with areas of woodland and freshwater.

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme has reported a steady incline in the Leisler's bats numbers since 2003 when monitoring by the Car-based Bat Monitoring Scheme was set up.

Concerns (Roche et al., 2014)
The principal concerns for Leisler's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Selection of maternity sites is limited to specific habitats
- Relative to the population estimates, the number of roost sites is poorly recorded.
- Tree felling, especially during autumn and winter months
- Increasing urbanisation

Landscape Favourability (Lundy et al., 2011)
The survey area has low-medium favourability for Leisler's bats for two of the 5 km squares while the remaining three square have medium favourability (Map 2.5). This fifth square is located in the east of the survey area. One 5km square of high favourability is located outside the survey area and to the west of the survey area. This coincides with the location of the River Shannon.



Map 2.5: Bat Conservation Ireland Landscape Favourability Map for Leisler's bat for survey area. (Leisler's bat: 0-19% favourable; 18-29% favourable; 30-37% favourable; 38-46% favourable and 47-71% favourable).

2.5.1.5 Brown long-eared bat *Plecotus auritus*

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	64,000 to 115,000 (2007-2012)
Irish Population Trend	2008-2013 Stable
Estimate Core Area (km^2) (Lundy *et al. 2011)*	49,929

Core Area (Lundy et al., 2011 and viewed on www.biodiversityireland.ie)
The modelled Core Area for brown long-eared bats is a relatively large area that covers much of the island of Ireland (52,820 km^2) with preference suitable areas in the southern half of the island. Particularly favourable areas include the Corrib in Galway, east County Clare, the Erne Catchment, east Wicklow and the Barrow, Nore and Suir river valleys.

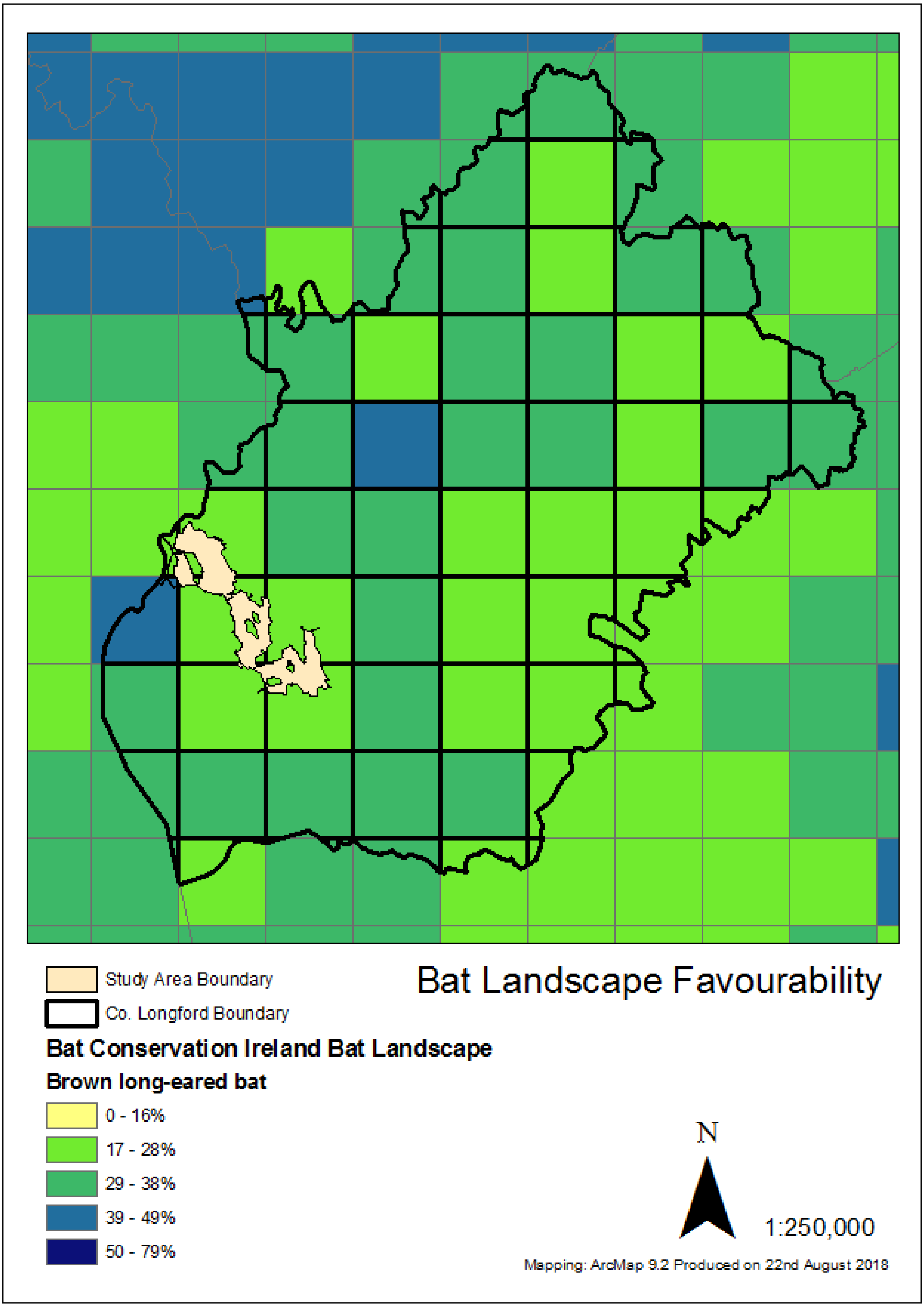
Habitat Preference/Avoidance (Lundy et al., 2011 and viewed on www.biodiversityireland.ie)
The Irish Landscape Model indicated that the brown long-eared bat habitat preference is for areas with broadleaf woodland and riparian habitats on a small scale of 0.5 km emphasising the importance of local landscape features for this species (Roche *et al.,* 2014).

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme has reported that this species is stable since 2009.

Concerns (Roche et al., 2014)
Principal concerns for brown long-eared bats are poorly known in Ireland, but those that are relevant for this survey area are as follows:

- Selection of maternity sites is limited to specific habitats
- Lack of knowledge of winter roosts
- Loss of woodland, scrub and hedgerows
- Tree surgery and felling
- Increasing urbanisation
- Light pollution

Landscape Favourability (Lundy et al., 2011)
The survey area has low-medium favourability for brown long-eared bat for all five of the 5 km squares (Map 2.6).



Map 2.6: Bat Conservation Ireland Landscape Favourability Map for brown long-eared bat for survey area. (Brown long-eared bat: 0-16% favourable; 17-28% favourable; 29-38% favourable; 39-49% favourable and 50-79% favourable).

2.5.1.6 Myotis bats

There are three *Myotis* species in Ireland, two of which are likely to be present in the survey area: Daubenton's bat *Myotis daubentonii* and Natterer's bat *Myotis nattereri*.

2.5.1.6.1 Natterer's bat *Myotis nattereri*

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	Unknown
Irish Population Trend	Unknown
Estimate Core Area (km2) (Lundy *et al. 2011)*	52,864

Core Area (Lundy et al., 2011)
The modelled Core Area for Natterer's bats is a relatively large area that covers much of the island of Ireland (52,864 km^2). A large contiguous area spans the middle of the island from east to west (Roche *et al.,* 2014).

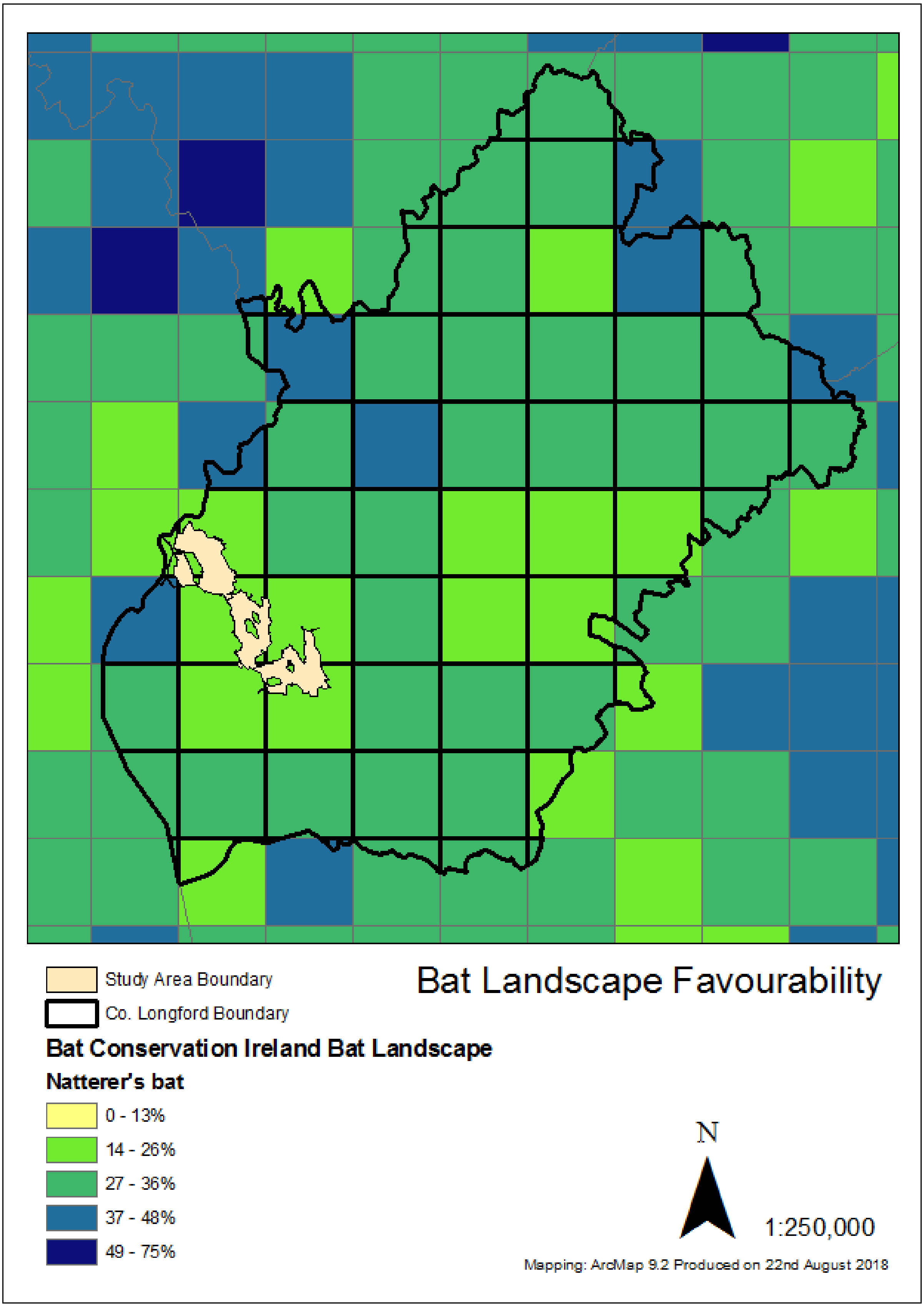
Habitat Preference/Avoidance (Lundy et al., 2011)
The Irish Landscape Model indicated that the Natterer's bat selects areas with broadleaf woodland, riparian habitats and areas with larger scale provision of mixed forest (Roche *et al.,* 2014). Other studies emphasise that this species forages up to 4 km away from the principal roosting sites and individuals are faithful to core hunting areas, returning to these night after night (Siemers *et al.,* 1991). Roosts tend to be in areas adjacent to woodland cover.

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme does not currently monitor this species. Therefore the current Irish bat population is unknown.

Concerns (Roche et al., 2014)
Principal concerns for Natterer's bats in Ireland that are relevant for this survey area are as follows:

- Lack of knowledge of roosting requirements
- This species has complex habitat requirements in the immediate vicinity of roosts. Therefore careful site specific planning for this species is required in order to ensure all elements are maintained
- Tree felling
- Increasing urbanisation (e.g. increase in lighting)

Landscape Favourability (Lundy et al., 2011)
The survey area has low-medium favourability for Natterer's bat for all five of the 5 km squares (Map 2.7).



Map 2.7: Bat Conservation Ireland Landscape Favourability Map for Natterer's bat for survey area. (Natterer's bat: 0-13% favourable; 14-26% favourable; 27-36% favourable; 37-48% favourable and 49-75% favourable).

2.5.1.6.2 Daubenton's bat *Myotis daubentonii*

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	81,000 to 103,000 (2007-2012)
Irish Population Trend	2008-2013 Stable
Estimate Core Area (km2) (Lundy *et al. 2011)*	41,285

Core Area (Lundy et al., 2011)
The modelled Core Area for Daubenton's bats is a relatively large area that covers much of the island of Ireland (41,285 km2) reflecting the distribution of sizeable river catchments. Particularly favourable areas are in include the Corrib, Shannon and Erne Catchments.

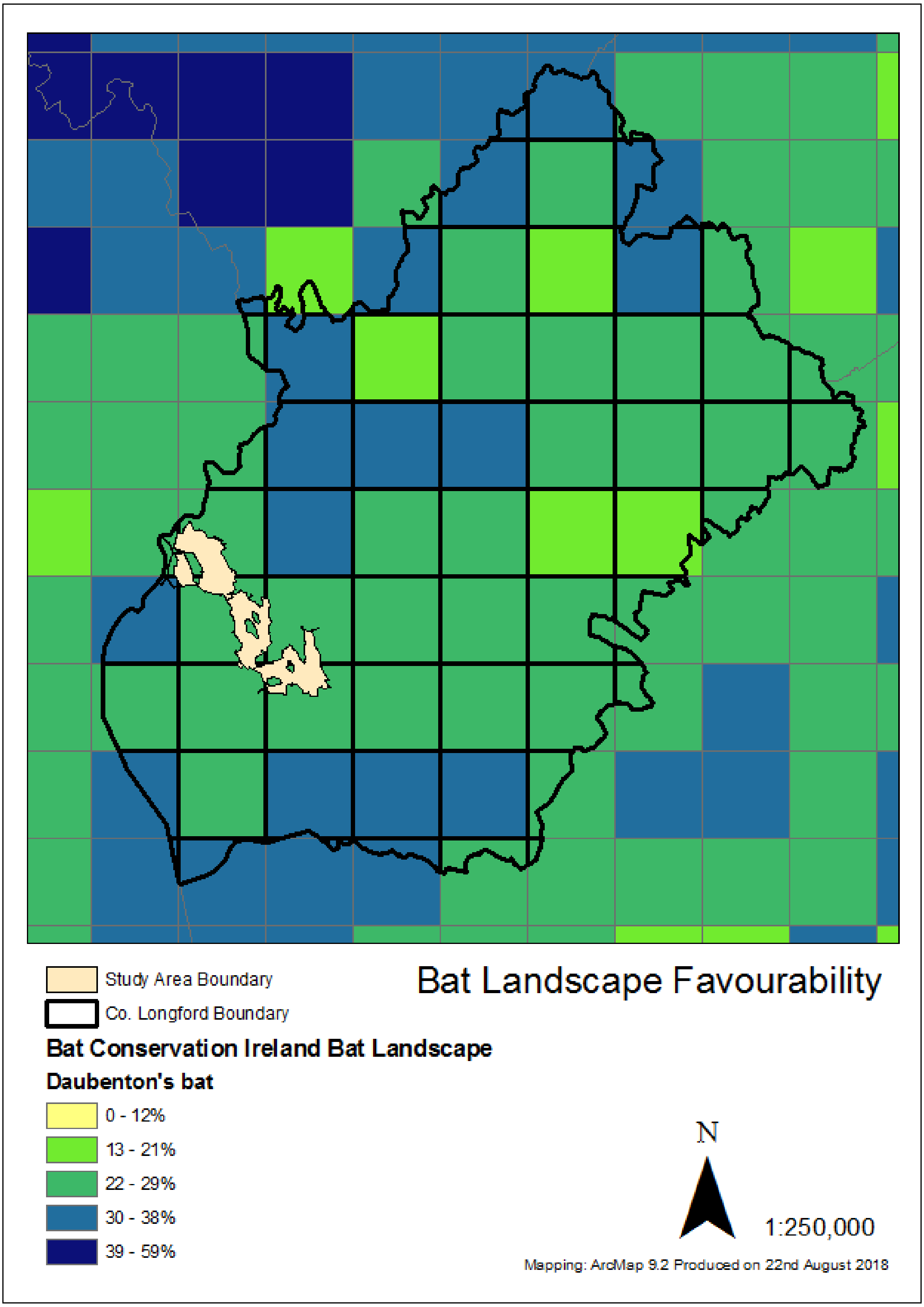
Habitat Preference/Avoidance (Lundy et al., 2011)
The Irish Landscape Model indicated that the Daubenton's bat habitat preference is for areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.*, 2014).

Population Trend (Roche et al., 2014)
Bat Conservation Ireland Irish Bat Monitoring Programme has reported that this species is stable from 2006-2013.

Concerns (Roche et al., 2014)
Principal concerns for Daubenton's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Potential roost loss due to bridge maintenance
- Loss of woodland and forest clearance
- Loss of woodland, scrub and hedgerows
- Tree surgery and felling
- Increasing urbanisation
- Light pollution

Landscape Favourability (Lundy et al., 2011)
The survey area has low-medium favourability for Daubenton's bat for all five of the 5 km squares (Map 2.8).

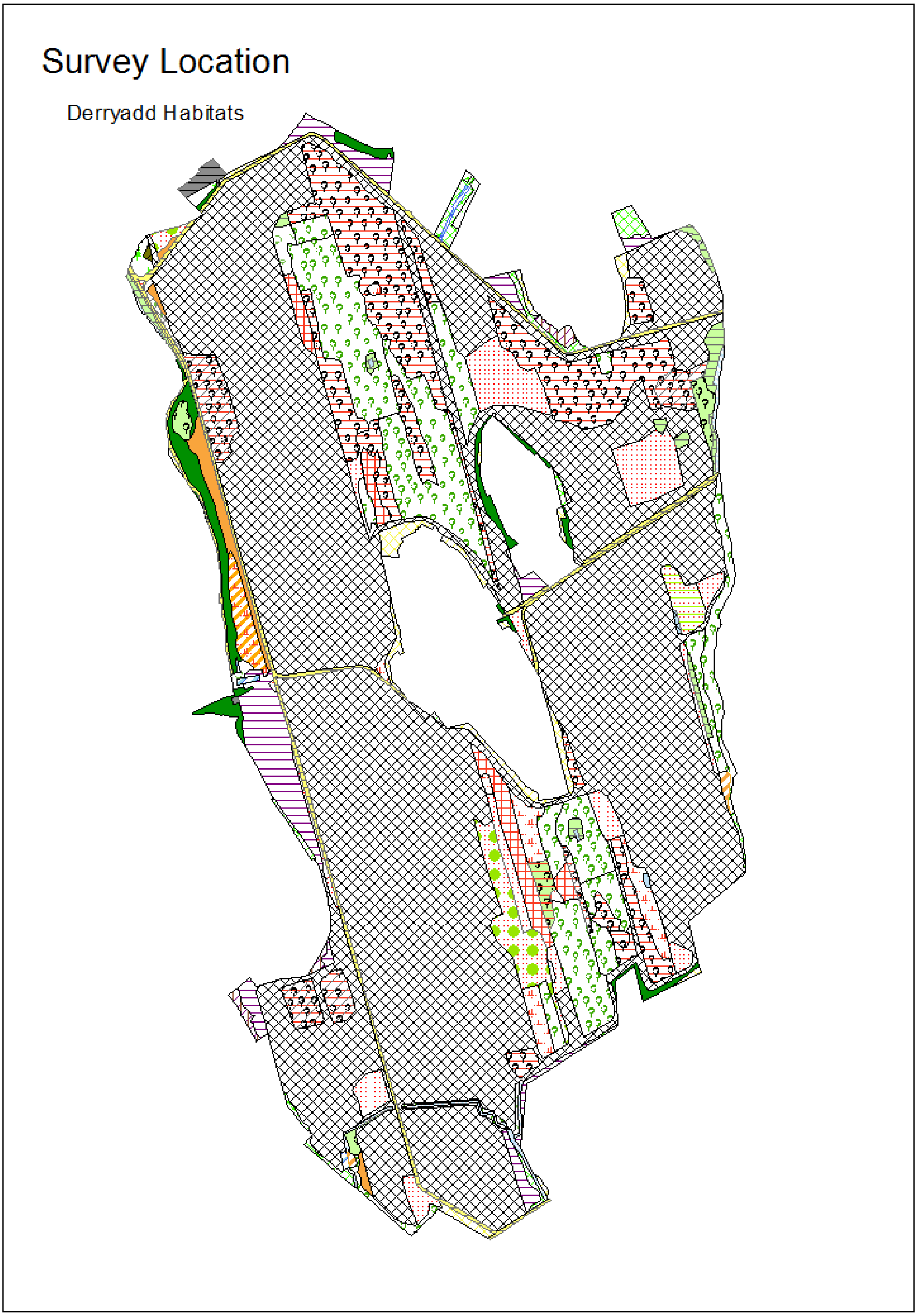


Map 2.8: Bat Conservation Ireland Landscape Favourability Map for Daubenton's bat for survey area. (Daubenton's bat: 0-12% favourable; 13-21% favourable; 22-29% favourable; 30-38% favourable and 39-59% favourable).

2.6 Habitat Description of Proposed Wind Farm Development

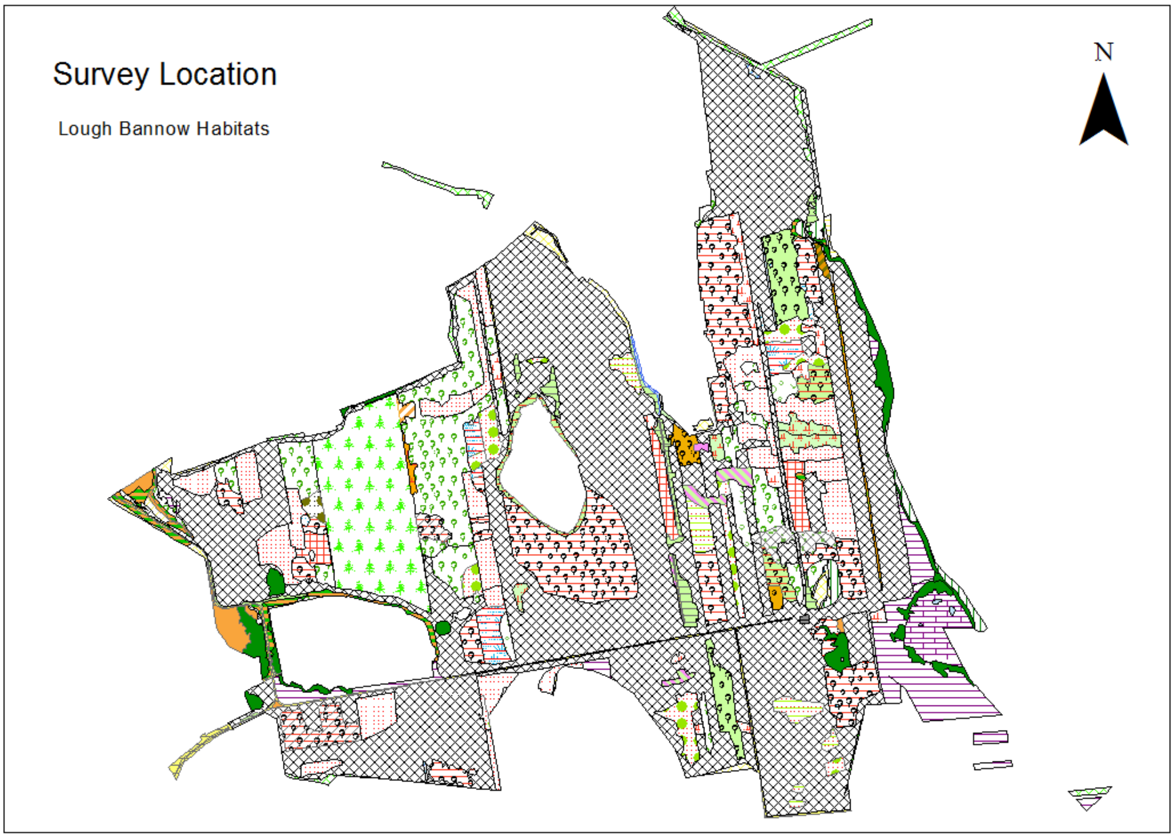
The following three maps depict the mosaic of habitat types recorded within the survey area. The data for these maps were provided by Bord na Mona (please consult ecological reports for more details). The survey area is divided into three distinct areas: Zone 1, Map 2.9 (Derryarogue), Zone 2, Map 2.10 (Derryadd and a small portion of Derryshanoge) and Zone 3, Map 2.11 (Lough Bannow). All three areas make up the Mountdillon Bog Group are comprised of a mosaic of habitat types including bare peat, heath, scrub, riparian features and bog woodlands.

Map 2.9: Derryaroge Habitat Map (Source: Bord na Mona).



Map 2.10: Derryadd Habitat Map (Source: Bord na Mona).
Note: portion of Derryshanoge Bog included in the Mountdillon Bog Group is not shown on map.

- Raised bog (PB1)
- Cutover bog (PB4)
- Oak-Ash-Hazel woodland (WN2)
- Bog woodland (WN7)
- Conifer plantation (WD4)
- Scrub (WS1)
- Improved grassland (GA1)
- Dry calcareous and neutral grassland (GS1)
- Dry meadows and grassy verges (GS2)
- Wet grassland (GS4)
- Dense Bracken (HD1)
- Depositing rivers (FW2)
- Buildings and artificial surfaces (BL3)
- Bare peat (BnM*)
- Bare peat & pioneer poor fen mosaic (BnM*)
- Bare peat & pioneer dry grassland mosaic (BnM*)
- Bare peat, pioneer poor fen & dry grassland mosaic (BnM*)
- Bare peat & exposed gravel (BnM*)
- Bare peat & pioneer Molinia grassland mosaic (BnM*)
- Bare gravel/subsoil (BnM*)
- Pioneer poor fen vegetation (BnM*)
- Pioneer poor fen mosaic (BnM*)
- Pioneer Reedbeds (BnM*)
- Pioneer Reedbeds & poor fen mosaic (BnM*)
- Bare peat & pioneer Reedbeds (BnM*)
- Open water (BnM*)
- Emerging Birch/Willow scrub (pioneer) (BnM*)
- Birch/Willow scrub (BnM*)
- Birch/Willow scrub & pioneer poor fen mosaic (BnM*)
- Birch/Willow scrub, pioneer dry grassland & poor fen mosaic (BnM*)
- Bare peat, Birch/Willow scrub & pioneer poor fen mosaic (BnM*)
- Birch/Willow scrub & pioneer Molinia grassland mosaic (BnM*)
- Birch/Willow scrub, pioneer Molinia grs ld & pioneer poor fen mosaic (BnM*)
- Open water & pioneer Reedbeds mosaic (BnM*)
- Pioneer dry heath (BnM*)
- Bracken, Birch/Willow scrub & pioneer Molinia grassland mosaic (BnM*)
- Bare peat & pioneer dry heath mosaic (BnM*)
- Pioneer dry heath & Birch scrub mosaic (BnM*)
- Pioneer dry heath & poor fen mosaic (BnM*)
- Pioneer dry heath, Molinia grassland & Birch scrub mosaic (BnM*)
- Pioneer dry heath & Molinia grassland mosaic (BnM*)
- Pioneer dry heath, Molinia grassland and poor fen mosaic (BnM*)
- Bare peat, pioneer dry heath & Birch/Willow scrub mosaic (BnM*)
- Pioneer dry grassland (BnM*)
- Pioneer Molinia grassland (BnM*)
- Pioneer dry grassland mosaic (BnM*)
- Pioneer dry grassland & poor fen mosaic (BnM*)
- Riparian areas (streams/drains with fringing habitats) (BnM*)
- Access (tracks or railways with adjacent habitats) (BnM*)
- Silt ponds (with fringing habitats) (BnM*)
- Works Areas (BnM*)



Map 2.11: Lough Bannow Habitat Map (Source: Bord na Mona).

There are areas of agricultural land enclosed by the survey area and these appear as blank areas surrounded by mapped habitats. These agricultural areas are primarily grassland fields with boundary hedgerows. Cattle are the primary grazer of these agricultural lands.

3. Materials and Methodology

Survey of bat fauna of the proposed development site was carried out by means of bat detector surveys. Bat detectors are used as the ultrasonic calls produced by bats cannot be heard by human hearing. In order to provide as detailed information on the local bat fauna, a full season survey was completed according to the Bat Conservation Ireland Wind Farm Survey Guidelines, surveys were also undertaken at height (50m) in order to detect potential high flying bat species and numerous methods of bat detection were completed across accessible areas of the proposed development site.

The nature and type of habitats present within the survey area are also indicative of the species likely to be present and this was analysed using the habitat surveys completed by Bord na Mona to extract a "Bat Habitats" layer.

The Bat Conservation Ireland Landscape Model was also investigated to provide additional reference material for the proposed survey area. This was reported in Section 2.

Therefore this bat survey report consists of the following elements and the materials and methodology used in the report are elaborated below:

- reporting of the Bat Conservation Ireland Landscape Model;
- assessment of habitat maps to determine suitable foraging, roosting and commuting areas for bats;
- bat surveys to determine bat species commuting and foraging in vicinity of the proposed development site and their level of activity.

3.1 Bat Survey Methodology

Three different types of bat surveys were used to gather information on the local bat fauna of the proposed development site:

- Passive Surveillance
- Walking Transects
- Driving Transects

Passive Surveillance (Acoustic Surveillance) involves setting up a bat detector (static recorder with an ultrasonic microphone) at a specific location in the field. There is no observer present but any bats that pass near enough to the recording unit are recorded and their calls are stored for analysis post surveying using computer software to view the recordings as sonograms. The bat detector is effectively used as a bat activity data logger. Each bat sequence is recorded as a single bat species (a bat sequence is a call sequence from the search phase to the catch phase). This type of bat surveying allows a far greater sampling effort, due to the use of numerous static units placed at numerous locations, over a shorter period of time.

Passive Surveillance was completed using Song Meter SM2BAT (2 units, hereafter known as Unit 1 and Unit 2) (192 kHz Stereo, SMX-US ultrasonic omni-directional microphone), Song Meter SM2BAT+ (2 units, hereafter known as Unit 4 and Unit 5) (192 kHz Stereo, SMX-US ultrasonic omni-directional microphone) and Song Meter SM3 (1 unit, hereafter known as Unit 3) (192 kHz Stereo, two SMX-US ultrasonic omni-directional microphones) units. New microphones were purchased to be used for this Four Season Bat Survey. Microphones used in the June 2018 were calibrated prior to the survey and all were deemed useable for the survey.

Three of these data logging platforms (static units) were erected on the two anemometers located on the proposed wind farm site (Unit 4 (at 4m height), Unit 5 (microphone as positioned at 50m height and connected to the unit via 50m extension cable), Unit 3 (this unit has the capacity for two ultrasonic microphones to be connected to the unit: one microphone was located at a height of 4m and the second microphone at 50m). The microphones located at the 50m height were strapped to a 1m steel bar and attached to the lattice frame of the anemometer. The microphones were directed away from the lattice frame of the anemometer. The remaining two static units were rotated around the proposed development site (Unit 1 and 2, both erected to 2m height) during the four season bat survey period.

During the June 2018 bat surveys, all five units were used for the stationary locations (erected to 2m height). The microphones of each unit were position horizontally to reduce potential damage from rain.

Bat echolocation calls recorded by the static recorders were analysed using SongMeter software. *Myotis* species were not identified to species level as this, generally, requires observation detail of the flying individual to complete full species identification. Where sufficient detail was recorded on the sonograms (i.e. sufficient information in relation to the minimum and maximum frequency of individual echolocation pulses) to identify Natterer's bat *Myotis nattereri*, this was noted. All other species were identified to species level. The bat codes are as follows (please see tables below):

SP = soprano pipistrelle *Pipistrellus pygmaeus*
CP = common pipistrelle *Pipistrellus pipistrellus*
LEIS = Leisler's bat *Nyctalus leisleri*
BLE = brown long-eared bat *Plecotus auritus*
MYOTIS = *Myotis* species
Nath Pip = Nathusius pipistrelle *Pipistrellus nathusii*

Walking Transects, as the name suggests, involves an observer walking at a steady pace and recording any bat activity (noting the species) along the walking route. The Irish Grid Reference of the bat encounter was recorded for mapping purposes. This was completed using Pettersson D200 Heterodyne Bat Detectors and Wildlife Acoustics Echometer Touch microphones connected to iPad2s.

Driving Transects involve a team of two driving at 24km/hr along the local and regional road network adjacent to the survey area. The passenger of the vehicle, using a Wildlife Acoustics Echometer Touch microphone connected to an iPad2, records any bat encounters along the driven route. A Garmin Navigator GPS unit was used to take Irish Grid Reference points when a bat was encountered during the Driving Transects.

Due to the fact that bat are nocturnal mammals, surveying in undertaken during the nocturnal hours from dusk to dawn. Dusk refers to the time period from sunset (this varies according to the date quoted) to midnight of the date stated. Dawn refers to the time period from midnight to sunrise of the date stated (this varies according to the date quoted). Walking transects tended to be undertaken at Dusk followed by Driving transects.

In summary the following surveys were completed:

- Static recorders located on anemometers (Stationary Statics)
    - Unit 3 consisted of 2 microphones, 4m and 50m respectively
    - Unit 4 consisted of 1 microphone at 4m
    - Unit 5 consisted of 1 microphone at 50m
- Static recorders moved from location to location (Stationary Statics)
    - Unit 1 with microphone at 2m
    - Unit 2 with microphone at 2m
- Walking Transects (within the survey site and adjacent road network)
- Driving Transects (along the adjacent road network outside the survey site)

Table 3.1: Bat Survey Dates

Anemometer Static Units			**Static Units**		**Walking Transects**	**Driving Transects**
Unit 3	***Unit 4***	***Unit 5***	***Unit 1***	***Unit 2***		
24th to 30th June 2016	24th to 30th June 2016	None (battery failure)			24th June 2016	25th June 2016
1st to 10th July 2016	1st to 10th July 2016					
15th to 23rd July 2016	15th to 20th July 2016	15th to 31st July 2016	15th to 18th July 2016	15th to 18th July 2016	17th July 2016	18th July 2016
17th to 28th August 2016	17th to 20th August 2016	17th to 28th August 2016	28th to 29 August 2016	28th to 29 August 2016	28th August 2016	28th to 29 August 2016
2nd to 13th September 2016	2nd to 5th September 2016	2nd to 13th September 2016	6th to 8th September 2016	6th to 8th September 2016	6th to 7th September 2016	8th September 2016
9th to 18th October 2016	9th to 11th October 2016	9th to 18th October 2016	17th to 18th October 2016	17th to 18th October 2016	17th October 2016	18th October 2016
12th to 18th November 2016	12th to 14th November 2016	12th to 20th November 2016	16th to 18th November 2016	16th to 18th November 2016	16th November 2016	

June 2018

● Static Units Surveillance 17th (dusk) to 18th (dawn) June 2018 (all five units)

●Walking Transects 16th (dusk) to 17th (dawn) June 2018

3.1.1 Survey constraints

The Full Season Bat Survey was completed over six months in 2016 (June to November). This provided detailed information in relation to local bat fauna of the survey area. However there were some survey constraints that lead to gaps in information for some sections of the survey area (e.g. safety concerns for lone surveyors). In addition, a review of the data collated in 2016 and survey locations couples with a new layout of wind turbines highlighted that there were gaps in information for two sections of the survey area. As a result of the additional surveying completed in 2018, such gaps in information were addressed and it is considered that this bat survey provides adequate seasonal surveying for bat activity within the boundary of the proposed wind farm.

However the following survey constraints that are associated with the Bat Survey is as follows:

a) Walking transects within the survey area was only undertaken along access tracks where it was safe to walk across open peat.
b) Access to the survey area was also limited to the small number of access roads into the survey area. It was along such access points that mobile statics were located.

3.2 Bat Habitat Mapping & Analysis Methodology

Roche *et al.* (2014) and Lundy *et al.* (2011) reported on the habitats consider favourable for each Irish bat species. Using the habitat maps (GIS map layers) produced by Bord na Mona, habitats considered to be ***"Bat Habitat"*** were extracted (ArcView 9.0) as a separate layer to aid analysis for this report. Habitats deemed by the author, under guidance of Roche *et al.* (2014) and Lundy *et al.* (2011), as ***"Bat Habitat"*** are as follows:

- Scrub (WS1)
- Work Areas
- Closed Betuala-dominated scrub
- Bog Woodland (WN7)
- Silt Ponds (artificial ponds with associated fringing habitats)
- Emerging Betula-dominated scrub
- Open Betula-dominated scrub
- Conifer plantation (WD4)
- Permanent pools & lakes (aquatic)
- Temporary open water (wetland)

Additional GIS layers were created to aid analysis for this report. Each bat encounter was mapped using Irish Grid Reference. However as bats echolocation calls can be detected some distance from where the actual bat is flying, a 100m fly zone was created around each bat encounter to represent the general area that individual bat recorded could be located at that point in time. This was named the ***"100m Buffer – Bat Encounter Points"*** and represents the potential distance that bat echolocation calls of the Leisler's bat can be detected by an ultrasonic microphone (i.e. bat detector zone).

A second analysis mapping layer was produced in relation to the location of wind turbines. As noted by EUROBATS, wind turbines are recommended to be a minimum distance of 200m from wooded habitats (i.e. potential ***"Bat Habitat"***). Therefore a layer was produced and named ***"200m Buffer – Turbine Locations"*** to represent the potential area/zone of influence for each individual wind turbine to aid analysis of the potential impact of the proposed wind turbine development on local bat populations. This layer was used for analysis in relation to the ***"100m Buffer – Bat Encounter Points"*** and for analysis in relation to the ***"Bat Habitat"*** layer.

All static recording locations sampled are also classed according to their favourability as a bat habitat within 100m radius of the static location. Three classifications are used:

- Open – for example, open peat bog. Typically, there is little tall vegetation in this category which is generally required for bat species to forage and commute along (exception to this is Leisler's bats and Nathusius' pipistrelle). This category would be considered to have a low potential for the majority of bat species.
- Edge – for example, hedgerows. Bat species such as *Pipistrellus* species have a preference to fly along linear habitat features.
- Closed – for example woodland. Bat species such a brown long-eared bats have a preference to foraging within woodland habitats.

3.3 Weather Data Analysis Methodology

To further help evaluate the potential impact of the proposed wind farm on bat usage of the survey area, weather data collated by the anemometers was investigated in relation to the potential influence of maximum wind speed (at the 50m and 10m level), average temperature (at the 79m and 5m level) and precipitation (rain gauge collection) on bat activity for each of the dates when bat activity was recorded by Units 3, 4 and 5 located on the anemometers.

The hourly data from Derryaroge 80m mast were analysed (n=262 hrs). Bat data collated by the microphone located on the Derryaroge 80m mast at a height of 4m was correlated with wind speed taken at the 10m level and air temperature recorded a 5m level. Bat data collated by the microphone located at the 50m height was correlated with wind speed taken 50m and air temperature recorded at 79m. Due to time constraints, this was not undertaken for the Lough Bannow mast data.

3.4 Proposed Road Haulage Network Analysis Methodology

To facilitate the construction of the proposed wind turbine, a road haulage network is required. This may result in the removal of habitats and the potential impact of this is investigated using the ***"Bat Habitat"*** layer, **"100m Buffer – Bat Encounters Points"** layer and the **"200m Buffer – Turbine Locations"** layer produced.

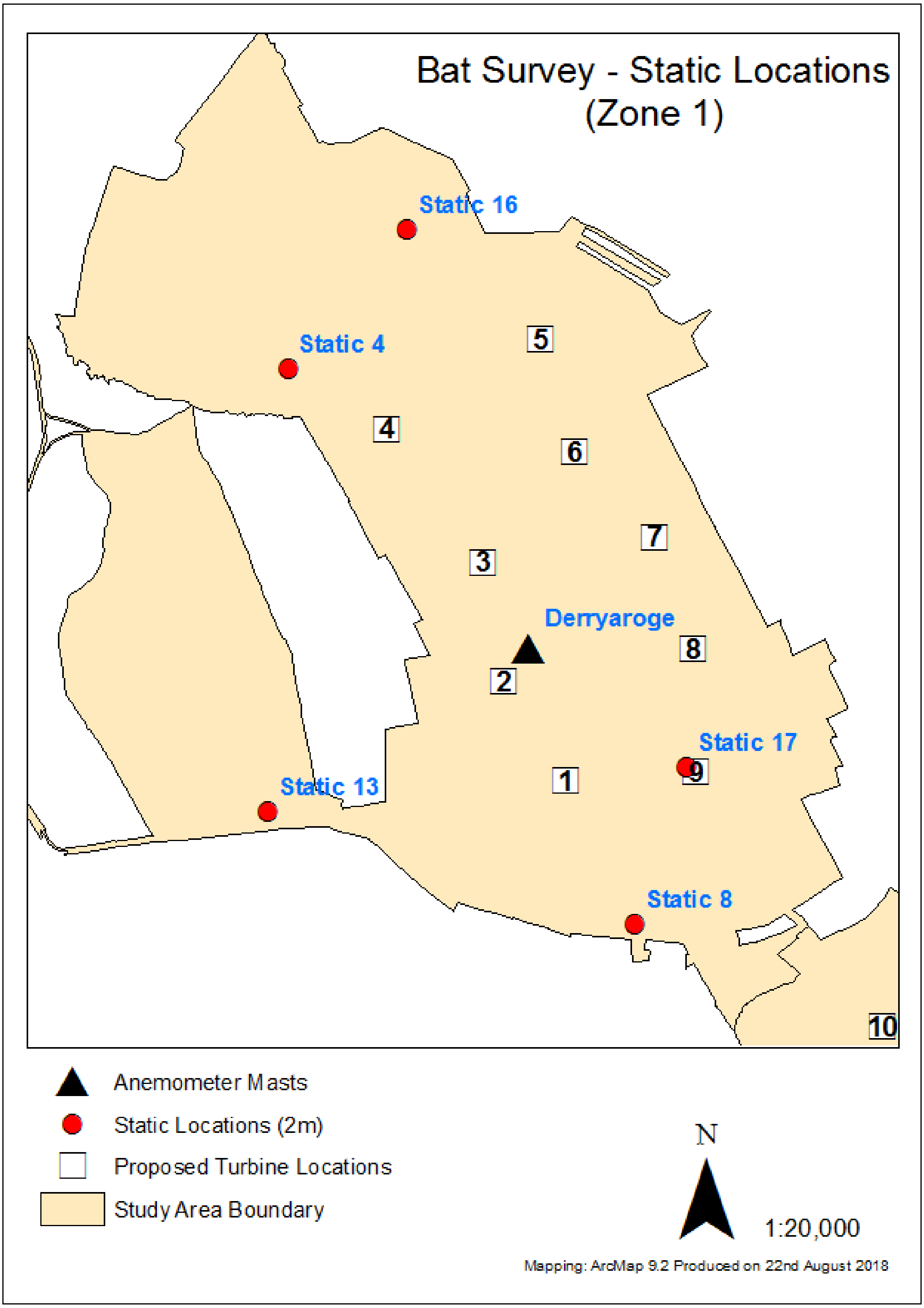
4 Results

4.1 Bat Survey Results

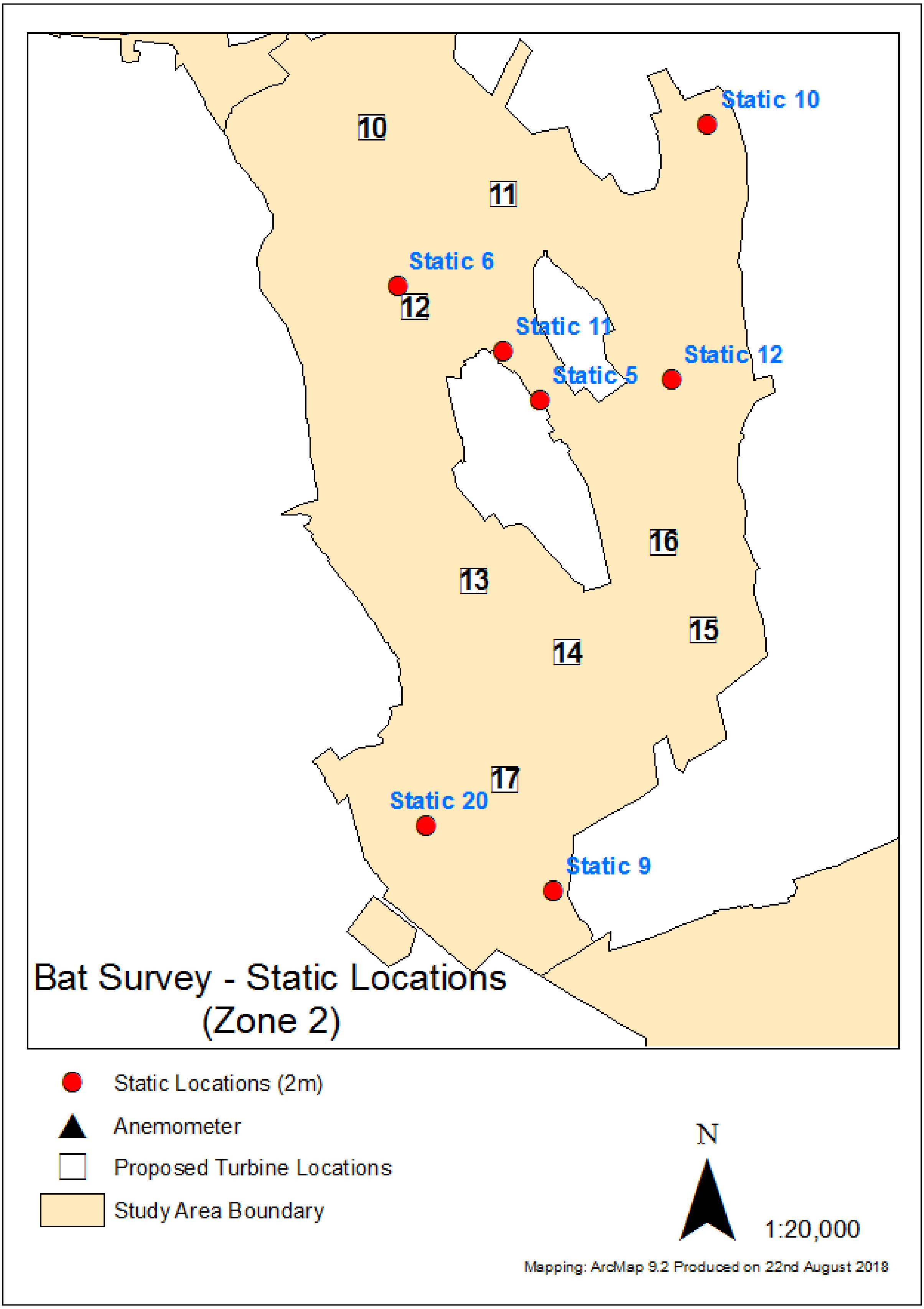
This report presents the results of various site visits by Bat Eco Services in June to November 2016 and June 2018 (Table 3.1). Extensive surveying was undertaken in 2016 in order to gather data on the seasonal activity of bats from June to November. Surveying comprised of three different survey types:

- Static recorders located on anemometers (Stationary Statics)
    - Unit 3 consisted of 2 microphones, 4m and 50m respectively
    - Unit 4 consisted of 1 microphone at 4m
    - Unit 5 consisted of 1 microphone at 50m
- Static recorders moved from location to location (Stationary Statics)
    - Unit 1 with microphone at 2m
    - Unit 2 with microphone at 2m
- Walking Transects (within the survey site and adjacent road network)
- Driving Transects (along the adjacent road network outside the survey site)

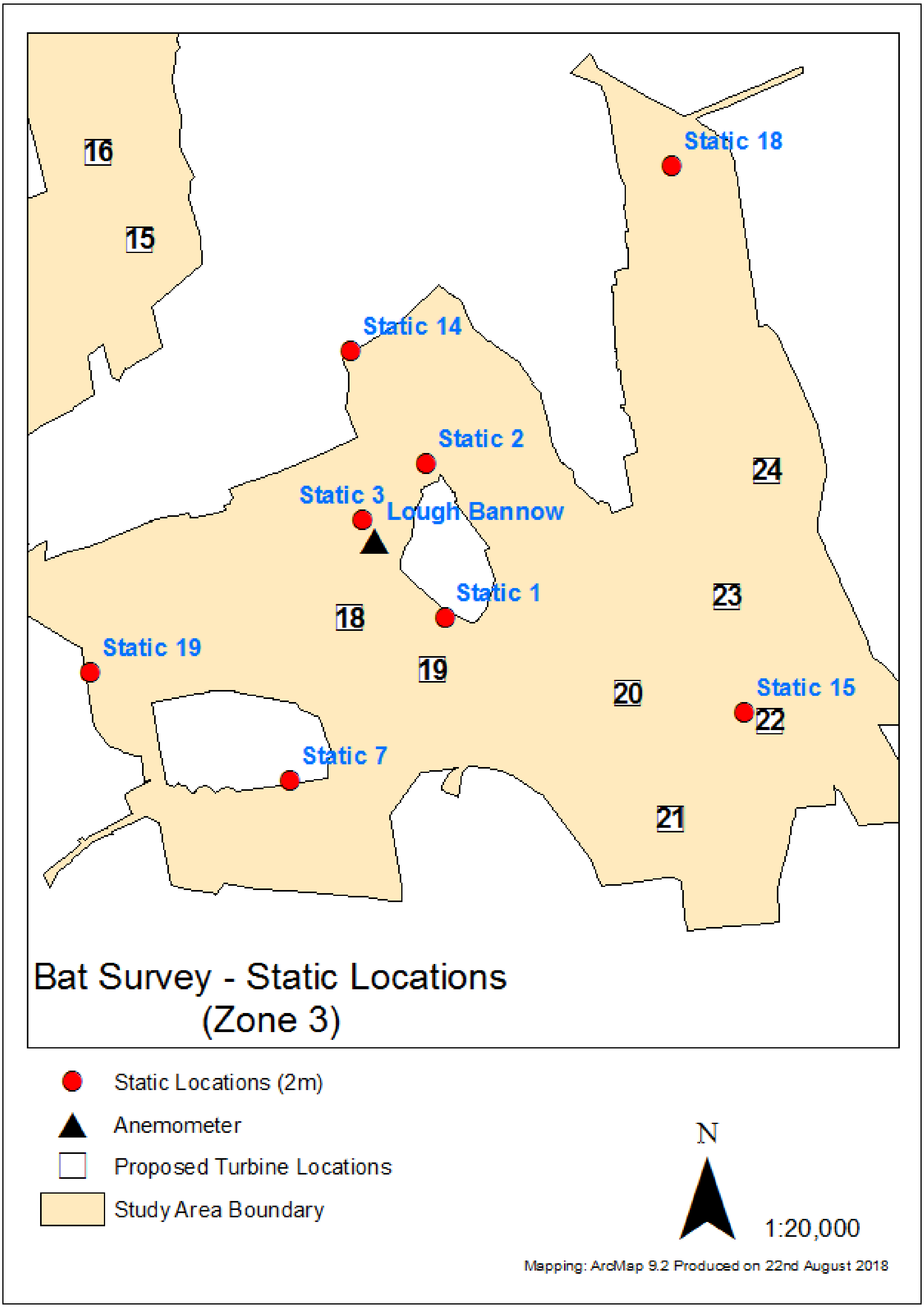
The location of static units is presented in Maps 4.1a, b, and c. These correspond to Zones 1, 2 and 3 which will be used for analysis. Zone 1 = Derryaroge, Zone 2 = Derryadd and Zone 3 – Lough Bannow.



Map 4.1a: Location of static recorders during full-season bat survey and additional survey work.



Map 4.1b: Location of static recorders during full-season bat survey and additional survey work.



Map 4.1c: Location of static recorders during full-season bat survey and additional survey work.

A total of 2,004 hours of surveying was completed during the full season bat survey in 2016 (Table 4.1).

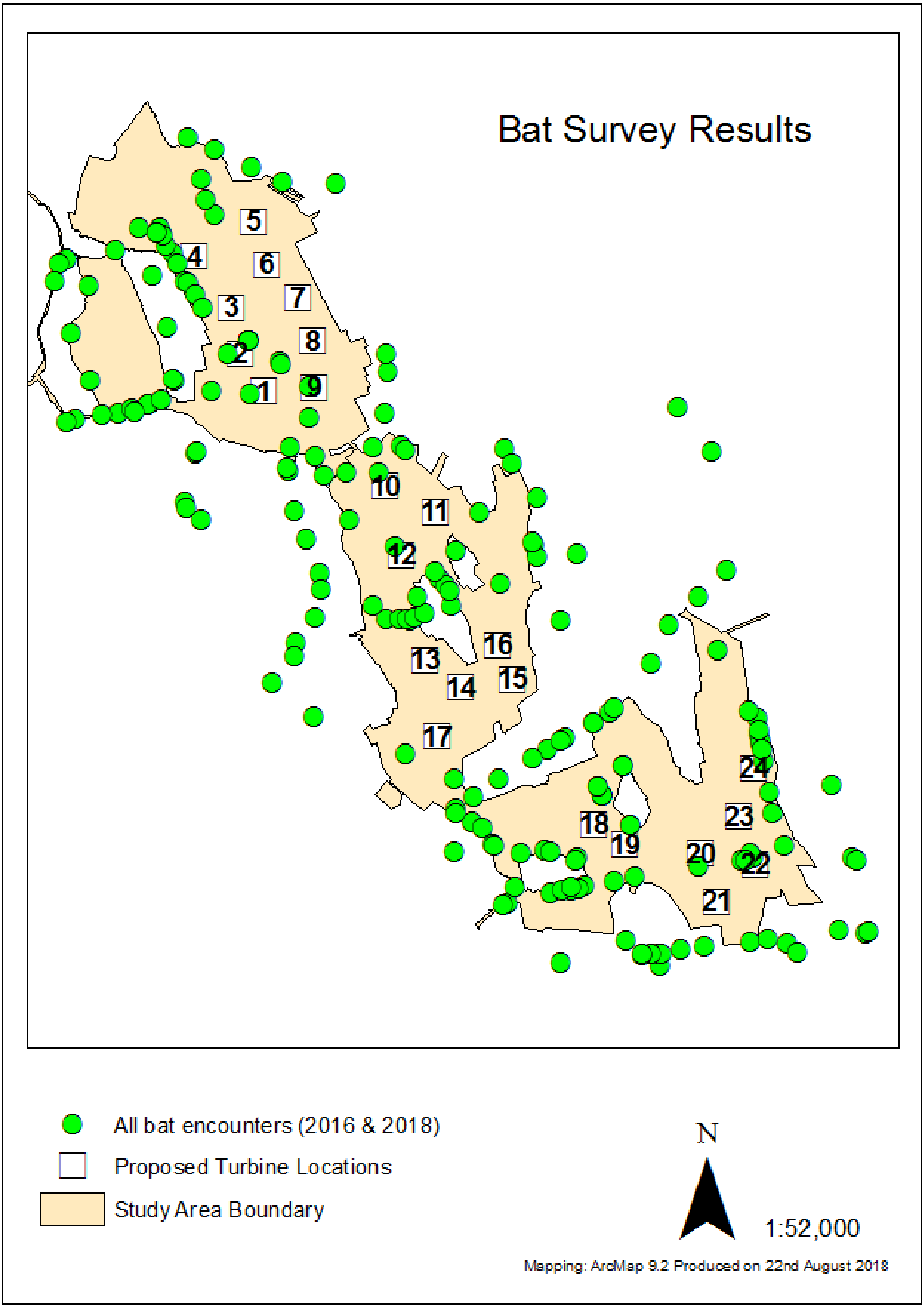
Table 4.1: Total number of bat survey hours completed in the 2016.

Month	Type	Hours	Type	Hours
June	Surveillance	108	Transects	5
July	Surveillance	497	Transects	5
August	Surveillance	342	Transects	5
September	Surveillance	400	Transects	8
October	Surveillance	310	Transects	5
November	Surveillance	316	Transects	3
	TOTAL	**1,973**		**31**

An additional 30 hours of surveillance (five static units) and 8 hours of walking transects (2 survey teams) was completed in June 2018. Therefore a total of 2,042 hours of bat surveying was competed for this report.

Between the numerous different types of bat surveys completed for this full season bat survey and additional surveying in June 2018, bats were encountered at a total of 184 unique grid referenced points (20 static unit points, four microphones locations on the two anemometer masts, 52 driving transect points and 112 walking transect points). In order to represent the data more clearly, each survey period for the static units on the anemometers are present as separate points. Therefore a total of 213 points are mapped (Map 4.2).

Some of these points have multiple bat species recorded (n=49 locations) and this will be presented under separate species headings. Where possible, bat encounters were recorded to species level. However for much of the *Myotis* species bat encounters recorded on static units were not identified to species level as it is important to have visual observations to assist with identification to species level. Two species of bats were recorded at twenty-three locations, three species of bat were recorded at 14 locations, four species of bat were recorded at 11 locations and five species of bat were recorded at one location (Static Site No. 5). All other locations had one species of bat recorded at the time of surveying (n=122) while 9 points had no bat species recorded.



Map 4.2: Location of all bat encounters during full-season bat survey (June–November 2016) and additional bat survey work (June 2018).

4.1.1 Static Detectors on Anemometer Masts (Stationary Statics)

The bat species codes are as follows (please see tables below):

SP = soprano pipistrelle *Pipistrellus pygmaeus*
CP = common pipistrelle *Pipistrellus pipistrellus*
LEIS = Leisler's bat *Nyctalus leisleri*
BLE = brown long-eared bat *Plecotus auritus*
MYOTIS = *Myotis* species
Nath Pip = Nathusius pipistrelle *Pipistrellus nathusii*

4.1.1.1 Lough Bannow Mast (100m) 4m Height Static Detector

This mast is located in an open area of bare peat. There is scrub located approximately 100m to the west and north-west of the mast and a block of agricultural land 75m to the east of the mast. A total of four bat species were recorded on the 4m microphone over the duration of the Full Season Bat Survey. The most common species encountered on the 4m static recorder was Leisler's bat followed by common pipistrelle bat. A single bat encounter for brown long-eared bat was recorded in June 2016. Bats were recorded during five of the six months of surveillance.

Table 4.3: Summary of bat species recorded during Full Season Bat Survey (June – November 2016) at 4m height on Lough Bannow Mast.

	SP	CP	LEIS	BLE	MYOTIS	Nath Pip
Survey Dates	**No of bat passes recorded**					
24th to 30th June 2016	1	0	1	1	0	0
1st to 10th July 2016	0	0	9	0	0	0
15th to 23rd July 2016	4	5	41	0	0	0
17th to 28th August 2016	3	25	10	0	0	0
2nd to 13th September 2016	1	3	21	0	0	0
9th to 18th October 2016	0	0	1	0	0	0
12th to 18th November 2016	0	0	0	0	0	0
TOTAL	**9**	**33**	**82**	**1**	**0**	**0**

4.1.1.2 Lough Bannow Mast (100m) 50m Height Static Detector

Four species of bat was also recorded on this unit. Again the most common species encountered on the 50m static recorder was Leisler's bat followed by common pipistrelle bat. Two bat encounters for Nathusius' pipistrelle was recorded in October 2016. This was the only recording for this species during the Full Season Bat Survey. Bats were recorded during five of the six months of surveillance.

Table 4.4: Summary of bat species recorded during Full Season Bat Survey (June – November 2016) at 50m height on Lough Bannow Mast.

	SP	CP	LEIS	BLE	MYOTIS	Nath Pip
Survey Dates	**No of bat passes recorded**					
24th to 30th June 2016	3	0	1	0	0	0
1st to 10th July 2016	0	2	6	0	0	0
15th to 23rd July 2016	3	13	31	0	0	0
17th to 28th August 2016	0	3	14	0	0	0
2nd to 13th September 2016	0	0	14	0	0	0
9th to 18th October 2016	0	1	2	0	0	2
12th to 18th November 2016	0	0	0	0	0	0
TOTAL	**6**	**19**	**68**	**0**	**0**	**2**

4.1.1.3 Derryaroge Mast (80m) 4m Height Static Detector

This mast is located in an open area comprised of a mosaic of peat habitats. There is scrub and riparian habitats located approximately 20m to the west. A total of four bat species were recorded on the 4m microphone over the duration of the Full Season Bat Survey. The most common species encountered on the 4m static recorder was common pipistrelle bat followed closely by Leisler's bat and soprano pipistrelle respectively. There was also a relatively similar number of *Myotis* species bat encounters recorded reflecting the scrub and riparian habitats located close by. Bats were recorded during five of the six months of surveillance.

Table 4.5: Summary of bat species recorded during Full Season Bat Survey (June – November 2016) at 4m height on Derryaroge Mast.

	SP	CP	LEIS	BLE	MYOTIS	Nath Pip
Survey Dates	**No of bat passes recorded**					
24th to 30th June 2016	4	7	8	0	10	0
1st to 10th July 2016	13	14	5	0	7	0
15th to 20th July 2016	0	1	0	0	0	0
17th to 20th August 2016	0	2	6	0	0	0
2nd to 5th September 2016	1	0	1	0	0	0
9th to 11th October 2016	0	0	0	0	0	0
12th to 14th November 2016	1	0	0	0	0	0
TOTAL	**19**	**24**	**20**	**0**	**17**	**0**

4.1.1.4 Derryaroge Mast (80m) 50m Height Static Detector

A total of three bat species were recorded on the 50m microphone over the duration of the Full Season Bat Survey. The most common species encountered on the 50m static recorder was Leisler's bat followed by common pipistrelle. Bats were recorded during four of the five months of surveillance successfully completed at this location.

Table 4.6: Summary of bat species recorded during Full Season Bat Survey (June – November 2016) at 50m height on Derryaroge Mast.

	SP	CP	LEIS	BLE	MYOTIS	Nath Pip
Survey Dates*	**No of bat passes recorded**					
15th to 31st July 2016	3	14	33	0	0	0
17th to 28th August 2016	7	25	13	0	0	0
2nd to 13th September 2016	1	0	3	0	0	0
9th to 18th October 2016	0	1	2	0	0	0
12th to 20th November 2016	0	0	0	0	0	0
TOTAL	**11**	**40**	**51**	**0**	**0**	**0**

** Battery failure during June survey*

COMMENTS ON RESULTS

There was a higher level of Leisler's bat encounter rates recorded at the 50m microphones compared to the 4m microphones.

There was a higher level of Leisler's bat encounter rates compared to all other bat species recorded.

There was a higher level of Leisler's bat encounter rates at the Lough Bannow Mast compared to the Derryaroge Mast.

There was a higher number of bat species recorded at the two microphones located at Lough Bannow mast compared to the Derryaroge mast.

Overall there was a ***low level*** *of bat passes recorded and this is a reflection of the low level of bat habitats present in the immediate area adjacent to the four sample points (i.e. four microphones located on the anemometers).*

4.1.2 Static Recording Detectors on Rotational Surveillance

Surveillance was completed using Song Meter SM2BAT (2 units, hereafter known as Unit 1 and Unit 2) (192 kHz Stereo, SMX-US ultrasonic omni-directional microphone), Song Meter SM3 unit (hereafter known as Unit 3) (192 kHz Stereo, SMX-US ultrasonic omni-directional microphone) and two units of Bat Logger A+ units. These units were located at a height of 2m at various locations throughout the full season bat survey. A total of 20 mobile static locations were surveyed during the Full Season Bat Survey and additional survey work completed in June 2018 (See Table 4.7) using all five static units.

At these locations the following bat species were recorded: soprano pipistrelle, common pipistrelle, Leisler's bat, brown long-eared bat and *Myotis* species. Natterer's bats were identified occasionally from sonogram analysis where the recordings were deemed sufficient to allow identification to level for this species.

Bat species can be defined according to the typical habitat types that individuals prefer to forage in. This broad definition is related to the echolocation calls and morphology characteristics of individual species (i.e. Open, Edge and Closed habitats). Leisler's bats prefer to fly in the "Open", *Pipistrellus* species are an "Edge" species while woodland bats, such as brown long-eared bats, forage in "Closed" habitats. Therefore location of static detectors are defined in the table below according to the broad habitat definition of "Open", "Edge" or "Closed". However the due to the fact that the microphones are omnidirectional, any passing bat in range of the microphone will be recorded (Range of bat is determined by the loudness of the bat echolocation call produced by individual species e.g. Leisler's bats produce a low frequency and loud call that can be picked up approximately 100m from a bat detector microphone).

A high level of common pipistrelle bat activity was recorded on Statics 7, 9 and 10 (> 100 bat passes per night). A medium level of bat activity was recorded at Statics 9 and 11 for soprano pipistrelles (51-100 bat passes per night) and at Statics 1, 4 and 8 for common pipistrelles. The behaviour pattern for individuals of two species means that individual bats will often forage as they commute through the landscape and as a consequence, a higher number of bat passes are recorded on static units compared to other bat species. Therefore, while there lower levels of activity for other species recorded on the statics, the number of bat passes recorded on Statics 4 and 7 identified as *Myotis* bats are comparatively high for this species group. The same can be said for Static 7 in relation to Leisler's bats. This species flies fast through the landscape and rarely forages in one spot for a long period of time.

Therefore, the locations of Statics 1, 4, 7, 8, 9, 10 and 11 provide important feeding / commuting areas for bat species (See Map 4.3). This map indicates that the statics located either near the boundary of the survey area or adjacent to agricultural sections within the survey area have a higher level of bat activity compared to all other static locations. None of these static locations were within 200m of a turbine location. However Turbine 19 is approximately 250m from Static 1.

Table 4.7: Summary of bat species recorded by Static Units Surveillance during Full Season Bat Survey (June – November 2016) at 15 locations and five additional locations in June 2018. Species encounters are colour coded according to Bat Habitat Type: Blue = Edge, Yellow = Open and Red = Closed.

	SP	CP	LEIS	BLE	MYOTIS	Nath Pip
Survey Dates	**No of bat passes recorded (per night)**					
Static Site 1 15/6/16-16/6/16 Lough Bannow (Zone 3)	24	68	0	5	0	0
Static Site 1 16/6/16-17/6/16 Lough Bannow (Zone 3)	16	79	4	0	4	0
Static Site 2 15/6/16-17/6/16 Lough Bannow (Zone 3)	13	20	7	0	0	0
Static Site 2 16/6/16-17/6/16 Lough Bannow (Zone 3)	8	43	8	0	3	0
Static Site 3 17/6/16-18/6/16 Lough Bannow (Zone 3)	18	13	2	0	5	0
Static Site 3 18/6/16-19/6/16 Lough Bannow (Zone 3)	10	27	10	0	1	0
Static Site 4 17/6/16-18/6/16 Derryaroge (Zone 3)	0	16	1	0	27	0
Static Site 4 18/6/16-19/6/16 Derryaroge (Zone 1)	15	52	14	0	3	0
Static Site 5 28/8/16-29/8/16 Derryadd (Zone 2)	9	21	5	1	17	0
Static Site 6 28/8/16-29/8/16 Derryadd (Zone 2)	9	3	5	0	11	0
Static Site 7 6/9/16-7/9/16 Lough Bannow (Zone 3)	39	**171**	22	0	7	0
Static Site 8 6/9/16-7/9/16 Derryaroge (Zone 1)	34	78	14	0	3	0
Static Site 9 7/9/16-8/9/16 Derryadd (Zone 2)	86	**280**	7	0	11	0
Static Site 10 7/9/16-8/9/16 Derryadd (Zone 2)	30	**119**	0	0	7	0
Static Site 11 9/10/16-10/10/16 Derryadd (Zone 2)	53	15	8	0	0	0
Static Site 12 9/10/16-10/10/16 Derryadd (Zone 2)	19	12	6	0	0	0
Static Site 13 16/11/16-17/11/16 Derryarogue (Zone 1)	0	0	0	4	0	0
Static Site 13 17/11/16-18/11/16 Derryarogue (Zone 1)	0	0	0	0	0	0
Static Site 14 16/11/16-17/11/16 Lough Bannow (Zone 3)	4	9	0	0	0	0
Static Site 15 17/11/16-18/11/16 Lough Bannow (Zone 3)	3	7	0	0	0	0
Static Site 16 17/6/18-18/6/18 Derryaroge (Zone 1)	6	43	3	3	2	0
Static Site 17 17/6/18-18/6/18	0	0	0	0	0	0

Derryaroge (Zone 1)						
Static Site 18 17/6/18-18/6/18 Lough Bannow (Zone 3)	0	0	0	0	0	0
Static Site 19 17/6/18-18/6/18 Lough Bannow (Zone 3)	36	17	1	0	0	0
Static Site 20 17/6/18-18/6/18 Derryadd (Zone 2)	37	12	2	0	0	0

Table 4.8: Irish Grid Reference, location description and Bat Habitat Category of all Static Units completed during Full Season Bat Survey (June – November 2016) and during additional bat survey work (June 2018).

Location	Grid Reference	Details	Category
Lough Bannow Mast	N0809264900 Lough Bannow	Mast is located in open bog. There is scrub to the NW and agricultural fields with hedgerows to the SE.	**OPEN**
Derryaroge Mast	N0388270304 Derryaroge	Mast is located in open bog. There is scrub and agricultural fields to the W with some scrub within 25m of the mast as well as a wet ditch.	**OPEN**
Static Site 1	N0841864546 Lough Bannow	Static detector located along hedgerow adjacent to open cutover bog	**EDGE**
Static Site 2	N0833565254 Lough Bannow	Static detector located along hedgerow adjacent to open cutover bog	**EDGE**
Static Site 3	N0804064993 Lough Bannow	Static detector located in open cutover bog approx. 50m from scrub	**OPEN**
Static Site 4	N0277971586 Derryaroge	Static recorder located along railway track with dense tree lines on either side	**CLOSED**
Static Site 5	N0627067324 Derryadd	Static recorder located along track through cutover bog	**EDGE**
Static Site 6	N0561867849 Derryadd	Static recorder located along scrub adjacent to cutover bog	**EDGE**
Static Site 7	N0771063800 Lough Bannow	Static recorder located along mature treelines adjacent to cutover bog (ISPCA)	**EDGE**
Static Site 8	N0436769043 Derryaroge	Static recorder adjacent work area, buildings and treelines (Bord na Mona Depot)	**EDGE**
Static Site 9	N0633465081 Derryadd	Static recorder located on cutover bog adjacent to scrub, ditch and treelines	**EDGE**
Static Site 10	N0700968846 Derryadd	Static recorder adjacent work area, buildings and treelines	**EDGE**
Static Site 11	N0610067548 Derryadd	Static recorder located adjacent to work area, buildings and treelines	**EDGE**
Static Site 12	N0687367422 Derryadd	Static recorder located on cutover bog adjacent to ditch	**OPEN**
Static Sit3 13	N0268369554 Derryaroge	Static recorder adjacent to conifer treeline and cutover bog	**EDGE**
Static Site 14	N0798865763	Static recorder located on cutover bog	**OPEN**

	Lough Bannow		
Static Site 15	N0978864113 Lough Bannow	Static recorder located on cutover bog	**OPEN**
Static Site 16	N0332072223 Derryaroge	Static recorder located on cutover bog adjacent to scrub vegetation	**EDGE**
Static Site 17	N0460169763 Derryaroge	Static recorder located on cutover bog	**OPEN**
Static Site 18	N0945766614 Lough Bannow	Static recorder located on cutover bog	**OPEN**
Static Site 19	N0679364297 Lough Bannow	Static recorder located on cutover bog	**OPEN**
Static Site 20	N0574565379 Derryadd	Static recorder located on cutover bog adjacent to some immature trees and a ditch	**EDGE**

COMMENTS ON RESULTS

There was a higher level of bat encounter rates recorded on the statics located at 2m height compared to the stationary statics. This is due to the fact that these units tended to be located in areas where there was a mosaic of habitats present and therefore a higher chance to encounter bats. The purpose of these statics was to sample as much of the survey area as possible of local bat populations in a safe manner compared to walking transects across bare peat during the hours of darkness.

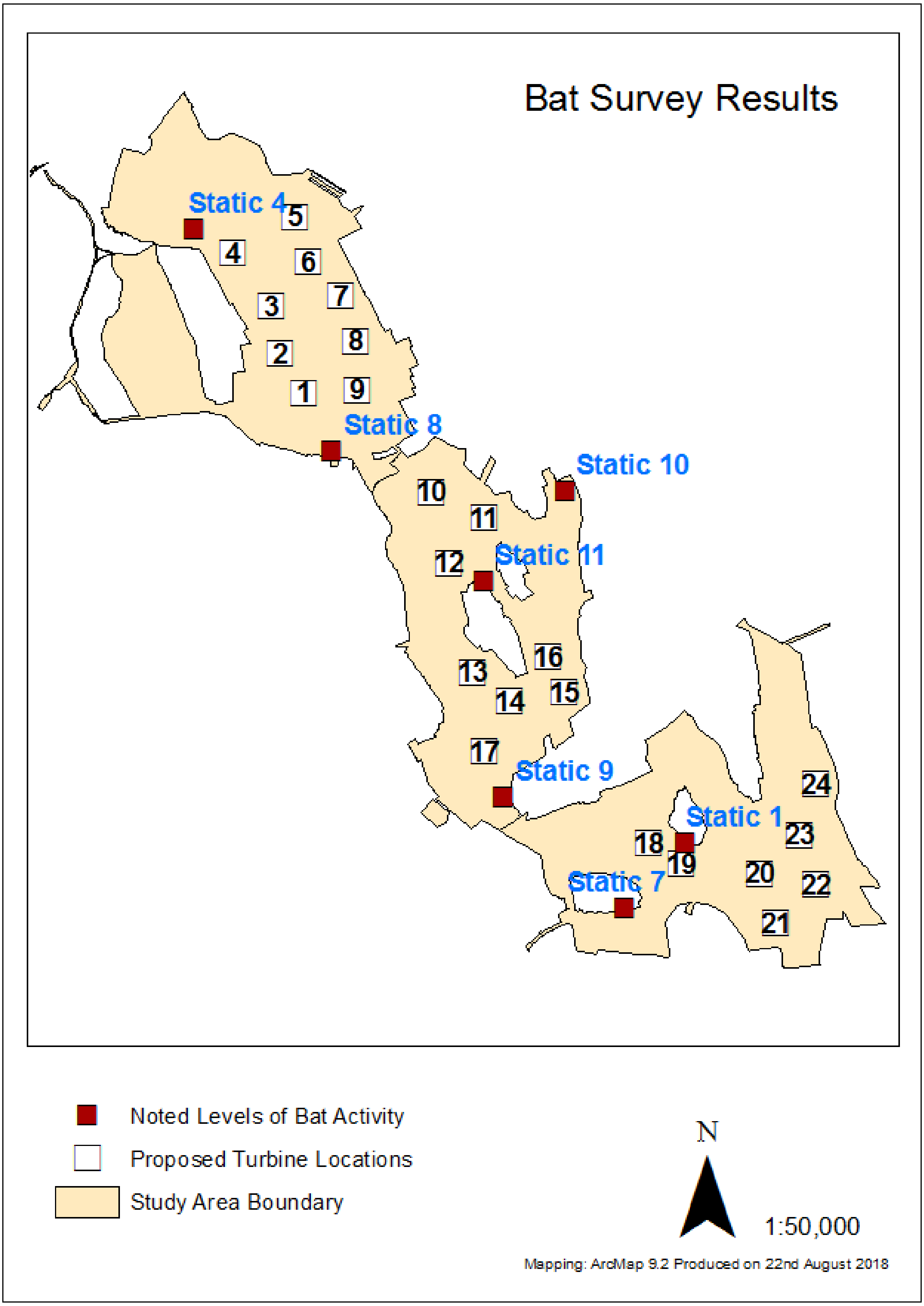
Bats were recorded at 85% of static locations.

Common pipistrelles were the most recorded bat species on the statics and this reflects that many of the statics were located along edge habitats, the preferred habitat of this bat species.

The following static locations were important for local bat populations: Statics 1, 4, 7, 8, 9, 10, 11. With reference to "Bat Habitat" maps present later in the report, all of these statics are located in habitats deemed as suitable "Bat Habitat" or adjacent to agricultural landscape with suitable linear habitats (e.g. hedgerows and treelines).

Statics 7, 9 and 10 had a high level of bat activity particularly for Common pipistrelles, a medium risk species in relation to wind turbine operations. However the location of these three stations were adjacent to good bat habitat, considered suitable for commuting and foraging bats. While static locations in the cutover bog (e.g. Static 17), generally, recorded a lower number of bat passes.

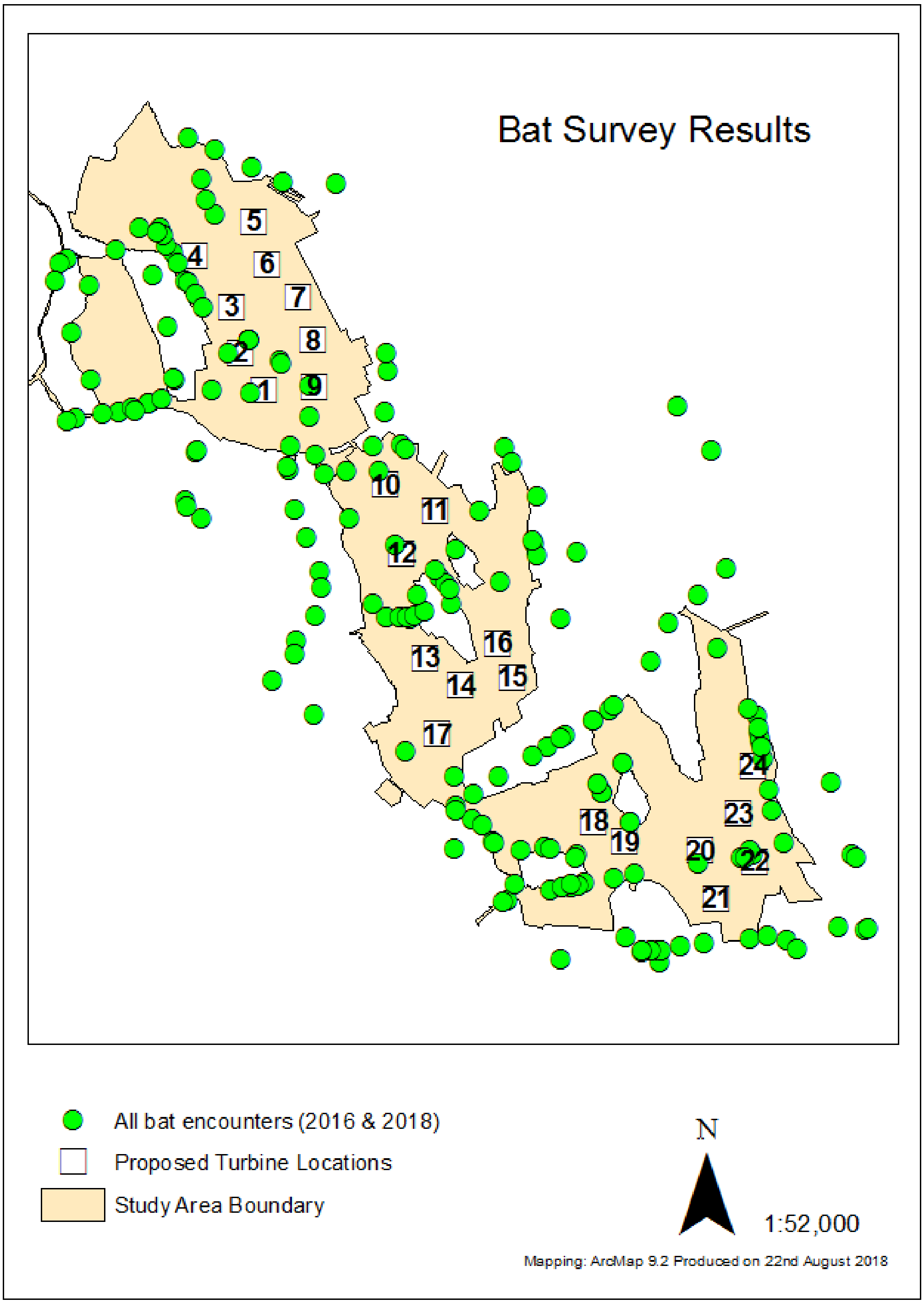
The static results provide good baseline information for bat activity levels in the mosaic of habitat types present within the survey area. Such baseline data should be used to assist assessment during any future surveillance of bat activity within the survey area.



Map 4.3: Statics located in areas deemed important for foraging/commuting bats.

4.1.3 Walking Transects

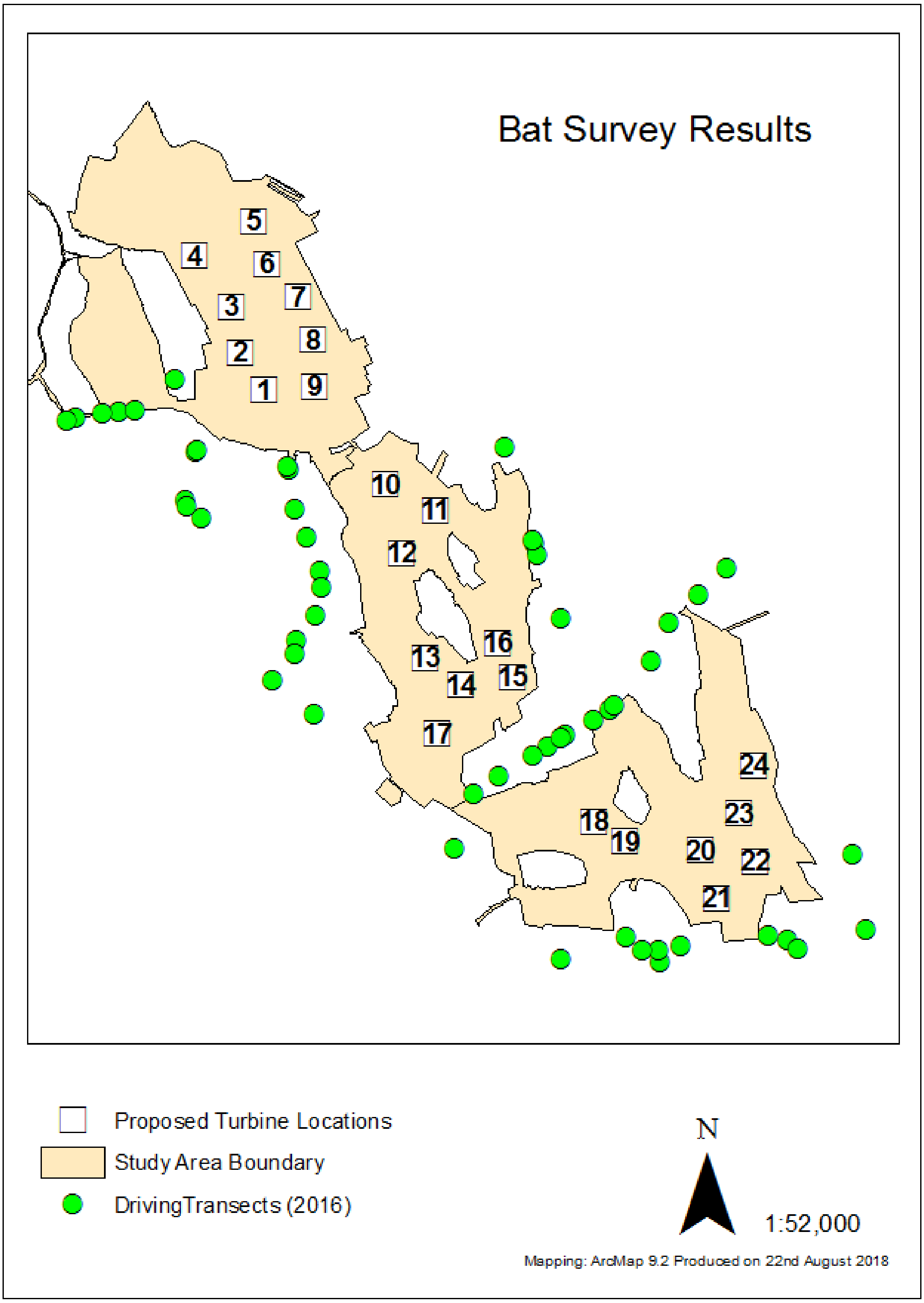
Walking Transects was completed along tracks through the proposed development area or along adjacent roads and lanes. One hundred and twelve Irish Grid Reference points were recorded with bat activity during walking transects (Map 4.4 The following bat species were recorded: common pipistrelle, soprano pipistrelle, Leisler's bat, brown long-eared bat, Natterer's bat, *Pipistrellus* spp. and *Myotis* spp.



Map 4.4: Walking transects bat encounters recorded during all bat surveys completed (Four Season Bat Survey, 2016 and additional survey work June 2018).

4.1.4 Driving Transects

Driving Transects was completed after the walking transects along roads and lanes adjacent to the proposed development site. Fifty-two Irish Grid Reference points were recorded with bat activity during driven transects (Map 4.5). The following bat species were recorded: common pipistrelle, soprano pipistrelle, Leisler's bat, and *Myotis* spp.

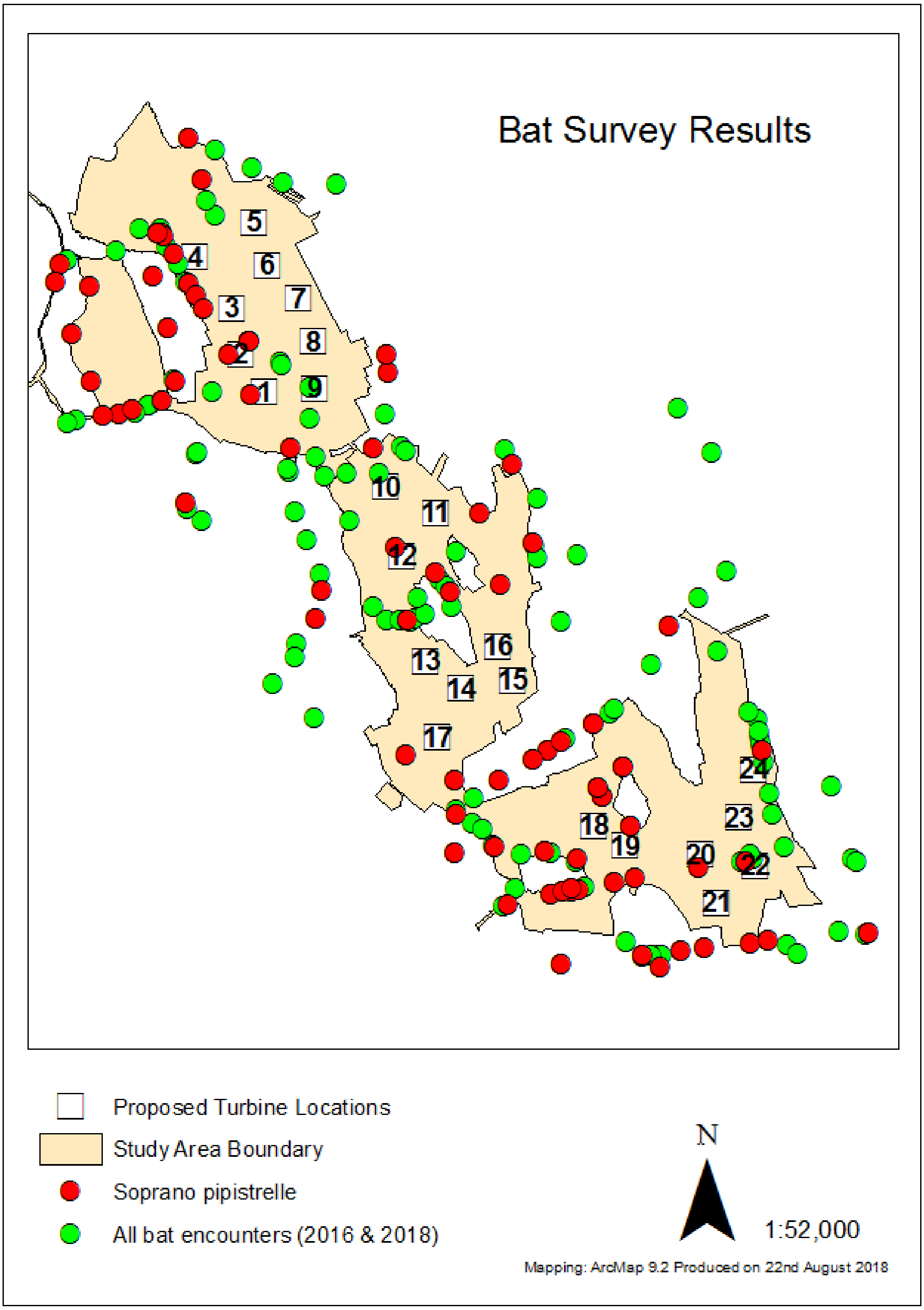


Map 4.5: Driven transect points with bat encounters during full-season bat survey only.

4.1.5 Bat Encounters according to Bat Species

4.1.5.1 Soprano pipistrelle *Pipistrellus pygmaeus*

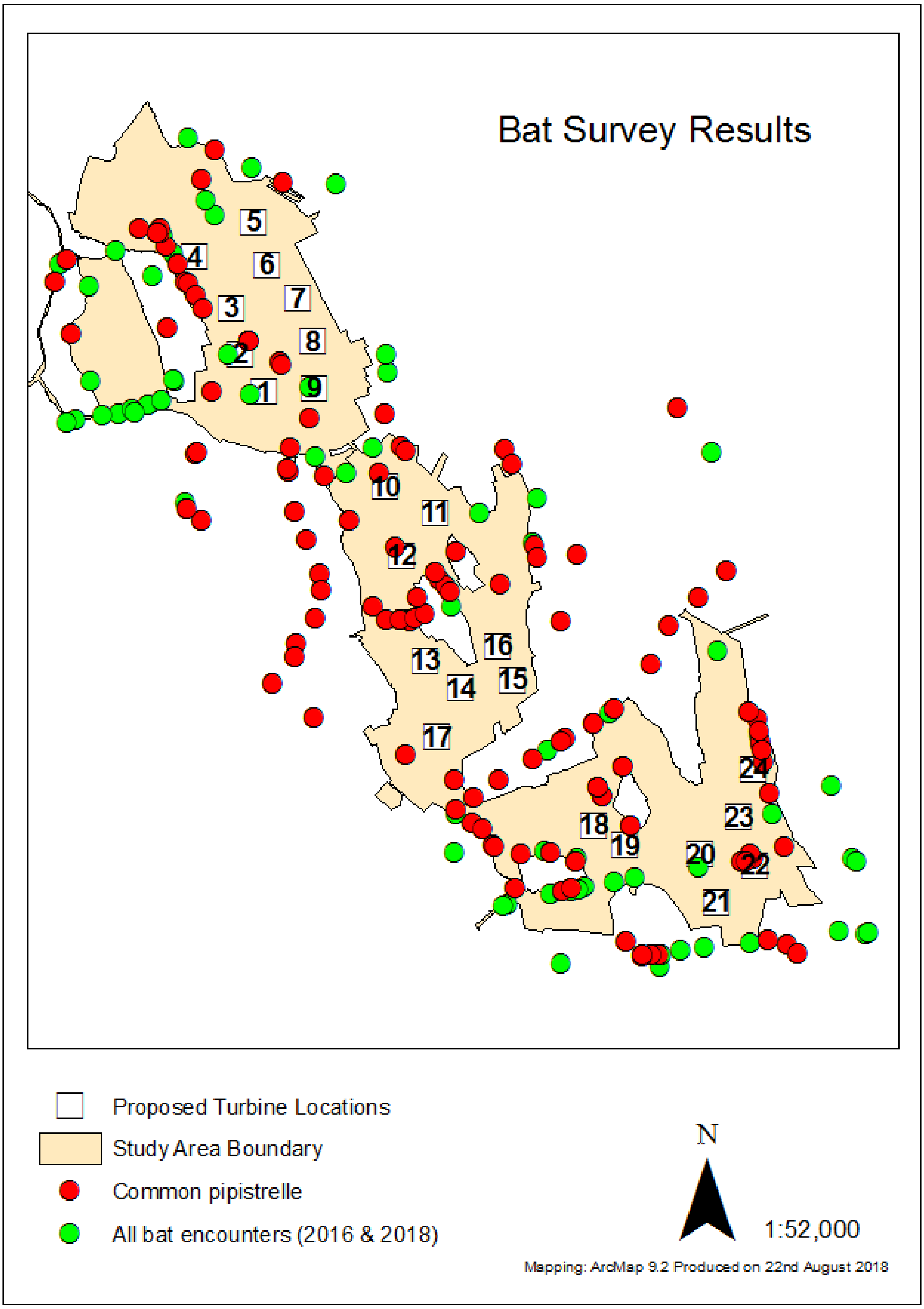
Out of 213 bat encounter (grid referenced) points (all survey methods), 90 encounters recorded were identified as soprano pipistrelles (Map 4.6). This was the second most common bat species recorded during the bat surveys.



Map 4.6: Soprano pipistrelle bat encounter locations recorded during all bat surveys completed.

4.1.5.2 Common pipistrelle *Pipistrellus pipistrellus*

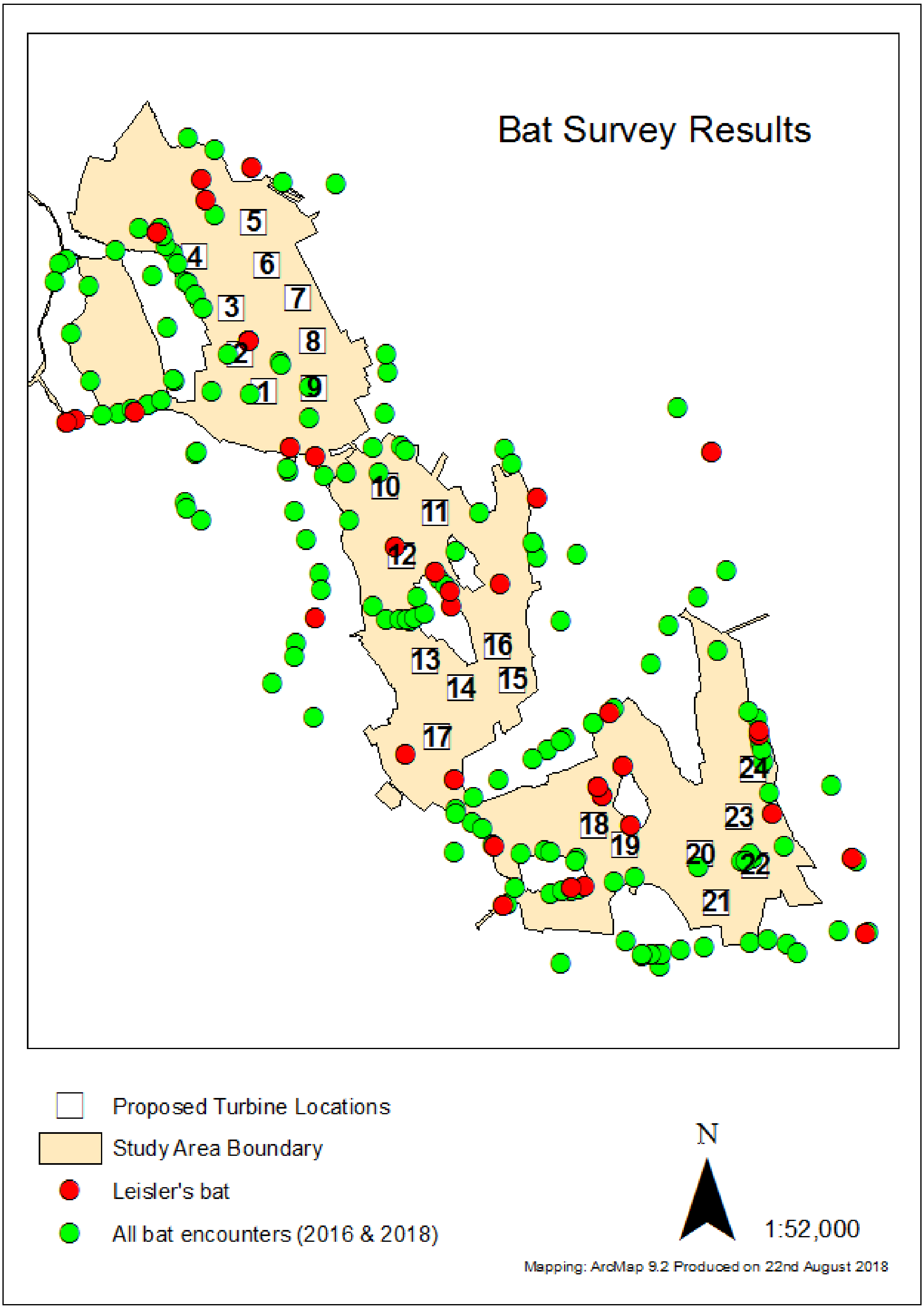
Out of 213 bat encounter (grid referenced) points, 125 encounters recorded were identified as common pipistrelles (Map 4.7). This was the most common bat species recorded during the bat surveys.



Map 4.7: Common pipistrelle bat encounter locations recorded during all bat surveys completed.

4.1.5.3 Leisler's bat *Nyctalus leislerl*

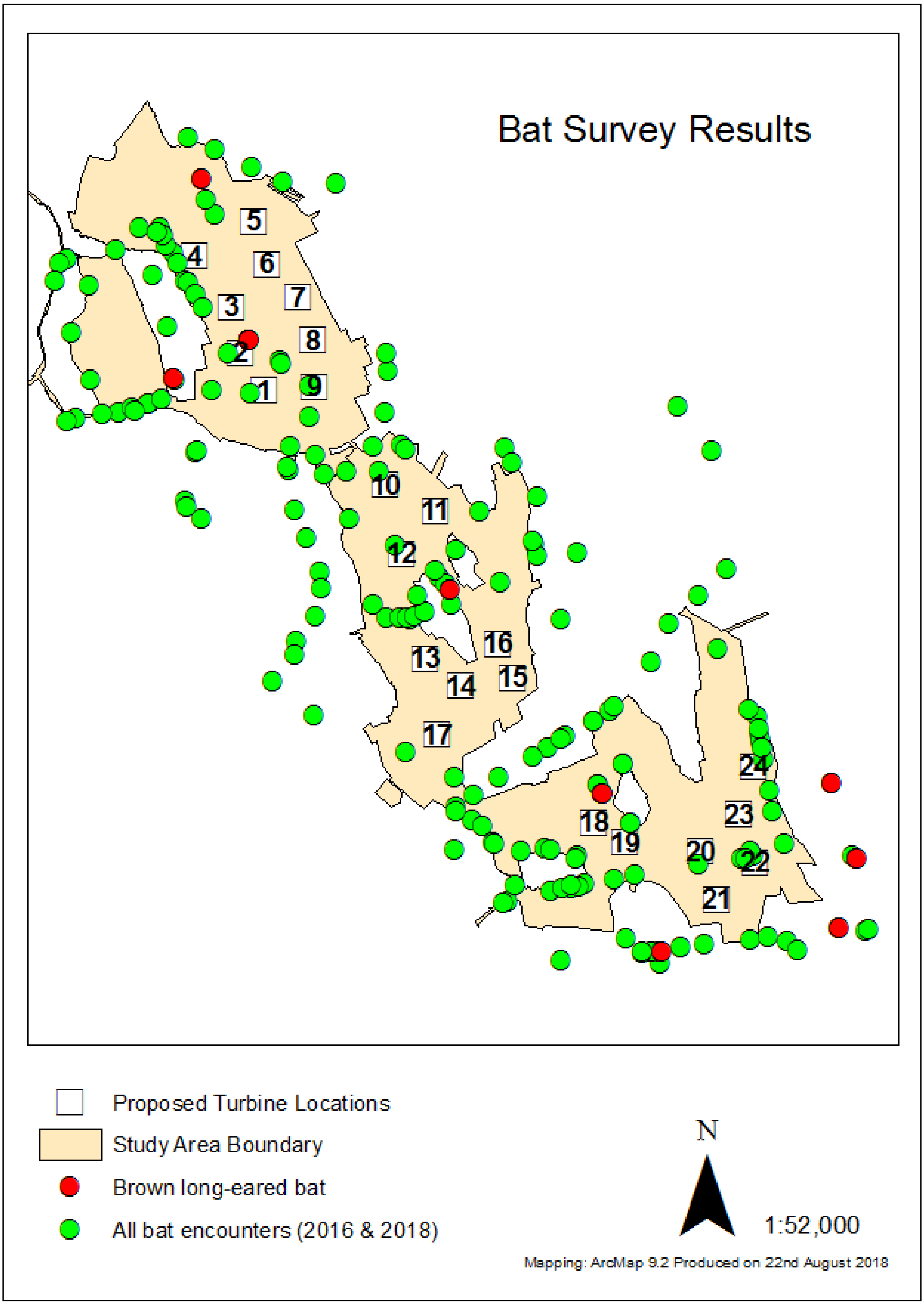
Out of 213 bat encounter (grid referenced) points, 48 encounters recorded were identified as Leisler's bats (Map 4.8). This was the third most common bat species recorded during the bat surveys.



Map 4.8: Leisler's bat encounter locations recorded during all bat surveys completed.

4.1.5.4 Brown long-eared bat *Plecotus auritus*

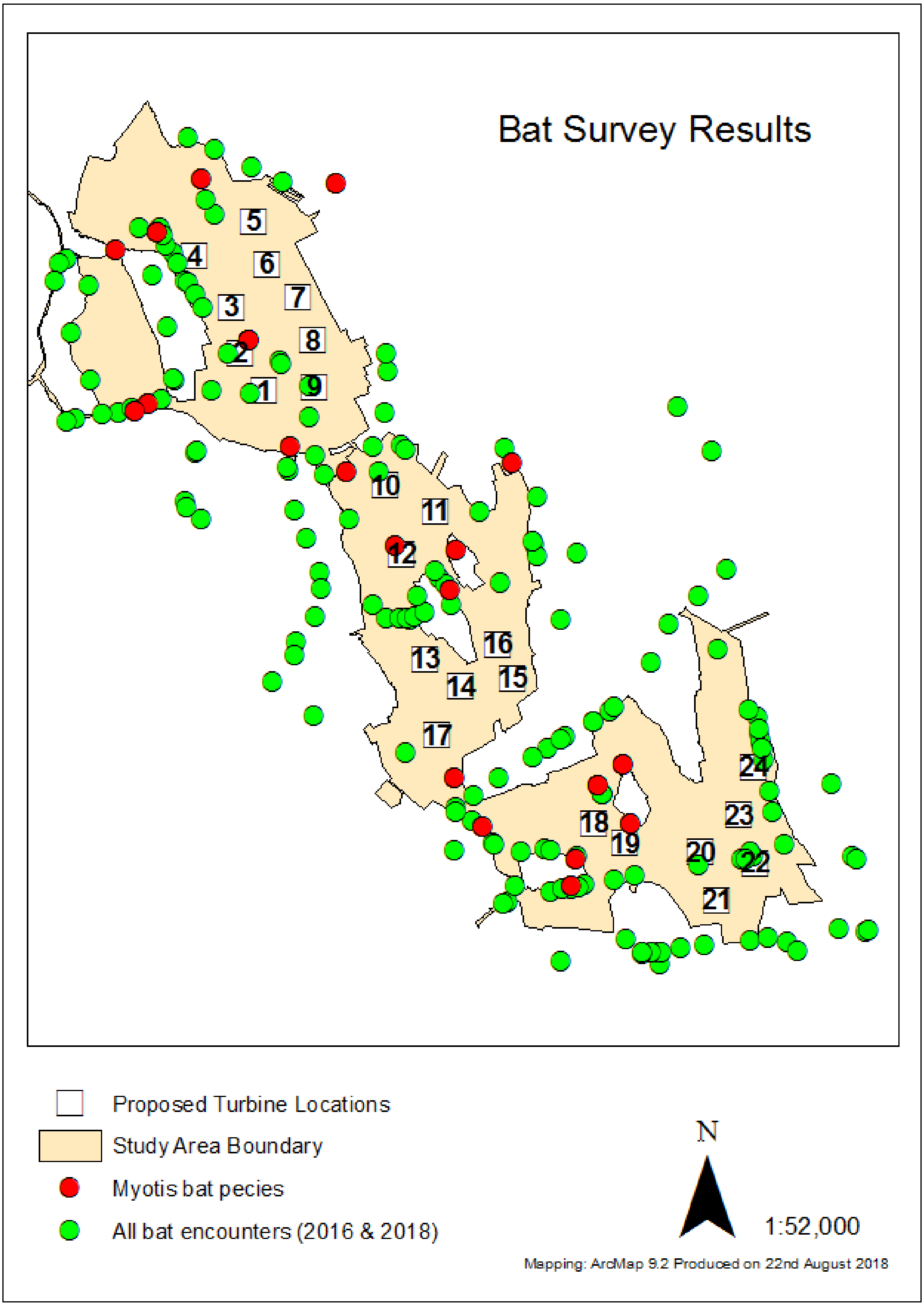
Out of 213 bat encounter (grid referenced) points, only 12 encounters recorded were identified as brown long-eared bats and these were primarily adjacent to the proposed wind farm area (Map 4.9).



Map 4.9: Brown long-eared bat encounter locations recorded during all bat surveys completed.

4.1.5.5 *Myotis* species

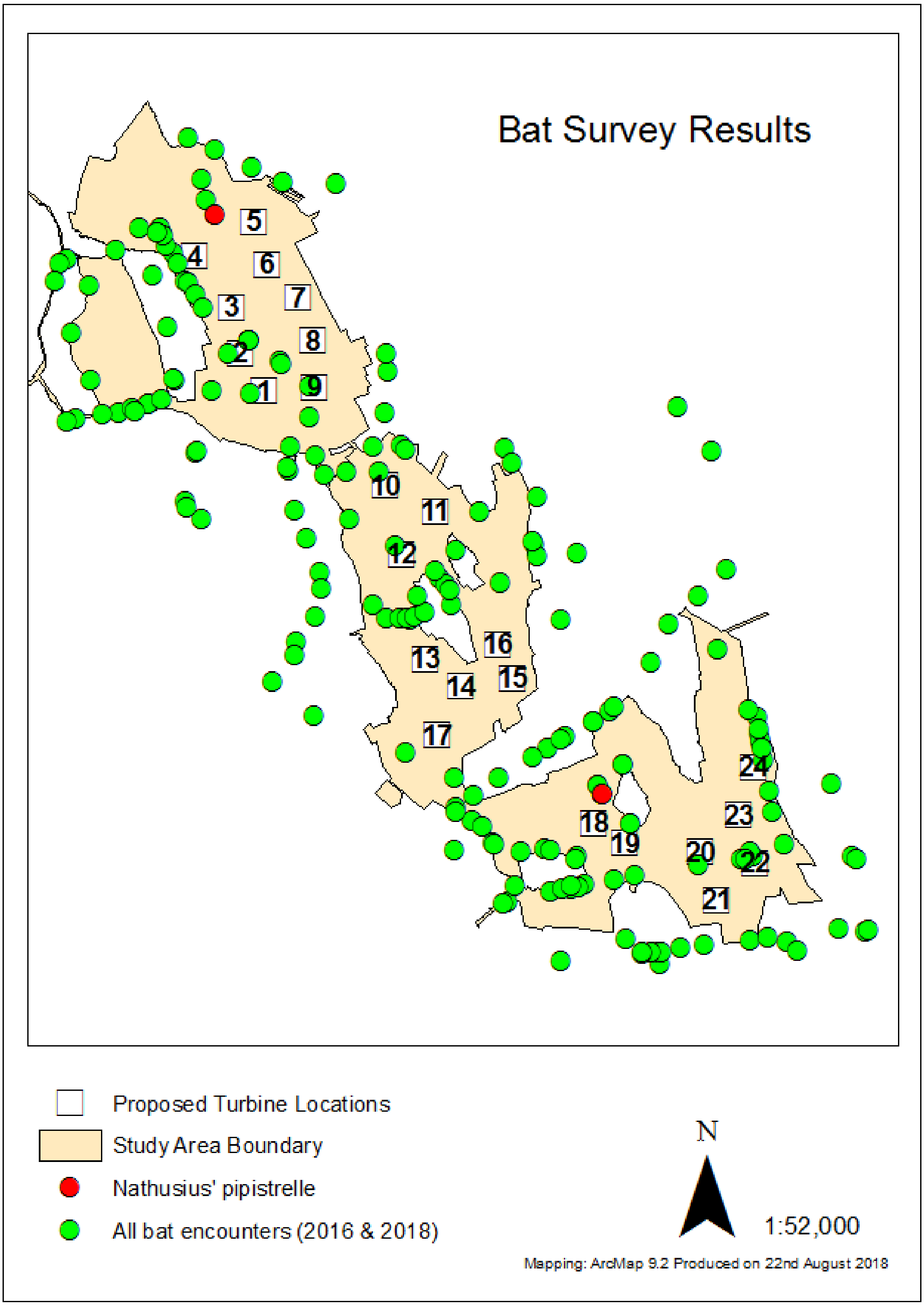
Out of 213 bat encountered (grid referenced) points, 24 encounters recorded were identified as *Myotis* species (Map 4.10). One of these was identified to species level: Natterer's bat.



Map 4.10: *Myotis* species bat encounter locations recorded during all bat surveys completed.

4.1.5.6 Nathusius' pipistrelle *Pipistrellus nathusii*

Out of 213 bat encountered (grid referenced) points, two encounters recorded was identified as Nathusius' pipistrelle (Map 4.11). This species was recorded on the stationary unit located on Lough Bannow mast at the 50m microphone during the month of October 2016, which coincides with the migration period. The second recording was during the June 2018 walking transects.



Map 4.11: Nathusius' pipistrelle bat encounter locations recorded during all bat surveys completed.

4.2 Analysis Results

4.2.100m Buffer Detection Zones & 200m Buffer Turbine Locations

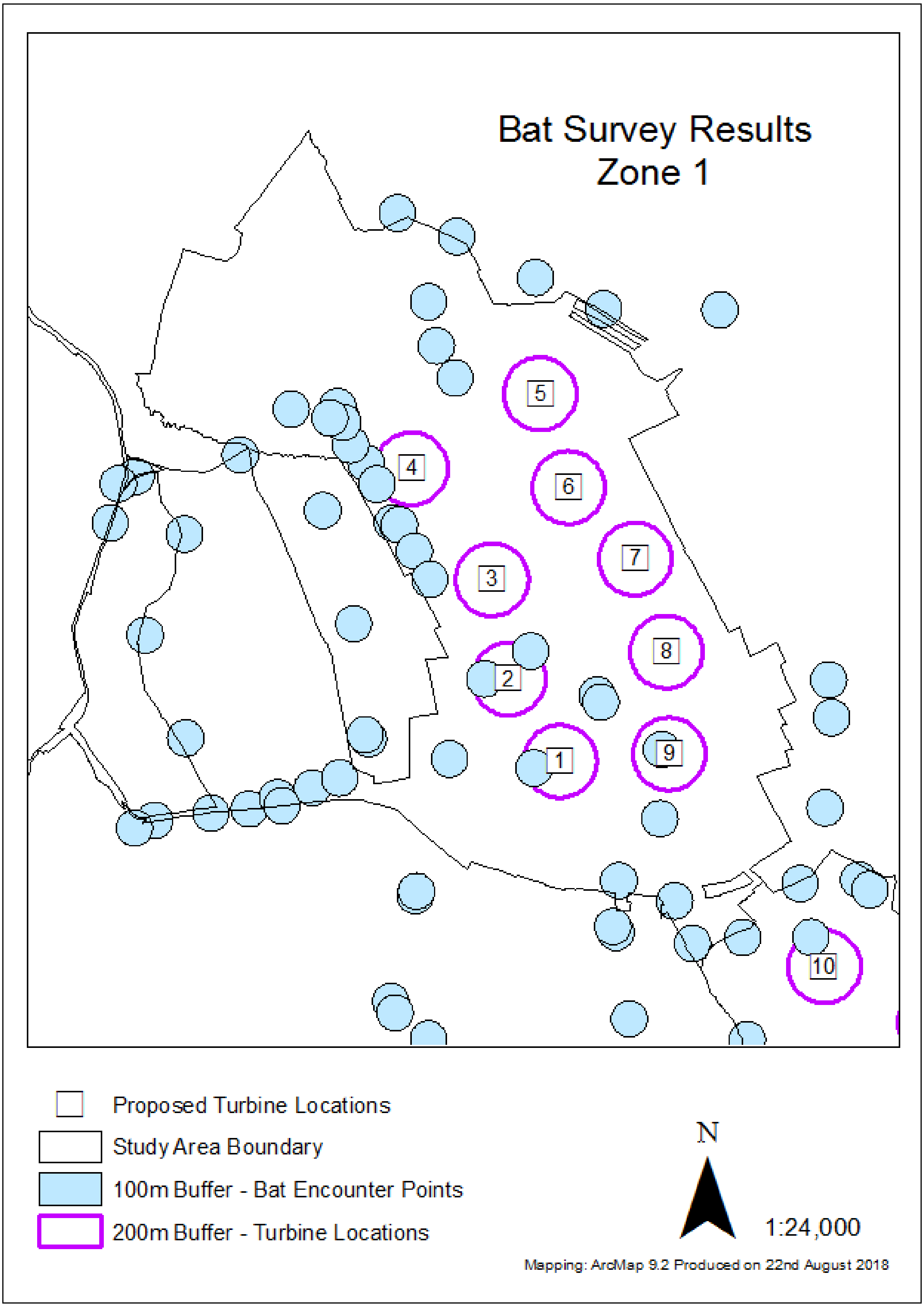
To help evaluate the potential impact of the proposed wind farm on bat usage of the survey area, a 100m buffer zone was created around each bat encounter grid reference point. Leisler's bats produce the loudest calls which mean that they can be detected at the greatest distance. This distance of detection varies depending on air temperature and the frequency that call is made at and also the sensitivity of the microphone. The 100m buffer will provide an arbitrary radius of the potential location of bats in relation to the static recorder/surveyor.

This is coupled with a 200m habitat buffer zone around each of the proposed turbine sites. A distance of 200m is recommended by EUROBATS for locating turbines away from bat foraging sites. These two sets of buffer zones are presented in the following maps.

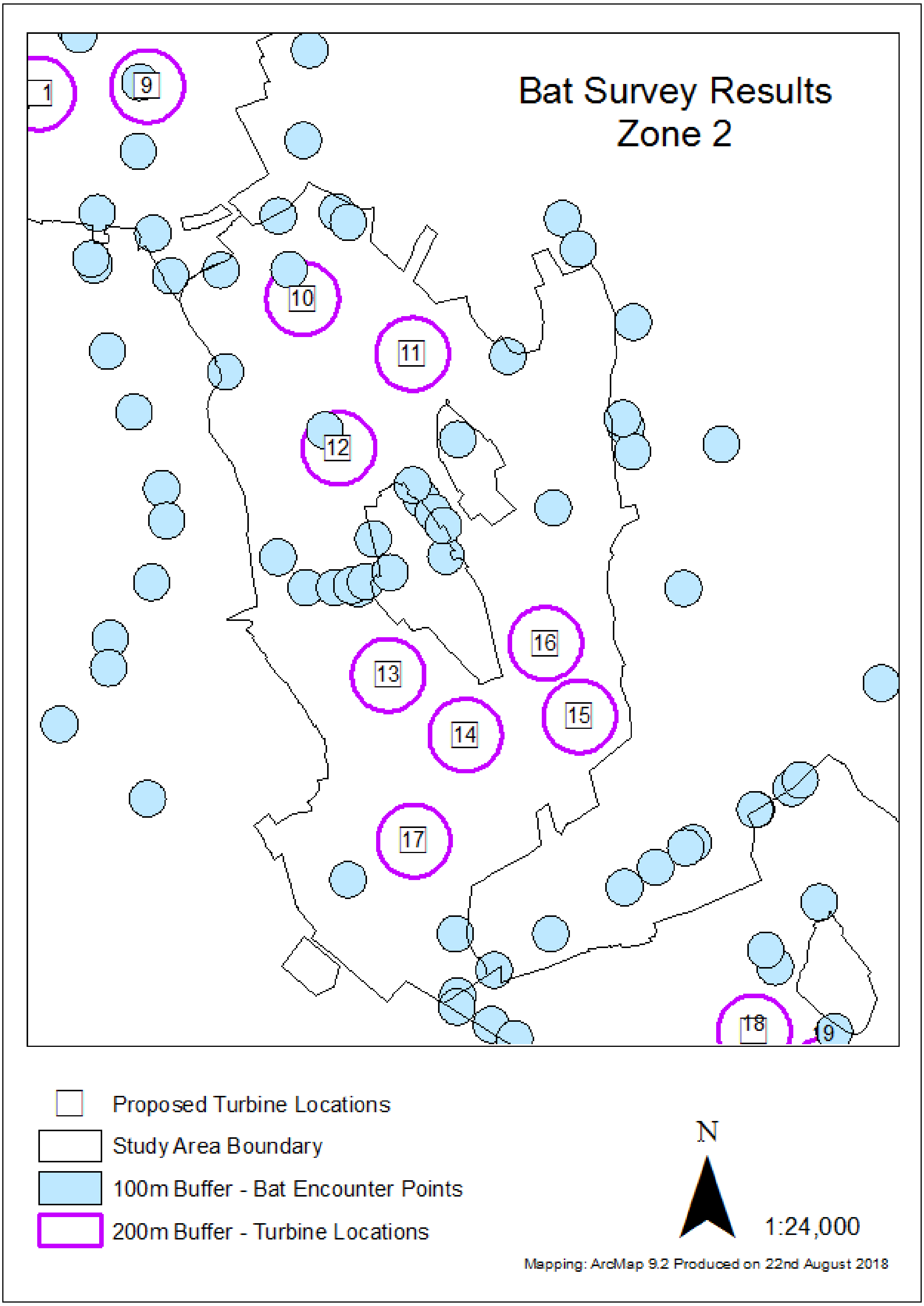
From these maps we can see that the following wind turbine locations may impact on local bat populations (Map 4.12 a, b & c):

Table 4.9: Turbines that may impact on local bat populations.

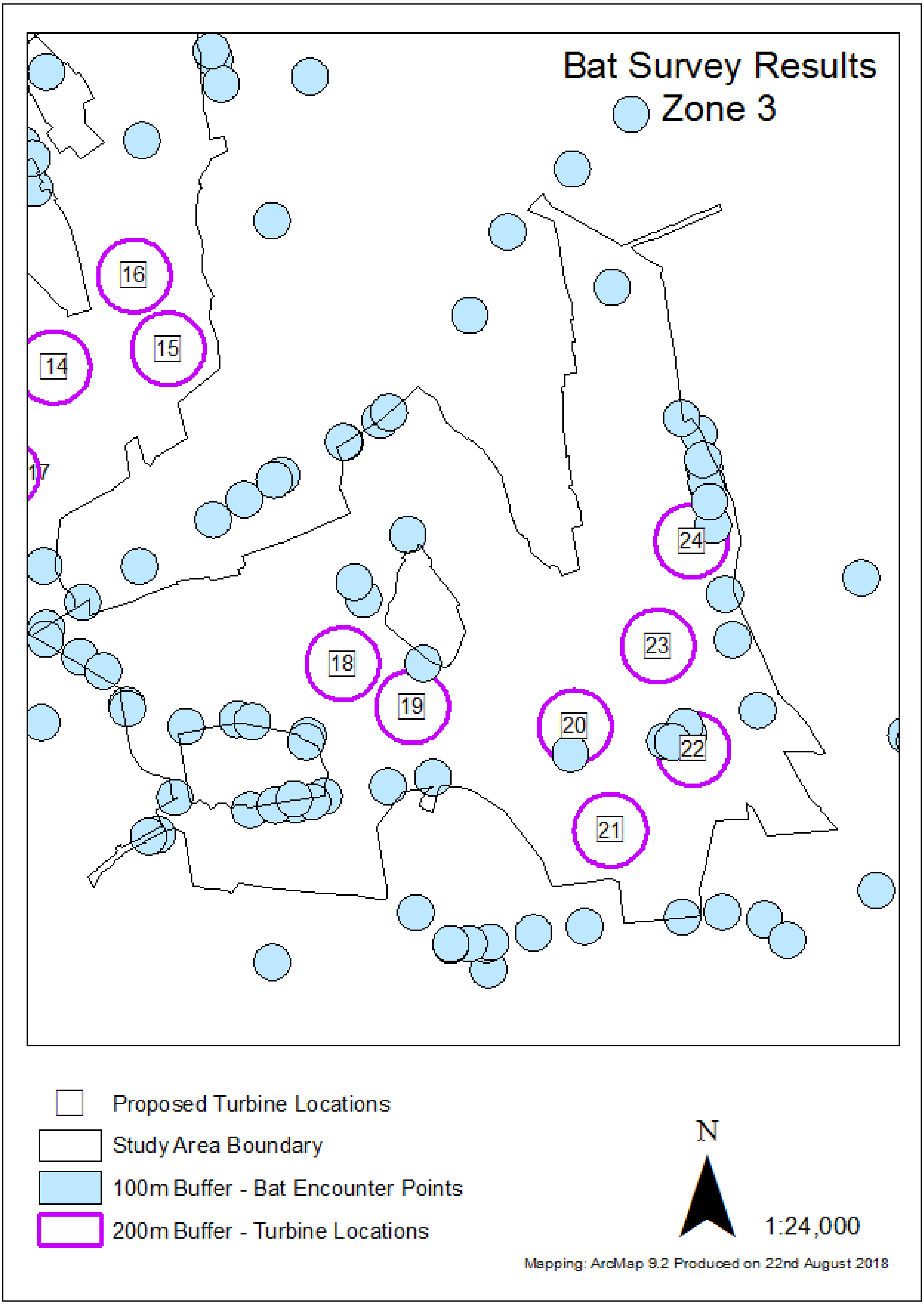
T1	T2	T4	T9	T10
Derryaroge	Derryaroge	Derryaroge	Derryaroge	Derryadd
Zone 1	Zone 1	Zone 1	Zone 2	Zone 2
T12	T19	T20	T22	T24
Derryadd	Derryadd	Lough Bannow	Lough Bannow	Lough Bannow
Zone 2	Zone 2	Zone 3	Zone 3	Zone 3



Map 4.12a: 100m buffer zones around bat encounters and 200m buffer zones around proposed location of wind turbines in Zone 1.



Map 4.12b: 100m buffer zones around bat encounters and 200m buffer zones around proposed location of wind turbines in Zone 2.



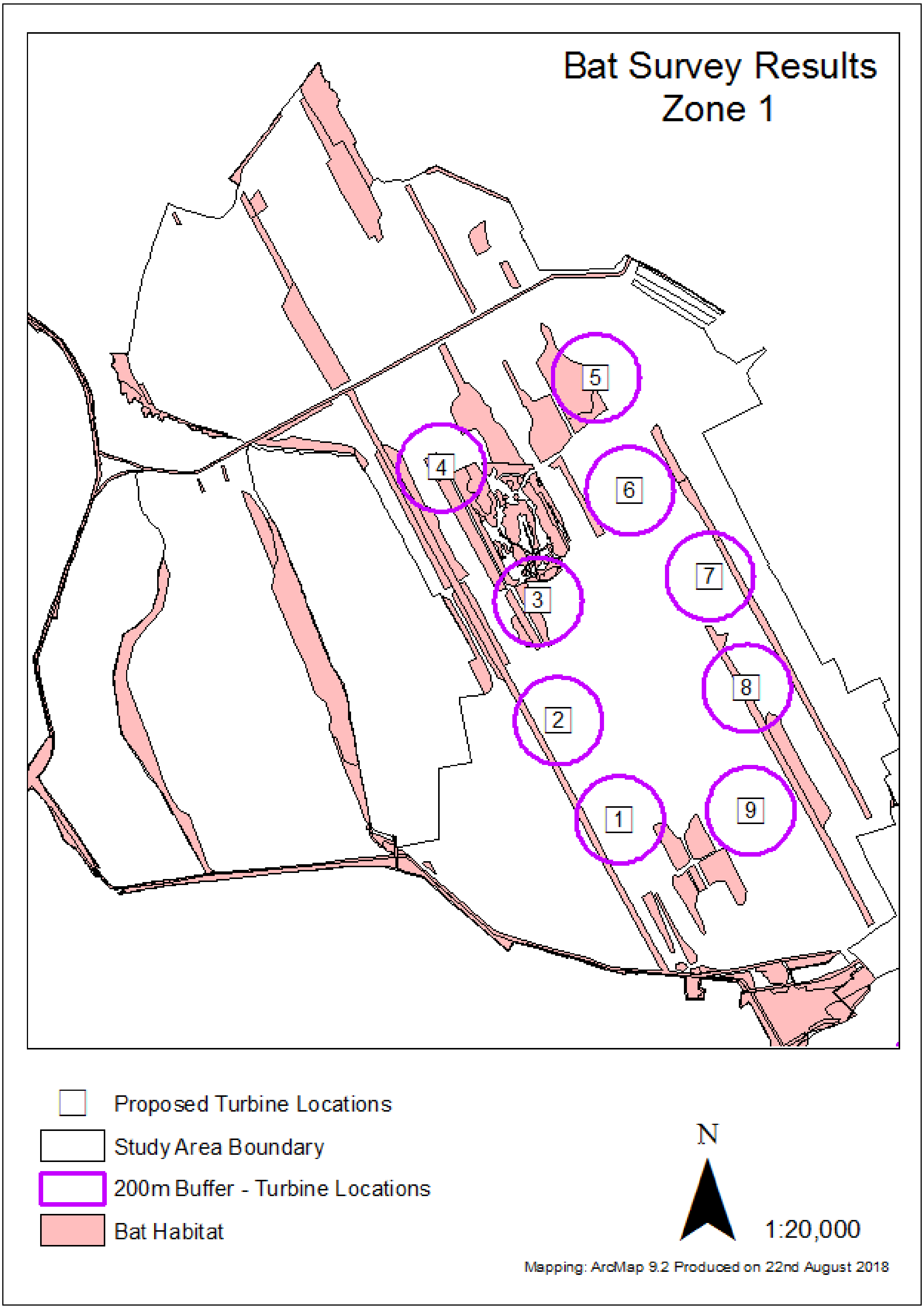
Map 4.12c: 100m buffer zones around bat encounters and 200m buffer zones around proposed location of wind turbines in Zone 3.

To further aid analysis, habitats deemed suitable for foraging bats were extracted from habitat maps produced by Bord na Mona and overlaid on the buffer zones.

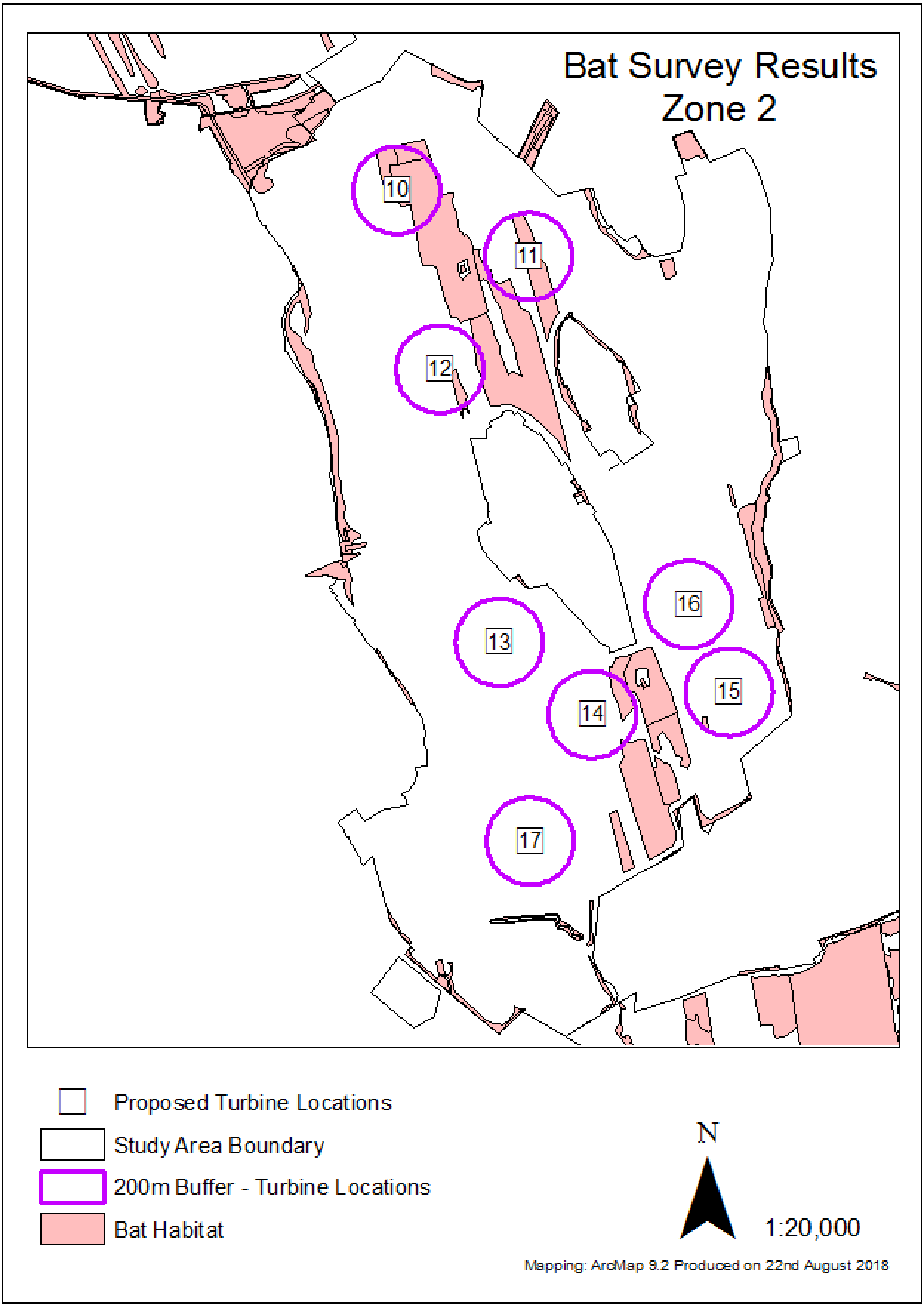
From these maps we can see that the following wind turbine locations (where 20% or more of suitable bat habitat was present within the 200m buffer zone of wind turbine locations) may impact on local bat populations (Map 4.13 a, b & c):

Table 4.10: Turbines that may impact on local bat populations.

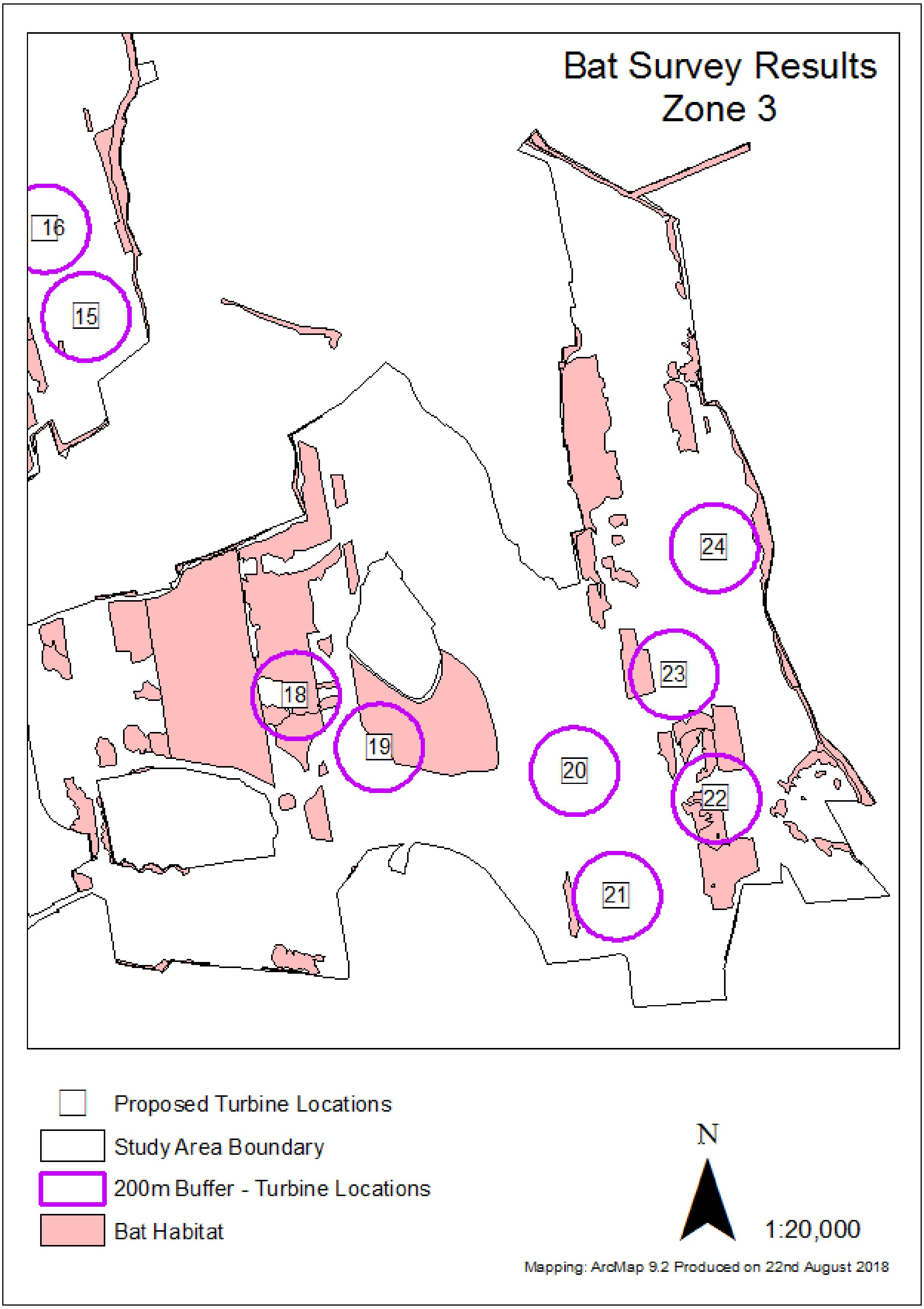
T3	T4	T5	T10	T11	T18	T19	T22
Derryaroge	Derryaroge	Derryaroge	Derryadd	Derryadd	Lough Bannow	Lough Bannow	Lough Bannow
Zone 1	Zone 1	Zone 1	Zone 2	Zone 2	Zone 3	Zone 3	Zone 3



Map 4.13 a: 200m buffer zones around proposed location of wind turbines along with "Bat Habitats" in Zone 1.



Map 4.13 a: 200m buffer zones around proposed location of wind turbines along with “Bat Habitats” in Zone 2.



Map 4.13 a: 200m buffer zones around proposed location of wind turbines along with “Bat Habitats” in Zone 3.

4.2.2 Weather Data Analysis Results

Weather data collated by the anemometer at Derryaroge was investigated in relation to the potential influence of maximum wind speed (at the 50m and 10m level) and average temperature (at the 79m and 5m level) on bat activity for each of the dates when bat activity was recorded by Units 4 and 5 located on the Derryaroge anemometers. The average hourly figures were used. This exercise was only completed for one mast in order to provide an example of the potential influence of air temperature and wind speed on bat activity.

The hourly data from Derryaroge 80m mast were analysed. Bat data collated by the microphone located on the Derryaroge 80m mast at a height of 4m was correlated with wind speed taken at the 10m level and air temperature recorded at 5m level. Bat data collated by the microphone located at the 50m height was correlated with wind speed taken 50m and air temperature recorded at 79m (the location of the data logger on the mast).

a) Data in relation to microphone at 4m height

Of the 257 hours of bat activity recording time was completed on Unit 4 at the 4m level at Derryaroge 80m mast. During this total number of recording hours bat activity was recorded during 48x 1 hour slots of the surveillance time (18%). A total of 81 bats passes were recorded relating to four bat species: soprano pipistrelle, common pipistrelle, *Myotis* species and Leisler's bats. Taking these 257 hours, the weather data corresponding to these recordings periods were analysed.

In relation to temperature data taken at the 5m height point, a total of 30 hours from 257 hours of surveillance was completed over the 6 months survey period was below 8^{o}C. This temperature is considered to be the lowest temperature at which bat activity surveying is undertaken as insect activity decreases once air temperatures goes below 8^{o}C. Within this 30 hours dataset, only on one occasion was bat recorded when the air temperature was below 8^{o}C (4/7/2016, 00:00 hrs, 7.6^{o}C, 2.3 m/s wind speed): *Myotis* species. The vast majority of bat passes were recorded in the temperatures of 8^{o}C and greater (n=80 bat passes or 99% of bat passes). The air temperature range where bat activity was recorded was 7.6 – 21 ^{o}C with an average temperature of 12.8 ^{o}C.

Table 4.11: Total number of hours where bat activity was recorded at >8^{o}C and <8^{o}C during bat recorded surveillance hours at Derryaroge 80m Mast in relation to the microphone located at 4m height level.

Air Temp >8^{o}C	**Bat Activity** *(Air Temp >8^{o}C)*	**Air Temp <8^{o}C**	**Bat Activity** *(Air Temp <8^{o}C)*
227 hrs	47 hrs (21%)	30 hrs	1 hr (3%)
	80 bat passes (1.7 bat passes/hr)		1 bat pass (1 bat pass/hr)

In relation to wind speed taken the 10m height point, the highest wind speed at which bat activity was recorded was 10 m/s (5/9/2016, 21:00hrs, 11.3 ^{o}C, no rain – Leisler's bat). Bat activity was recorded during wind speeds ranging from 1.1 to 10.0 m/s (Average = 4.8 m/s). Of the 257 hours of data analysed, bat activity was recorded for 19% of this time (n=81 bat passes in 48x 1 hr slots).

Often cut-in speeds for wind turbines in relation to bats are recommended to be set at 5.5 – 6.0 m/s. Therefore taking 6.0 m/s as a cut-off point to look at the data, wind speed was less than 6 m/s for 175 hours of recording (68%). Of the 257 hours of surveillance at this microphone height, 82 hours had a recorded an average wind speed of 6.0 m/s or greater. Bat activity was recorded during 17x 1 hr slots (24 bat passes) of the time when the higher wind speed category was recorded compared to 31x 1 hr slots (57 bat passes) of the surveillance time when wind speed was less than 6.0 m/s (See Table 4.12).

Table 4.12: Total number of hours where bat activity (Unit 4) was recorded at <6 m/s and equal or >6 m/s during bat recorded surveillance hours at Derryaroge 80m Mast in relation to the microphone located at 4m height level.

Wind Speed <6 m/s	**Bat Activity** *(Wind Speed <6 m/s)*	**Wind Speed >6 m/s**	**Bat Activity** *(Wind Speed >6 m/s)*
175 hrs	31 hrs (18%)	82 hrs	17 hrs (20%)
	57 bat passes (1.8 bat passes/hr)		24 bat passes (1.4 bat passes/hr)

In relation to species composition, Table 4.13 shows that there is a slightly higher level of common pipistrelle bat passes at the lower wind speed category while there is a slightly higher level of Leisler's bat passes at the higher wind speed category. However caution is required her as the number of bat passes recorded is a low.

Table 4.13: Total number of bat passes recorded per species (Unit 4) at <6 m/s and equal or >6 m/s during bat recorded surveillance hours at Derryaroge 80m Mast in relation to the microphone located at 4m height level.

Wind Speed <6 m/s	**Leisler's bat**	**Soprano pipistrelle**	**Common pipistrelle**	***Myotis* species**
<6 m/s (31 hrs)	12 bat passes (0.4 bat passes/hr)	13 bat passes (0.4 bat passes/hr)	20 bat passes (0.6 bat passes/hr)	12 bat passes (0.4 bat passes/hr)
>6 m/s (17 hrs)	8 bat passes (0.5 bat passes/hr)	6 bat passes (0.4 bat passes/hr)	5 bat passes (0.3 bat passes/hr)	5 bat passes (0.3 bat passes/hr)

b) Data in relation to microphone at 50m height

Of the 556 hours of recording analysed, bat activity was recorded during 43 hours of the surveillance time (7.7%). A total of 102 bats passes were recorded relating to three bat species: soprano pipistrelle, common pipistrelle and Leisler's bats.

In relation to temperature data taken a the 79m height point, a total of 92 hours from 556 hours of surveillance over the 6 months survey period was below 8^{o}C. Within this 92 hours dataset, there was no bat activity recorded when the air temperature was below 8^{o}C. Bat activity was only recorded when the temperature was 8^{o}C or more. The air temperature range where bat activity was recorded was 9.0 – 20.5 ^{o}C with an average temperature of 14.7 ^{o}C.

Table 4.14: Total number of hours where bat activity was recorded at <8^{o}C and equal to or >8^{o}C during bat recorded surveillance hours at Derryaroge 80m Mast in relation to the microphone located at 50m height level.

Air Temp <8^{o}C	**Bat Activity** *(Air Temp <8^{o}C)*	**Air Temp >8^{o}C**	**Bat Activity** *(Air Temp >8^{o}C)*
464 hrs	43 hrs (9%)	92 hrs	0 hrs (0%)
	102 bat passes (2.4 bat passes/hr)		0 bat passes (0 bat passes/hr)

In relation to wind speed taken the 50m height point, the highest wind speed at which bat activity was recorded was 12 m/s (5/9/2016, 21:00hrs, 20.5 ^{o}C, no rain – Leisler's bat). This date coincides with the date reported at the 4, height microphone. Therefore the Leisler's bat recorded at both microphones is likely to be the same individual picked up by both microphones.

Often cut-in speeds for wind turbines in relation to bats are recommended to be set at 5.5 – 6.0 m/s. Therefore taking 6.0 m/s wind speed category, bat activity was recorded during 12 hours (30% of hours where bat activity was recorded) when the wind speed was equal to or great than 6.0m/s. Bat activity was recorded during wind speeds ranging from 1.1 to 12.0 m/s (Average = 5 m/s).

Of the 556 hours of surveillance at this microphone height, 331 hours had a recorded wind speed of 6.0 m/s or greater. Bat activity was only recorded during 4% of surveillance time when wind speed exceed 6 m/s compared to 14% of the surveillance time when wind speed was less than 6.0 m/s (See Table 4.15).

Table 4.15: Total number of hours where bat activity was recorded at <6 m/s and equal to or >6 m/s during bat recorded surveillance hours at Derryaroge 80m Mast in relation to the microphone located at 50m height level.

Wind Speed <6 m/s	**Bat Activity** *(Wind Speed <6 m/s)*	**Wind Speed >6 m/s**	**Bat Activity** *(Wind Speed >6 m/s)*
225 hrs	31 hrs (14%)	331 hrs	12 hrs (4%)
	89 bat passes (2.8 bat passes/hr)		17 bat passes (1.4 bat passes/hr)

In relation to species composition, Table 4.16 shows that there is a higher level of Leisler's bat and common pipistrelle bat passes at the lower wind speed category. However caution is required her as the number of bat passes recorded is a low.

Table 4.16: Total number of bat passes recorded per species (Unit 5) at <6 m/s and equal or >6 m/s during bat recorded surveillance hours at Derryaroge 80m Mast in relation to the microphone located at 50m height level.

Wind Speed <6 m/s	Leisler's bat	Soprano pipistrelle	Common pipistrelle
<6 m/s (31 hrs)	41 bat passes (1.3 bat passes/hr)	10 bat passes (0.3 bat passes/hr)	37 bat passes (1.2 bat passes/hr)
>6 m/s (12 hrs)	8 bat passes (0.7 bat passes/hr)	6 bat passes (0.5 bat passes/hr)	5 bat passes (0.4 bat passes/hr)

4.3.3 Potential "Bat Habitat" Clearance Results

To evaluate the potential impact of the construction of the internal road network required for the proposed wind farm on bat usage of the survey area, the zone of construction was investigated using the internal road network against the 100m Buffer – Bat Encounter points and "Bat Habitats" layer. As a bat survey is a snap shot of bat activity, it is important to consider both the bat survey results and the occurrence of bat habitat. The potential impact of the internal road network is in relation to potential clearance of "Bat Habitats" along the route of the road network.

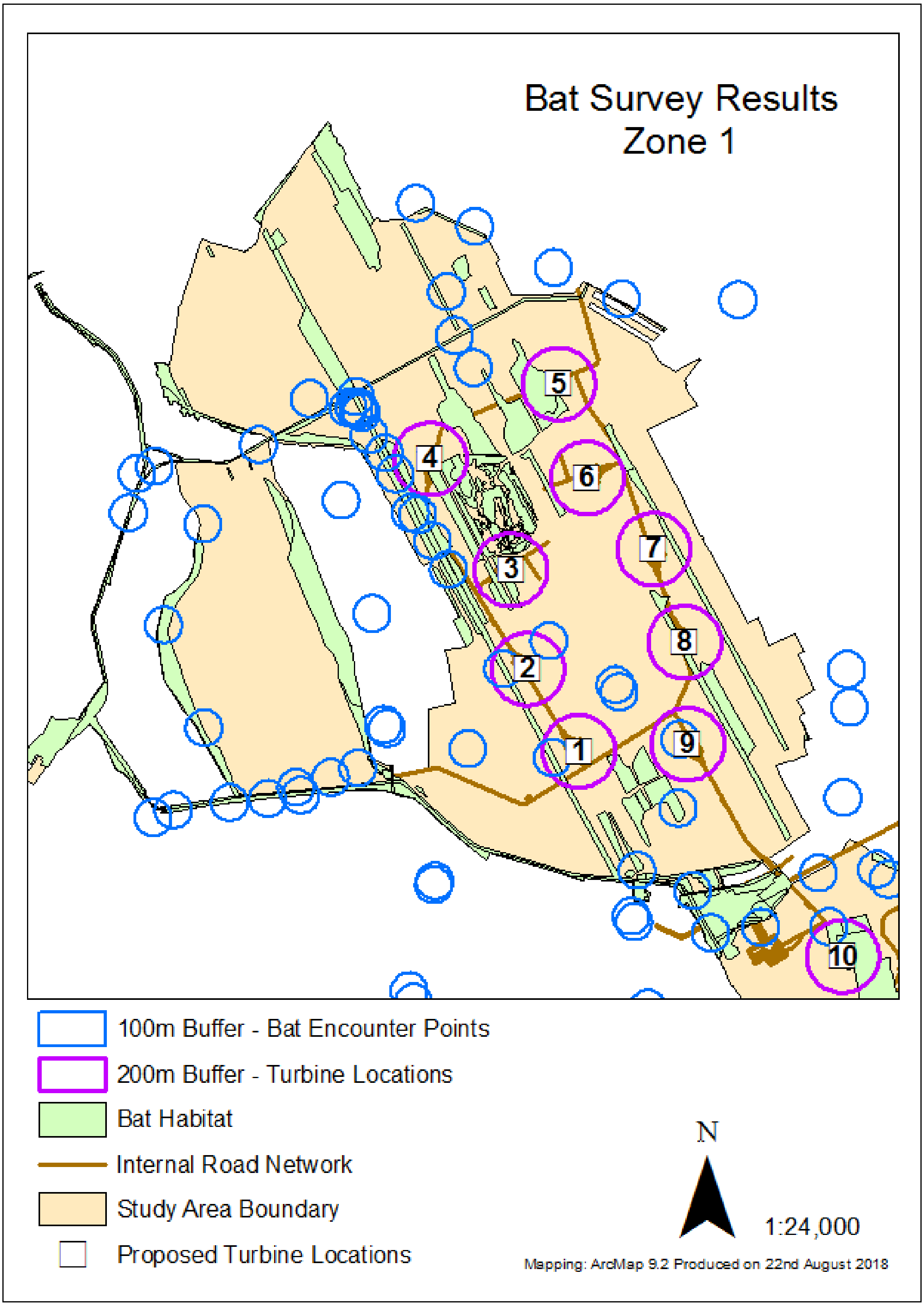
The following three maps (4.14a, b and c) show locations where "Bat Habitats" may require clearance along the internal road network. This is also presented in Table 4.17. The maps depict potential bat habitat clearance in vicinity of T1, T3, T4, T5, T6, T8, T10, T11, T18, T19 and T22. There are also sections of the internal road network that may impact on bat habitat between T4 – T5, T5 - T6, T14 – T15 and T2 – T21.

The total area of "Bat Habitats" calculated using GIS is 434.53 ha. The length of haul road estimated to traverse through "Bat Habitats" is 9km. Therefore it is estimated that 1.24% of "Bat Habitat" will be cleared to facilitate haul roads.

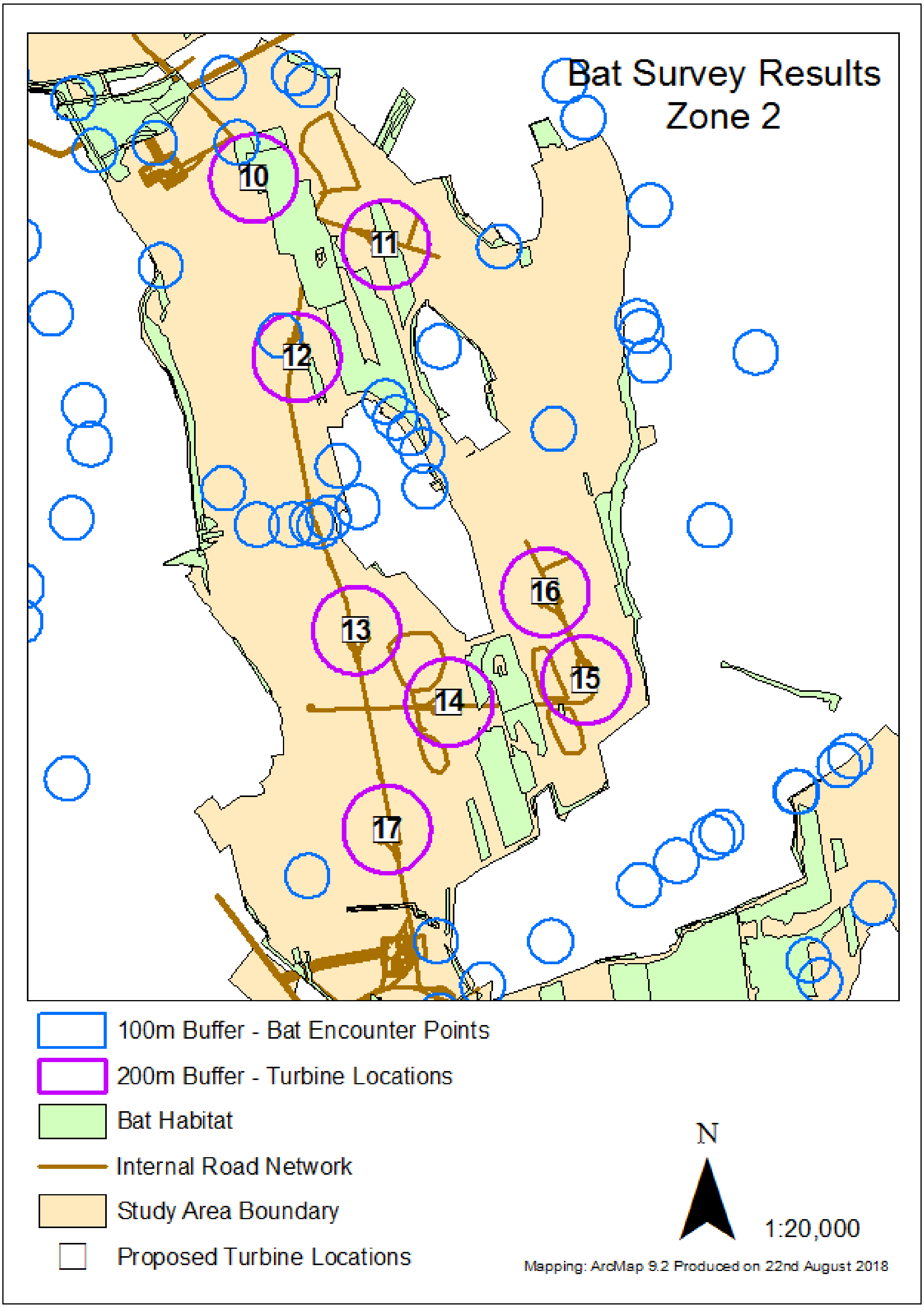
Table 4.17: Sections of the internal road network that may impact on local bat populations.

T1	**T3**	**T4**	**Between T4 – T5**	**T5**	**Between T5 – T6**	**T8**
Derryaroge	Derryaroge	Derryaroge	Derryaroge	Derryaroge	Derryaroge	Derryaroge
Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1

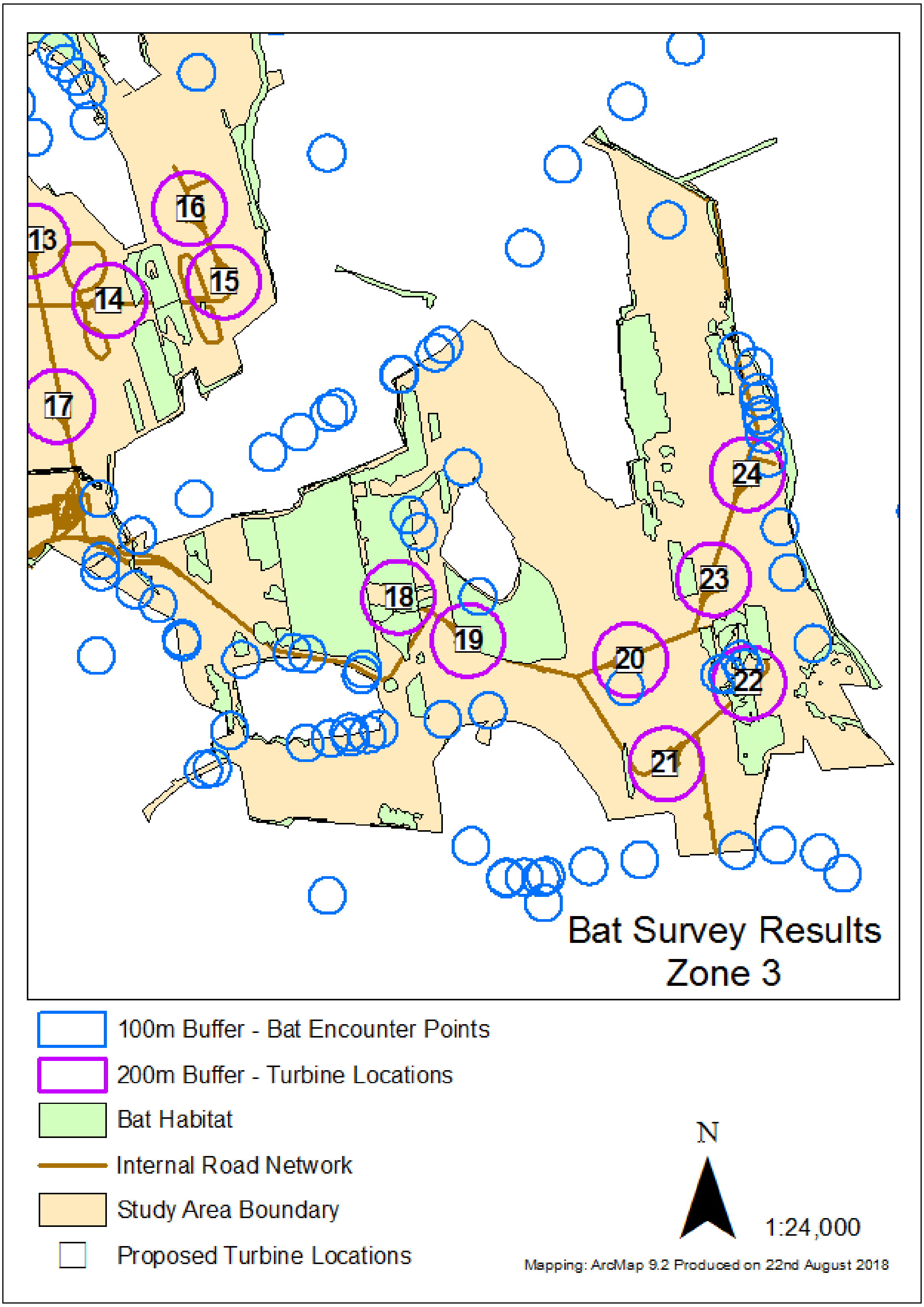
T10	**T11**	**Between T14 – T15**	**T18**	**T19**	**Between T20 – T21**	**T22**
Derryadd	Derryadd	Lough Bannow	Lough Bannow	Lough Bannow	Lough Bannow	Lough Bannow
Zone 2	Zone 2	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3



Map 4.14a: Potential impact from construction of internal road network as a result of potential removal of “Bat Habitats” in Zone 1.



Map 4.14b: Potential impact from construction of internal road network as a result of potential removal of "Bat Habitats" in Zone 2.



Map 4.13c: Potential impact from construction of internal road network as a result of potential removal of “Bat Habitats” in Zone 3.

5. Potential Impacts of Proposed Development on Bats

For this ecological assessment, the habitats adjacent to the proposed development may be considered in terms of extent, diversity, naturalness, rarity, fragility, typicalness, recorded history, position, potential value and intrinsic appeal (Regini, 2000). The potential of these habitats for bat fauna is considered in this framework also.

i Bats may use trees with heavy ivy growth as occasional roosts. Bats may use mature trees with tree holes etc., as roosting sites all year around. However, in general, there is a paucity of these two types of mature trees within the survey area. They are present in the adjacent landscape or within the blocks of agricultural land enclosed by the survey area.

ii Foraging and commuting areas are available to bats adjacent to and within the proposed wind farm areas along scrub habitats, treeline tracks and riparian linear features. There is less foraging and commuting capacity over bare peat and similar low height vegetation habitats. The exception to this is Leisler's bats and Nathusius' pipistrelles, which are bat species that fly high over the landscape. They are not a reliant on linear habitats to traverse through the landscape.

iii An extensive array of buildings are located adjacent to the survey area while a small number of buildings (generally associated with the operation of peat harvesting) are located within the survey area. During walking and driving transects, a number of buildings (primarily residential buildings and agricultural buildings) were recorded as bat roosts but these were located outside the survey area boundary. Buildings within the survey area were surveyed and none of them were recorded as roosting sites during the bat surveys. However, bats are extremely transient animals, moving between summer, autumn, winter and spring roosting sites and the typical farmed landscape of the adjacent area and adjacent diverse habitats provides an array of building with supporting commuting network (treelines, hedgerows and stonewalls) and foraging habitat (scrub, woodland, treelines, hedgerows and local road network) that is essential for a healthy local bat population. This diversity is typical example of midland Irish landscapes.

1 *agricultural grasslands*.

This habitat is present within the survey area as agricultural blocks surrounded by bare peat habitats. These agricultural blocks and associated hedgerows/treeline boundaries provides foraging habitat for common bat species especially common pipistrelle and Leisler's bat. May be considered as Medium ecological value for bats.

2 *hedgerow and treeline boundaries, access tracks*.

These habitat types are present around agricultural blocks, boundaries of the survey area, around work areas and along access tracks (rail system) through the survey area. Such provide wildlife corridors and foraging areas for many bat species. Bat roosts may be present in mature trees or larger ivy-covered trees, which are few in this primarily peat landscape. However, these linear habitats are essential for commuting bats. May be considered as High ecological value for bats.

3 *areas of scrub and woodland*.

The survey area includes some large areas of scrub. Variable in species composition, any areas of scrub can provide foraging areas for bats with some commuting potential. In general, a bare peat landscape, which is primarily found in the survey area, means that the importance of scrub habitat increases as it provides cover for commuting and foraging bats through the survey area. Its importance is higher when associated with riparian ditches and treelines/hedgerows. May be considered as of High Local value for bats.

4 *bare peat and associated habitats*.

There are large areas of open peatland. These areas provide little foraging habitat for bats and are not suitable for commuting for the majority of bat species, excluding Leisler's bats and Nathusius' pipistrelles, as both of these two species do not rely on linear landscape features to commute from roosting site to foraging habitats. May be considered as Low ecological value for bats.

5 *ponds/riparian linear habitats*.

There is a large array of riparian ditches throughout the survey area with a small number of open water. Where these are located adjacent to scrub, hedgerows/treelines, their value to bats is higher and creates an area of medium ecological value for commuting and foraging bats. May be considered as of Medium Local value for bats.

6 buildings – work areas.

There are a small number of buildings located within the survey area but these are located on the boundary of the survey area. These are work areas are for the current operation of peat harvesting. These buildings may provide roosting potential occasionally for bats but none was recorded during the bat survey completed to-date. Their ecological value increase when associated with hedgerows and treelines, which many of them area. May be considered as of low to medium ecological value for bats.

The ecological value of the different bat species are presented in Table 5.1 along with the Natural England "Bat Risk". Two High "Bat Risk" bat species were recorded during the bat surveys. Therefore a high level of bat mitigation is required for these two bat species. Leisler's bats were recorded within the 200m buffer zone of T2, T12 and T19. The two recordings of Nathusius' pipistrelle were not within a 200m buffer zone of any current turbine location.

Table 5.1: Ecological valuation of the bat species recorded during the bat survey (CIEM Guidelines, 2016) and “Bat Risk” in relation to Wind Turbines (Natural England).

Ecological Value	Geographical Scale of Importance	Bat Risk
International	Leisler’s bat	High
National	Nathusius’ pipistrelle	High
Regional	Brown long-eared bat Natterer’s bat	Low Low
County		
Local	Soprano pipistrelle Common pipistrelle	Medium Medium
Negligible		

An evaluation of the potential impacts of the wind turbines are outlined in Table 5.2 below. Site evaluations are based on the Natural England Technical Information Note TIN051 for evaluating the potential impacts of wind turbines on bats and EUROBATS guidelines (200m zone). The revised EUROBATS guidelines (2014) stated that 200m zone should be applied to all habitats deemed used by bats for foraging and commuting. However Natural England offer an equation to calculate a buffer zone depending on the height of the turbine hub and the length of the turbine blade. The Natural England Guidance states *“The Eurobats guidance proposes that the buffer surrounding woodland areas should be 200m, while this document (Natural England) suggest a buffer zone of at least 50m from the tip of the turbine blade. One reason for the difference is that the European guidelines are catering for a greater diversity of species, some of which are known to fly very long distances, often in the open away from woodland.*” Therefore taking the equation and if the potential size of the turbine hub height is100m and turbine blades is 65m, then buffer zone is set at 77.5m from the tip of the turbine blade. This calculation will need to be completed according to the final turbine hub height and blade length is clarified for this proposed wind farm.

Due to the paucity of information on the impacts of wind turbines on bats, the ‘bat risk’ is based on what bat fauna group is recorded in the area of each turbine location (both in the zone category and within the buffer areas) and the bat fauna group is categorised as either low, medium or high risk bat groups (high flying bats = Leisler’s and Nathusius’ pipistrelle) and therefore requiring a low, medium or high level of bat mitigation. There are three distinct zones to the proposed wind farm location (Zone 1: turbines 1-9; Zone 2: turbines 10-17 and Zone 3: turbines 18-24). This risk assessment is also based on the presence of bat habitats (2 levels: >20% and <20%) within the 200m buffer area around each of the turbines.

The current location of six wind turbines is deemed to have a potential high impact on local bat populations: T2, T4, T10, T12, T19 and T22.

The current location of five wind turbines is deemed to have a potential medium impact on local bat populations: T1, T3, T5, T11 and T18.

The current location of seven wind turbines is deemed to have a potential low impact on local bat populations: T7, T8, T9, T20, T21, T23, T24.

The current location of the remaining turbines is considered to have negligible impact on local bat populations: T6, T13, T14, T15, T16 and T17.

The potential impact of the Construction Phase is presented in Table 5.3. This phase will require the removal of vegetation (i.e. areas deemed to be bat habitat) in vicinity of the turbine location and along infrastructure routes to facilitate construction.

NOTE: While there will be an impact from this phase, in order to reduce the operational impact of the wind turbines (i.e. reducing the attractiveness of bats foraging in vicinity of the individual turbines), clearance of bat habitat is recommended as part of the bat mitigation measures.

NOTE: The final draft of this report was completed prior to the publication of SNH, 2019. The report assessment was completed using the potential risk of species as reported by Natural England. As a consequence, the assessment was completed as Common and Soprano pipistrelle assessed as "Medium Risk" species. However it is deemed that the assessment completed in this report is appropriate for this proposed development site due to its primary open habitat of cut-over bog.

Table 5.2: Evaluation of the potential impacts of individual turbine locations on local bat populations.

Potential Impact - High	Potential Impact - Medium	Potential Impact - Low	Potential Impact - Negligible

Potential Impact - High: where **ALL** boxes are ticked: Boxes 1 – 6 including >20% Bat Habitat is present or if Leisler's bat was recorded within the 200m buffer zone

Potential Impact - Medium: where at least five of the boxes are ticked: Boxes 1 – 6, including >20% Bat Habitat is present

Potential Impact - Low: where at least four boxes are ticked: Boxes 1 – 6

Turbine	Zones	1. Low Impact Species (according to zones)	2. Medium Impact Species (according to zones)	3. High Impact Species (according to zones)	4. Bats recorded within 200m	5. Bat Habitat Present	6. Bat Habitat along Internal Road Network
1	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	Yes (<20%)	Yes
2	Zone 1	BLE, Myotis	SP, CP	Leis	Yes (Leisler's bat)	Yes (<20%)	No
3	Zone 1	BLE, Myotis	SP, CP	Leis	No	**Yes (>20%)**	Yes
4	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	**Yes (>20%)**	Yes
5	Zone 1	BLE, Myotis	SP, CP	Leis	No	**Yes (>20%)**	Yes
6	Zone 1	BLE, Myotis	SP, CP	Leis	No		No
7	Zone 1	BLE, Myotis	SP, CP	Leis	No	Yes (<20%)	No
8	Zone 1	BLE, Myotis	SP, CP	Leis	No	Yes (<20%)	Yes
9	Zone 1	BLE, Myotis	SP, CP	Leis	Yes		No
10	Zone 2	BLE, Myotis	SP, CP	Leis	Yes	**Yes (>20%)**	Yes
11	Zone 2	BLE, Myotis	SP, CP	Leis	No	**Yes (>20%)**	Yes
12	Zone 2	BLE, Myotis	SP, CP	Leis	Yes (Leisler's bat)	Yes (<20%)	No
13	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No

14	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
15	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
16	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
17	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
18	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip		**Yes (>20%)**	Yes
19	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	**Yes (>20%)**	Yes
20	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	No	No
21	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	No	Yes (<20%)	No
22	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	**Yes (>20%)**	Yes
23	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	No	Yes (<20%)	No
24	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	No	No

Table 5.3: Evaluation of the potential impacts of construction of turbine locations (i.e. vegetation removal, infrastructure etc.) on local bat populations.

High Level	Medium Level	Low Level	Negligible Level

High Level: where the following boxes are ALL ticked: High Impact Species, Haul Road Impact & Bat Habitat present (>20%)

Medium Level: where at least two of the following boxes are ticked: High Impact Species Haul Road Impact & Bat Habitat present (>20%)

Low Level: where at least one of the following boxes are ticked: High Impact Species, Haul Road Impact & Bat Habitat present (>20%)

Turbine	Zones	High Impact Species (according to zones)	Medium Impact Species (according to zones)	Low Impact Species (according to zones)	Haul Road Impact*	Bat Habitat Present^	Bat Mitigation Required
1	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	Yes (<20%) + Along haul road route	Yes
2	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	Yes (<20%)	Yes
3	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	Yes (>20%) + Along haul road route	Yes
4	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	Yes (>20%) + Along haul road route	Yes
5	Zone 1	BLE, Myotis	SP, CP	Leis	Yes	Yes (>20%) + Along haul road route	Yes
6	Zone 1	BLE, Myotis	SP, CP	Leis	No	No	No
7	Zone 1	BLE, Myotis	SP, CP	Leis	No	Yes (<20%)	Yes
8	Zone 1	BLE, Myotis	SP, CP	Leis	No	Yes (<20%)	Yes
9	Zone 1	BLE, Myotis	SP, CP	Leis	No	No	No
10	Zone 2	BLE, Myotis	SP, CP	Leis	Yes	Yes (>20%) + Along haul road route	Yes
11	Zone 2	BLE, Myotis	SP, CP	Leis	Yes	Yes (>20%) + Along haul road route	Yes
12	Zone 2	BLE, Myotis	SP, CP	Leis	Yes	Yes (<20%) + Along haul road route	Yes
13	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
14	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
15	Zone 2	BLE, Myotis	SP, CP	Leis	Yes	Along haul road route only	Yes

16	Zone 2	BLE, Myotis	SP, CP	Leis	No	No	No
17	Zone 2	BLE, Myotis	SP, CP	Leis	Yes	Along haul road route only	Yes
18	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	No	Yes (>20%) + Along haul road route	Yes
19	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	Yes (>20%) + Along haul road route	Yes
20	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	No	Yes
21	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	No	Yes (<20%) + Along haul road route	Yes
22	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	Yes	Yes (>20%) + Along haul road route	Yes
23	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	No	Yes (<20%)	Yes
24	Zone 3	BLE, Myotis	SP, CP	Leis, Nath pip	No	No	No

** In vicinity of turbine location, or to and from the listed turbine location.*

^ Bat Habitat – where >20% or <20% is listed, this refers to the estimated amount of bat habitat present within the 200m buffer zone of wind turbine locations. Otherwise, if there is bat habitat along the road haul route, this is listed in addition.

6. Bat Mitigation Recommendations

Suitable mitigation measures to minimise the impacts of wind farms on bats are currently limited. Therefore it is essential that new and positive measures for bats that become available in the interim are implemented, where possible, for this proposal. As new guidelines are reported, the mitigation measures should be reconsidered prior to operation and subject to monitoring results.

6.1 Design Phase

Mitigation is best achieved through avoidance especially in relation to bat fauna. It is proposed that the following measures be put in place to avoid or lessen the degree of impacts on local bat populations.

1. DESIGN – size of turbines

The principal design recommendation is the size of the turbine (i.e. vertical extent and height of the rotor swept area). The hub height and blade length for this project has not been clarified to-date. Some papers have reported that shorter turbines have less of an impact on bats as it means that the blade length is less and therefore less likely to collide with flying bats. It was deemed that mitigation measures should be centred on turbine height and blade size when considering facility characteristics, and centred on which at-risk species may fly through the facility. Taller turbines often have much larger rotor-swept areas, and it has been hypothesized that collision fatalities will increase due to the greater overlap with flight heights of bats (Johnson et al. 2002; Barclay et al. 2007). The turbine blade option is up to 65m.

2. DESIGN – Location of wind turbines & landscaping

The first stage of Planning & Siting of a proposed wind energy facility provides the opportunity to make best practices in relation to minimising the impact on wildlife particularly in avoiding high risk areas. Particular habitats, such as riverine valleys, woodland edges and linear landscape features such as hedgerows should be avoided as these are particularly used by commuting bats. This has been undertaken initially by the project.

The highest level of bat mitigation is recommended for turbine locations where Leisler’s bats were recorded within the 200m buffer zone (i.e. T2 and T12). The location and landscaping of the wind turbines is an important element to ensure the impact on local bat populations are reduced as much as possible before the operation of the wind farm.

Details of recommendations are provided in 6.1.

Table 6.1: Bat Mitigation Measures recommended during the Design Phase.

High Level Bat Mitigation – Leisler's bats This applies to T2 and T12	**High Level Bat Mitigation** This applies to T4, T10, T19 and T22 This applies to Internal Road Network between T4 – T5	**Medium Level Bat Mitigation** This applies to T1, T3, T5, T11 and T18 This applies to Internal Road Network between T5 – T6	**Low Level Bat Mitigation** This applies to T7, T8, T9, T20, T21, T23 and T24.
Move wind turbine 200m away from bat habitats (Eurobats Guidelines, 2014).	Ensure that wind turbine is >50m away from bat habitat according to English Nature calculation (detailed below and to be calculated once size of turbines is clarified).	Ensure that wind turbine is >50m away from bat habitat according to English Nature calculation (detailed below and to be calculated once size of turbines is clarified). This can be achieved, where possible through micro-siting.	Where possible, move wind turbine is >50m away from bat habitat according to English Nature calculation (detailed below and to be calculated once size of turbines is clarified). This can be achieved, where possible through micro-siting.
Move haul road routes to ensure that they are located outside "Bat Habitat" zones.	Move haul road routes, where possible, to locate the route away from bat habitat zones and minimise "Bat Habitat" removal.	Move haul road routes, where possible, to locate the route away from bat habitat zones and minimise "Bat Habitat" removal.	

- 50m buffer zone

To minimize risk to bat populations, a buffer zone of 50m around any treeline, hedgerow, woodland feature, into which no part of the turbine should intrude. Therefore, 50m should be the minimum distance from the blade tip to the nearest habitat feature.

Using the formula quoted below, the minimum distances of wind turbines for Low Bat Mitigation Level are calculated:

formula: *Buffer distance* = $\sqrt{(50 + b1)^2 - (hh - fh)^2}$

where bl = blade length, hh = hub height, fh = feature height (all in meters)

The dimensions of the wind turbine have to be clarified. Once this is clarified the buffer should be calculated as per the actual turbine specifications.

6.2 Construction Phase

Mitigation is best achieved through avoidance especially in relation to bat fauna. It is proposed that the following measures be put in place to avoid or lessen the degree of impacts on local bat populations.

The Rehabilitation Plan for the proposed development is likely to raise the water table to the surface without creating open water. These conditions are likely to discourage scrub and other tall vegetation to establish. This is an advantageous situation as it will reduce scrub growth in vicinity of the wind turbines and therefore reduce the favourability of the landscape around the individual turbines. It is also important that open water is not present as such a habitat is an attractive one for foraging bats due to potentially increased aquatic insect presence.

Providing alternative foraging areas outside the wind farm zone has been shown to reduce the presence of bats within cleared zones around individual wind turbines (i.e. bats are attracted to the more favourable foraging habitats).

Table 6.2: Bat Mitigation Measures recommended during the Construction Phase.

High Level Bat Mitigation – Leisler's bats This applies to T2 and T12	**High Level Bat Mitigation** This applies to T4, T10, T19 and T22 This applies to Internal Road Network between T4 – T5	**Medium Level Bat Mitigation** This applies to T1, T3, T5, T11 and T18	**Low Level Bat Mitigation** This applies to T7, T8, T9, T20, T21, T23 and T24.
A zone of 200m around the wind to reduce favourability of this zone for foraging and commuting bats. A low level of vegetation should be maintained for the entire operational phase. This could be achieved by rehabilitation plan which is likely to suppress of vegetation growth. This should be monitored to ensure that scrub vegetation does not develop within the zone around the turbines.	A zone of according to English Nature calculation around the wind turbines (from the tip of the blade) should be cleared of tall vegetation (shrubs, trees, scrub etc.) to reduce favourability of this zone for foraging and commuting bats. A low level of vegetation should be maintained for the entire operational phase. This could be achieved by rehabilitation plan which is likely to suppress of vegetation growth. This should be monitored to ensure that scrub vegetation does not develop within the zone around	A zone of 50m around the wind turbines (from the tip of the blade) should be cleared of tall vegetation (shrubs, trees, scrub etc.) to reduce favourability of this zone for foraging and commuting bats. A low level of vegetation should be maintained for the entire operational phase. This could be achieved by rehabilitation plan which is likely to suppress of vegetation growth. This should be monitored to ensure that scrub vegetation does not develop within the zone around the turbines.	A zone of 50m around the wind turbines (from the tip of the blade) should be cleared of tall vegetation (shrubs, trees, scrub etc.) to reduce favourability of this zone for foraging and commuting bats. A low level of vegetation should be maintained for the entire operational phase. This could be achieved by rehabilitation plan which is likely to suppress of vegetation growth. This should be monitored to ensure that scrub vegetation does not develop within the zone around the turbines.

	the turbines.		
.	A corridor of 50m along the haul roads (between T4-T5) should be cleared of tall vegetation (i.e. >1m height - shrubs, trees, scrub etc.) to reduce favourability of this zone for foraging and commuting bats. A low level of vegetation should be maintained for the entire operational phase.		
Complete clearance work during the autumn and spring months. Complete clearance work at least 6 months prior to installation of wind turbines. Studies have shown that bats are attracted to clear felled forestry areas due to increase insect loading. This has been shown to occur for a period of 3-6 months before the insect loading reduces to pre-cleared felled levels.	Complete clearance work during the autumn and spring months. Complete clearance work at least 6 months prior to installation of wind turbines. Studies have shown that bats are attracted to clear felled forestry areas due to increase insect loading. This has been shown to occur for a period of 3-6 months before the insect loading reduces to pre-cleared felled levels.	Complete clearance work during the autumn and spring months. Complete clearance work at least 6 months prior to installation of wind turbines. Studies have shown that bats are attracted to clear felled forestry areas due to increase insect loading. This has been shown to occur for a period of 3-6 months before the insect loading reduces to pre-cleared felled levels.	Complete clearance work during the autumn and spring months. Complete clearance work at least 6 months prior to installation of wind turbines. Studies have shown that bats are attracted to clear felled forestry areas due to increase insect loading. This has been shown to occur for a period of 3-6 months before the insect loading reduces to pre-cleared felled levels.
Provide “bat habitat” of 2 hectares/wind turbine. This land should be located at least 1km away from the nearest wind turbine. Natural regeneration of peat bog by scrub vegetation is recommended 1km outside the zone of the wind farm.	Provide “bat habitat” of 2 hectares/wind turbine. This land should be located at least 1km away from the nearest wind turbine. Natural regeneration of peat bog by scrub vegetation is recommended outside the zone of the wind farm.	Provide “bat habitat” of 1 hectares/wind turbine. This land should be located at least 1km away from the nearest wind turbine. Natural regeneration of peat bog by scrub vegetation is recommended outside the zone of the wind farm.	Provide “bat habitat” of 0.5 hectare/wind turbine. This land should be located at least 1km away from the nearest wind turbine. Natural regeneration of peat bog by scrub vegetation is recommended outside the zone of the wind farm.

6.2 Operation Phase

6.2.1 Feathering of blades

The operation of the turbines should be those that will restrict the rotation of turbine blades as much as possible below the manufacturer's cut-in speed (e.g. by feathering the blades during low wind levels - changes in blade feathering by altering the angle of the blade preventing it from rotating on low wind situations). This would prevent freewheeling or idling of the blades. In low wind conditions, turbine blades can often be freewheeling (spinning) but not generating electricity. But freewheeling blades can still kill bats while non-spinning blades (feathering) do not kill bats (Horn *et al.,* 2008). A study completed by Exeter University on behalf of Bat Conservation Trust, UK has shown that this single measure relating to the operation of the wind turbines will have a positive outcome for bats, as the amount of time the blades are turning at low wind speeds will be reduced during potential higher bat activity levels (i.e. bats tend to be more active during low wind conditions). The measure was also reported by other studies to effective when combined an increase of wind turbine cut-in speed (the velocity at which turbines start producing electricity) and). These two measures have been proven to reduce bat fatalities from 30% to 90% (Arnett et al., 2008, 2011; Baerwald et al., 2009).

Therefore ensure that blades are prevented from freewheeling (idling/spinning) but are below the manufacture's cut-in speed. Feathering of the blades during low wind conditions are recommended for all turbines.

6.2.2
This section consists of two options.

Option 1 Cut-in Speeds to be implemented from Day 1 of operation of wind farm according to Point 3 of Table 6.3a.

OR

Option 2 Operation without cut-in speeds coupled with 2 years of surveillance to determine if cut-in speeds are required.

Option 1

1. Turbine Cut-Speeds

There are few bat mitigation measures available in relation to wind farms to reduce fatalities. One successful measure applied to wind farms in Europe is to increase the cut-in speeds of the individual turbines. Raising the cut-in speed above that set by the manufacture can reduce the impact of the wind turbine on bats. Arnett *et al.* (2011) showed that a 50% decrease in bat fatality can be achieved by increasing the cut-in speed by 1.5 m/s with similar results achieved at European sites. This would be important in order to protect High Risk species (Leisler's bats and Nathusius' pipistrelle) and Medium Risk species (soprano and common pipistrelle) foraging/commuting in vicinity of turbine locations. Leisler's bats were recorded within the 200m buffer zone of T2 and T12.

Increasing the cut-in speed to 5.5 m/s from 30 minutes prior to sunset and to 30 minutes after sunrise to reduce bat collisions with turbines should be employed where required (i.e. at turbine locations where surveillance recorded high bat activity levels for High Risk and Medium Risk bat species and/or bat carcasses were recorded). The duration required depends on the level of bat mitigation required for individual turbine sites (i.e. full bat activity season or confined to spring & autumn months – this will be determine by first year surveillance). A risk assessment should be undertaken using the surveillance data and analysed using best practice e.g. assessment of static data should be completed using the online tool *Ecobat* (http://www.mammal.org.uk/science-research/ecostat/) as recommended by SNH, 2019 or other equivalent tool depending on most up to-date recommendations at the time of monitoring.

Where cut-in speeds are required they should be operated according to specific weather conditions:

1. When the air temperature is greater than 7°C as there was no bat activity recorded below this temperature during surveys.
2. In general, bat activity is highest at low wind speeds (<5.5m/s). Therefore, it has been shown that curtailing the operations of wind turbines at low wind speeds can reduce bat mortality dramatically, especially during the late summer and early autumn months.

Reducing fatalities can be reduced by changing the speed trigger or cut-in speeds of the turbines (i.e. meaning that the turbine is not operational during low wind speeds) or by changing the turbine blades angles which will mean that higher wind speeds are needed to start the wind turbine blades moving. Modern remotely operated wind turbines allow such cut-in speeds to be controlled centrally and automatically.

2. Vegetation Maintenance & Removal

Scrub and other tall vegetation growth are likely to occur in vicinity of the wind turbines during the construction and operation of the wind farm. The presence of such habitats in vicinity of the wind turbines may encourage bats to commute and foraging within the wind swept area of individual turbines. Areas of such habitats around wind turbines may entice bats to forage in these locations, which can lead to fatalities (Horn *et al.* 2008). Therefore the immediate surrounding individual turbines should be managed and maintained in such a manner that they do not attract insects (*i.e.* the concentration of insects in the wind turbine vicinity should be reduced as much as possible, but not such that insect abundancies affected elsewhere on the site). Therefore it is important to ensure that limited scrub development is permitted within the buffer zones for the turbines and these buffer zones are dependent on the bat activity and bat species recorded within specified buffer zones of the current turbine locations.

Table 6.3a: Bat Mitigation Measures recommended during the Operational Phase under Option 1.

High Level Bat Mitigation – Leisler's bats This applies to T2 and T12	**High Level Bat Mitigation** This applies to T4, T10, T19 and T22 This applies to Internal Road Network between T4 – T5	**Medium Level Bat Mitigation** This applies to T1, T3, T5, T11 and T18 This applies to Internal Road Network between T5 – T6	**Low Level Bat Mitigation** This applies to T7, T8, T9, T20, T21, T23 and T24.
Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)	Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)	Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)	Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)
Operate the wind turbine from sunset to sunrise at a cut-in speed of 5.5 m/s during specified weather conditions and during the active bat season (April to October).	Operate wind turbine from sunset to sunrise at a cut-in speed of 5.5 m/s during specified weather conditions and during the spring and autumn.	Put in a monitoring programme for the first year of operation to ensure that bat activity is at a low level in vicinity of these turbines.	Put in a monitoring programme for the first year of operation to ensure that bat activity is at a low level in vicinity of these turbines.
Maintain immediate area around the wind turbines in a manner that does not attract insects.	Maintain immediate area around the wind turbines in a manner that does not attract insects.	Maintain immediate area around the wind turbines in a manner that does not attract insects.	Maintain immediate area around the wind turbines in a manner that does not attract insects.

Option 2

Bat mitigation measures during the Operational Phase can be determined by implementing a strict surveillance programme for the first two years of operation of the wind farm in order to identify if there exists a substantial risk at a particular turbine location or during a particular time-period (As per recommendation of EUROBATS 2014 Revised Guidelines). This surveillance should then be repeated at Year 10 and Year 20 of the operation of the wind farm to ensure that sufficient mitigation is being implemented. This surveillance required is as follows:

a) Bat activity surveillance
The level of bat activity should be monitoring for a minimum of 5 nights at each turbine location (ground level and at height) during three of the eight month activity period (March/April to October/November). The surveillance periods should be divided into three survey periods to represent the three main periods where bat collisions have been documented: Spring (April/May); Summer (June/July) and Autumn (August/September). Use of the ground-level data alone would underestimate the relative abundance of bat species such as Leisler's bats because bat passes from this species are made only at heights beyond the acoustic range of the ground-based detector. Given that Leisler's bats are at risk of collision with wind turbines, acoustic monitoring at height as well as at ground level is essential.

b) Carcass search
During the surveillance periods of specific wind turbines, carcass search is required for a minimum of 1 morning per turbine (i.e. 3/4 mornings in total over the 1 year surveillance i.e. one per surveillance period). For each turbine, the search area should be 100m radius after ideal bat foraging weather conditions (mild, calm and dry weather and greater than 10^{o}C).

c) Surveillance should be undertaken within Zones to determine the potential cluster effect of wind turbines (i.e. surveillance is completed at Zone 1 Turbines 1-9, followed by Zone 2 and Zone 3). The number of turbines in a particular area has been shown to have potential higher impact on bat populations. Therefore, in order to understand the potential results from surveillance, it is important to complete surveying for each zone within the same surveillance period.

d) For exact protocols consult most up-date best practice guidelines from current research publications / guidelines.

e) Assessment of static data should be completed using the online tool *Ecobat* (http://www.mammal.org.uk/science-research/ecostat/) as recommended by SNH, 2019 or other equivalent tool depending on most up to-date recommendations at the time of monitoring.

If surveillance results indicate medium to high bat activity levels and/or bat carcasses are collected then the following bat mitigation measures are required at specific turbine locations (Please consult best practice guidelines in relation activity level indices (see Barataud, 2012 for an example):

1. Turbine Cut-Speeds

Increasing the cut-in speed to 5.5 m/s from 30 minutes prior to sunset and to 30 minutes after sunrise to reduce bat collisions with turbines should be employed where required (i.e. at turbine locations where surveillance recorded high bat activity levels for High Risk and

Medium Risk bat species and/or bat carcasses were recorded). The duration required depends on the level of bat mitigation required for individual turbine sites (i.e. full bat activity season or confined to spring & autumn months – this will be determine by two years of surveillance).

Where cut-in speeds are required they should be operated according to specific weather conditions:

3. When the air temperature is greater than 7°C as there was no bat activity recorded below this temperature during surveys.
4. In general, bat activity is highest at low wind speeds (<5.5m/s). Therefore, it has been shown that curtailing the operations of wind turbines at low wind speeds can reduce bat mortality dramatically, especially during the late summer and early autumn months.

2. Vegetation Maintenance & Removal

Scrub and other tall vegetation growth are likely to occur in vicinity of the wind turbines during the construction and operation of the wind farm. The presence of such habitats in vicinity of the wind turbines may encourage bats to commute and foraging within the wind swept area of individual turbines. Areas of such habitats around wind turbines may entice bats to forage in these locations, which can lead to fatalities (Horn *et al.* 2008). Therefore the immediate surrounding individual turbines should be managed and maintained in such a manner that they do not attract insects (*i.e.* the concentration of insects in the wind turbine vicinity should be reduced as much as possible, but not such that insect abundancies affected elsewhere on the site). Therefore it is important to ensure that limited scrub development is permitted within the buffer zones for the turbines and these buffer zones are dependent on the bat activity and bat species recorded within specified buffer zones of the current turbine locations.

Table 6.3b: Bat Mitigation Measures recommended during the Operational Phase under Option 2.

High Level Bat Mitigation – Leisler's bats This applies to T2 and T12	**High Level Bat Mitigation** This applies to T4, T10, T19 and T22 This applies to Internal Road Network between T4 – T5	**Medium Level Bat Mitigation** This applies to T1, T3, T5, T11 and T18 This applies to Internal Road Network between T5 – T6	**Low Level Bat Mitigation** This applies to T7, T8, T9, T20, T21, T23 and T24.
Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)	Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)	Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)	Operate the wind turbines in a manner the reduces the movement of the blades below the cut-in speed (e.g. by feathering the blades)
Undertake a carcass search for 2 years post operation of the wind farm to determine whether a higher cut-in speed of the blades is required.	Undertake a carcass search for 2 years post operation of the wind farm to determine whether a higher cut-in speed of the blades is required.	Undertake a carcass search for 2 years post operation of the wind farm to determine whether a higher cut-in speed of the blades is required.	Undertake a carcass search for 2 years post operation of the wind farm to determine whether a higher cut-in speed of the blades is required.
Operate the wind turbine with cut-in speeds, if required, as a result of surveillance.	Operate the wind turbine with cut-in speeds, if required, as a result of surveillance.	Operate the wind turbine with cut-in speeds, if required, as a result of surveillance.	Operate the wind turbine with cut-in speeds, if required, as a result of surveillance.
Maintain immediate area around the wind turbines in a manner that does not attract insects.	Maintain immediate area around the wind turbines in a manner that does not attract insects.	Maintain immediate area around the wind turbines in a manner that does not attract insects.	Maintain immediate area around the wind turbines in a manner that does not attract insects.

7. Bat Monitoring Recommendations

Bat Survey Work

It is recommended that if three years lapse from between pre-construction surveys and the construction of the wind turbines, it may be necessary to repeat the pre-construction surveys (EUROBATS, 2014). Surveys completed for this report concluded in 2018. Therefore a review should be undertaken no later than Spring 2021. Future survey work should be completed according to best practice guidelines available.

Monitoring: Operational phase

The mitigation measures should be monitored by wildlife experts at intervals during the initial years of operation of the development to ensure successful implementation. Good practice also requires that impacts on adjoining areas are also monitored (Perrow, 2017).

As described above, Years 1 & 2 Surveillance, Year 10 Surveillance and Year 20 Surveillance is required.

a) Static Surveys
- Minimum of 5 nights surveillance per turbine
- 3 periods within the months of March/April to October/November
- 3 periods should be Spring, Summer and Autumn to investigate bat activity during the 3 periods where bat collisions have been documented and when bat movement is at it's highest.

b) Carcass Searches
- Minimum of 1 morning per turbine during the 5 day static survey.
- After ideal bat foraging weather conditions (mild, calm and dry weather and greater than 10^{o}C). Searches should be completed at dawn in order to find bats before predation of corpses occurs.
- Follow best practice carcass search protocols as new guidelines are published/updated.

8. Conclusion

The survey area is deemed to have a Low-Medium landscape favourability for Irish bat species.

During bat surveys a minimum of six species of bat were recorded within the survey area and this is a high level of bat biodiversity. However, the level of bat activity was, in general, low.

Medium to high levels of bat activity was recorded adjacent to field boundaries, woodlands and agricultural land located either within the survey area or adjacent to it and as a consequence such areas should be voided in relation to the proposed wind farm operations.

In areas of open cutover bog, the level of bat activity was low and may be attributed to commuting individuals and occasional opportunistic feeding. It is in these open areas that the wind turbines are proposed to be located. However it is due to this commuting behaviour, particularly in relation to high risk bat species such as Leisler's bats that the proposed wind farm will impact on local bat populations.

The mitigation measures recommended in this report require strict implementation to reduce the long-term impact of the proposed wind farm on local bat populations. The proposed wind farm is likely to have Low to Medium impact on local bat populations. The implementation of mitigation measures will likely reduce this to a Low Impact on local bat populations.

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APPENDIX I

Statement of Authority

Dr Aughney is a consultant ecologist specialising in bat and bat ecology. She holds a Ph.D. in Agri-Environmental Policy and Entomology. After finishing her research she branched into the area of bats and has worked as a Bat Specialist since 2000. She has undertaken extensive training and survey work for all Irish bat species completing courses in Ireland and the UK. She has undertaken extensive survey work in relation to large development projects including motorway road schemes, wind farm projects, renovation works and monitoring programmes. She is on the Heritage Council Bat Panel.

Dr Aughney also manages national and all-island monitoring programmes on behalf of Bat Conservation Ireland for the NPWS in the Republic of Ireland and NIEA in Northern Ireland. Management responsibilities include administration of the monitoring schemes, volunteer recruitment and training, information validation and management, data analysis and mapping and reporting.

Dr Aughney has presented her bat research and bat work experience at Irish, British and European Bat Conferences. She has also provided training for European bat monitoring programmes in The Netherlands and Romania.

Dr Aughney was awarded "Distinguished Recorder of the Year, 2011" by the National Biodiversity Data Centre and she is a co-author of the publication on bats in Ireland titled "Irish Bats in the 21st Century". She is also a contributing author for the publication "Atlas of Mammals in Ireland 2010-2015".

Dr Tina Aughney – licenced bat specialist

NPWS licence C30/2017 (Licence to handle bats, expires 31st December 2019)

NPWS licence 33/2017 (Licence to photograph/film bats, expires 31st December 2019)

NPWS licence DER/BAT 2017-09 (Licence to disturb a roost, expires 29th March 2020)

Reporting

Draft 1 & 2 reported on original layout as provided to the author in 2016.

Draft 3 reports on new layout provided to the author in February 2018.

Draft 4 report contains additional survey work completed in June 2018.

Final Draft submitted in November 2018.

Supplemented in January 2019 with SNH, 2019 guidelines.