Environmental Impact Assessment Report (EIAR)

Volume 3 Part 1 Appendices

In respect of
The Royal Canal Urban Greenway

On behalf of
Fingal County Council

October 2026

This Volume should be read in conjunction with the EIAR Main Document. This Volume contains Appendices associated with Chapter 3 (Policy Context) and Chapter 8 (Biodiversity), as follows:

Chapter 3 Policy Context

Appendix 3.1 Land Use Zoning Map

Chapter 8 Biodiversity

Appendix 8.1 NBDC records of protected species within 2km of the Proposed Development since 2016

Appendix 8.2 NBDC records of invasive species within 2km of the Proposed Development since 2016

Appendix 8.3 Habitat Maps A-O of the Proposed Development

Appendix 8.4: Royal Canal Tree Removal Plan (with m² values per area)

Appendix 8.5:Additional Non-JBA surveys

- 8.5.1. BEC (2013), Ecological Study of the Royal Canal between Talbot Bridge and Maynooth Train Station
- 8.5.2. Natura Environmental Consultants (2018), Royal Canal Urban Greenway Biodiversity Assessment 2018 Report To Fingal County Council
- 8.5.3. Triturus Environmental Ltd (2024) Royal Canal (1st to 16th lock) macrophyte survey 2023.
- 8.5.4. Triturus Environmental Ltd (2025) Royal Canal (1st to 16th lock) macrophyte survey 2024.
- 8.5.5. Triturus Environmental Ltd (2024) Royal Canal (1st to 16th lock) aquatic macro-invertebrate survey 2023
- 8.5.6. Moorkens E.A. and Killeen, I (2025) Survey of the Royal Canal east of Kilcock for freshwater molluscs with particular reference to the glutinous snail, *Myxas glutinosa*, Spring 2024.
- 8.5.7. Triturus Environmental Ltd (2025c) Royal Canal Urban Greenway glutinous snail (*Myxas glutinosa*) survey 2025
- 8.5.8. Royal Canal Bat Assessment – 8km Section, Co. Dublin & Co. Kildare. 2026. Bat Eco Services

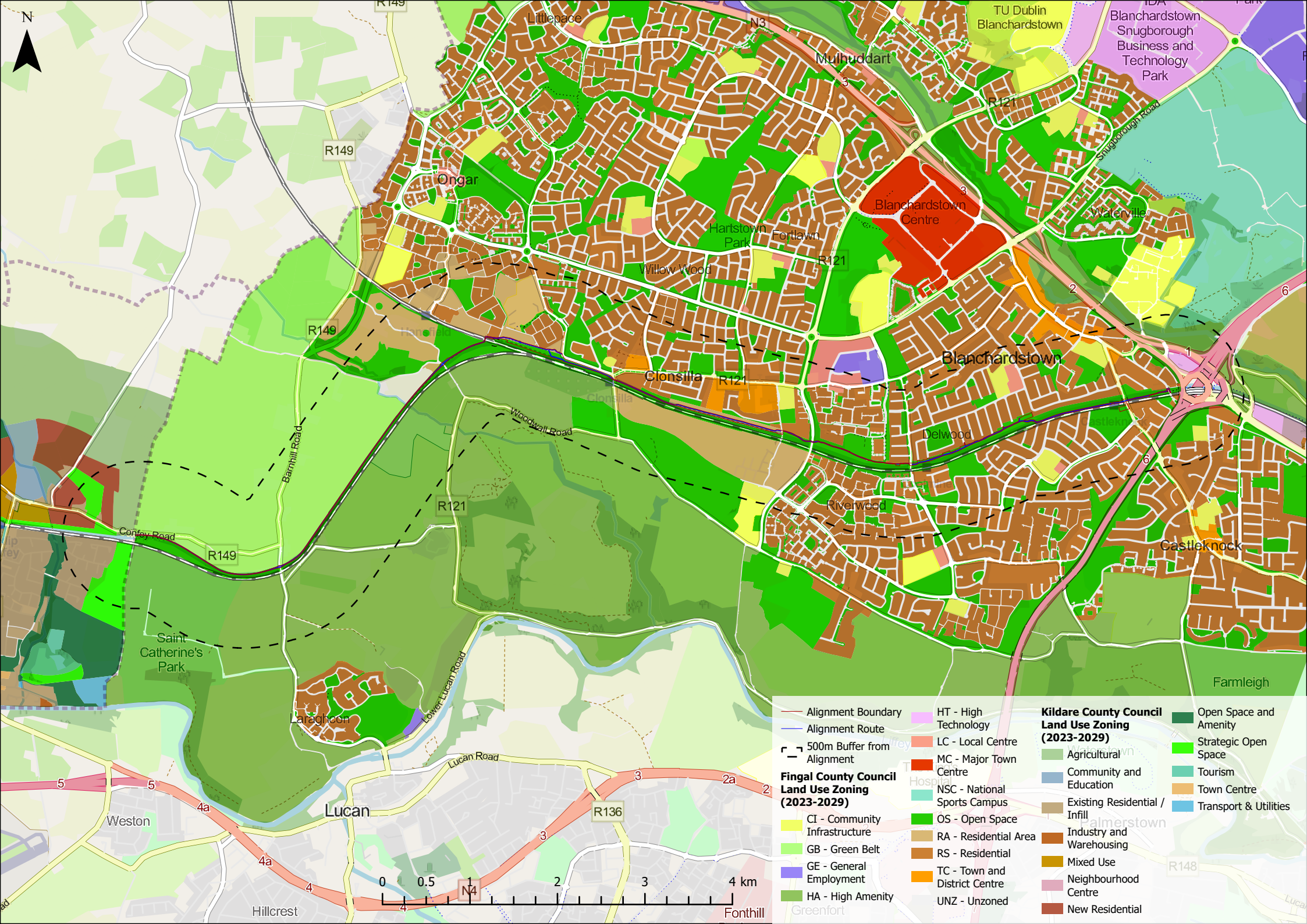
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Royal Canal Urban Greenway
Environmental Impact Assessment Report

Appendix 3.1 Land Use Zoning Map

October 2026




N
Littlepace
N3
Mulhuddart
TU Dublin Blanchardstown
IDA Blanchardstown Snugborough Business and Technology Park
R121
Snugborough Road
R149
Ongar
Blanchardstown Centre
Waterville
Hartstown
Fortlawn
Willow Wood
R121
R149
Clonsilla
R121
Blanchardstown
Woodwall Road
Delwood
Barnhill Road
R121
Riverwood
Castleknock
Confey Road
R149
Saint Catherine's Park
Lower Lucan Road
Laraghcon
Farmleigh
Lucan Road
Weston
Lucan
R136
N4
Hillcrest
Fonthill
Greenfort
Palmerstown
R148
0 0.5 1 2 3 4 km
Alignment Boundary
Alignment Route
500m Buffer from Alignment
Fingal County Council Land Use Zoning (2023-2029)
CI - Community Infrastructure
GB - Green Belt
GE - General Employment
HA - High Amenity
HT - High Technology
LC - Local Centre
MC - Major Town Centre
NSC - National Sports Campus
OS - Open Space
RA - Residential Area
RS - Residential
TC - Town and District Centre
UNZ - Unzoned
Kildare County Council Land Use Zoning (2023-2029)
Agricultural
Community and Education
Existing Residential / Infill
Industry and Warehousing
Mixed Use
Neighbourhood Centre
New Residential
Open Space and Amenity
Strategic Open Space
Tourism
Town Centre
Transport & Utilities

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Royal Canal Urban Greenway

Environmental Impact Assessment Report

Appendix 8.1 NBDC records of protected species within 2km of the Proposed Development since 2016

October 2026



Appendix 8.1 NBDC records of protected species within 2km of the Proposed Development since 2016

Species name	Date of last record	Designation
Amphibians		
Common Frog (*Rana temporaria*)	25/04/2023	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex V || Protected Species: Wildlife Acts
Smooth Newt (*Lissotriton vulgaris*)	05/04/2023	Protected Species: Wildlife Acts
Birds		
Barn Owl (*Tyto alba*)	04/12/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Bar-tailed Godwit (*Limosa lapponica*)	04/06/2020	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Black Guillemot (*Cepphus grylle*)	27/08/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Black-headed Gull (*Chroicocephalus ridibundus*)	27/12/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Black-tailed Godwit (*Limosa limosa*)	19/08/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Brambling (*Fringilla montifringilla*)	18/12/2018	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Common Gull (*Larus canus*)	30/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened

Species name	Date of last record	Designation
		Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Common Sandpiper (*Actitis hypoleucos*)	12/07/2022	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Common Tern (*Sterna hirundo*)	14/07/2023	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Coot (*Fulica atra*)	06/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Cormorant (*Phalacrocorax carbo*)	15/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Curlew (*Numenius arquata*)	06/02/2023	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Dunlin (*Calidris alpina*)	29/09/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Gadwall (*Mareca strepera*)	05/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened

Species name	Date of last record	Designation
		Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Garganey (*Spatula querquedula*)	11/09/2022	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Goldcrest (*Regulus regulus*)	19/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Goldeneye (*Bucephala clangula*)	23/10/2022	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Goosander (*Mergus merganser*)	26/12/2021	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Great Crested Grebe (*Podiceps cristatus*)	16/04/2023	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Great Spotted Woodpecker (*Dendrocopos major*)	04/06/2023	Protected Species: Wildlife Acts
Greenfinch (*Chloris chloris*)	18/11/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Grey Partridge (*Perdix perdix*)	12/04/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section I Bird

Species name	Date of last record	Designation
		Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Grey Wagtail (*Motacilla cinerea*)	26/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Hen Harrier (*Circus cyaneus*)	24/06/2021	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
House Martin (*Delichon urbicum*)	26/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Kestrel (*Falco tinnunculus*)	15/03/2023	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Kingfisher (*Alcedo atthis*)	26/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Kittiwake (*Rissa tridactyla*)	01/03/2018	Protected Species: Wildlife Acts || Threatened Species: OSPAR Convention || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Knot (*Calidris canutus*)	16/01/2019	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Lapwing (*Vanellus vanellus*)	24/09/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive

Species name	Date of last record	Designation
		|| Protected Species: EU Birds Directive >> Annex II, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Linnet (*Linaria cannabina*)	02/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Little Egret (*Egretta garzetta*)	26/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species
Little Grebe (*Tachybaptus ruficollis*)	11/11/2024	Protected Species: Wildlife Acts
Little Ringed Plover (*Charadrius dubius*)	08/07/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Mallard (*Anas platyrhynchos*)	26/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Meadow Pipit (*Anthus pratensis*)	12/03/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Mediterranean Gull (*Ichthyaetus melanocephalus*)	29/09/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Merlin (*Falco columbarius*)	30/08/2019	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of

Species name	Date of last record	Designation
		Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Mistle Thrush (*Turdus viscivorus*)	08/05/2025	Protected Species: Wildlife Acts
Mute Swan (*Cygnus olor*)	15/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Oystercatcher (*Haematopus ostralegus*)	25/01/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Peregrine (*Falco peregrinus*)	13/08/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species
Pheasant (*Phasianus colchicus*)	21/11/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section I Bird Species
Pink-footed Goose (*Anser brachyrhynchus*)	28/09/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section II Bird Species
Pintail (*Anas acuta*)	29/09/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Pochard (*Aythya ferina*)	19/01/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List

Species name	Date of last record	Designation
Red Grouse (*Lagopus lagopus*)	06/11/2022	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Red Kite (*Milvus milvus*)	12/02/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Red-breasted Merganser (*Mergus serrator*)	17/01/2021	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Redshank (*Tringa totanus*)	16/04/2023	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Redwing (*Turdus iliacus*)	25/01/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Ringed Plover (*Charadrius hiaticula*)	23/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Robin (*Erithacus rubecula*)	26/05/2025	Protected Species: Wildlife Acts
Rock Dove (*Columba livia*)	02/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species
Ruff	29/09/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive

Species name	Date of last record	Designation
(*Calidris pugnax*)		|| Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Sand Martin (*Riparia riparia*)	27/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Scaup (*Aythya marila*)	02/12/2022	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section II Bird Species || Protected Species: EU Birds Directive >> Annex III, Section III Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Shelduck (*Tadorna tadorna*)	29/11/2021	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Shoveler (*Spatula clypeata*)	04/01/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section III Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Skylark (*Alauda arvensis*)	31/05/2024	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Smew (*Mergellus albellus*)	08/05/2016	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List

Species name	Date of last record	Designation
Snipe (*Gallinago gallinago*)	29/09/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section III Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Sparrowhawk (*Accipiter nisus*)	23/05/2025	Protected Species: Wildlife Acts
Spotted Flycatcher (*Muscicapa striata*)	25/05/2023	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Stock Dove (*Columba oenas*)	24/05/2022	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Stonechat (*Saxicola rubicola*)	18/04/2024	Protected Species: Wildlife Acts
Swallow (*Hirundo rustica*)	17/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Swift (*Apus apus*)	30/06/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Teal (*Anas crecca*)	25/01/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Tree Sparrow (*Passer montanus*)	03/03/2018	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern -

Species name	Date of last record	Designation
		Amber List
Tufted Duck (*Aythya fuligula*)	06/05/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Turtle Dove (*Streptopelia turtur*)	15/03/2021	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Twite (*Linaria flavirostris*)	16/01/2019	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Wheatear (*Oenanthe oenanthe*)	11/08/2021	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Whinchat (*Saxicola rubetra*)	16/09/2015	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Whooper Swan (*Cygnus cygnus*)	04/03/2020	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Wigeon (*Mareca penelope*)	25/01/2025	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List

Species name	Date of last record	Designation
Willow Warbler (*Phylloscopus trochilus*)	26/05/2025	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Wood Sandpiper (*Tringa glareola*)	23/08/2024	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex I Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Woodcock (*Scolopax rusticola*)	22/03/2023	Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section III Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Yellowhammer (*Emberiza citrinella*)	15/03/2023	Protected Species: Wildlife Acts || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Red List
Crustacean		
White-clawed Crayfish (*Austropotamobius pallipes*)	31/12/2021	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex II || Protected Species: EU Habitats Directive >> Annex V || Protected Species: Wildlife Acts
Flowering Plant		
Hairy St John's-wort (*Hypericum hirsutum*)	22/05/2023	Protected Species: Flora Protection Order (FPO) || Protected Species: Flora Protection Order (FPO) >> FPO 2022 Schedule A (Vascular Plants) || Threatened Species: Vulnerable
Insect-Butterfly		
Marsh Fritillary (*Euphydryas aurinia*)	10/06/2019	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex II || Threatened Species: Vulnerable
Reptile		
Common Lizard	21/05/2020	Protected Species: Wildlife Acts

Species name	Date of last record	Designation
(*Zootoca vivipara*)		
Mammal		
Badger (*Meles meles*)	08/04/2023	Protected Species: Wildlife Acts
Brown Long-eared Bat (*Plecotus auritus*)	02/05/2022	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Common Pipistrelle (*Pipistrellus pipistrellus sensu stricto*)	15/08/2023	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Daubenton's Bat (*Myotis daubentonii*)	03/05/2022	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Hedgehog (*Erinaceus europaeus*)	07/12/2023	Protected Species: Wildlife Acts
Leisler's Bat (*Nyctalus leisleri*)	15/08/2023	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Myotis Bat species (*Myotis*)	25/05/2020	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Nathusius's Pipistrelle (*Pipistrellus nathusii*)	02/05/2022	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Natterer's Bat (*Myotis nattereri*)	06/06/2021	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Otter (*Lutra lutra*)	06/12/2018	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex II || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Pine Marten (*Martes martes*)	13/12/2021	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex V || Protected Species: Wildlife Acts
Pipistrelle (*Pipistrellus pipistrellus sensu lato*)	21/11/2022	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts

Species name	Date of last record	Designation
Pygmy Shrew (*Sorex minutus*)	06/01/2023	Protected Species: Wildlife Acts
Red Deer (*Cervus elaphus*)	29/05/2018	Protected Species: Wildlife Acts
Red Squirrel (*Sciurus vulgaris*)	28/06/2022	Protected Species: Wildlife Acts
Soprano Pipistrelle (*Pipistrellus pygmaeus*)	15/08/2023	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Whiskered Bat (*Myotis mystacinus*)	15/07/2017	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts
Whiskered/Brandt's Bat (*Myotis mystacinus/brandtii*)	25/05/2020	Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV || Protected Species: Wildlife Acts

Appendix 8.2 NBDC records of invasive species within 2km of the Proposed Development since 2016

Species name	Date of last record	Designation
Birds		
Greylag Goose (*Anser anser*)	18/04/2023	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Protected Species: Wildlife Acts || Protected Species: EU Birds Directive || Protected Species: EU Birds Directive >> Annex II, Section I Bird Species || Protected Species: EU Birds Directive >> Annex III, Section II Bird Species || Threatened Species: Birds of Conservation Concern || Threatened Species: Birds of Conservation Concern >> Birds of Conservation Concern - Amber List
Mandarin Duck (*Aix galericulata*)	09/11/2024	Invasive Species: The Wildlife (Northern Ireland) Order 1985
Ring-necked Parakeet (*Psittacula krameri)*	13/05/2025	Invasive Species: High Risk Invasive Species (2013 Report)
Flatworm (Turbellaria)		
Australian flatworm (*Australoplana sanguinea*)	25/03/2021	Invasive Species: Medium Risk Invasive Species (2013 Report)
New Zealand Flatworm (*Arthurdendyus triangulates*)	05/05/2020	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: High Risk Invasive Species (2013 Report)
Flowering Plant		
American Skunk-cabbage (*Lysichiton americanus*)	11/04/2023	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Medium Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland)
Black Currant (*Ribes nigrum*)	16/09/2017	Invasive Species: Medium Risk Invasive Species (2013 Report)
Brazilian Giant-rhubarb (*Gunnera manicata*)	29/03/2019	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Medium Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland)

Species name	Date of last record	Designation
Butterfly-bush (*Buddleja davidii*)	10/08/2025	Invasive Species: Medium Risk Invasive Species (2013 Report)
Canadian Fleabane (*Conyza canadensis*)	26/10/2020	Invasive Species: Medium Risk Invasive Species (2013 Report)
Canadian Waterweed (*Elodea canadensis*)	25/05/2022	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: The Wildlife (Northern Ireland) Order 1985
Cherry Laurel (*Prunus laurocerasus*)	25/01/2025	Invasive Species: High Risk Invasive Species (2013 Report)
Common Broomrape (*Orobanche minor*)	26/06/2021	Invasive Species: Medium Risk Invasive Species (2013 Report)
Evergreen Oak (*Quercus ilex*)	01/06/2020	Invasive Species: Medium Risk Invasive Species (2013 Report)
Few-flowered Garlic (*Allium paradoxum*)	28/02/2022	Invasive Species: The Wildlife (Northern Ireland) Order 1985
Fringed Water-lily (*Nymphoides peltata*)	15/06/2016	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Detailed Risk Assessment || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: The Wildlife (Northern Ireland) Order 1985 || Invasive Species: Detailed Risk Assessment >> Moderate Risk
Giant Hogweed (*Heracleum mantegazzianum*)	07/05/2025	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland)
Giant Knotweed (*Fallopia sachalinensis*)	03/08/2017	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: The Wildlife (Northern Ireland) Order 1985
Giant-rhubarb (*Gunnera tinctoria*)	01/06/2023	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species:

Species name	Date of last record	Designation
		Regulation S.I. 477/2011 (Ireland) || Invasive Species: Detailed Risk Assessment || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: Detailed Risk Assessment >> High Risk
Himalayan Balsam (*Impatiens glandulifera*)	25/08/2025	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Detailed Risk Assessment || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: Detailed Risk Assessment >> High Risk
Himalayan Honeysuckle (*Leycesteria formosa*)	05/09/2025	Invasive Species: Medium Risk Invasive Species (2013 Report)
Japanese Knotweed (*Reynoutria japonica*)	23/08/2025	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: The Wildlife (Northern Ireland) Order 1985
Japanese Rose (*Rosa rugosa*)	15/05/2024	Invasive Species: Medium Risk Invasive Species (2013 Report)
Least Duckweed (*Lemna minuta*)	22/07/2020	Invasive Species: Medium Risk Invasive Species (2013 Report)
Narrow-leaved Ragwort (*Senecio inaequidens*)	07/07/2023	Invasive Species: Medium Risk Invasive Species (2013 Report)
Nuttall's Waterweed (*Elodea nuttallii*)	10/05/2023	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland)
Ragweed (*Ambrosia artemisiifolia*)	06/09/2022	Invasive Species: Medium Risk Invasive Species (2013 Report)
Rhododendron ponticum	28/05/2023	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Detailed Risk

Species name	Date of last record	Designation
		Assessment || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: Detailed Risk Assessment >> High Risk
Russian-vine (*Fallopia baldschuanica*)	11/08/2020	Invasive Species: Medium Risk Invasive Species (2013 Report)
Sea-buckthorn (*Hippophae rhamnoides*)	31/08/2022	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Detailed Risk Assessment || Invasive Species: Medium Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: The Wildlife (Northern Ireland) Order 1985 || Invasive Species: Detailed Risk Assessment >> Moderate Risk
Spanish Bluebell (*Hyacinthoides hispanica*)	18/04/2022	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: The Wildlife (Northern Ireland) Order 1985
Sycamore (*Acer pseudoplatanus*)	20/08/2025	Invasive Species: Medium Risk Invasive Species (2013 Report)
Three-cornered Garlic (*Allium triquetrum*)	19/05/2025	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: Detailed Risk Assessment || Invasive Species: Medium Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: Detailed Risk Assessment >> Moderate Risk
Traveller's-joy (*Clematis vitalba*)	07/09/2024	Invasive Species: Medium Risk Invasive Species (2013 Report)
Turkey Oak (*Quercus cerris*)	09/05/2019	Invasive Species: Medium Risk Invasive Species (2013 Report)
Wall Cotoneaster (*Cotoneaster horizontalis*)	30/11/2021	Invasive Species: Medium Risk Invasive Species (2013 Report)
Wild Parsnip (*Pastinaca sativa*)	09/07/2022	Invasive Species: Medium Risk Invasive Species (2013 Report)
Insect - beetle (Coleoptera)		
Harlequin Ladybird (*Harmonia axyridis*)	30/09/2025	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive

Species name	Date of last record	Designation
		Species: Regulation S.I. 374/2024 (Ireland)
Insect - moth		
Oak Processionary (*Thaumetopoea processionea*)	12/06/2023	Invasive Species: High Risk Invasive Species (2013 Report)
Jenkins' Spire Snail (*Potamopyrgus antipodarum)*	05/07/2017	Invasive Species: Medium Risk Invasive Species (2013 Report)
Pond Terrapin (*Trachemys scripta*)	10/05/2025	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Medium Risk Invasive Species (2013 Report)
Mammals		
American Mink (*Neovison vison*)	02/03/2025	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Invasive Species: The Wildlife (Northern Ireland) Order 1985
Brown Rat (*Rattus norvegicus*)	14/04/2023	Invasive Species: High Risk Invasive Species (2013 Report)
Fallow Deer (*Dama dama*)	04/12/2022	Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland) || Protected Species: Wildlife Acts
Ferret (*Mustela putorius* subsp. *furo*)	12/08/2018	Invasive Species: High Risk Invasive Species (2013 Report)
Greater White-toothed Shrew (*Crocidura russula*)	10/07/2024	Invasive Species: Medium Risk Invasive Species (2013 Report)
Grey Squirrel (*Sciurus carolinensis*)	29/03/2025	Invasive Species: EU Invasive Alien Species Regulation No. 1143/2014 || Invasive Species: Regulation S.I. 477/2011 (Ireland) || Invasive Species: High Risk Invasive Species (2013 Report) || Invasive Species: Regulation S.I. 374/2024 (Ireland)

Species name	Date of last record	Designation
House Mouse (*Mus musculus*)	25/07/2018	Invasive Species: High Risk Invasive Species (2013 Report)
Rabbit (*Oryctolagus cuniculus*)	25/04/2023	Invasive Species: Medium Risk Invasive Species (2013 Report)

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Royal Canal Urban Greenway

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Appendix 8.2 NBDC records of invasive species within 2km of the Proposed Development since 2016

October 2026



Royal Canal Urban Greenway

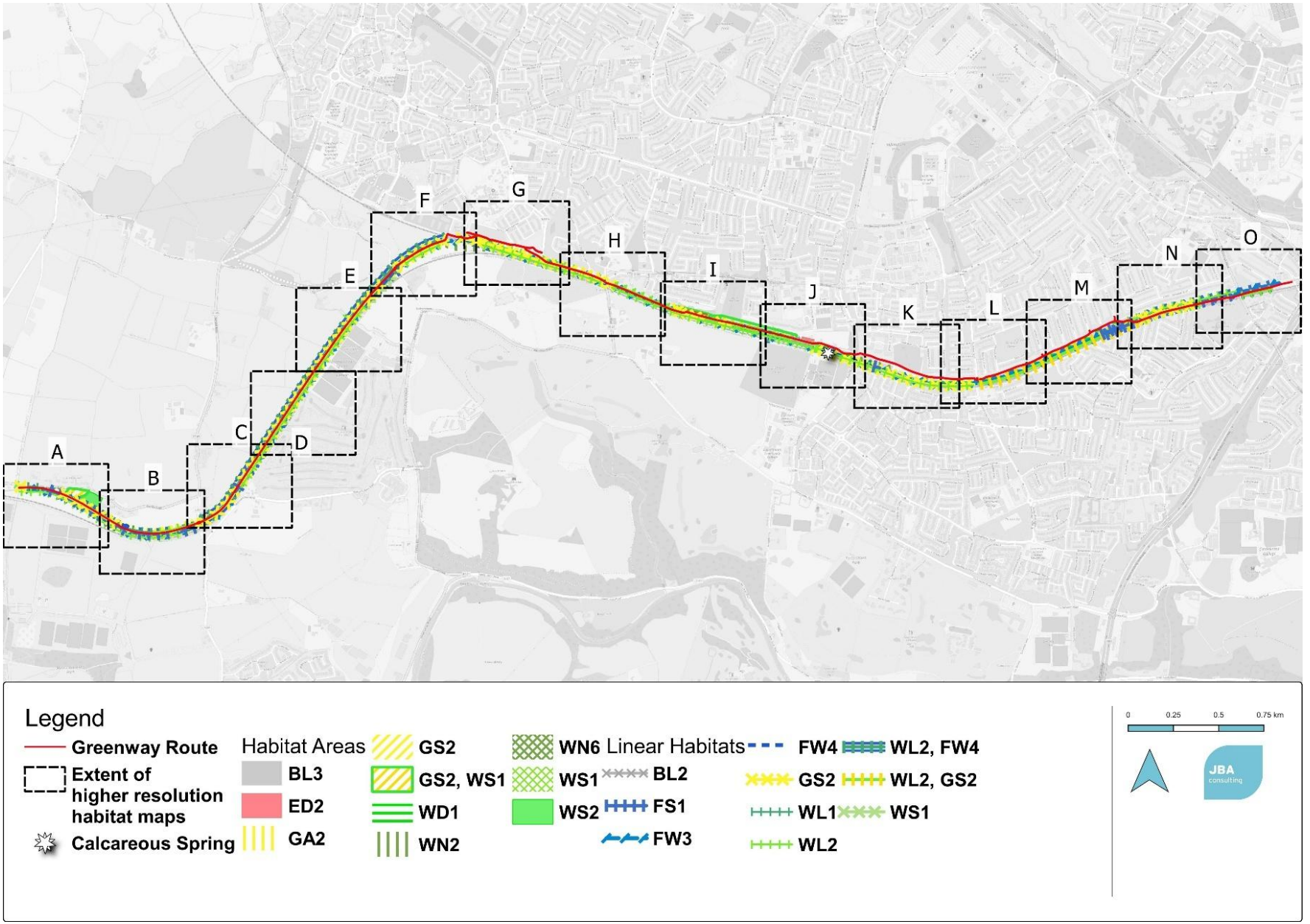
Environmental Impact Assessment Report

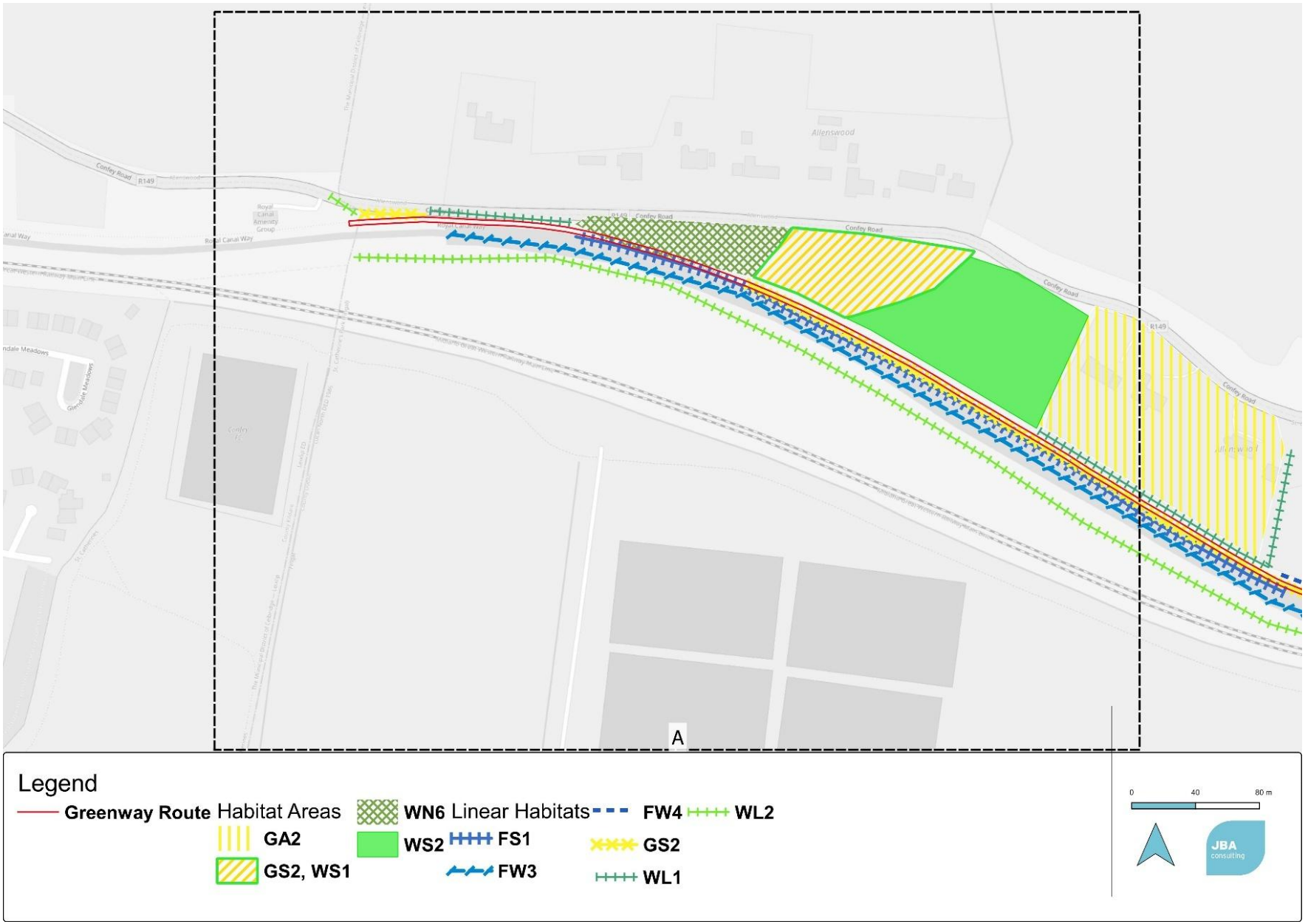
Appendix 8.3 Habitat Maps A-O of the Proposed Development

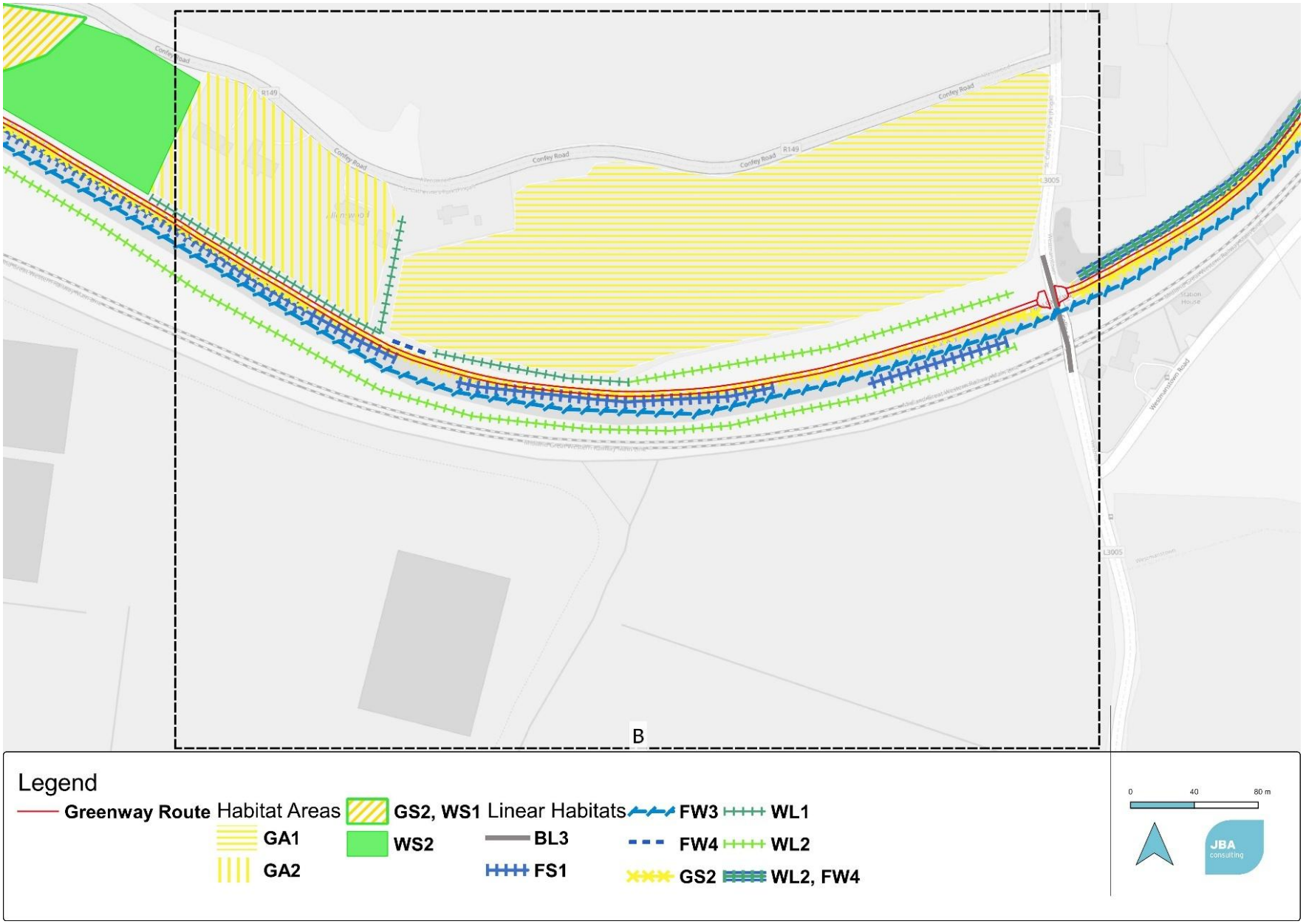
October 2026

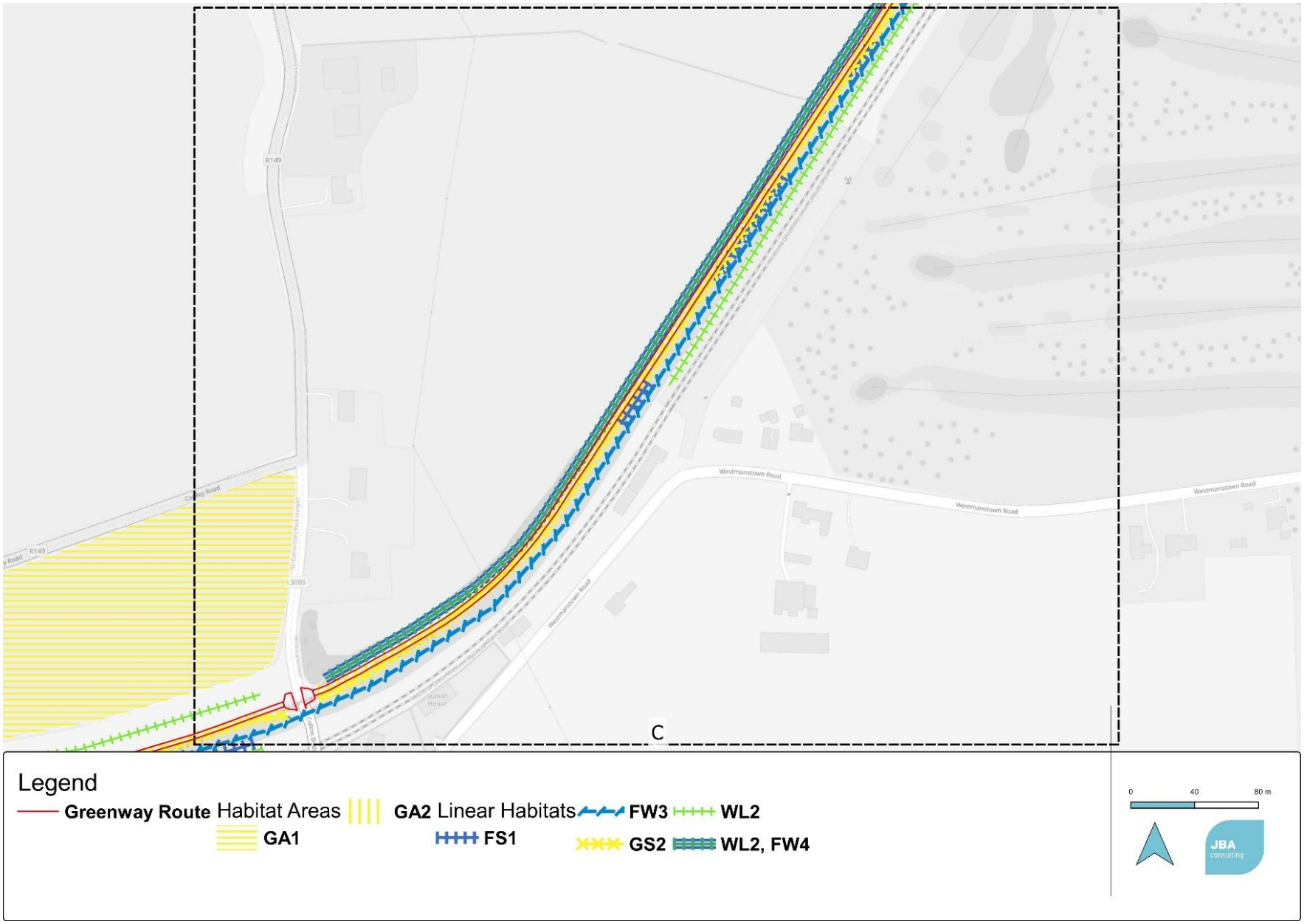


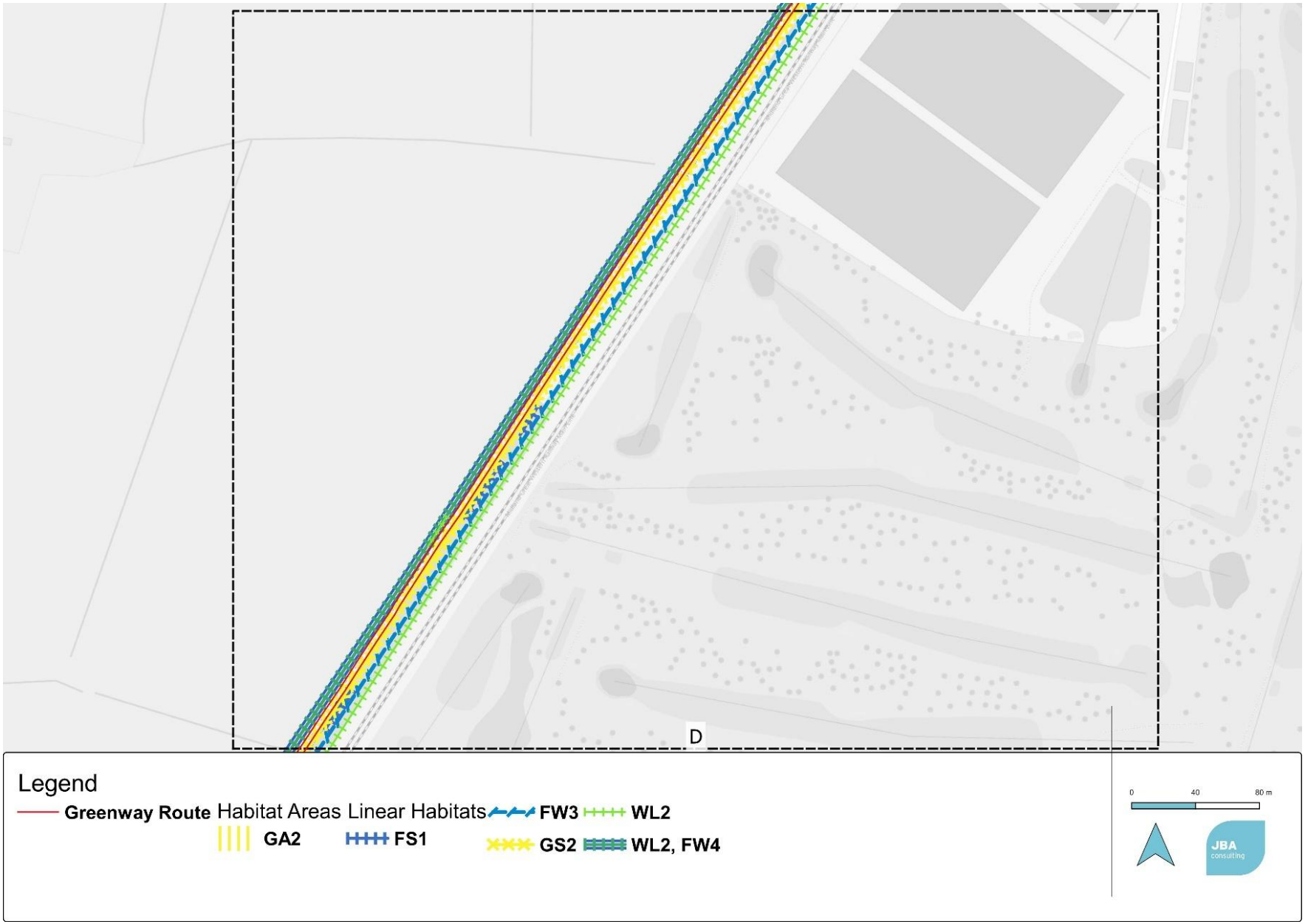
Appendix 8.3 Habitat Maps A-O of the Proposed Development


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
Legend
Greenway Route
Extent of higher resolution habitat maps
Calcareous Spring
Habitat Areas
BL3
ED2
GA2
GS2
GS2, WS1
WD1
WN2
WN6
WS1
WS2
Linear Habitats
BL2
FS1
FW3
FW4
GS2
WL1
WL2
WL2, FW4
WL2, GS2
WS1
0
0.25
0.5
0.75 km
JBA consulting

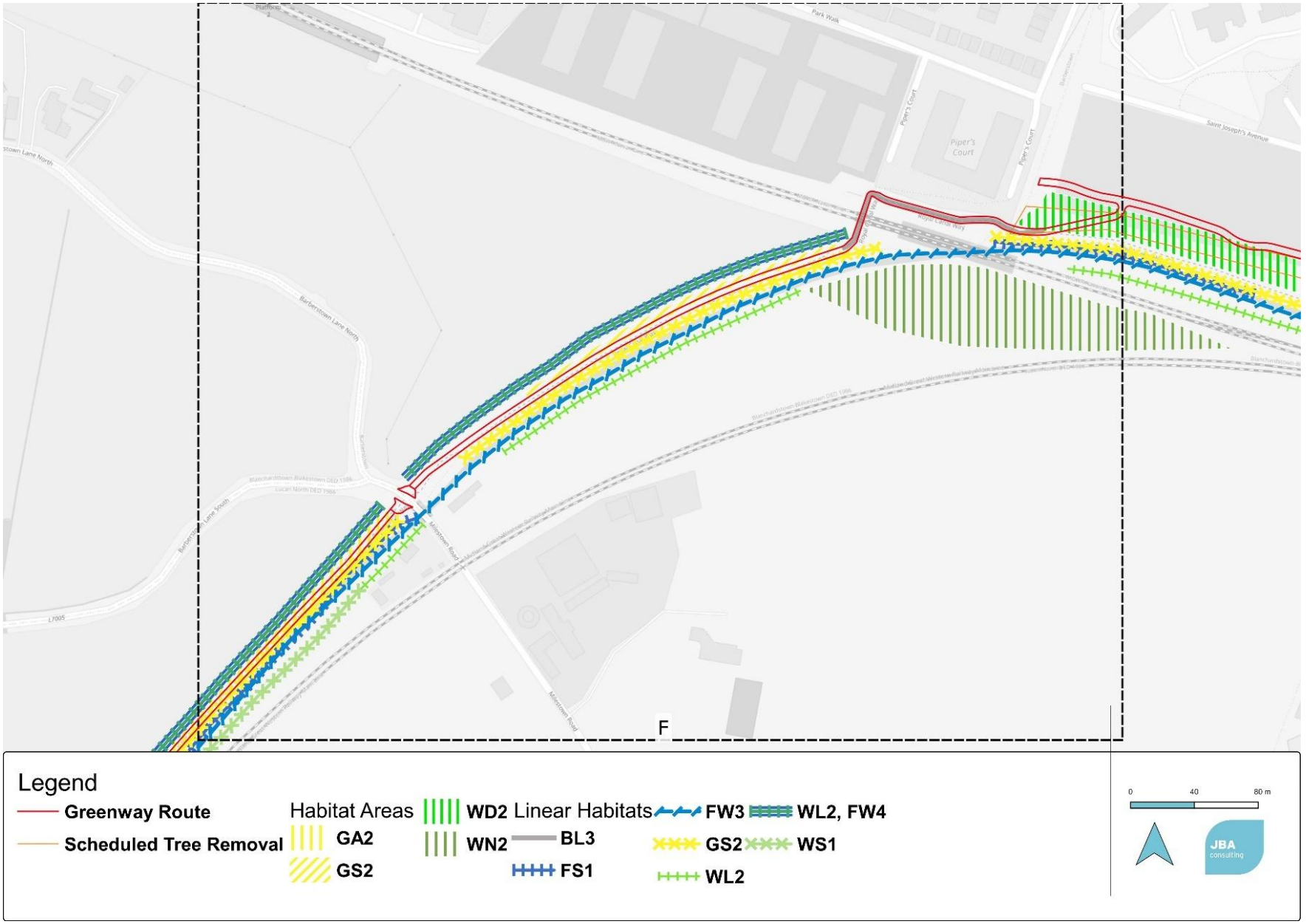

Allenswood
Confey Road
R149
Royal Canal Way
A
Legend
Greenway Route
Habitat Areas
GA2
GS2, WS1
WN6
WS2
Linear Habitats
FS1
FW3
FW4
GS2
WL1
WL2
0
40
80 m
JBA consulting

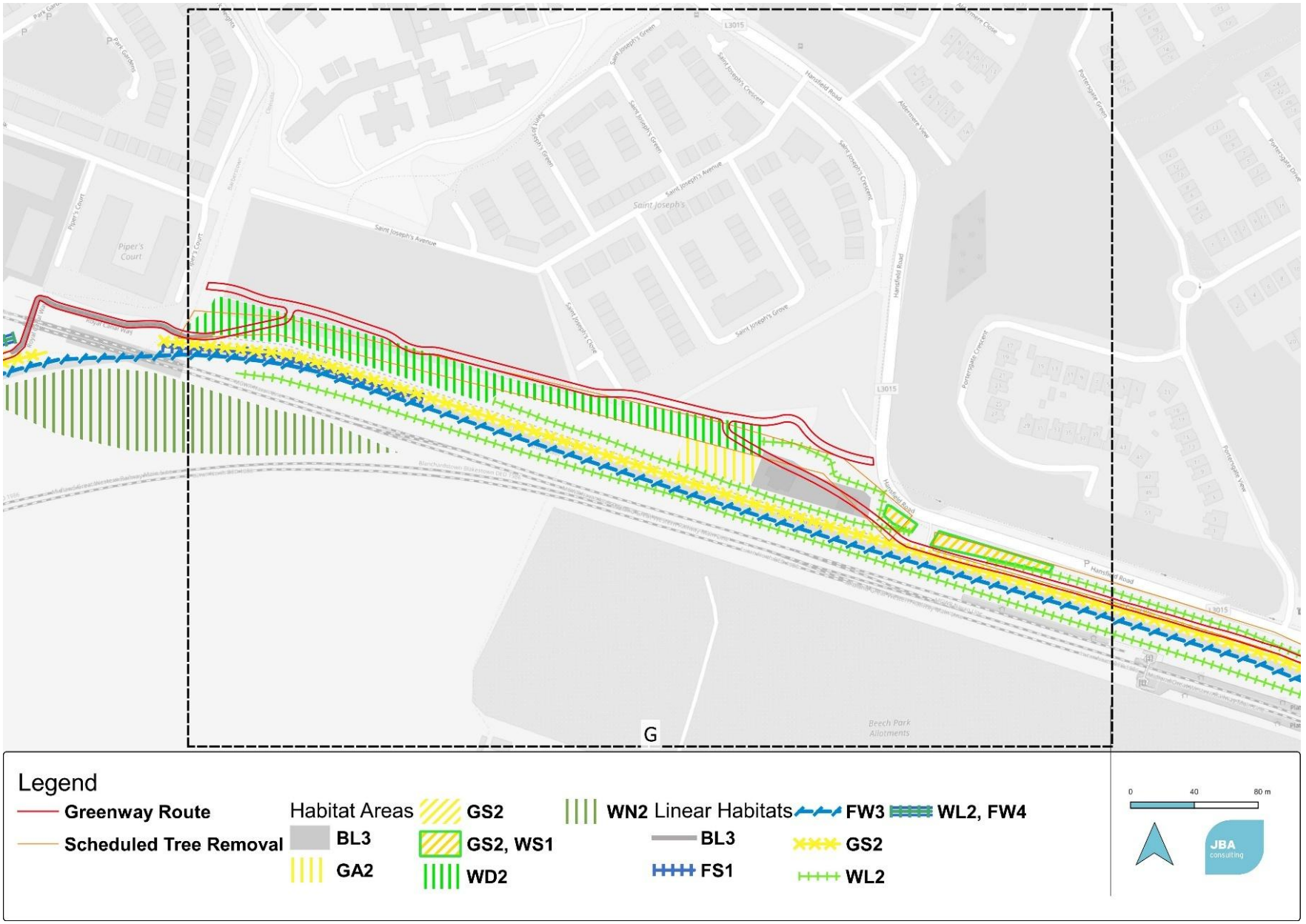

Confey Road
R149
L3005
Westmanstown Road
B
Legend
Greenway Route
Habitat Areas
GA1
GA2
GS2, WS1
WS2
Linear Habitats
BL3
FS1
FW3
FW4
GS2
WL1
WL2
WL2, FW4
0
40
80 m
JBA consulting

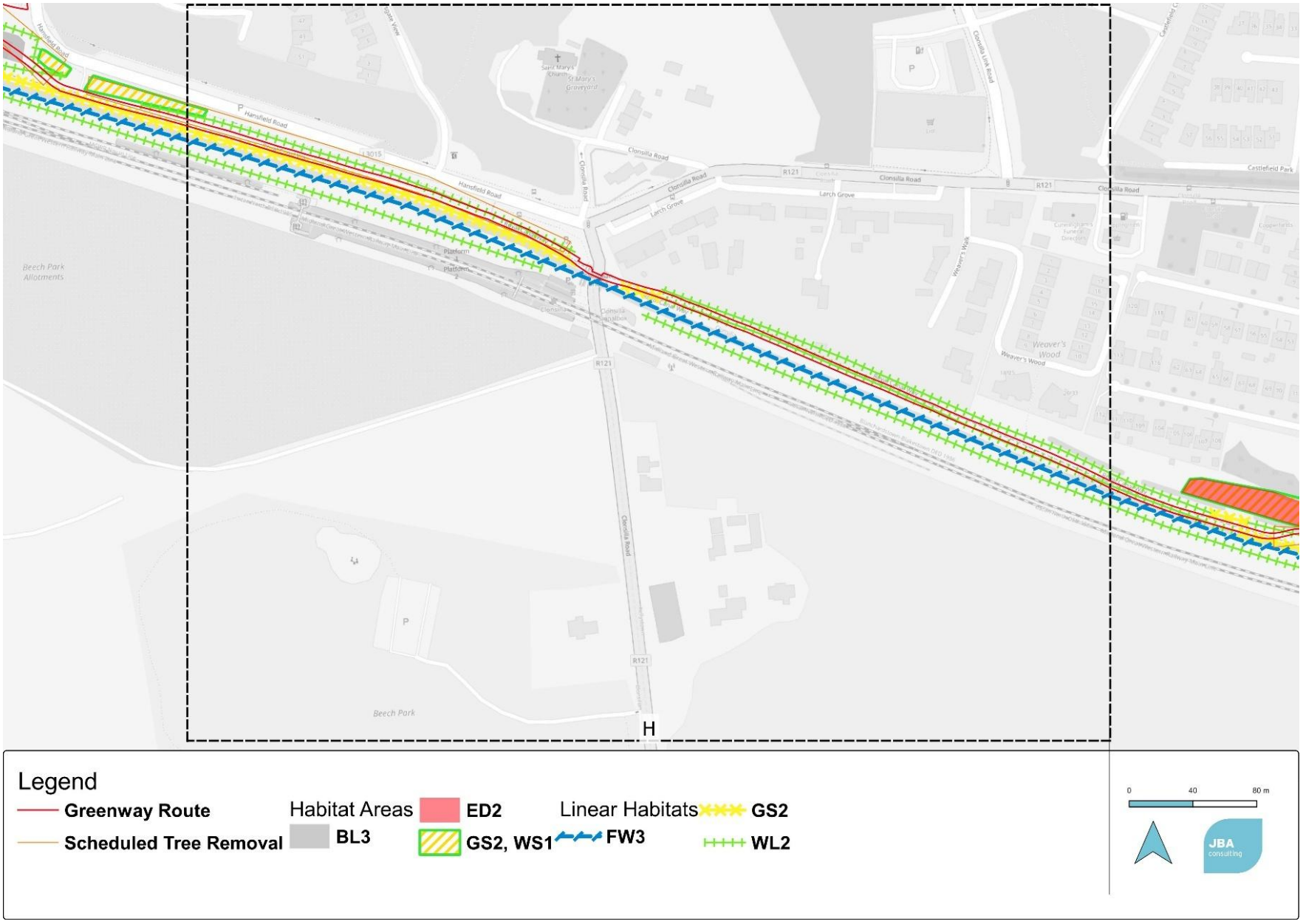

R149
Westmanstown Road
Westmanstown Road
Westmanstown Road
Westmanstown Road
C
Legend
Greenway Route
Habitat Areas
GA1
GA2
Linear Habitats
FS1
FW3
WL2
GS2
WL2, FW4
0
40
80 m
JBA consulting

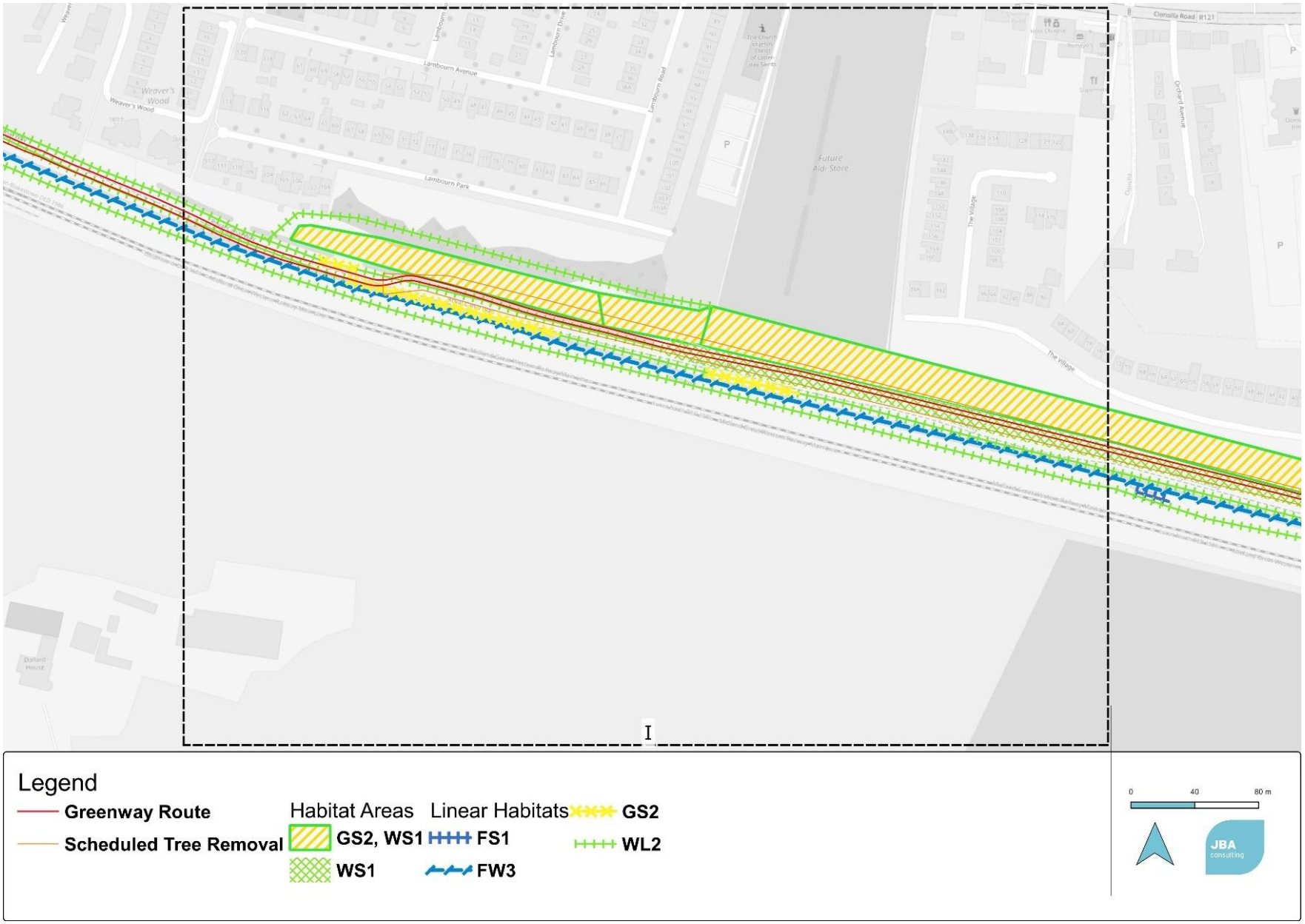

D
Legend
Greenway Route
Habitat Areas
Linear Habitats
GA2
FS1
FW3
WL2
GS2
WL2, FW4
0
40
80 m
JBA consulting

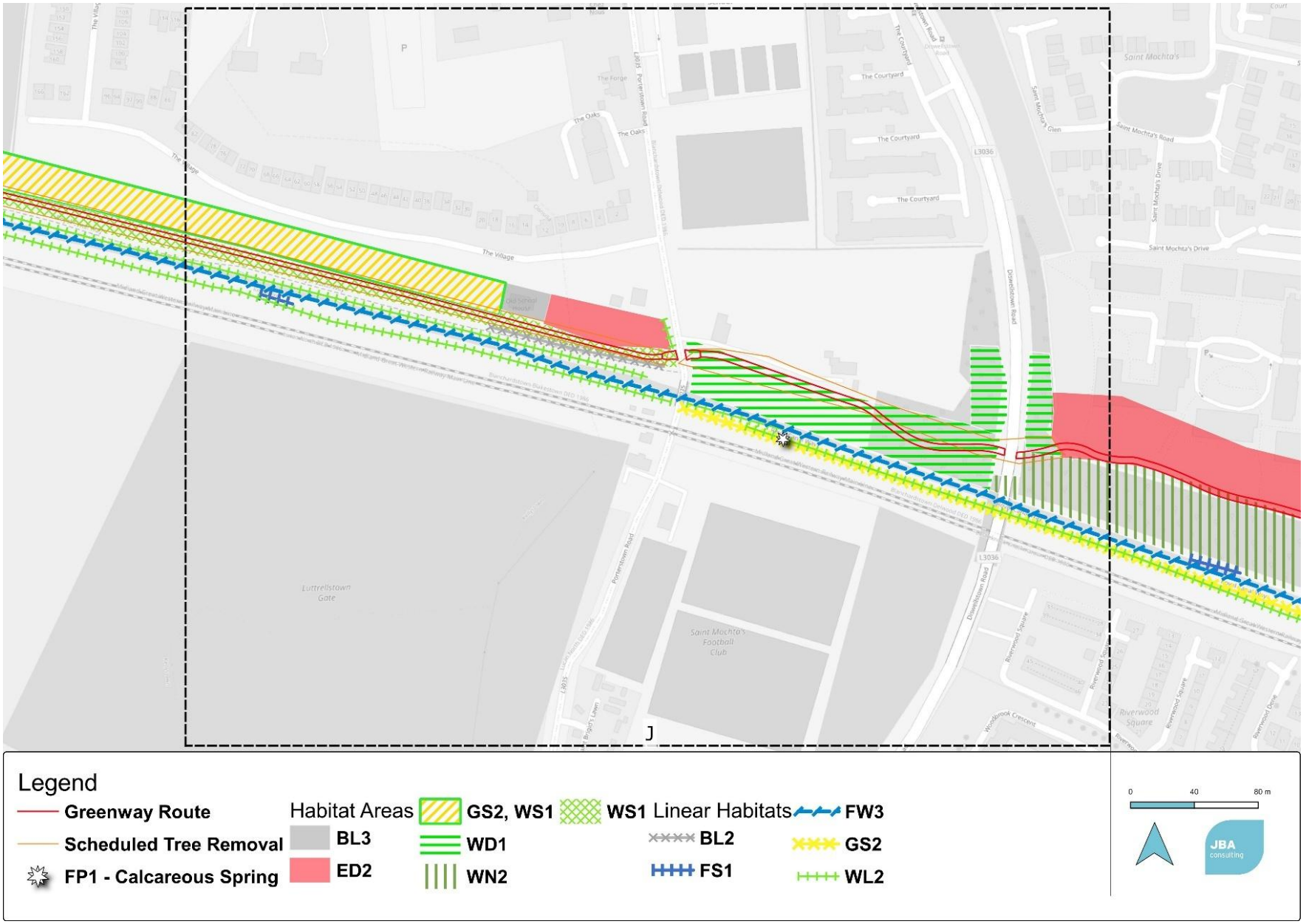

Legend
Greenway Route
Habitat Areas
Linear Habitats
GA2
FS1
FW3
GS2
WL2, FW4
FW4
WL2
WS1
E
0
40
80 m
JBA consulting

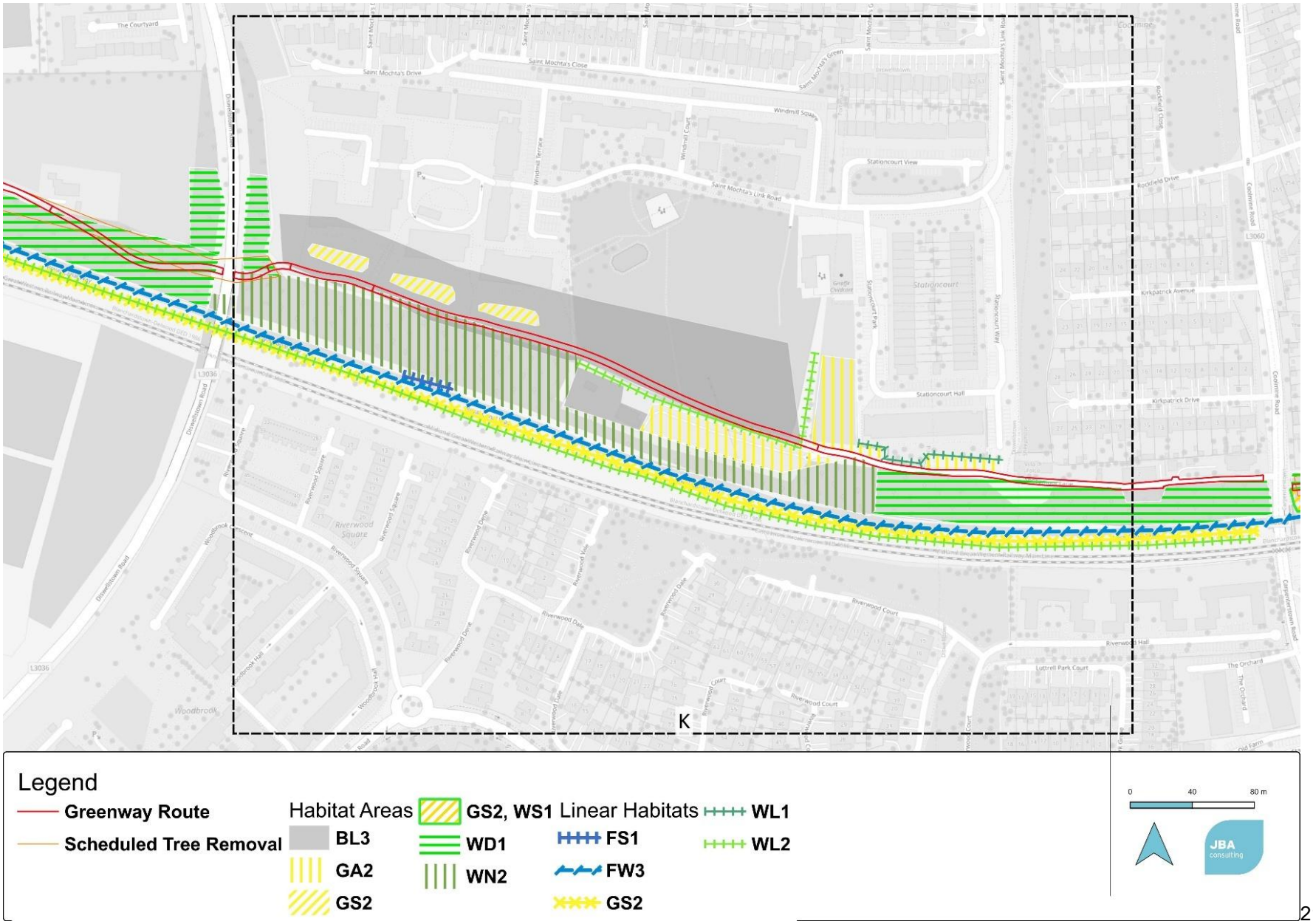

Park Walk
Piper's Court
Piper's Court
Piper's Court
Saint Joseph's Avenue
Barberstown Lane North
Barberstown Lane South
Blanchardstown-Blakestown DED 1986
Lucan North DED 1986
Blanchardstown-Blakestown DED 1986
Milestown Road
Milestown Road
L7005
F
Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
GA2
GS2
WD2
WN2
Linear Habitats
BL3
FS1
FW3
GS2
WL2
WL2, FW4
WS1
0
40
80 m
JBA consulting

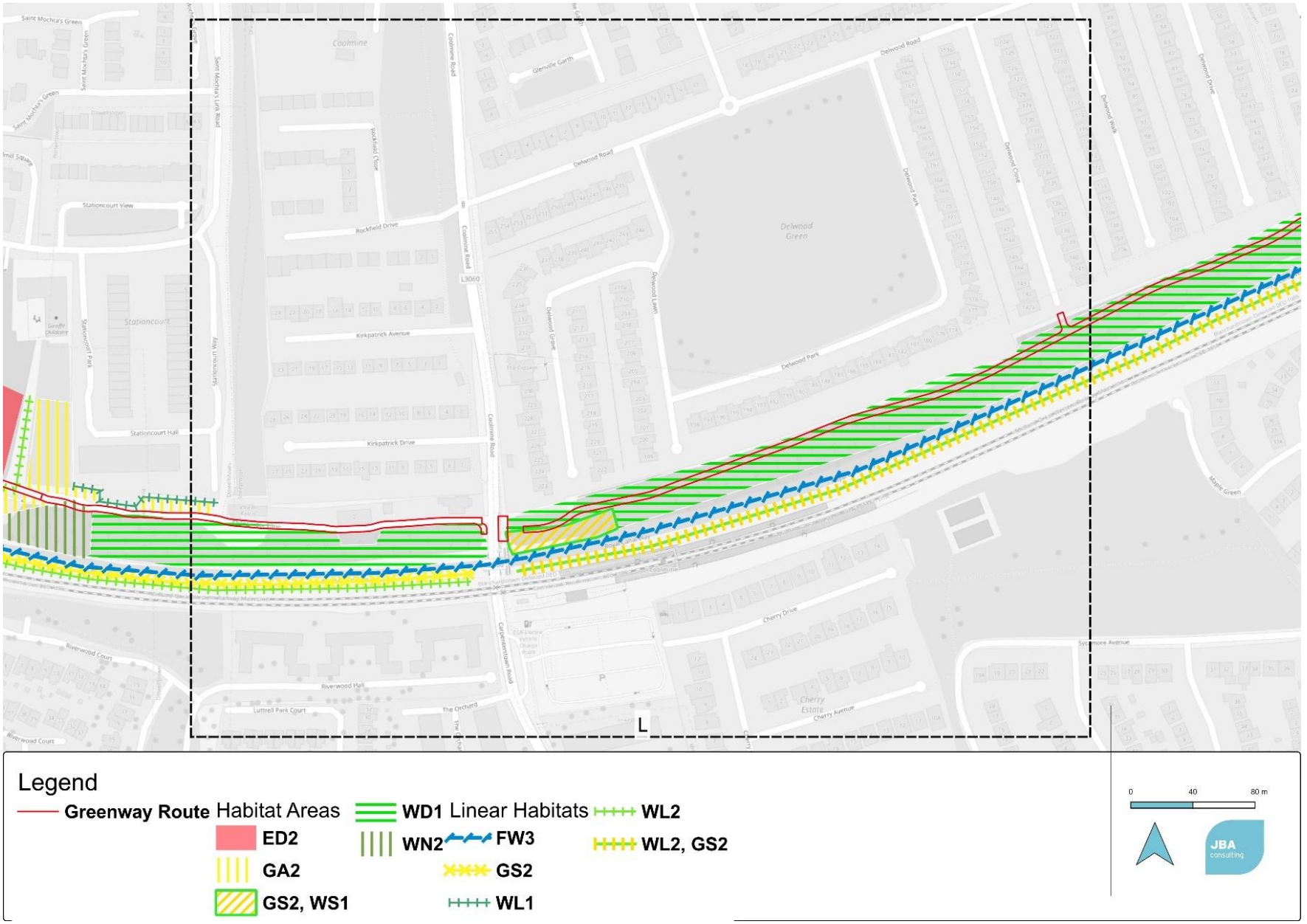

Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
BL3
GA2
GS2
GS2, WS1
WD2
WN2 Linear Habitats
BL3
FS1
FW3
GS2
WL2
WL2, FW4
0
40
80 m
JBA consulting
G
Saint Joseph's Avenue
Saint Joseph's Grove
Saint Joseph's Close
Saint Joseph's Crescent
Saint Joseph's Green
Hansfield Road
L3015
Piper's Court
Park Gardens
Allotments View
Portergate Green
Portergate Drive
Portergate Crescent
Portergate View
Beech Park Allotments


Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
BL3
ED2
GS2, WS1
Linear Habitats
FW3
GS2
WL2
0
40
80 m
JBA consulting
H
Hansfield Road
Clonsilla Road
R121
Larch Grove
Weaver's Wood
Beech Park
Beech Park Allotments
Castlefield Park
Platform

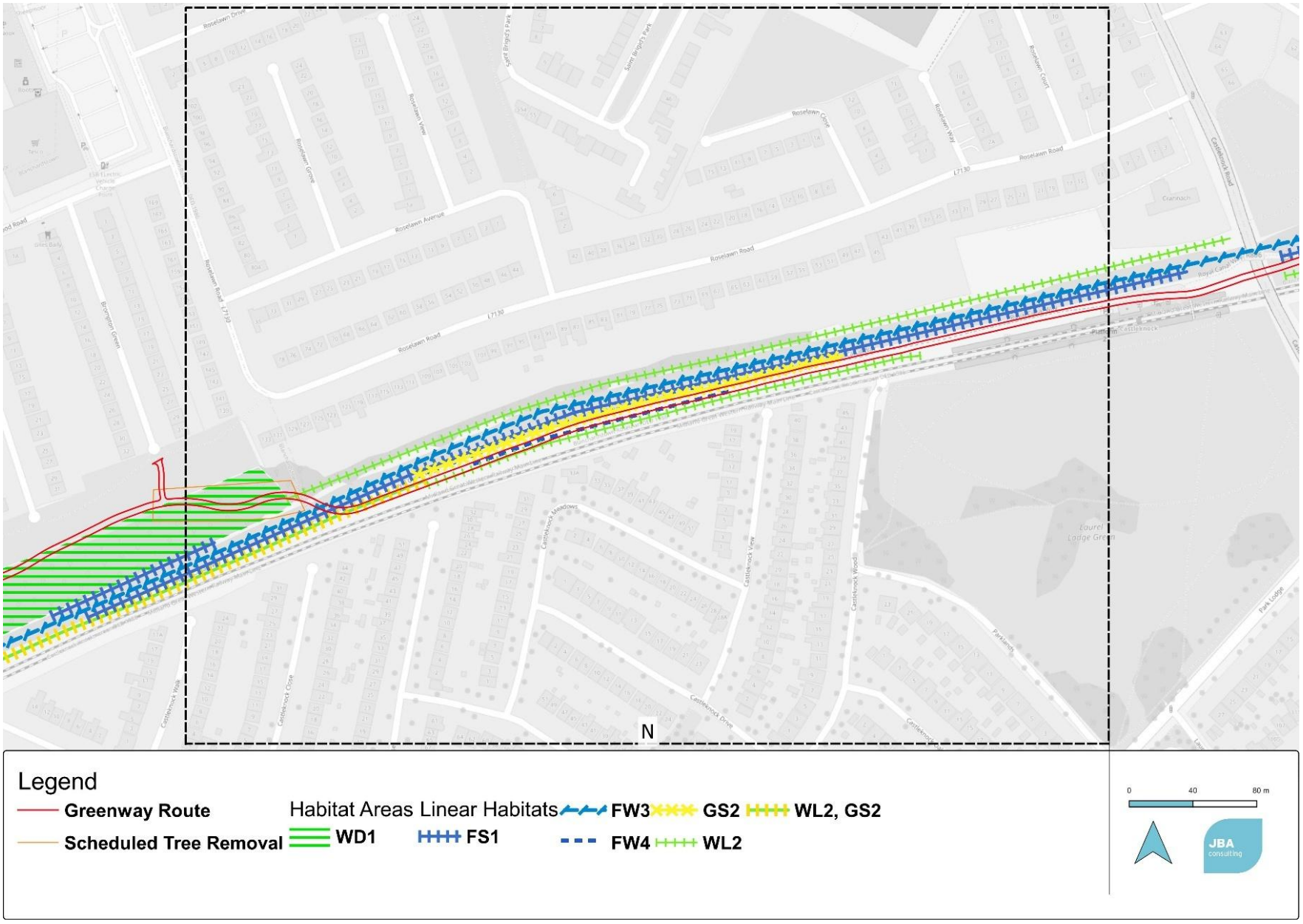

Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
GS2, WS1
WS1
Linear Habitats
FS1
FW3
GS2
WL2
0
40
80 m
JBA consulting
Lambourn Avenue
Lambourn Drive
Lambourn Road
Lambourn Park
Weaver's Wood
Clonsilla Road R121
Orchard Avenue
The Village
Future Aldi Store
Dollard House

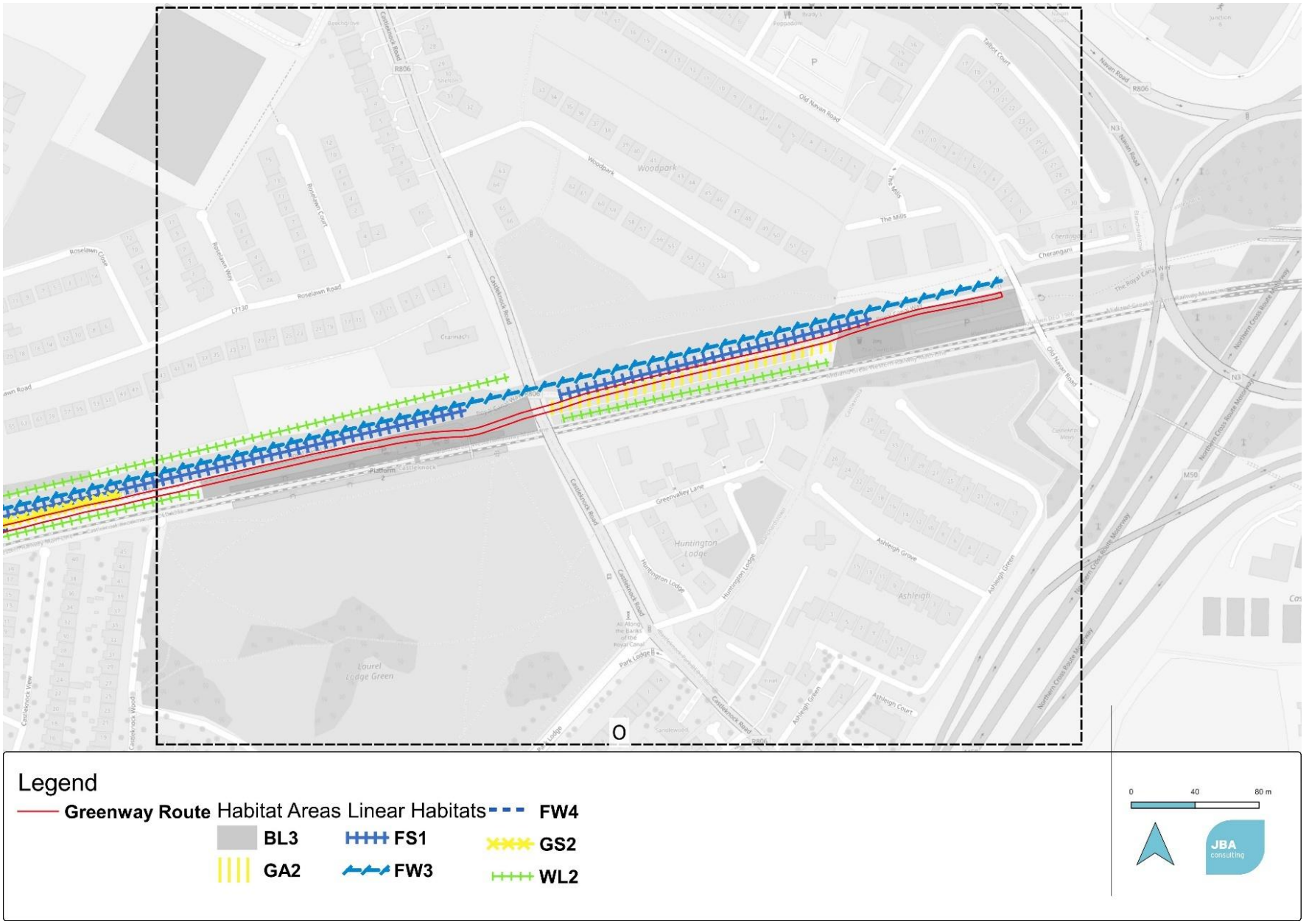

Legend
Greenway Route
Scheduled Tree Removal
FP1 - Calcareous Spring
Habitat Areas
BL3
ED2
GS2, WS1
WD1
WN2
WS1
Linear Habitats
BL2
FS1
FW3
GS2
WL2
0
40
80 m
JBA consulting
The Village
The Courtyard
Saint Mochta's
Saint Mochta's Road
Saint Mochta's Drive
Dowdstown Road
Portrane Road
L3036
Luttrellstown Gate
Saint Mochta's Football Club
Riverwood Square
Woodbrook Crescent


K
Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
BL3
GA2
GS2
GS2, WS1
WD1
WN2
Linear Habitats
FS1
FW3
GS2
WL1
WL2
0
40
80 m
JBA consulting


Legend
Greenway Route
Habitat Areas
ED2
GA2
GS2, WS1
WD1
WN2
Linear Habitats
FW3
GS2
WL1
WL2
WL2, GS2
0
40
80 m
JBA consulting
Coolmine
Delwood Green
Stationcourt
Cherry Estate
L


Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
WD1
Linear Habitats
FS1
FW3
GS2
WL2, GS2
FW4
WL2
0
40
80 m
JBA consulting
M


Roselawn Road
Roselawn Avenue
Roselawn Grove
Roselawn View
Roselawn Close
Roselawn Court
Roselawn Way
Castleknock Road
Brompton Green
Castleknock Meadows
Castleknock View
Castleknock Wood
Castleknock Close
Castleknock Drive
Park Lodge
N
Legend
Greenway Route
Scheduled Tree Removal
Habitat Areas
WD1
Linear Habitats
FS1
FW3
GS2
WL2, GS2
FW4
WL2
0
40
80 m
JBA consulting


Legend
Greenway Route
Habitat Areas
BL3
GA2
Linear Habitats
FS1
FW3
FW4
GS2
WL2
0
40
80 m
JBA consulting

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Royal Canal Urban Greenway

Environmental Impact Assessment Report

Appendix 8.4 Royal Canal Tree Removal (with m² values per area)

October 2026



Royal Canal Tree Removal Plan (with m^2 values per area)

Tree Removal Plan No.	Area (m^2)	Presence within Royal Canal pNHA	Habitat	Chainages
17	36.86	pNHA	(Mixed) broadleaved woodland	+5310 - +5500, +5500 - +5610
18	829.44	65% in pNHA	(Mixed) broadleaved woodland	+5610 - +5770
18	117.57	not in pNHA	(Mixed) broadleaved woodland	+5610 - +5770
18	39.14	not in pNHA	(Mixed) broadleaved woodland	+5610 - +5770
20	97.66	pNHA	(Mixed) broadleaved woodland	+6250 - +6600
20	210.27	pNHA	(Mixed) broadleaved woodland	+6250 - +6600
21	1434.42	pNHA	(Mixed) broadleaved woodland	+6600 - +6940
22	2981.65	pNHA	(Mixed) broadleaved woodland	+6940 - +7210
22	591.87	pNHA	(Mixed) broadleaved woodland	+6940 - +7210
22	308.7	50% in pNHA	(Mixed) broadleaved woodland	+6940 - +7210
22	158.63	90% in pNHA	(Mixed) broadleaved woodland	+6940 - +7210
Total Area (m^2)	6806.21	6189 lost from within the pNHA		
No. 14	total area not listed (arboricultural consultant to mark trees for removal within group prior to construction			

Ecological Study of the Royal Canal between Talbot Bridge and Maynooth Train Station.



November 2013

John Brophy and Fiona Devaney

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Website: www.botanicalenvironmental.com
Email: info@botanicalenvironmental.com

Table of Contents

1 Introduction 1

2 Study area 1

3 Methodology 4
3.1 Desk study 4
3.2 Consultation 4
3.3 Field survey 5
3.3.1 Habitats & plants 5
3.3.2 Mammals 5
3.3.3 Birds 6
3.3.4 Ant hills 6

4 Existing environment 6
4.1 The Royal Canal - general 6
4.2 The Royal Canal – study area 7
4.2.1 Habitats 7
4.2.2 Plant species 16
4.2.3 Rare/protected plants 17
4.2.4 Invasive plant species 18
4.2.5 Bryophytes 18
4.2.6 Mammals 19
4.2.7 Birds 20
4.2.8 Ant hills 20
4.2.9 Fish 21
4.2.10 Aquatic macroinvertebrates 21
4.2.11 Environmentally Sensitive Areas 22

5 Discussion 22

6 References 25

Appendix I – NPWS Site synopsis 27

Appendix II – Consultation 29

Appendix III – Maps 31

Appendix IV – Tables 32

Appendix V – Plates 64

Appendix VI – Bat survey report 67

1 Introduction

BEC Consultants Ltd was contracted by the National Transport Authority (NTA) to undertake an ecological survey of the Royal Canal between Talbot Bridge (12th Lock), Blanchardstown, Co. Dublin and Maynooth Train Station, Maynooth, Co. Kildare.

The aim of the survey was to collect data on the flora, fauna and habitats that exist within the sections of the Royal Canal being studied. This survey will help inform any future plans for development along the Royal Canal.

The Royal Canal is a proposed Natural Heritage Area (pNHA) under the Wildlife Acts 1976 to 2012. Its importance lies in the diversity of the habitats along the canal corridor rather than the presence of rare habitats or species. The National Parks and Wildlife Service (NPWS) site synopsis for the site is presented in Appendix I.

2 Study area

The study area was on the Royal Canal between Talbot Bridge (12th Lock), Blanchardstown, Co. Dublin and Maynooth Train Station, Maynooth, Co. Kildare; a distance of approximately 16 km. The study area was limited to the area within the pNHA boundary (Figure 1).

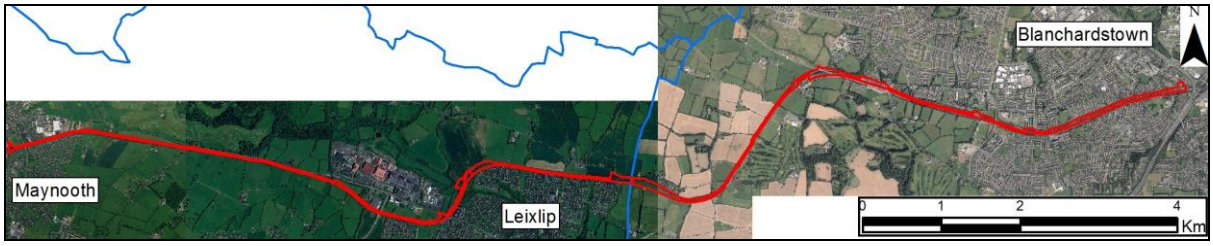


Figure 1. Map of study area (Red lines = pNHA boundary, Blue lines = County boundary)

The study area was divided into sections by the distance markers set out in Table 1. The study area comprised 15 sections beginning at Talbot Bridge (12th Lock), Blanchardstown and ending at Maynooth Harbour, boatslip and footbridge. The sections varied in length from 150 m to 2.15 km.

Table 1. Survey sections as demarcated by Royal Canal distance markers.

	From:	To:	Distance (km)
1	Talbot Bridge & Lock 12, Blanchardstown	Granard Bridge, Castleknock Road	0.30
2	Granard Bridge, Castleknock Road	Kirkpatrick Bridge, Carpenterstown	1.55
3	Kirkpatrick Bridge, Carpenterstown	Kennan or Neville Bridge, Porterstown	0.90
4	Kennan or Neville Bridge, Porterstown	Callaghan or Carhampton Bridge, Clonsilla	1.20
5	Callaghan or Carhampton Bridge, Clonsilla	Dublin & Meath Railway Bridge	0.85
6	Dublin & Meath Railway Bridge	Pakenham Bridge, Barberstown	0.40
7	Pakenham Bridge, Barberstown	Collins Bridge, Coldblow	1.80
8	Collins Bridge, Coldblow	Dublin-Kildare county boundary, boat slip & amenity area	1.05
9	Dublin-Kildare county boundary, boat slip & amenity area	Cope Bridge	0.90
10	Cope Bridge	Ryewater aqueduct	1.40
11	Ryewater aqueduct	Leixlip Spa and Louisa Bridge	0.45
12	Leixlip Spa and Louisa Bridge	Deey Bridge & Lock 13	1.60
13	Deey Bridge & Lock 13	Carton Wharf & Pike Bridge	1.85
14	Carton Wharf & Pike Bridge	Mullen Bridges	2.15
15	Mullen Bridges	Maynooth Harbour, boat slip & footbridge	0.15

Figure 2 illustrates the location of designated sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)) within 15 km of the study area, while the designated site names and codes are listed in Table 2.

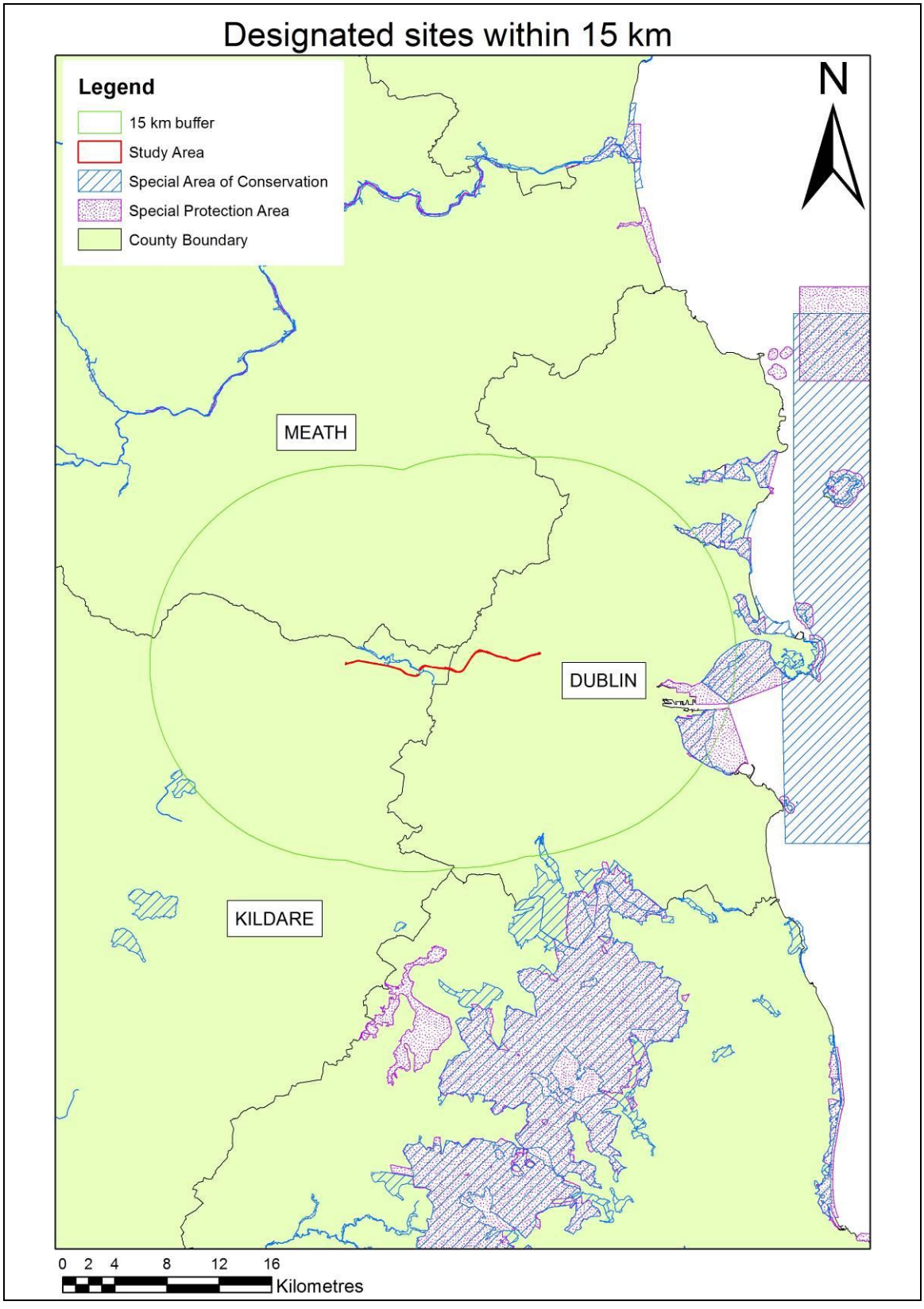


Figure 2. SACs and SPAs within 15 km of the Royal Canal study area.

Table 2. SACs and SPAs within 15 km of the Royal Canal study area.

County	Site name	Site code
Kildare	Ballynafagh Bog SAC	000391
Kildare	Ballynafagh Lake SAC	001387
Kildare	Rye Water Valley/Carton SAC	001398
Dublin	Malahide Estuary SAC	000205
Dublin	North Dublin Bay SAC	000206
Dublin	South Dublin Bay SAC	000210
Dublin	Glenasmole Valley SAC	001209
Dublin	North Bull Island SPA	004006
Dublin	South Dublin Bay and River Tolka Estuary SPA	004024
Dublin	Malahide Estuary SPA	004025

3 Methodology

3.1 Desk study

A desk study was carried out to gather existing information on the Royal Canal, its habitats and species, including fish and aquatic macroinvertebrates. This desk study included a review of the NPWS mapping tool, the National Biodiversity Data Centre mapping tool, an internet search and scientific papers.

3.2 Consultation

Consultation was carried out with a number of people and agencies in order to gather as much data as possible related to the species and habitats found within the study area. Consultation was carried out by means of e-mail and telephone conversations. Details of the consultation carried out are presented in Appendix II. People/organisations contacted as part of the consultation included:

a) Paul McLoone of Inland Fisheries Ireland (IFI) to obtain any relevant fish data for the survey area.

b) Tara Gallagher of IFI to obtain data on aquatic macroinvertebrates of the study area.

c) Dr Tina Aughney of Bat Conservation Ireland.

d) Ciara Flynn and Dr Maurice Eakin - District Conservation Officers with National Parks and Wildlife Service (NPWS) with responsibility for Kildare and Dublin respectively.

e) Relevant Biodiversity and Heritage Officers.

f) Birdwatch Ireland.

g) Tree Council of Ireland/Champion Trees.

h) Relevant BSBI County Recorders.

3.3 Field survey

A field survey was carried along the Royal Canal within the study area on 12-14th and 20-23rd June 2013, with additional work carried out from a barge within the Deep Sinking on 2nd August 2013, and a final supplementary site visit on August 24th. The project team consisted of John Brophy, Dr Fiona Devaney, Dr Fionnuala O'Neill, Dr Jim Martin and Dr Jenni Roche of BEC Consultants Ltd. Dr Tina Aughney of Bat Eco Services carried out the specialised bat survey over a number of days and nights in June. Some of the bryophyte identifications were confirmed by Dr Rory Hodd. The aim of the field survey was to map the habitats and record plant (including bryophytes), bird and mammal species within the study area, while highlighting habitats and species of particular importance (e.g. rare or protected).

3.3.1 Habitats & plants

The habitats present in the study area were identified and recorded following the Fossitt (2000) classification. Habitats were mapped on to base-maps in the field and on return to the office digitised using ArcGIS. Habitat mapping techniques followed those of Smith *et al*. (2011). It should be noted that the accuracy of standard GPS units usually ranges from 5 – 15 metres and the aerial photograph base maps were also utilised to inform the habitat mapping. In the case of mapping the linear habitats along the canal corridor, a small margin of error should be expected and maps should be treated as schematic rather than precise representations of what is on the ground. This is particularly true when considering the width of linear habitats; mapped as polylines, which are always less than 4 m but could vary considerably within the range of 0.1 m to 4 m. An inventory of plant species, including bryophytes, was prepared for each survey section. Nomenclature follows Atherton *et al*. (2010) for bryophytes and Stace (2010) for all other plant species. Old names are in parentheses where recent name changes have taken place. The locations of invasive species found in the course of the survey were recorded using a hand-held GPS.

Submerged aquatic vegetation was sampled by means of a double-headed rake. Approximately three stations were sampled per section, with more stations sampled in longer stretches. The relative abundance of the species recorded was described using the DAFOR scale: Dominant = 76-100%, Abundant = 41-75%, Frequent = 11-40%, Occasional = 3-10% and Rare = <3%.

3.3.2 Mammals

For the purposes of this survey, mammals were divided into volant (bats) and non-volant (all other mammals). Non-volant mammal activity was recorded by the BEC Consultants team, while the bat survey was carried out by Dr Tina Aughney.

The study area was surveyed for the presence of non-volant mammals, including otters (*Lutra lutra*) and badgers (*Meles meles*). This included looking for signs such as droppings, footprints, potential dwellings (holts/setts/warrens, *etc*.), latrines, tracks and feeding signs. The locations of any particularly notable signs found were recorded using a handheld GPS.

3.3.3 Birds

A bird survey of the study area was carried out. This survey consisted of walking the study area and recording all bird species within the boundary of the pNHA. Bird species were identified by sight or calls and a species inventory for each canal section was compiled. Bird species were only recorded if they were considered to be interacting with the canal corridor and so species transiting the area were not recorded.

3.3.4 Ant hills

The locations of notable ant hills, particularly in the Deep Sinking, were recorded using a hand-held GPS, while ants were sampled using a pooter. Ants were preserved in 70% Industrial Methylated Spirits (IMS) and returned to the laboratory for identification.

4 Existing environment

4.1 The Royal Canal - general

The Royal Canal extends across the midlands of Ireland linking the River Shannon at Richmond Harbour, Cloondara, Co. Longford to the River Liffey estuary in Dublin, with a branch also connecting to Longford Town. The canal is listed as a proposed Natural Heritage Area (pNHA, site code: 002103) for the presence of numerous habitats and species along its corridor. The habitats present include hedgerows, treelines, tall herbs, calcareous grassland, grassy verges, tall reed swamp, open water, scrub and woodland. While the ecological value of the Royal Canal lies more in the diversity of the habitats and species it supports, as well as its role as a corridor in an otherwise largely agricultural landscape, rare and protected species do occur. Opposite-leaved pondweed (*Groenlandia densa*), a plant listed on the Flora Protection Order 1999 (S.I. 94/1999), otters (*Lutra lutra*), white-clawed crayfish (*Austropotamobius pallipes*) and kingfishers (*Alcedo atthis*) protected under the Wildlife Acts 1976 to 2012 and the European Communities (Birds and Natural Habitats) Regulations 2011 are recorded from the site. Otters are listed under Annex II and IV of the European Union's Habitats Directive (92/43/EEC), while white-clawed crayfish are also listed under Annex II of the Habitats Directive and kingfishers are listed under Annex I of the Birds Directive (2009/147/EC).

A detailed survey of the Royal Canal was carried out in 1989/90 (Dromey *et al*., 1990a), which identified habitats and species along the length of the canal, highlighting areas and species of ecological value. The protected species Green-winged Orchid (*Anacamptis morio* (=*Orchis morio*)) was recorded along the Royal Canal, but not within the current study area, while Opposite-leaved Pondweed (*Groenlandia densa*), also protected, was only recorded within Dublin City. Many of the recommendations made by Dromey *et al.* (1990b) are still applicable to works within the canal corridor today.

The water quality assessment of the Royal Canal carried out in 2009, showed good water quality in general; however there were breaches in the limits set for Total Phosphorus (TP) and Molybdate

Reactive Phosphorus (MRP) in November 2009, which may have been the result of higher than normal rainfall levels leading to increased surface water run-off (McGarrigle *et al*., 2010).

The NPWS site synopsis for the Royal Canal pNHA is presented in Appendix I.

4.2 The Royal Canal – study area

4.2.1 Habitats

Twenty-six habitat types described in Fossitt (2000) were recorded within the study area in the course of the current survey (Table 3). The habitat maps are presented in Appendix III. Sections in Dublin had 11 habitats recorded within them on average, while sections in Kildare had a mean of 12 habitats. Section 2 (Granard Bridge to Kirkpatrick Bridge) had the most habitats recorded within it (15 habitats), while Section 1 (Talbot Bridge & 12th Lock to Granard Bridge) had the least (6 habitats).

Table 3. List of habitats recorded within the Royal Canal study area

Habitat code	Habitat name	No. of sections habitat recorded
BC1	Arable crops	1
BC4	Flower beds and borders	1
BL1	Stone walls and other stonework	11
BL2	Earth banks	1
BL3	Buildings and artificial surfaces	15
ED2	Spoil and bare ground	10
ED3	Recolonising bare ground	3
ER2	Exposed calcareous rock	3
FP1	Calcareous springs	1
FS1	Reed and large sedge swamps	11
FS2	Tall-herb swamps	1
FW3	Canals	15
FW4	Drainage ditches	4
GA2	Amenity grassland (improved)	13
GM1	Marsh	1
GS1	Dry calcareous and neutral grassland	3
GS2	Dry meadows and grassy verges	14
GS4	Wet grassland	6
WD1	(Mixed) broadleaved woodland	3
WD5	Scattered trees and parkland	1
WL1	Hedgerows	12
WL2	Treelines	14
WN2	Oak-ash-hazel woodland	10
WN6	Wet willow-alder-ash woodland	3
WS1	Scrub	12
WS3	Ornamental/non-native shrub	2

4.2.1.1 BC1 Arable crops

One area of Arable crops (BC1) was recorded within the study area, just west of the Royal Canal Amenity Group (RCAG) building, close to the Kildare-Dublin county boundary (Section 9).

4.2.1.2 BC4 Flower beds and borders

Two areas of Flower beds and borders (BC4) were recorded within the study area, both in Section 2. The larger of the two areas was recorded on the north side of the canal, between a treeline and a housing estate and comprised private gardens. The smaller area is represented by municipal planting in the platform area of Castleknock train station.

4.2.1.3 BL1 Stone walls and other stonework

The habitat Stone walls and other stonework (BL1) was recorded in many locations within the study area (11 sections). This habitat includes stone walls other than those of intact buildings. In the case of the study area, the habitat occurred on bridges, the Ryewater aqueduct, and walls in locks and along other parts of the canal bank. In stretches of the Deep Sinking, areas of stone wall were visible close to the water line of the canal.



Stone walls and other stonework of this type provides habitat for a number of specialised species, including ferns, lichens and mosses. Plant pecies recorded in this habitat within the study area included Common Ivy (*Hedera helix*), Wall-rue (*Asplenium ruta-muraria*), Maidenhair Spleenwort (*A. trichomanes*) and the non-natives Fairy Foxglove (*Erinus alpinus*) and Ivy-leaved Toadflax (*Cymbalaria muralis*).

4.2.1.4 BL2 Earth banks

Earth banks (BL2) were recorded in Section 2 only. While earth banks also occurred in other sections, the treelines, which were found on top of the earth banks, always dominated and therefore these areas were mapped as part of the treeline (WL2) habitat. However, the earth bank in Section 2 was not topped by treelines and the bank was rounded on top before descending to the train track on the other side. An anthill was found on the top of the earth bank. Typical species of the earth bank included many species found in dry meadow habitat, such as Common Knapweed (*Centaurea nigra*), False Oat-grass (*Arrhenatherum elatius*) and Dandelion (*Taraxacum officinale* agg).

4.2.1.5 BL3 Buildings and artificial surfaces

Within the study area the habitat Buildings and artifical surfaces (BL3) was represented by a number of features including modern bridges, road surfaces, gravel and tarmacadam paths, and jetties. This habitat has minimal ability to support species and is generally of little conservation importance, though there can be exceptions (e.g. bats roosting



within buildings). Bridges contributed greatly to the extent of the BL3 habitat along the Royal Canal, as do stretches of gravel and tarmacadam path. This habitat was recorded in all 15 sections within the study area.

4.2.1.6 ED2 Spoil and bare ground



The Spoil and bare ground (ED2) habitat may be transient in nature or may persist due to on-going disturbance. It can include land that is kept unvegetated by heavy trampling or by the operation of vehicles. Within the study area, ED2 was common due to the cycling of bikes along the grassy stretches of the towpath and also in areas where works were on-going on the towpath and canal banks, such as that occurring in Section 4 (Kennan/Neville Bridge to Callaghan/Carhampton Bridge) during the time of the survey. This habitat was recorded in ten of the 15 sections, with the majority recorded from the Dublin sections.

4.2.1.7 ED3 Recolonising bare ground



Recolonising bare ground (ED3) occurs when bare or disturbed ground becomes invaded by herbaceous plants, with plant cover exceeding 50%. It occurred in a few places within the survey area (Sections 4, 11 and 13), usually adjacent to the track (ED2) where trampling is less severe, therefore giving vegetation a chance to recolonise. Species recorded in this habitat within the study area included Great Willowherb (*Epilobium hirsutum*), Bramble (*Rubus fruticosus* agg.), Common Nettle (*Urtica dioica*), Cleavers (*Galium aparine*), Creeping Buttercup (*Ranunculus repens*) and the rare introduction Prickly Lettuce (*Lactuca serriola*).

4.2.1.8 ER2 Exposed calcareous rock



Exposed calcareous rock (ER2) was recorded in the Deep Sinking (Sections 2 and 3), where the channel of the canal was cut through an area of limestone. It was also recorded in Section 13. Grassland and treeline habitats have encroached on the majority of this habitat, though some areas still retain bare rock or areas covered only by mosses. When compared with photographs taken

by Dromey *et al*. (1990a), it can be seen that this encroachment has occurred considerably over the last two decades.

4.2.1.9 FP1 Calcareous springs



One area of Calcareous springs (FP1) was recorded in the course of the current study, and this was in the Deep Sinking in Section 3 (ITM 706155 737768). The spring was located on a rock face created by the construction works of the canal, and abundant moss and liverwort species occurred, including *Eucladium verticillatum*, *Palustriella falcata*, *Aneura pinguis* and *Leiocolea badensis*. This type of calcareous spring corresponds to the priority Annex I habitat: Petrifying springs with tufa formation (Cratoneurion) (7220).

4.2.1.10 FS1 Reed and tall sedge swamps



Strictly speaking, reed swamp did not occur in the study area, as the only place where this habitat was found was along the canal fringe, and so should be included in Canals (FW3); however, due to the importance of this habitat to aquatic birds, fish and macroinvertebrates the habitat is considered separately here. The reed swamp habitat along the canal is dominated by Reed Sweet-grass (*Glyceria maxima*), Common Club-rush (*Schoenoplectus lacustris*) and Bottle Sedge (*Carex rostrata*), with Unbranched Bur-reed (*Sparganium emersum*) present in places. Greater Spearwort (*Ranunculus lingua*) was recorded from this habitat in a number of sections. It was quite an abundant habitat within the survey area, recorded in 11 sections; however it had quite a fragmented distribution along some stretches.



One area of tall sedge swamp was found in a depression within the survey area, bordering Wet willow-alder-ash woodland (WN6) just west of Louisa Bridge (Section 12). This habitat had open water at the time of the survey and supported species such as Ragged Robin (*Silene flos-cuculi* (=*Lychnis flos-cuculi*)), Bogbean (*Menyanthes trifoliata*), Meadowsweet (*Filipendula ulmaria*) and Water Horsetail (*Equisetum fluviatile*), and was dominated by Tufted-sedge (*Carex elata*).

4.2.1.11 FS2 Tall herb swamps



Tall herb swamps (FS2) was only recorded along a short stretch of one section within the study area – Section 8. The habitat supported plants such as Meadowsweet (*Filipendula ulmaria*), Common Valerian (*Valeriana officinalis*) and Wild Angelica (*Angelica sylvestris*). The habitat here was considered to qualify as the Annex I habitat Hydrophilous tall herb fringe communities of plains and of the montane to alpine level (6430). The habitat extended along the southern canal bank, behind a fringe of FS1 in very limited areas.

4.2.1.12 FW3 Canals



The Canals (FW3) habitat was clearly the dominant habitat within the study area, with a width of greater than 10 m in most places and extending the full length of the study area. Canals are defined in Fossitt (2000) as "artificial linear bodies of water that were originally constructed for the purposes of navigation". The canal habitat supported numerous aquatic plant species including Yellow Water-lily (*Nuphar lutea*), Mare's Tail (*Hippuris vulgaris*), waterweeds (*Elodea* spp.), Reed Sweet-grass (*Glyceria maxima*) and Ivy-leaved duckweed (*Lemna trisulca*). A number of stonewort (Charophyta) species are also found in the Royal Canal, of which Common Stonewort (*Chara vulgaris*) and Fragile Stonewort (*Chara globularis*) were recorded in this survey.

In addition to the plant species, the canal supports fish, macroinvertebrates, birds and mammals.

4.2.1.13 FW4 Drainage ditches



The Drainage ditches (FW4) habitat was limited in occurrence within the study area, partly due to the fact that it is a requirement that, to be considered FW4, a ditch should either contain water (flowing or stagnant) or be wet enough to support wetland vegetation. FW4 was associated with Hedgerows (WL1) and Treelines (WL2). The habitat, in places, supported starworts (*Callitriche* spp.) and Water Figwort (*Scrophularia auriculata*) (pictured above). It was recorded in four sections; two either side of the Dublin-Kildare border (Sections 7, 8, 9 and 10).

4.2.1.14 GA2 Amenity grassland (improved)



Amenity grassland (improved) (GA2) is identified by its low species diversity and its management for purposes other than the production of grass. Along the Royal Canal within the study area, this habitat is maintained by mowing and supports species such as Dandelion (*Taraxacum offinale* agg.), plantains (*Plantago* spp.) and clovers (*Trifolium* spp.). The largest areas of GA2 within the study area tended to be at bridges crossing the canal, where the tow-path widens out. It was an extremely abundant habitat within the study area, recorded in 13 of the 15 sections.

4.2.1.15 GM1 Marsh

Marsh (GM1), along with the Tall herb swamps (FS2) habitat, were the rarest of the semi-natural habitats recorded within the study area, with both habitats only recorded in one section each. Marsh was recorded in Section 5 and was noted as an Environmentally Sensitive Area. The marsh habitat existed just above the water level of the canal and broadleaved herbs, such as Hemp-agrimony (*Eupatorium canabinum*) and Meadowsweet *(Filipendula ulmaria*), accounted for greater than 50% of the vegetation. Although marsh was recorded less frequently than wet grassland (GS4) and grassy verges (GS2) marshier elements were recorded within both of these habitats during the survey.

4.2.1.16 GS1 Dry calcareous and neutral grassland



Dry calcareous and neutral grassland (GS1) was occasionally noted within the study area, recorded in Sections 10, 11 and 12 only. No GS1 was recorded within any of the Dublin sections. This habitat can be identified by the presence of calcareous plant species and by its more open sward when compared with dry meadows and grassy verges (GS2). Areas that had high species diversity and supported orchid species such as Pyramidal Orchid (*Anacamptis pyramidalis*) were mapped as Environmentally Sensitive Areas (ESAs). The habitat appears to be maintained by mowing and/or strimming, though on steeper banks encroachment by Bramble (*Rubus fruticosus* agg.), roses (*Rosa* spp.) and other woody species is occurring. The habitat supports species such as Salad Burnet (*Poterium sanguisorba* (=*Sanguisorba minor*)), Lady's Bedstraw (*Galium verum*), Field Scabious (*Knautia arvensis*), Red Fescue (*Festuca rubra*) and Oxeye Daisy (*Leucanthemum vulgare*).

4.2.1.17 GS2 Dry meadows and grassy verges



Dry meadow and grassy verges (GS2) was the most frequently occurring grassland habitat within the study area (14 sections). It was usually noted on both sides of the path (ED2; BL3), with a thin border of amenity grassland (GA2) acting as a buffer zone between them in places. Accessible areas appear to be managed by mowing. The habitat is identifiable by large tussock-forming grasses such as Cock's-foot (*Dactylis glomerata*) and False Oat-grass (*Arrhenatherum elatius*), tall broadleaf herbs such as Meadowsweet (*Filipendula ulmaria*), Common Knapweed (*Centaurea nigra*) and Cow Parsley (*Anthriscus sylvestris*), as well as by climbing plants such as Bush Vetch (*Vicia sepium*), Hedge Bindweed (*Calystegia sepium*) and Meadow Vetchling (*Lathyrus pratensis*). This habitat became damper closer to the canal edge, as indicated by the presence of Yellow Iris (*Iris pseudacorus*), Hemp-agrimony (*Eupatorium cannabinum*) and Wild Angelica (*Angelica sylvestris*).

4.2.1.18 GS4 Wet grassland



Wet grassland (GS4) was recorded in 6 sections, with the majority of these sections located in Dublin. Characteristic species of wet grassland were often present in a narrow area between the grassy verges (GS2) and reed swamp (FS1) fringing the canal; however this area was generally not mapped as GS4 as it reflected a transitional zone rather than genuine habitat. Where it did occur as a distinct habitat, Hard Rush (*Juncus inflexus*), Meadowsweet (*Filipendula ulmaria*), Yellow Iris (*Iris pseudacorus*), Wild Angelica (*Angelica sylvestris*) and Hemp-agrimony (*Eupatorium cannabinum*) were abundant.

4.2.1.19 WD1 (Mixed) broadleaved woodland



The habitat (Mixed) broadleaved woodland (WD1) was recorded in Sections 12 and 13 in Kildare, with a small pocket of this woodland type also recorded in Section 2 in Dublin. WD1 comprised tree species such as Ash (*Fraxinus excelsior*), Beech (*Fagus sylvatica*), Holly (*Ilex aquifolium*), Sycamore (*Acer pseudoplatanus*), Horse-chestnut (*Aesculus hippocastanum*), Lime (*Tilia* x *europaea*) and

Pedunculate Oak (*Quercus robur*). In Section 13, Scots Pine (*Pinus sylvestris*) was also recorded in this habitat.

4.2.1.20 WD5 Scattered trees and parkland



The habitat Scattered trees and parkland (WD5) is applicable to situations where scattered trees, standing alone or in small clusters, cover less than 30% of the total area under consideration. Within the study area, this habitat was found to the north of the canal in Section 1, just above the 12th Lock. It included tree species such as Beech (*Fagus sylvatica*), Lime (*Tilia* x *europaea*) and Lawson's Cypress (*Chamaecyparis lawsoniana*), which are all introduced species. Scots Pine (*Pinus sylvestris*) was also found here. The underlying grass was dominated by Perennial Rye-grass (*Lolium perenne*).

4.2.1.21 WL1 Hedgerows



The habitat Hedgerows (WL1) was very abundant within the study area (12 sections). Hedgerows are defined as being mainly less than 5 m high and 4 m wide, and may include dry drainage ditches. The hedgerows of the Royal Canal included species such as Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*), Dog-rose (*Rosa canina*) and privets (*Ligustrum* spp.). Hedgerows provide shelter and foraging for animals, and habitat for woodland edge plant species. Numerous bird species nest within hedgerows and for this reason their removal is regulated between 1st March and 31st August under Section 40 of the Wildlife Acts 1976 to 2012. While exceptions may apply in some cases, the destruction of birds' nests remains illegal at any time of the year without a derogation licence from the NPWS.

4.2.1.22 WL2 Treelines



Treelines (WL2) were recorded in 14 of the 15 sections. It was not present in Section 11; however an extensive area of Oak-ash-hazel woodland (WN2) was present in that section instead. Treelines are defined as rows of trees greater than 5 m in height and less that 4 m wide (at the base). Common species recorded within the WL2 habitat included Ash (*Fraxinus excelsior*), Elder (*Sambucus*

nigra), Sycamore (*Acer pseudoplatanus*) and Beech *(Fagus sylvaticus*). Treelines provide important shelter and foraging habitat for animals and nesting sites for birds.

4.2.1.23 WN2 Oak-ash-hazel woodland



This habitat is defined as native, natural woodland that occurs on base-rich or calcareous soils. Tree species recorded in this habitat include Pedunculate Oak (*Quercus robur*), Ash (*Fraxinus excelsior*) and Hazel (*Corylus avellana*), with occasional Beech (*Fagus sylvatica*) and Sycamore (*Acer pseudoplatanus*). This habitat was the most frequently occurring woodland habitat recorded within the study area (10 sections), including Sections 10 and 11, where it extends into the Rye Water Valley.

4.2.1.24 WN6 Wet willow-alder-ash woodland



A number of areas of wet woodland (WN6) were recorded in the course of the survey. These included an area on the Maynooth side of Louisa Bridge on the left bank of the canal (looking downstream) (Section 12), an area east of the Ryewater Aqueduct on the right bank, between the canal and the railway line (Section 10) and a final area located north of the canal, east of the Royal Canal Amenity Group (RCAG) building (Section 8). Grey Willow (*Salix cinerea*) was the dominant tree species recorded in the WN6 habitat, with Ash (*Fraxinus excelsior*) also common.

4.2.1.25 WS1 Scrub



Scrub (WS1) was recorded in a number of areas within the study area, most notably where the railway line ran adjacent to the canal bank (12 sections). Scrub areas are identified by the presence of more than 50% cover of shrubs, stunted trees or brambles, with a height of <5 m or < 4 m for wetlands. Scrub species recorded included Bramble *(Rubus fruticosus* agg.), willows (*Salix* spp.) and Gorse (*Ulex europaeus*). Scrub provides important cover for animals.

4.2.1.26 WS3 Ornamental/non-native shrub

Ornamental/non-native shrub (WS3) habitat was recorded in two sections within the study area, and was associated with the landscaped areas around Pike Bridge (Sections 13 and 14). Species recorded in this habitat included barberries (*Berberis* spp.), cotoneasters (*Cotoneaster* spp.), Escallonia (*Escallonia macrantha*), Hebe (*Hebe* sp.) and Shrubby Cinquefoil (*Potentilla fruticosa*).



4.2.2 Plant species

A total of 372 plant species (including bryophytes, aquatic and invasive species) were recorded in the course of the survey. Forbs were the most abundant plant group (170 species), followed by woody species (trees, shrubs, woody climbers) (79 species), bryophytes (59 species), grasses (30 species), sedges (13 species), ferns (9 species), rushes (5 species), algae (4 species) and the fern-allies, horsetails (3 species). Due to access difficulties (primarily the presence of the railway track) only one side of the canal for each section could be surveyed in detail, however the other side of the canal was viewed from the opposite bank, by binoculars when necessary, to ensure no obvious plant species were missed. While every effort was made to identify horticultural shrubs and garden escapes, the main focus of the plant survey was on species naturally found in the wild. Horticultural species and garden escapes were identified to species level where possible; however some could only be identified to genus level. Refer to the notes section after Appendix IV, Table A2, for additional notes on these species. Nomenclature follows Atherton *et al*. (2010) for bryophytes and Stace (2010) for all other plant species. Old names are in parentheses where recent name changes have taken place.

In terms of the terrestrial plant species recorded, forbs such as Wild Angelica (*Angelica sylvestris*), Meadowsweet (*Filipendula ulmaria*), Yellow Iris (*Iris pseudacorus*), Ribwort Plantain (*Plantago lanceolata*), Creeping Cinquefoil (*Potentilla reptans*), Creeping Buttercup (*Ranunculus repens*), Common Ragwort (*Senecio jacobaea*), Dandelion (*Taraxacum officinale* ag.), Common Nettle (*Urtica dioica*) and Bush Vetch (*Vicia sepium*) were extremely frequent throughout the survey area (100% frequency of occurrence by section), with the majority of these species recorded in the grassy verge habitat. Hawthorn (*Crataegus monogyna*), Ash (*Fraxinus excelsior*), Ivy (*Hedera helix*) and Bramble (*Rubus fruticosus* agg.) were also recorded in all sections within the survey area, while the grasses False Oat-grass (*Arrhenatherum elatius*), Cock's-foot (*Dactylis glomerata*), Red Fescue (*Festuca rubra*) and Perennial Rye-grass (*Lolium perenne*) were recorded in all but one section (93% frequency). The most common fern within the survey area was Hart's-tongue (*Asplenium scolopendrium* (=*Phyllitis scolopendrium*)), which was usually found on the stone walls of the bridges (87% frequency), while the Hard Rush (*Juncus inflexus*), Glaucous Sedge (*Carex flacca*) and

Common Club-rush (*Schoenoplectus lacustris*) were also frequent (80%, 73%, 73% frequency respectively).

Grapnel sampling of the submerged aquatic vegetation of the Royal Canal was carried out in all sections within the study area, though due to a lack of aquatic vegetation, most likely caused by heavy shading, and difficulty of access, limited sampling was carried out in the Deep Sinking. A total of 49 grapnel samples were taken across the 15 sections (Appendix IV, Table A3), with 14 species recorded (including stoneworts and algae). The invasive species Canadian Waterweed (*Elodea canadensis*) was the most frequently recorded species in the grapnel samples (55%) followed by Yellow Water-lily (*Nuphar lutea*) (51%). Other species recorded in the course of the sampling were Ivy-leaved Duckweed (*Lemna trisulca*), Mare's Tail (*Hippuris vulgaris*), the invasive species Nuttall's Waterweed (*Elodea nuttallii*) and Unbranched Bur-reed (*Sparganium emersum*).

The aquatic vegetation of the Royal Canal is largely similar within the study area, with the exception of the Deep Sinking, where heavy shading from the trees combined with the steep rock banks, restrict the distribution of aquatic vegetation, both submerged and emergent.

A full list of all plant species recorded in order of frequency (number of sections) is presented in Appendix IV, Table A1, while a full inventory of the species recorded by section is presented in Appendix IV, Table A2. Detailed results of the grapnel sampling of aquatic plants are presented in Appendix IV Table A4. Rare/protected plants, invasive plant species and bryophytes are discussed in the following sub-sections.

4.2.3 Rare/protected plants

No protected plants were recorded in the course of the current survey. The Marsh Pea (*Lathyrus palustris*) and Cowslip (*Primula veris*) are protected under the Wildlife (NI) Order of 1985 as amended by SR345 in 2007 in Northern Ireland, but neither species is protected under Irish law (Parnell & Curtis, 2012). Prickly Lettuce (*Lactuca serriola*), recorded in section 4, is rare in Ireland, but as it is a recent introduction, it is not protected. The Greater Spearwort (*Ranunculus lingua*) (Appendix V, Plate 1), which was commonly recorded in the emergent vegetation along the canal edge, and Salad Burnet (*Poterium sanguisorba* (=*Sanguisorba minor*)) (Appendix V, Plate 2), which was recorded in areas of calcareous grassland along the canal bank, are notable species due to their rather restricted distribution in Ireland. The native Hoary Ragwort (*Senecio erucifolius*), although widespread throughout Co. Dublin, is nationally rare and is therefore also notable.

Opposite-leaved Pondweed (*Groenlandia densa*), which is listed on the Flora Protection Order 1999 (S.I. 94/1999), has been recorded on the Royal Canal within Dublin City, but none was recorded within the study area. Tassel Stonewort (*Tolypella intricata*), listed in the Red Data Book as being Vulnerable in Ireland (Stewart & Church, 1992), has been recorded in the Royal Canal in Dublin; the only site in Ireland where it is now found. Again, this was not found within the study area during this survey.

4.2.4 Invasive plant species

Alien invasive plant species are a major and increasing threat to biodiversity in Ireland. A number of species that are considered invasive were recorded within the study area, both terrestrial and aquatic; these included Japanese Knotweed (*Fallopia japonica*) (Appendix V, Plate 3), cotoneasters (*Cotoneaster* spp.) (Appendix V, Plate 4), Snowberry (*Symphoricarpos albus*) (Appendix V, Plate 5), Winter Heliotrope (*Petasites fragrans*) (Appendix V, Plate 6), Cherry Laurel (*Prunus laurocerasus*) (Appendix V, Plate 7), Buddleja (*Buddleja davidii*) (Appendix V, Plate 8), Wilson's Honeysuckle (*Lonicera nitida*), Sycamore (*Acer pseudoplatanus*), Canadian Waterweed (*Elodea canadensis*) and Nuttall's Waterweed (*Elodea nuttallii*). Locations where terrestrial invasive plant species were recorded in the course of the current survey are presented in Appendix IV, Table A5, while aquatic invasive species can be found in Appendix IV, Table A4. Due to the widespread distribution of Sycamore throughout the study area, no specific locations were recorded for this species.

4.2.5 Bryophytes

The survey of the bryophyte flora of the study area recorded 59 species. These species were, for the most part, found growing on stone walls and surfaces, exposed soil and rock faces, and trees. Section 3 had the highest proportion of bryophytes recorded (38 species), while Section 8 had none recorded. Although no bryophytes were recorded within Section 8 this is probably due to no species being obviously present and with an increased sampling effort it would be expected that some bryophyte species could be found. The majority of the bryophytes collected from Section 3 were taken from the Calcareous springs (FP1) habitat and surrounding Treelines (WL2) and Oak-ash-hazel woodland (WN2). Section 3 runs through an area known as the Deep Sinking. The Deep Sinking is an ideal spot for bryophytes as it is shaded, sheltered and humid, providing an excellent array of habitats for bryophytes.

Frequency of occurrence of each bryophyte throughout the entire survey area was low; only four species were recorded in five or more of the fifteen sections while all other bryophyte species had a lower number of occurrences within the study area. The four most frequent species were Bird's-claw Beard-moss (*Barbula unguiculata*) (40% frequency; 6 out of 15 sections), Rough-stalked Feather-moss (*Brachythecium rutabulum*) (33% frequency; 5 out of 15 sections), Common Feather-moss (*Kindbergia praelonga*) (33% frequency) and Swartz's Feather-moss (*Oxyrrhynchium hians*) (33% frequency). Thirty species (51%) only occurred in one section within the survey area, with ten of these species having a relatively scattered distribution in Ireland (Atherton *et al.,* 2010). Scarce Notchwort (*Leiocolea badensis*) and Claw-leaved Hook-moss (*Palustriella falcata* (=*Palustriella commutata* v. *falcata*)) are new vice-county records for Dublin (both found in Section 3), while Small-mouthed Beardless-moss (*Weissia brachycarpa* v. *obliqua*) is a new vice-county record for Kildare (recorded in Section 12) (Blockeel *et al.,* 2013). Bryophytes recorded in the course of the survey are presented in Appendix IV, Table A1 and A2.

4.2.6 Mammals

4.2.6.1 Non-volant mammals

The semi-natural habitats recorded along the Royal Canal within the study area are suitable for supporting many of Ireland's mammal species (Appendix IV, Table A6). Sightings of rabbit (*Oryctolagus cuniculus*) and brown rat (*Rattus norvegicus*), as well as American mink (*Mustela vison*) and grey squirrel (*Sciurus carolinensis*) (both invasive) were made during the survey, while definite evidence of otter (*Lutra lutra*) was also found at a number of sites in the form of spraints (Appendix V, Plate 9, Appendix IV, Table A7). Feeding signs, likely to be red fox (*Vulpes vulpes*), were recorded along the canal bank, while badger (*Meles meles*) feeding signs and two badger setts were also recorded. In addition to sightings of rabbits, burrows and droppings were noted at a number of locations along the canal, mainly in treeline/hedgerow embankments and areas of woodland.

Otters are protected under the Wildlife Acts 1976 to 2012 and are listed under Annex II and Annex IV of the Habitats Directive (92/43/EEC), which was transposed into Irish law by the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477/2011). Annex II lists species of community interest whose conservation requires the designation of Special Areas of Conservation (SACs), while those species listed under Annex IV are those in need of strict protection. Badgers are protected under the Wildlife Acts 1976 to 2012.

The woodlands and hedgerows of the Royal Canal pNHA are also likely to support other mammal species, such as wood mouse (*Apodemus sylvaticus*) and hedgehog (*Erinaceus europaeus*), though these were not observed at the time of the survey.

While the sections in which evidence of specific mammal activity was recorded are presented in Appendix IV, Table A6, these species are likely to occur more widely within the study area than illustrated by these data. Mammal paths were evident in numerous places along the canal banks, hedgerows and treelines, even where evidence of specific species was not recorded.

A survey carried out by Keeley (2004) along the Royal Canal within the Fingal County Council area recorded evidence of brown rat, grey squirrel, rabbit, fox and badger. No evidence of otter activity was recorded by Keeley (2004).

4.2.6.2 Bats

Four species of bat were recorded in the course of the survey carried out by Bat Eco Services as part of this study: common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), Leisler's bat (*Nyctalus leisleri*) and Daubenton's bat (*Myotis daubentonii*). These species were recorded foraging or commuting along the canal corridor, along treelines and hedgerows and over the canal surface itself.

Collins Bridge and Cope Bridge both had suitability for bats, while the building at Leixlip Spa had roost potential and the house at Pakenham Bridge provides a roosting site for soprano pipistrelles. The

remaining bridges had no bat potential owing to the lack of suitable crevices for bats. A number of large, ivy-covered trees within the study area were identified as Potential Bat Roosts (PBRs).

An inventory of the bat species recorded per section is presented in Appendix IV, Table A8, while the full bat survey report is presented in Appendix VI.

In addition to the four bat species recorded in the course of the current survey, three other bat species have been recorded on the Bat Conservation Ireland database as occurring along or close to the canal: brown long-eared bat (*Plecotus auritus*), Nathusius' pipistrelle (*Pipistrellus nathusii*) and whiskered bat (*Myotis mystacinus*).

4.2.7 Birds

A total of 40 bird species were recorded in the course of the survey, with commonly recorded species including Wood Pigeon, Blackbird, Wren, Great Tit, Robin, Swallow, Chaffinch, Mallard, Magpie and Rook. Kingfisher, listed under Annex I of the Bird Directive (2009/147/EC) and on the Birds of Conservation Concern in Ireland (BoCCI) Amber List, was recorded in Section 3 (Kirkpatrick Bridge to Kennan/Neville Bridge), while seven other species recorded are also on the Amber List (House Sparrow, Lesser Black-backed Gull, Little Grebe, Mute Swan, Starling, Swallow and Swift). One species listed on the BoCCI Red List was recorded in the course of the survey – Yellowhammer. A list of bird species recorded in order of frequency (number of sections) is presented in Appendix IV, Table A9, while a full inventory of the species recorded by section, including their scientific name, is presented in Appendix IV, Table A10.

The hedgerows, treelines and small areas of woodland provide nesting and feeding habitat for many terrestrial bird species, while the emergent vegetation of the canal provides cover vital to aquatic birds like Mallard, Moorhen and Little Grebe.

4.2.8 Ant hills

Ant hills were recorded at a number of locations along the Royal Canal in the Deep Sinking and also in an area of grassland west of Louisa Bridge. Sections 2 and 3 of the study area supported numerous ant hills between the path and the canal bank. The ants recorded here were identified as the yellow meadow ant (*Lasius flavus*), which is the main mound-building ant.

Very little work has been carried out on the ant fauna of Ireland, which consists of 26 species, of which 18 are considered native (Niechoj, 2011); this is an increase from the 17 species noted by Collingwood (1958). In a survey of sites in Galway, Clare and Limerick, *L. flavus* was found to be the third most frequently recorded species of ant after *Myrmica scabrinodis* and *M. ruginodis* and is considered widespread in Ireland (Niechoj, 2011). Well-developed ant hills are a sign that a grassland has remained undisturbed for some time, increasing the likelihood that the habitat supports high species diversity and may be of conservation value.

It seems that the abundance of ant hills in the Deep Sinking is due to the inaccessibility of the area, resulting in lower maintenance compared to the towpath further out. The use of tractor-mounted mowers on the towpath and other path maintenance works along the stretches out into Kildare appear to have prevented the development of large ant hills despite the presence of the yellow meadow ant in these areas also.

The limited area of semi-natural grassland in Dublin and Kildare means that there are few areas that will support ant hills. The Irish Semi-natural Grassland Survey carried out by BEC Consultants Ltd did not record any ant hills in the grassland sites visited in Dublin and Kildare.

Ant hill locations along the Royal Canal within the study area are listed in Appendix IV, Table A11.

4.2.9 Fish

The fish community of the Royal Canal is entirely comprised of coarse fish (excepting the occasional stray salmonid that may enter the system from nearby rivers), with six species and one hybrid recorded during an electro-fishing survey in 2011 between Collins Bridge and the 13th Lock (Paul McLoone, IFI, pers. comm.). Roach (*Rutilus rutilus*) completely dominated the fish community in this section, in terms of both numbers and biomass, followed by perch (*Perca fluviatilis*), pike (*Esox lucius*), roach-bream hybrid (*R. rutilus* x *Abramis brama*) and eel (*Anguilla anguilla*). Small numbers of tench (*Tinca tinca*) and bream (*A. brama*) were also recorded. The results of this sampling are presented in Appendix IV, Table A12.

Roach, perch, pike and eel were all seen in the course of the current survey, along with numerous shoals of juvenile fish.

4.2.10 Aquatic macroinvertebrates

Inland Fisheries Ireland carried out sampling of the aquatic macroinvertebrate population of the Royal Canal in spring 2009 (Tara Gallagher, IFI, pers. comm.). Samples were taken at RCE19, just upstream of Louisa Bridge, Leixlip, Co. Kildare (ITM 699294 736527) and RCE22, just upstream of Granard Bridge, Blanchardstown, Co. Dublin (ITM 708229 738043).

The most common species recorded in the sample taken at RCE19 was the mayfly *Caenis luctuosa*, with the water slater *Asellus aquaticus*, the mayfly *C. horaria* and the pea mussel *Pisidium* spp. the next most abundant species.

The most common species recorded in the sample taken at RCE22 was the water slater *Asellus aquaticus*, with the invasive freshwater shrimp *Crangonyx pseudogracilis* also abundant. Other common species included the mussels *Sphaerium corneum* and *Pisidium* spp. and the snails *Bithynia tentaculata* and *B. leachii*.

A full list of the species/taxa recorded by the IFI is presented in Appendix IV, Table A13.

A number of dragonfly/damselfly species were recorded in the course of the current survey, including the four-spotted chaser (*Libellula quadrimaculata*), common blue damselfly (*Enallagma cyathigerum*), variable damselfly (*Coenagrion pulchellum*), azure damselfly (*Coenagrion puella*), blue-tailed damselfly (*Ischnura elegans*) and the banded demoiselle (*Calopteryx splendens*).

4.2.11 Environmentally Sensitive Areas

While the canal corridor is highly modified, it has naturalised to a large degree allowing the development of semi-natural habitats. Some of these habitats are of higher ecological value than others and in need of greater protection. These include stretches of the canal bank supporting grassland of high species diversity (Sections 4, 5, 6, 10, 12 & 14), all types of woodland (mixed broadleaved, oak-ash-hazel and wet willow-alder-ash woodland) (Sections 2, 3, 4, 5, 6, 8, 9, 10, 11, 12 and 13), reed and large sedge swamp (Sections 8 and 12), tall-herb swamp (Section 8), calcareous springs (Section 3), extensive areas of aquatic communities within the canal (Section 10), and some areas of freshwater marsh (Section 5) and wet grassland (Section 8). All woodland areas within the study area were deemed to be Environmentally Sensitive Areas (ESAs) due to the fact that semi-natural woodland in Ireland today tends to be limited in extent and scattered in distribution. The woodland habitats within the survey area provide a valuable habitat for flora and fauna, particularly when the larger landscape of intensively managed farmland and urban areas surrounding the study area is considered.

A number of areas of high-quality grassland were identified as ESAs owing to their close correspondence to Annex I habitats such as 6210 calcareous grassland and 6510 lowland hay meadows. As with the areas of woodland, such grasslands are important in the context of the intensively managed farmland and urban areas surrounding the study area.

The Hydrophilous tall herb community (6430) is an Annex I habitat that is rare within the study area, and as such is considered an ESA.

Locations of ESAs recorded in the course of the survey are presented in Appendix IV, Table A14 and are also mapped in Appendix II.

5 Discussion

As noted in the NPWS site synopsis, the conservation value of the Royal Canal pNHA is in its diversity of habitats, rather than the presence of rare species. This diversity of habitats is particularly important when compared to the surrounding areas of intensive agriculture and urban development. In fact, within the boundaries of the survey area, 26 habitats were recorded, with over half being either natural or semi-natural habitats.

A number of the habitats found within the survey area are of conservation interest; dry calcareous and neutral grassland (GS1), species-rich communities of dry meadows and grassy verges (GS2), an area of tall sedge swamp (FS1), tall-herb swamp (FS2) and woodland habitats. Care should be taken to

not cut the grassland habitats too frequently; ideally they should be cut once a year in September to allow plants to flower and set seed, while the use of seeds from high productivity grassland species (e.g., Perennial Rye-grass (*Lolium perenne*) and White Clover (*Trifolium repens*)) should be avoided during any restoration works of canal bank habitats. In terms of the tall sedge swamp and wet woodland habitats, the existing hydrological regime is important for their continuation, therefore no initiatives such as the digging of new drainage ditches should be carried out in the areas where these are located. The tall-herb swamp was found in one section behind an area of tall reed swamp fringing the canal. Regular dredging of the canal is a necessary part of the canal maintenance, however it is recommended to avoid this area when dredging in order to prevent disturbance of this Annex I habitat. The oak-ash-hazel woodland and mixed broadleaved woodland had a number of non-native species recorded within them. It would be advisable to remove the non-native shrub species (e.g., cotoneasters (*Cotoneaster* spp.), Cherry Laurel (*Prunus laurocerasus*) and Snowberry (*Symphoricarpos albus*) if possible, due to the negative effect they have on the regeneration of native tree species. The non-native trees Sycamore (*Acer pseudoplatanus*), Beech (*Fagus sylvatica*) and Horse-chestnut (*Aesculus hippocastanum*) have a wildlife value however, and should not be cut down.

Japanese Knotweed (*Fallopia japonica*) was recorded in two sections within the survey area. This is a particularly problematic invasive species, especially along watercourses and transport routes. Efforts should be made to remove the current populations, and to prevent its spread into unaffected areas. Spread of this species can occur by plant material being washed downstream from infected areas, importing infected soil, illegal dumping and by carrying it into unaffected areas on contaminated vehicles and equipment. Vehicles and equipment used within the survey area (e.g., tractors, mowing equipment and dredging equipment) should be periodically checked to ensure they are free from contamination. This will be of particular relevance for construction works related to any future development along the canal. For control and removal of Japanese Knotweed, refer to Invasive Species Ireland's "Best Practice Management Guidelines – Japanese knotweed".

There were definite signs of otter activity along sections of the Royal Canal within the study area. Otters are protected under the Wildlife Acts 1976 to 2012 and are listed under Annex II and Annex IV of the Habitats Directive (92/43/EEC), which was transposed into Irish law by the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477/2011). Annex II lists species of community interest whose conservation requires the designation of Special Areas of Conservation (SACs), while those species listed under Annex IV are those in need of strict protection. Additionally, four species of bat, also protected under Annex IV of the EU Habitats Directive, were detected within the study area, and the Kingfisher, listed under Annex I of the Bird Directive (2009/147/EC), was also recorded during the course of this survey. The rare plant species Prickly Lettuce (*Lactuca serriola*) and Hoary Ragwort (*Senecio erucifolius*) were recorded within the study area, however no protected plant species were found as part of this survey.

The Royal Canal is designated as a pNHA and is an important wildlife corridor. The habitats of the canal should be protected and care taken not to damage the functionality of this ecological corridor. While pNHAs have no statutory protection, they are often protected under County Development Plans with a view to preventing damage to sites by poor planning. The Kildare County Development Plan seeks to "protect and enhance these elements and identify locally important biodiversity areas", with many policies in place to maintain and attain this objective (Kildare County Council, 2011). Similarly, Fingal County Council have set out objectives to "ensure that all development proposals include measures to protect and enhance biodiversity" and to "protect the ecological functions and integrity of the corridors indicated on the Development Plan Green Infrastructure maps", of which the Royal Canal is included (Fingal County Council, 2011). Any proposed future developments along the Royal Canal should therefore be carefully considered in the context of the aforementioned County Development Plans and overall ecological value and importance of the Royal Canal.

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Appendix I – NPWS Site synopsis

SITE NAME: ROYAL CANAL pNHA

SITE CODE: 002103

The Royal Canal is a man-made waterway linking the River Liffey at Dublin to the River Shannon near Tarmonbarry. There is a branch line from Kilashee to Longford Town. The canal pNHA comprises the central channel and the banks on either side of it. The main water supply is from Lough Owel (also an NHA) via a feeder channel into the canal at Mullingar. The Royal Canal was closed to navigation in 1961. The section of canal west of Mullingar was allowed to dry out, and the eastern section silted up and became overgrown. Restoration began in 1988, and is still in progress.

A number of different habitats are found within the canal boundaries - hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland.

The hedgerow, although diverse, is dominated by Hawthorn (*Crataegus monogyna*). On the limestone soils of the midlands Spindle (*Euonymus europaeus*) and Guelder-rose (*Viburnum opulus*) are present.

The vegetation of the towpath is usually dominated by grass species. Crested Dog's-tail (*Cynosurus cristatus*), Quaking Grass (*Briza media*) and Sweet Vernal-grass (*Anthoxanthum odoratum*) are typical species of the calcareous grasslands of the midlands. Where the canal was built through a bog, soil (usually calcareous) was brought in to make the banks. The contrast between the calcicolous species of the towpath and the calcifuge species of the bog is very striking.

Otter spraints are found along the towpath, particularly where the canal passes over a river or stream.

The Rare and legally protected Opposite-leaved Pondweed (*Groenlandia densa*) (Flora Protection Order 1987) is present at one site in Dublin, between Locks 4 and 5. *Tolypella intricata* (a stonewort listed in the Red Data Book as being Vulnerable) is also in the Royal Canal in Dublin, the only site in Ireland where it is now found.

The ecological value of the canal lies more in the diversity of species it supports along its linear habitats than in the presence of rare species. It crosses through agricultural land and therefore provides a refuge for species threatened by modern farming methods.

13th February, 1995.

Appendix II – Consultation

Name	Organisation	Response
Paul McLoone	Inland Fisheries Ireland	Provided fisheries data
Tara Gallagher	Inland Fisheries Ireland	Provided macroinvertebrate data
Maurice Eakin	NPWS	Highlighted likely importance of Deep Sinking
Ciara Flynn	NPWS	Provided some possible sources of information
Declan Doogue	County Recorder – Kildare	No response
David Nash	County Recorder – Dublin	No response
Olivia Crowe	Birdwatch Ireland	No data on study area
Bridget Loughlin	Kildare Co. Co. – Heritage Officer	Stated scope of study covered areas of concern
Hans Visser	Fingal Co. Co. – Heritage Officer	Will await results of survey before making comment
Aubrey Fennell	Champion Trees via Tree Council of Ireland	No response

Appendix III – Maps

[See separate files]

Appendix IV – Tables

Table A1. Plant species recorded by frequency of occurrence on the Royal Canal within the study area, separated by the main plant groups.

Common name*	Latin name*	No. of sections	% frequency of occurrence
Algae			
Filamentous algae	*Cladophora* spp.	8	53
Stonewort species	*Chara* species	4	27
Fragile Stonewort	*Chara globularis*	2	13
Common Stonewort	*Chara vulgaris*	2	13
Bryophytes			
Bird's-claw Beard-moss	*Barbula unguiculata*	6	40
Rough-stalked Feather-moss	*Brachythecium rutabulum*	5	33
Common Feather-moss	*Kindbergia praelonga*	5	33
Swartz's Feather-moss	*Oxyrrhynchium hians*	5	33
Pointed Spear-moss	*Calliergonella cuspidata*	4	27
Greater Water-moss	*Fontinalis antipyretica*	4	27
Tender Feather-moss	*Rhynchostegiella tenella*	4	27
Cylindric Beard-moss	*Didymodon insulanus*	3	20
Rigid Beard-moss	*Didymodon rigidulus*	3	20
Lesser Pocket-moss	*Fissidens bryoides*	3	20
Common Pocket-moss	*Fissidens taxifolius*	3	20
Flat Neckera	*Neckera complanata*	3	20
Intermediate Screw-moss	*Syntrichia intermedia*	3	20
Fox-tail Feather-moss	*Thamnobryum alopecurum*	3	20
Wall Screw-moss	*Tortula muralis*	3	20
Creeping Feather-moss	*Amblystegium serpens*	2	13
Greasewort	*Aneura pinguis*	2	13
Lesser Bird's-claw Beard-moss	*Barbula convoluta*	2	13
Comb-moss	*Ctenidium molluscum*	2	13
Common Striated Feather-moss	*Eurhynchium striatum*	2	13
Dilated Scalewort	*Frullania dilatata*	2	13
Supine Plait-moss	*Hypnum resupinatum*	2	13
Wood Bristle-moss	*Orthotrichum affine*	2	13
-	*Pellia* species	2	13
Long-beaked Thyme-moss	*Plagiomnium rostratum*	2	13
Hart's-tongue Thyme-moss	*Plagiomnium undulatum*	2	13
Springy Turf-moss	*Rhytidiadelphus squarrosus*	2	13
Common Tamarisk-moss	*Thuidium tamariscinum*	2	13
Curly Crisp-moss	*Trichostomum crispulum*	2	13
Lesser Bird's-claw Beard-moss	*Barbula sardoa*	1	7
River Feather-moss	*Brachythecium rivulare*	1	7
Silver-moss	*Bryum argenteum*	1	7
Capillary Thread-moss	*Bryum capillare*	1	7
-	*Bryum* section *erythrocarpum*	1	7
Golden Feather-moss	*Campyliadelphus chrysophyllus*	1	7
Hair pointed Feather-moss	*Cirriphyllum piliferum*	1	7
Variable Forklet-moss	*Dicranella varia*	1	7
Wavy Beard-moss	*Didymodon sinuosus*	1	7
Spiral Extinguisher-moss	*Encalypta streptocarpa*	1	7
Whorled Tufa-moss	*Eucladium verticillatum*	1	7
Maidenhair Pocket-moss	*Fissidens adianthoides*	1	7

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Bryophytes (continued)			
Grey-cushioned Grimmia	*Grimmia pulvinata*	1	7
Yellow Feather-moss	*Homalothecium lutescens*	1	7
Silky Wall Feather-moss	*Homalothecium sericeum*	1	7
Mamillate Plait-moss	*Hypnum andoi*	1	7
Cypress-leaved Plait-moss	*Hypnum cupressiforme* agg.	1	7
-	*Jungermannia* species	1	7
Scarce Notchwort	*Leiocolea badensis*	1	7
Bifid Crestwort	*Lophocolea bidentata*	1	7
Anamalous Bristle-moss	*Orthotrichum anomalum*	1	7
Hooded Bristle-moss	*Orthotrichum cupulatum*	1	7
Claw-leaved Hook-moss	*Palustriella falcata*	1	7
Neat Feather-moss	*Pseudoscleropodium purum*	1	7
Dotted Thyme-moss	*Rhizomnium punctatum*	1	7
Dwarf Feather-moss	*Rhynchostegiella pumila*	1	7
Thickpoint Grimmia	*Schistidium crassipilum*	1	7
Elegant Grimmia	*Schistidium elegantulum*	1	7
-	*Tortula* species	1	7
Small-mouthed Beardless-moss	*Weissia brachycarpa* v. *obliqua*	1	7
Ferns			
Hart's-tongue	*Asplenium scolopendrium*	13	87
Wall-rue	*Asplenium ruta-muraria*	6	40
Maidenhair Spleenwort	*Asplenium trichomanes*	3	20
Male-fern	*Dryopteris filix-mas*	3	20
Golden-scaled Male-fern	*Dryopteris affinis*	2	13
Broad Buckler-fern	*Dryopteris dilatata*	1	7
Polypody	*Polypodium vulgare*	1	7
Soft Shield-fern	*Polystichum setiferum*	1	7
Bracken	*Pteridium aquilinum*	1	7
Forbs			
Wild Angelica	*Angelica sylvestris*	15	100
Meadowsweet	*Filipendula ulmaria*	15	100
Yellow Iris	*Iris pseudacorus*	15	100
Yellow Water-lily	*Nuphar lutea*	15	100
Ribwort Plantain	*Plantago lanceolata*	15	100
Creeping Cinquefoil	*Potentilla reptans*	15	100
Creeping Buttercup	*Ranunculus repens*	15	100
Common Ragwort	*Senecio jacobaea*	15	100
Dandelion	*Taraxacum officinale* ag.	15	100
Common Nettle	*Urtica dioica*	15	100
Bush Vetch	*Vicia sepium*	15	100
Hedge Bindweed	*Calystegia sepium*	14	93
Creeping Thistle	*Cirsium arvense*	14	93
Canadian Waterweed	*Elodea canadensis*	14	93
Cleavers	*Galium aparine*	14	93
Hogweed	*Heracleum sphondylium*	14	93
Meadow Buttercup	*Ranunculus acris*	14	93

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Forbs (continued)			
Red Clover	*Trifolium pratense*	14	93
White Clover	*Trifolium repens*	14	93
Germander Speedwell	*Veronica chamaedrys*	14	93
Cow Parsley	*Anthriscus sylvestris*	13	87
Common Knapweed	*Centaurea nigra*	13	87
Hoary Willowherb	*Epilobium parviflorum*	13	87
Lady's Bedstraw	*Galium verum*	13	87
Meadow Vetchling	*Lathyrus pratensis*	13	87
Common Bird's-foot-trefoil	*Lotus corniculatus*	13	87
Greater Plantain	*Plantago major*	13	87
Common Valerian	*Valeriana officinalis*	13	87
Tufted Vetch	*Vicia cracca*	13	87
Mare's-tail	*Hippuris vulgaris*	12	80
Amphibious Bistort	*Persicaria amphibia*	12	80
Daisy	*Bellis perennis*	11	73
Great Willowherb	*Epilobium hirsutum*	11	73
Hemp-agrimony	*Eupatorium cannabinum*	11	73
Yarrow	*Achillea millefolium*	10	67
Spear Thistle	*Cirsium vulgare*	10	67
Ivy-leaved Duckweed	*Lemna trisulca*	10	67
Black Medick	*Medicago lupulina*	10	67
Wild Marjoram	*Origanum vulgare*	10	67
Unbranched Bur-reed	*Sparganium emersum*	10	67
Common Mouse-ear	*Cerastium fontanum*	9	60
Rosebay Willowherb	*Chamerion angustifolium*	9	60
Common Marsh-bedstraw	*Galium palustre*	9	60
Herb-Robert	*Geranium robertianum*	9	60
Spiked Water-milfoil	*Myriophyllum spicatum*	9	60
Common Restharrow	*Ononis repens*	9	60
Curled Dock	*Rumex crispus*	9	60
Broad-leaved Dock	*Rumex obtusifolius*	9	60
Water-plantain	*Alisma plantago-aquatica*	8	53
Beaked Hawk's-beard	*Crepis vesicaria*	8	53
Wood Avens	*Geum urbanum*	8	53
Water Mint	*Mentha aquatica*	8	53
Butterbur	*Petasites hybridus*	8	53
Colt's-foot	*Tussilago farfara*	8	53
Cat's-ear	*Hypochaeris radicata*	7	47
Clustered Dock	*Rumex conglomeratus*	7	47
Wood Dock	*Rumex sanguineus*	7	47
Perennial Sowthistle	*Sonchus arvensis*	7	47
Branched Bur-reed	*Sparganium erectum*	7	47
Lords-and-Ladies	*Arum maculatum*	6	40
Red Valerian	*Centranthus ruber*	6	40
Smooth Hawk's-beard	*Crepis capillaris*	6	40
Wild Carrot	*Daucus carota*	6	40

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Forbs (continued)			
Nuttall's Waterweed	*Elodea nuttallii*	6	40
Broad-leaved Willowherb	*Epilobium montanum*	6	40
Perforate St John's-wort	*Hypericum perforatum*	6	40
Nipplewort	*Lapsana communis*	6	40
Rough Hawkbit	*Leontodon hispidus*	6	40
Broad-leaved Pondweed	*Potamogeton natans*	6	40
Silverweed	*Potentilla anserina*	6	40
Cowslip	*Primula veris*	6	40
Greater Spearwort	*Ranunculus lingua*	6	40
Groundsel	*Senecio vulgaris*	6	40
Cuckooflower	*Cardamine pratensis*	5	33
Field Scabious	*Knautia arvensis*	5	33
Oxeye Daisy	*Leucanthemum vulgare*	5	33
Common Fleabane	*Pulicaria dysenterica*	5	33
Yellow-rattle	*Rhinanthus minor*	5	33
Prickly Sowthistle	*Sonchus asper*	5	33
Ivy-leaved Toadflax	*Cymbalaria muralis*	4	27
Common Spotted-orchid	*Dactylorhiza fuchsii*	4	27
Selfheal	*Prunella vulgaris*	4	27
Hedge Mustard	*Sisymbrium officinale*	4	27
Smooth Sowthistle	*Sonchus oleraceus*	4	27
Hop Trefoil	*Trifolium campestre*	4	27
Bulrush	*Typha latifolia*	4	27
Lesser Burdock	*Arctium minus*	3	20
Turnip	*Brassica rapa*	3	20
Wavy Bitter-cress	*Cardamine flexuosa*	3	20
Dove's-foot Crane's-bill	*Geranium molle*	3	20
Ground-ivy	*Glechoma hederacea*	3	20
Purple-loosestrife	*Lythrum salicaria*	3	20
Winter Heliotrope	*Petasites fragrans*	3	20
Bittersweet	*Solanum dulcamara*	3	20
Hedge Woundwort	*Stachys sylvatica*	3	20
Devil's-bit Scabious	*Succisa pratensis*	3	20
Lesser Trefoil	*Trifolium dubium*	3	20
Wood Speedwell	*Veronica montana*	3	20
Agrimony	*Agrimonia eupatoria*	2	13
Garlic Mustard	*Alliaria petiolata*	2	13
Winter-cress	*Barbarea vulgaris*	2	13
Water-starwort species	*Callitriche* species	2	13
Rough Hawk's-beard	*Crepis biennis*	2	13
Willowherb species	*Epilobium* species	2	13
Fairy Foxglove	*Erinus alpinus*	2	13
Treacle-mustard	*Erysimum cheiranthoides*	2	13
Cut-leaved Crane's-bill	*Geranium dissectum*	2	13
Dame's-violet	*Hesperis matronalis*	2	13
Square-stalked St John's-wort	*Hypericum tetrapterum*	2	13

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Forbs (continued)			
Fairy Flax	*Linum catharticum*	2	13
Greater Bird's-foot-trefoil	*Lotus pedunculatus*	2	13
Gypsywort	*Lycopus europaeus*	2	13
Pineappleweed	*Matricaria discoidea*	2	13
Field Forget-me-not	*Myosotis arvensis*	2	13
Changing Forget-me-not	*Myosotis discolor*	2	13
Common Poppy	*Papaver rhoeas*	2	13
Mouse-ear-hawkweed	*Pilosella officinarum*	2	13
Various-leaved Pondweed	*Potamogeton gramineus*	2	13
Salad Burnet	*Poterium sanguisorba*	2	13
Bulbous Buttercup	*Ranunculus bulbosus*	2	13
Buttercup species	*Ranunculus* species	2	13
Weld	*Reseda luteola*	2	13
Sanicle	*Sanicula europaea*	2	13
Hoary Ragwort	*Senecio erucifolius*	2	13
Lesser Stitchwort	*Stellaria graminea*	2	13
Upright Hedge-parsley	*Torilis japonica*	2	13
Goat's-beard	*Tragopogon pratensis*	2	13
Common Vetch	*Vicia sativa*	2	13
Pyramidal Orchid	*Anacamptis pyramidalis*	1	7
Scarlet Pimpernel	*Anagallis arvensis*	1	7
Kidney Vetch	*Anthyllis vulneraria*	1	7
Yellow-wort	*Blackstonia perfoliata*	1	7
Common Water-starwort	*Callitriche stagnalis*	1	7
Sticky Mouse-ear	*Cerastium glomeratum*	1	7
Montbretia	*Crocosmia* x *crocosmiiflora*	1	7
Early Marsh-orchid	*Dactylorhiza incarnata*	1	7
Foxglove	*Digitalis purpurea*	1	7
Wild Teasel	*Dipsacus fullonum*	1	7
Eyebrights	*Euphrasia officinalis* ag.	1	7
Wild Strawberry	*Fragaria vesca*	1	7
Common Fumitory	*Fumaria officinalis*	1	7
Hedgerow Crane's-bill	*Geranium pyrenaicum*	1	7
Chalk Fragrant-orchid	*Gymnadenia conopsea*	1	7
Prickly Lettuce	*Lactuca serriola*	1	7
Marsh Pea	*Lathyrus palustris*	1	7
Lesser Hawkbit	*Leontodon saxatilis*	1	7
Bogbean	*Menyanthes trifoliata*	1	7
Forget-me-not species	*Myosotis* species	1	7
Water-cress	*Nasturtium officinale*	1	7
Common Twayblade	*Neottia ovata*	1	7
Love-in-a-mist	*Nigella damascena*	1	7
Red Bartsia	*Odontites vernus*	1	7
Poppy species	*Papaver* species	1	7
Green Alkanet	*Pentaglottis sempervirens*	1	7
Fox-and-cubs	*Pilosella aurantiaca*	1	7

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Forbs (continued)			
Trailing Tormentil	*Potentilla anglica*	1	7
Barren Strawberry	*Potentilla sterilis*	1	7
Wild Mignonette	*Reseda lutea*	1	7
Common Sorrel	*Rumex acetosa*	1	7
Autumn Hawkbit	*Scorzoneroides autumnalis*	1	7
Water Figwort	*Scrophularia auriculata*	1	7
Common Figwort	*Scrophularia nodosa*	1	7
Stonecrop species	*Sedum* species	1	7
Red Campion	*Silene dioica*	1	7
Ragged-Robin	*Silene flos-cuculi*	1	7
Bladder Campion	*Silene vulgaris*	1	7
Marsh Woundwort	*Stachys palustris*	1	7
Common Chickweed	*Stellaria media*	1	7
Blue Water-speedwell	*Veronica anagallis-aquatica*	1	7
Common Dog-violet	*Viola riviniana*	1	7
Grasses			
False Oat-grass	*Arrhenatherum elatius*	14	93
Cock's-foot	*Dactylis glomerata*	14	93
Red Fescue	*Festuca rubra*	14	93
Perennial Rye-grass	*Lolium perenne*	14	93
Reed Sweet-grass	*Glyceria maxima*	13	87
Annual Meadow-grass	*Poa annua*	13	87
Sweet Vernal-grass	*Anthoxanthum odoratum*	12	80
Yorkshire-fog	*Holcus lanatus*	12	80
Reed Canary-grass	*Phalaris arundinacea*	12	80
Rough Meadow-grass	*Poa trivialis*	12	80
Creeping Bent	*Agrostis stolonifera*	11	73
False Brome	*Brachypodium sylvaticum*	11	73
Crested Dog's-tail	*Cynosurus cristatus*	8	53
Upright Brome	*Bromopsis erecta*	5	33
Smooth Meadow-grass	*Poa pratensis*	5	33
Meadow Foxtail	*Alopecurus pratensis*	4	27
Common Couch	*Elytrigia repens*	4	27
Quaking-grass	*Briza media*	3	20
Timothy	*Phleum pratense*	3	20
Meadow Fescue	*Schedonorus pratensis*	3	20
Soft-brome	*Bromus hordeaceus*	2	13
Tall Fescue	*Schedonorus arundinacea*	2	13
Yellow Oat-grass	*Trisetum flavescens*	2	13
Common Bent	*Agrostis capillaris*	1	7
Downy Oat-grass	*Avenula pubescens*	1	7
Creeping Soft-grass	*Holcus mollis*	1	7
Wall Barley	*Hordeum murinum*	1	7
Italian Rye-grass	*Lolium multiflorum*	1	7
Common Reed	*Phragmites australis*	1	7
Bread Wheat	*Triticum aestivum*	1	7

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Horsetails			
Field Horsetail	*Equisetum arvense*	10	67
Marsh Horsetail	*Equisetum palustre*	2	13
Water Horsetail	*Equisetum fluviatile*	1	7
Rushes			
Hard Rush	*Juncus inflexus*	12	80
Sharp-flowered Rush	*Juncus acutiflorus*	2	13
Jointed Rush	*Juncus articulatus*	1	7
Soft-rush	*Juncus effusus*	1	7
Field Wood-rush	*Luzula campestris*	1	7
Sedges			
Glaucous Sedge	*Carex flacca*	11	73
Common Club-rush	*Schoenoplectus lacustris*	11	73
Hairy Sedge	*Carex hirta*	8	53
False Fox-sedge	*Carex otrubae*	7	47
Bottle Sedge	*Carex rostrata*	7	47
Remote Sedge	*Carex remota*	5	33
Tufted-sedge	*Carex elata*	2	13
Brown Sedge	*Carex disticha*	1	7
Grey Sedge	*Carex divulsa*	1	7
Common Sedge	*Carex nigra*	1	7
Carnation Sedge	*Carex panicea*	1	7
Wood-sedge	*Carex sylvatica*	1	7
Common Spike-rush	*Eleocharis palustris*	1	7
Woody (climbers, trees, shrubs)			
Hawthorn	*Crataegus monogyna*	15	100
Ash	*Fraxinus excelsior*	15	100
Common Ivy	*Hedera helix*	15	100
Bramble	*Rubus fruticosus* ag.	15	100
Sycamore	*Acer pseudoplatanus*	14	93
Dog-rose	*Rosa canina*	14	93
Elder	*Sambucus nigra*	14	93
Beech	*Fagus sylvatica*	12	80
Blackthorn	*Prunus spinosa*	12	80
Alder	*Alnus glutinosa*	11	73
Honeysuckle	*Lonicera periclymenum*	10	67
Pedunculate Oak	*Quercus robur*	10	67
Gorse	*Ulex europaeus*	10	67
Cotoneaster species	*Cotoneaster* species	9	60
Grey Willow	*Salix cinerea*	9	60
Holly	*Ilex aquifolium*	8	53
Wild Privet	*Ligustrum vulgare*	8	53
Cherry Laurel	*Prunus laurocerasus*	7	47
Wych Elm	*Ulmus glabra*	7	47
Horse-chestnut	*Aesculus hippocastanum*	6	40
Butterfly-bush	*Buddleja davidii*	6	40
Hazel	*Corylus avellana*	6	40

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Woody (climbers, trees, shrubs) (continued)			
Snowberry	*Symphoricarpos albus*	5	33
Lime	*Tilia x europaea*	5	33
Lawson's Cypress	*Chamaecyparis lawsoniana*	4	27
Wild Cherry	*Prunus avium*	4	27
Rose species	*Rosa* species	4	27
Garden Privet	*Ligustrum ovalifolium*	3	20
Apple	*Malus pumila*	3	20
Yew	*Taxus baccata*	3	20
Maple species	*Acer* species	2	13
Darwin's Barberry	*Berberis darwinii*	2	13
Silver Birch	*Betula pendula*	2	13
Hornbeam	*Carpinus betulus*	2	13
Red-osier Dogwood	*Cornus sericea*	2	13
Franchet's Cotoneaster	*Cotoneaster franchetii*	2	13
Japanese Knotweed	*Fallopia japonica*	2	13
Tutsan	*Hypericum androsaemum*	2	13
Privet species	*Ligustrum* species	2	13
Wilson's Honeysuckle	*Lonicera nitida*	2	13
Scots Pine	*Pinus sylvestris*	2	13
Aspen	*Populus tremula*	2	13
Japanese Rose	*Rosa rugosa*	2	13
White Willow	*Salix alba*	2	13
Crack Willow	*Salix euxina*	2	13
Osier	*Salix viminalis*	2	13
Rowan	*Sorbus aucuparia*	2	13
English Elm	*Ulmus procera*	2	13
Elm species	*Ulmus* species	2	13
Field Maple	*Acer campestre*	1	7
Norway Maple	*Acer platanoides*	1	7
Grey Alder	*Alnus incana*	1	7
Barberry species	*Berberis* species	1	7
Thunberg's Barberry	*Berberis thunbergii*	1	7
Birch species	*Betula* species	1	7
Sweet Chestnut	*Castanea sativa*	1	7
Traveller's-joy	*Clematis vitalba*	1	7
Dogwood	*Cornus sanguinea*	1	7
Hawthorn species	*Crataegus* species	1	7
Escallonia	*Escallonia macrantha*	1	7
Hebe species	*Hebe* species	1	7
European Larch	*Larix decidua*	1	7
Japanese Larch	*Larix kaempferi*	1	7
Box-leaved Honeysuckle	*Lonicera pileata*	1	7
Black-popular	*Populus nigra*	1	7
Hybrid Black-popular	*Populus x canadensis*	1	7
Grey Popular	*Populus x canescens*	1	7
Shrubby Cinquefoil	*Potentilla fruticosa*	1	7

Table A1. Continued

Common name*	Latin name*	No. of sections	% frequency of occurrence
Woody (climbers, trees, shrubs) (continued)			
Red Oak	*Quercus rubra*	1	7
Oak species (seedling)	*Quercus* species	1	7
Rhododendron	*Rhododendron ponticum*	1	7
Red Currant	*Ribes rubrum*	1	7
Field-rose	*Rosa arvensis*	1	7
Goat Willow	*Salix caprea*	1	7
Creeping Willow	*Salix repens*	1	7
Willow species	*Salix* species	1	7
Shrubby Osier	*Salix x fruticosa*	1	7
Whitebeam species	*Sorbus* species	1	7
Guelder-rose	*Viburnum opulus*	1	7

*****Nomenclature follows Atherton *et al*. (2010) for bryophytes and Stace (2010) for all other plant species.

Table A2. Plant species occurrence by section on the Royal Canal within study area

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Algae															
Chara globularis	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
Chara species	X	-	-	-	-	-	-	-	X	X	X	-	-	-	-
Chara vulgaris	-	-	-	-	-	-	X	-	-	-	-	X	-	-	-
Cladophora spp.	X	X	-	-	-	-	X	X	X	X	-	X	-	X	-
Bryophytes															
Amblystegium serpens	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Aneura pinguis	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-
Barbula convoluta	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
Barbula sardoa	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Barbula unguiculata	-	-	X	-	-	X	X	-	-	-	X	-	X	X	-
Brachythecium rivulare	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Brachythecium rutabulum	-	-	X	-	X	-	X	-	-	-	-	X	-	X	-
Bryum argenteum	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Bryum capillare	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Bryum section *erythrocarpum*	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Calliergonella cuspidata	X	-	X	-	-	-	-	-	-	-	-	X	-	X	-
Campyliadelphus chrysophyllus	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Cirriphyllum piliferum	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Ctenidium molluscum	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Dicranella varia	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Didymodon insulanus	-	X	X	-	X	-	-	-	-	-	-	-	-	-	-
Didymodon rigidulus	-	X	X	-	-	-	-	-	-	-	-	-	X	-	-
Didymodon sinuosus	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Encalypta streptocarpa	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Eucladium verticillatum	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Eurhynchium striatum	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Fissidens adianthoides	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Fissidens bryoides	-	X	X	-	-	-	-	-	-	-	-	-	-	X	-
Fissidens taxifolius	-	X	X	-	X	-	-	-	-	-	-	-	-	-	-
Fontinalis antipyretica	-	-	X	-	-	-	-	-	X	X	X	-	-	-	-
Frullania dilatata	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Grimmia pulvinata	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Homalothecium lutescens	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Homalothecium sericeum	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Hypnum andoi	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Hypnum cupressiforme agg.	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Hypnum resupinatum	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-
Jungermannia species	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Kindbergia praelonga	-	X	X	-	-	-	-	-	-	-	-	X	X	X	-
Leiocolea badensis	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Lophocolea bidentata	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Neckera complanata	-	X	X	-	-	-	-	-	-	-	-	-	X	-	-
Orthotrichum affine	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-
Orthotrichum anomalum	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Orthotrichum cupulatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Oxyrrhynchium hians	-	X	X	-	X	-	-	-	-	-	-	X	-	X	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Bryophytes (continued)															
Palustriella falcata	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Pellia species	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Plagiomnium rostratum	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Plagiomnium undulatum	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Pseudoscleropodium purum	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Rhizomnium punctatum	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhynchostegiella pumila	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhynchostegiella tenella	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-
Rhytidiadelphus squarrosus	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-
Schistidium crassipilum	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Schistidium elegantulum	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Syntrichia intermedia	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X
Thamnobryum alopecurum	-	X	X	-	X	-	-	-	-	-	-	-	-	-	-
Thuidium tamariscinum	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Tortula muralis	X	X	-	-	-	-	-	-	-	-	-	-	-	X	-
Tortula species	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Trichostomum crispulum	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-
Weissia brachycarpa v. *obliqua*	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Ferns															
Asplenium ruta-muraria	X	X	-	X	-	-	-	X	-	-	-	X	-	-	X
Asplenium scolopendrium	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Asplenium trichomanes	X	X	-	-	-	X	-	-	-	-	-	-	-	-	-
Dryopteris affinis	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-
Dryopteris dilatata	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Dryopteris filix-mas	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-
Polypodium vulgare	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Polystichum setiferum	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Pteridium aquilinum	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Forbs															
Achillea millefolium	-	X	-	-	-	X	X	X	X	X	X	X	X	X	-
Agrimonia eupatoria	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-
Alisma plantago-aquatica	-	X	-	-	X	X	-	-	X	X	-	X	X	X	-
Alliaria petiolata	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
Anacamptis pyramidalis	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Anagallis arvensis	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Angelica sylvestris	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Anthriscus sylvestris	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-
Anthyllis vulneraria	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Arctium minus	-	-	-	-	-	-	-	X	-	-	X	-	-	X	-
Arum maculatum	-	X	X	X	X	-	-	-	-	-	-	X	-	X	-
Barbarea vulgaris	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-
Bellis perennis	X	X	-	-	X	X	-	-	X	X	X	X	X	X	X
Blackstonia perfoliata	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Brassica rapa	-	-	-	X	-	-	-	-	-	-	-	-	X	X	-
Callitriche species	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
Callitriche stagnalis	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Forbs (continued)															
Calystegia sepium	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X
Cardamine flexuosa	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-
Cardamine pratensis	-	-	-	-	-	X	-	X	X	-	X	-	-	-	X
Centaurea nigra	X	-	X	X	X	X	X	X	X	X	X	X	X	X	-
Centranthus ruber	-	-	-	X	X	X	-	-	-	X	X	-	-	X	-
Cerastium fontanum	-	X	X	-	X	X	X	-	-	-	X	X	X	X	-
Cerastium glomeratum	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Chamerion angustifolium	X	X	X	X	X	-	X	-	X	-	-	X	X	-	-
Cirsium arvense	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Cirsium vulgare	-	X	-	X	X	-	X	X	X	-	X	X	X	X	-
Crepis biennis	-	-	X	-	-	-	-	-	-	-	X	-	-	-	-
Crepis capillaris	X	X	X	X	-	-	X	-	-	-	-	-	-	X	-
Crepis vesicaria	-	-	X	X	X	-	-	X	-	-	-	X	X	X	X
Crocosmia x *crocosmiiflora*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymbalaria muralis	-	-	-	-	-	-	X	-	X	-	-	-	X	-	X
Dactylorhiza fuchsii	-	-	-	X	-	X	X	-	-	X	-	-	-	-	-
Dactylorhiza incarnata	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Daucus carota	-	X	-	X	X	-	-	-	-	-	X	X	-	X	-
Digitalis purpurea	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Dipsacus fullonum	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Elodea canadensis	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Elodea nuttallii	X	X	-	-	X	-	X	-	-	-	-	-	X	X	-
Epilobium hirsutum	X	X	X	X	X	-	X	X	X	X	X	-	X	-	-
Epilobium montanum	X	X	X	X	X	-	-	-	-	-	-	X	-	-	-
Epilobium parviflorum	X	X	X	X	X	X	X	X	-	X	X	X	X	-	X
Epilobium species	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-
Erinus alpinus	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Erysimum cheiranthoides	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-
Eupatorium cannabinum	-	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Euphrasia officinalis ag.	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Filipendula ulmaria	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fragaria vesca	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Fumaria officinalis	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Galium aparine	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X
Galium palustre	X	X	-	-	-	-	X	X	X	X	X	X	-	X	-
Galium verum	X	X	X	X	X	X	X	X	X	X	X	X	-	X	-
Geranium dissectum	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-
Geranium molle	X	-	-	-	-	-	-	X	-	-	-	X	-	-	-
Geranium pyrenaicum	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Geranium robertianum	-	X	X	X	X	-	X	-	-	X	X	-	X	X	-
Geum urbanum	-	X	X	X	X	-	-	-	-	X	-	X	X	X	-
Glechoma hederacea	-	-	-	-	X	-	-	-	-	-	-	X	-	X	-
Gymnadenia conopsea	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Heracleum sphondylium	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X
Hesperis matronalis	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-
Hippuris vulgaris	-	X	-	X	X	X	X	X	X	X	-	X	X	X	X

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Forbs (continued)															
Hypericum perforatum	-	-	X	X	-	-	-	X	-	-	X	X	-	X	-
Hypericum tetrapterum	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-
Hypochaeris radicata	-	X	X	-	-	-	-	X	-	X	X	X	-	X	-
Iris pseudacorus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Knautia arvensis	-	X	X	X	-	-	-	-	-	-	-	X	-	X	-
Lactuca serriola	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Lapsana communis	X	-	X	X	X	-	X	-	-	-	-	-	X	-	-
Lathyrus palustris	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Lathyrus pratensis	X	X	X	X	X	X	X	X	X	X	-	X	X	X	-
Lemna trisulca	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-
Leontodon hispidus	-	-	X	X	X	X	-	-	-	X	-	X	-	-	-
Leontodon saxatilis	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Leucanthemum vulgare	-	-	-	-	X	X	-	-	-	X	-	X	-	X	-
Linum catharticum	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-
Lotus corniculatus	-	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Lotus pedunculatus	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopus europaeus	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Lythrum salicaria	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-
Matricaria discoidea	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-
Medicago lupulina	X	-	X	X	-	-	-	X	X	X	X	X	X	X	-
Mentha aquatica	X	-	-	-	X	-	X	-	X	X	X	X	-	X	-
Menyanthes trifoliata	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Myosotis arvensis	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
Myosotis discolor	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-
Myosotis species	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Myriophyllum spicatum	X	X	-	-	X	X	-	-	-	X	-	X	X	X	X
Nasturtium officinale	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Neottia ovata	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Nigella damascena	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Nuphar lutea	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Odontites vernus	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ononis repens	-	-	-	X	X	X	X	X	-	X	X	X	-	X	-
Origanum vulgare	-	X	X	X	X	X	-	-	-	X	X	X	X	X	-
Papaver rhoeas	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
Papaver species	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Pentaglottis sempervirens	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Persicaria amphibia	X	X	-	-	X	X	X	X	X	X	X	X	X	X	-
Petasites fragrans	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-
Petasites hybridus	-	X	-	X	X	-	X	-	X	X	X	-	-	X	-
Pilosella aurantiaca	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Pilosella officinarum	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-
Plantago lanceolata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plantago major	X	X	X	-	X	X	X	X	X	X	X	X	X	X	-
Potamogeton gramineus	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
Potamogeton natans	-	-	-	X	X	-	-	X	-	-	-	X	X	X	-
Potentilla anglica	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Forbs (continued)															
Potentilla anserina	-	-	-	-	-	X	-	X	-	X	X	X	-	X	-
Potentilla reptans	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Potentilla sterilis	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Poterium sanguisorba	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-
Primula veris	-	-	-	X	-	X	X	-	-	X	-	X	-	X	-
Prunella vulgaris	-	-	-	-	X	-	-	-	-	-	X	X	-	X	-
Pulicaria dysenterica	-	-	-	-	-	-	-	X	-	X	X	X	-	X	-
Ranunculus acris	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Ranunculus bulbosus	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-
Ranunculus lingua	-	X	-	-	X	X	-	X	X	-	-	X	-	-	-
Ranunculus repens	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ranunculus species	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Reseda lutea	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Reseda luteola	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-
Rhinanthus minor	-	-	-	X	-	-	-	-	X	X	-	X	-	X	-
Rumex acetosa	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Rumex conglomeratus	-	-	-	X	X	X	X	-	X	X	-	-	-	X	-
Rumex crispus	-	X	-	-	X	-	X	-	-	X	X	X	X	X	X
Rumex obtusifolius	X	X	-	-	X	X	X	-	-	-	X	X	X	-	X
Rumex sanguineus	X	X	-	-	-	-	-	X	-	X	X	X	X	-	-
Sanicula europaea	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-
Scorzoneroides autumnalis	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Scrophularia auriculata	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Scrophularia nodosa	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Sedum species	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Senecio erucifolius	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Senecio jacobaea	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Senecio vulgaris	-	X	X	X	X	-	-	-	-	-	X	-	X	-	-
Silene dioica	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Silene flos-cuculi	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Silene vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Sisymbrium officinale	X	-	-	X	X	-	-	-	-	-	-	-	X	-	-
Solanum dulcamara	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-
Sonchus arvensis	-	-	-	X	X	-	-	X	-	X	X	X	X	-	-
Sonchus asper	-	X	-	X	-	-	X	-	-	-	-	X	-	X	-
Sonchus oleraceus	X	X	-	X	X	-	-	-	-	-	-	-	-	-	-
Sparganium emersum	X	X	X	-	X	X	X	-	-	-	-	X	X	X	X
Sparganium erectum	X	-	-	X	X	-	X	X	X	-	-	X	-	-	-
Stachys palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Stachys sylvatica	-	-	-	-	X	X	-	-	-	-	-	X	-	-	-
Stellaria graminea	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-
Stellaria media	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Succisa pratensis	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-
Taraxacum officinale ag.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Torilis japonica	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-
Tragopogon pratensis	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Forbs (continued)															
Trifolium campestre	-	-	-	X	X	X	X	-	-	-	-	-	-	-	-
Trifolium dubium	-	X	-	-	-	-	-	X	X	-	-	-	-	-	-
Trifolium pratense	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Trifolium repens	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X
Tussilago farfara	X	X	X	X	X	-	-	-	-	X	X	X	-	-	-
Typha latifolia	-	-	-	-	-	-	-	X	-	X	-	X	-	X	-
Urtica dioica	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Valeriana officinalis	X	X	X	X	X	X	X	X	X	X	-	X	X	X	-
Veronica anagallis-aquatica	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Veronica chamaedrys	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Veronica montana	-	X	-	-	-	-	-	X	X	-	-	-	-	-	-
Vicia cracca	X	X	X	X	X	X	X	X	X	X	X	X	-	X	-
Vicia sativa	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-
Vicia sepium	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Viola riviniana	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Grasses															
Agrostis capillaris	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Agrostis stolonifera	-	X	-	X	X	-	X	X	X	X	X	X	X	X	-
Alopecurus pratensis	-	X	-	X	-	-	-	-	-	X	-	-	-	X	-
Anthoxanthum odoratum	-	X	X	X	X	X	X	X	X	X	-	X	X	X	-
Arrhenatherum elatius	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Avenula pubescens	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Brachypodium sylvaticum	-	X	X	X	X	X	X	-	-	X	X	X	X	X	-
Briza media	-	X	-	-	-	X	-	-	-	X	-	-	-	-	-
Bromopsis erecta	-	X	X	X	-	-	-	-	-	X	X	-	-	-	-
Bromus hordeaceus	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-
Cynosurus cristatus	-	X	-	X	-	X	X	-	X	X	-	X	-	X	-
Dactylis glomerata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Elytrigia repens	-	X	-	X	X	-	X	-	-	-	-	-	-	-	-
Festuca rubra	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X
Glyceria maxima	X	X	X	X	X	X	X	X	X	X	-	X	X	X	-
Holcus lanatus	X	X		X	X	X	-	X	X	X	X	X	X	X	-
Holcus mollis	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Hordeum murinum	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Lolium multiflorum	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Lolium perenne	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Phalaris arundinacea	X	X	-	X	X	X	-	X	X	X	X	X	X	-	X
Phleum pratense	-	-	-	X	-	X	X	-	-	-	-	-	-	-	-
Phragmites australis	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Poa annua	X	X	-	X	X	X	-	X	X	X	X	X	X	X	X
Poa pratensis	-	X	X	-	-	-	-	-	-	X	-	X	X	-	-
Poa trivialis	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Schedonorus arundinacea	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
Schedonorus pratensis	-	-	-	-	-	-	X	-	X	X	-	-	-	-	-
Trisetum flavescens	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Triticum aestivum	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Horsetails															
Equisetum arvense	X	X	-	-	X	X	-	X	X	X	-	X	X	X	-
Equisetum fluviatile	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Equisetum palustre	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-
Rushes															
Juncus acutiflorus	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-
Juncus articulatus	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Juncus effusus	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Juncus inflexus	X	X	-	-	X	X	X	X	X	X	X	X	X	X	-
Luzula campestris	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Sedges															
Carex disticha	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Carex divulsa	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Carex elata	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-
Carex flacca	X	X	X	X	X	X	-	X	-	X	X	X	-	X	-
Carex hirta	-	X	-	-	-	X	X	X	-	X	X	X	-	X	-
Carex nigra	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Carex otrubae	-	-	-	-	-	X	X	X	-	-	X	X	X	X	-
Carex panicea	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Carex remota	-	-	-	-	-	-	X	-	X	X	-	-	-	X	X
Carex rostrata	-	-	-	-	X	-	X	X	X	X	X	X	-	-	-
Carex sylvatica	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis palustris	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Schoenoplectus lacustris	X	X	-	-	X	-	X	X	X	X	X	X	X	X	-
Woody (climbers, trees, shrubs)															
Acer campestre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Acer platanoides	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Acer pseudoplatanus	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Acer species	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Aesculus hippocastanum	-	-	-	-	-	-	-	-	X	X	X	X	X	X	-
Alnus glutinosa	X	X	X	X	X	X	X	X	-	X	X	X	-	-	-
Alnus incana	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Berberis darwinii	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Berberis species	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Berberis thunbergii	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Betula pendula	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X
Betula sp.	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buddleja davidii	X	X	X	X	-	-	X	-	-	-	X	-	-	-	-
Carpinus betulus	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-
Castanea sativa	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Chamaecyparis lawsoniana	X	-	-	X	-	-	-	-	-	-	-	-	X	-	X
Clematis vitalba	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Cornus sanguinea	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Cornus sericea	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Corylus avellana	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X
Cotoneaster franchetii	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Cotoneaster species	X	X	X	X	-	-	-	X	-	X	X	-	X	X	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Woody (climbers, trees, shrubs) (continued)															
Crataegus monogyna	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Crataegus species	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Escallonia macrantha	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Fagus sylvatica	X	-	-	-	X	X	X	X	X	X	X	X	X	X	X
Fallopia japonica	-	-	-	-	-	X	-	-	-	-	X	-	-	-	-
Fraxinus excelsior	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hebe species	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Hedera helix	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hypericum androsaemum	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-
Ilex aquifolium	-	X	-	X	X	-	-	X	X	X	-	X	-	X	-
Larix decidua	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Larix kaempferi	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Ligustrum ovalifolium	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-
Ligustrum species	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Ligustrum vulgare	-	X	X	X	-	-	-	X	X	X	X	X	-	-	-
Lonicera nitida	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-
Lonicera periclymenum	-	X	X	-	-	-	X	X	X	X	X	X	X	X	-
Lonicera pileata	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malus pumila	-	X	X	-	-	-	X	-	-	-	-	-	-	-	-
Pinus sylvestris	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Populus nigra	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Populus tremula	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-
Populus x canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Populus x canescens	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Potentilla fruticosa	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Prunus avium	-	-	X	-	-	-	X	X	-	-	-	-	-	X	-
Prunus laurocerasus	X	-	X	X	X	-	-	X	-	-	-	-	X	-	X
Prunus spinosa	-	X	X	X	X	X	X	X	-	X	X	X	X	X	-
Quercus robur	-	-	-	-	X	-	X	X	X	X	X	X	X	X	X
Quercus rubra	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus species	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Rhododendron ponticum	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribes rubrum	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Rosa arvensis	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa canina	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rosa rugosa	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
Rosa species	-	X	-	X	X	X	-	-	-	-	-	-	-	-	-
Rubus fruticosus ag.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Salix alba	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-
Salix caprea	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Salix cinerea	-	-	-	-	X	-	X	X	X	X	X	X	-	X	X
Salix euxina	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-
Salix repens	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Salix species	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Salix viminalis	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Salix x fruticosa	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-

Table A2. Continued

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species*															
Woody (climbers, trees, shrubs) (continued)															
Sambucus nigra	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
Sorbus aucuparia	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-
Sorbus species	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Symphoricarpos albus	-	-	X	-	X	X	X	-	-	-	-	-	-	X	-
Taxus baccata	-	-	-	-	-	-	-	-	X	-	-	X	-	X	-
Tilia x europaea	X	-	-	-	-	-	X	-	X	-	X	X	-	-	-
Ulex europaeus	-	X	X	X	X	X	-	X	-	-	X	X	X	X	-
Ulmus glabra	-	X	X	X	X	-	X	X	-	-	-	-	X	-	-
Ulmus procera	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-
Ulmus species	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
Viburnum opulus	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-

*****Nomenclature follows Atherton *et al*. (2010) for bryophytes and Stace (2010) for all other plant species.

Notes:

Section 5: *Rosa* sp. is a garden rambler.

Section 11: *Fallopia japonica*: sample leaves for one specimen were a little larger than normal for this species, with some rounded at the base; all other characters fit for this species.

Section 11: *Fagus sylvatica* f. *purpurea* is present in this section near Louisa Bridge.

Section 11: *Crataegus* sp. is a cultivated variety of Hawthorn.

Section 12: *Betula pendula* exhibiting abnormal characteristics; possibly a cultivated variety.

Section 13: One unknown cultivated shrub in this section, most likely belonging to the Rosaceae family.

Section 14: *Acer* sp. and *Salix* sp. are cultivated varieties.

Section 15: Variegated garden shrub present, possibly *Cornus alba.*

Table A3. Location of grapnel samples of aquatic vegetation along the Royal Canal

Section	Sample	County	ITM
S1 Talbot Bridge & 12th Lock to Granard Bridge	G1A	Dublin	708630 738156
	G1B	Dublin	708567 738143
	G1C	Dublin	708463 738128
S2 Granard Bridge to Kirkpatrick Bridge	G2A	Dublin	708371 738077
	G2B	Dublin	707885 737951
	G2C	Dublin	707046 737601
S3 Kirkpatrick Bridge to Kennan/Neville Bridge	G3A	Dublin	706163 737767
S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	G4A	Dublin	705976 737828
	G4B	Dublin	705581 737925
	G4C	Dublin	704970 738140
S5 Callaghan/Carhampton Br. to Dublin & Meath Railway Br.	G5A	Dublin	704887 738171
	G5B	Dublin	704461 738310
	G5C	Dublin	704190 738399
S6 Dublin & Meath Railway Br. to Pakenham Br.	G6A	Dublin	704041 738384
	G6B	Dublin	703963 738355
	G6C	Dublin	703808 738263
S7 Pakenham Bridge to Collins Bridge	G7A	Dublin	703735 738203
	G7B	Dublin	703477 737898
	G7C	Dublin	703199 737492
	G7D	Dublin	702786 736888
S8 Collins Bridge to Dublin-Kildare county boundary	G8A	Dublin	701723 737016
	G8B	Dublin	702143 736862
	G8C	Dublin	702610 736799
S9 Dublin-Kildare county boundary to Cope Bridge	G9A	Kildare	700857 737076
	G9B	Kildare	701361 737025
	G9C	Kildare	701571 737014
S10 Cope Bridge to Ryewater aqueduct	G10A	Kildare	699621 737104
	G10B	Kildare	700325 737164
	G10C	Kildare	700754 737101
S11 Ryewater aqueduct to Leixlip Spa and Louisa Br.	G11A	Kildare	699413 736664
	G11B	Kildare	699473 736737
S12 Leixlip Spa and Louisa Br. to Deey Br. & Lock 13	G12A	Kildare	697923 736949
	G12B	Kildare	698102 736833
	G12C	Kildare	698409 736614
	G12D	Kildare	698508 736584
	G12E	Kildare	698996 736464
S13 Deey Br. & Lock 13 to Carton Wharf & Pike Br.	G13A	Kildare	696112 737389
	G13B	Kildare	696548 737313
	G13C	Kildare	697058 737231
	G13D	Kildare	697791 737011
S14 Carton Wharf & Pike Br. to Mullen Bridges	G14A	Kildare	693991 737451
	G14B	Kildare	694128 737489
	G14C	Kildare	694628 737613
	G14D	Kildare	695029 737572
	G14E	Kildare	695478 737495
	G14F	Kildare	695975 737414
S15 Mullen Bridges to Maynooth Harbour	G15A	Kildare	693732 737366
	G15B	Kildare	693800 737414
	G15C	Kildare	693893 737432

Table A4. Results of grapnel sampling of the aquatic vegetation of the Royal Canal

Sample	Common name	Latin name	Abundance (DAFOR)
G1A	Filamentous algae	*Cladophora* spp.	D
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G1B	Filamentous algae	*Cladophora* spp.	D
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G1C	Filamentous algae	*Cladophora* spp.	D
	Stonewort	*Chara* spp.	A
	Nuttall's Waterweed*	*Elodea nuttallii**	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G2A	Filamentous algae	*Cladophora* spp.	D
	Ivy-leaved Duckweed	*Lemna trisulca*	R
	Nuttall's Waterweed*	*Elodea nuttallii**	R
G2B	Filamentous algae	*Cladophora* spp.	D
	Canadian Waterweed*	*Elodea canadensis**	R
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G2C	-	-	-
G3A	Canadian Waterweed*	*Elodea canadensis**	D
	Ivy-leaved Duckweed	*Lemna trisulca*	O
G4A	-	-	-
G4B	Canadian Waterweed*	*Elodea canadensis**	D
G4C	Mare's-tail	*Hippuris vulgaris*	D
	Canadian Waterweed*	*Elodea canadensis**	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G5A	-	-	-
G5B	Canadian Waterweed*	*Elodea canadensis**	D
	Ivy-leaved Duckweed	*Lemna trisulca*	O
G5C	Unbranched Bur-reed	*Sparganium emersum*	D
	Nuttall's Waterweed*	*Elodea nuttallii**	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G6A	Yellow Water-lily	*Nuphar lutea*	D
G6B	Canadian Waterweed*	*Elodea canadensis**	D
	Ivy-leaved Duckweed	*Lemna trisulca*	F
G6C	Canadian Waterweed*	*Elodea canadensis**	D
	Spiked Water-milfoil	*Myriophyllum spicatum*	F
	Ivy-leaved Duckweed	*Lemna trisulca*	O

Table A4. Continued

Sample	Common name	Latin name	Abundance (DAFOR)
G7A	Yellow Water-lily	*Nuphar lutea*	A
	Filamentous algae	*Cladophora* spp.	A
	Canadian Waterweed*	*Elodea canadensis**	O
	Unbranched Bur-reed	*Sparganium emersum*	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G7B	Canadian Waterweed*	*Elodea canadensis**	D
	Nuttall's Waterweed*	*Elodea nuttallii**	O
	Stonewort	*Chara vulgaris*	R
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G7C	Filamentous algae	*Cladophora* spp.	Q
	Canadian Waterweed	*Elodea canadensis*	O
	Mare's-tail	*Hippuris vulgaris*	O
	Stonewort	*Chara vulgaris*	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G7D	Filamentous algae	*Cladophora* spp.	A
	Mare's-tail	*Hippuris vulgaris*	F
	Canadian Waterweed	*Elodea canadensis*	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G8A	Mare's-tail	*Hippuris vulgaris*	A
	Yellow Water-lily	*Nuphar lutea*	F
	Filamentous algae	*Cladophora* spp.	O
	Canadian Waterweed*	*Elodea canadensis**	R
G8B	Mare's-tail	*Hippuris vulgaris*	A
	Stonewort	*Chara globularis*	A
	Yellow Water-lily	*Nuphar lutea*	F
	Canadian Waterweed*	*Elodea canadensis**	O
	Ivy-leaved Duckweed	*Lemna trisulca*	R
G8C	Yellow Water-lily	*Nuphar lutea*	D
G9A	Yellow Water-lily	*Nuphar lutea*	A
	Canadian Waterweed*	*Elodea canadensis**	A
	Stonewort	*Chara* spp.	R
G9B	Yellow Water-lily	*Nuphar lutea*	F
	Mare's-tail	*Hippuris vulgaris*	F
	Stonewort	*Chara* spp.	O
	Ivy-leaved Duckweed	*Lemna trisulca*	O
	Filamentous algae	*Cladophora* spp.	F
	Canadian Waterweed*	*Elodea canadensis**	O
G9C	Mare's-tail	*Hippuris vulgaris*	A
	Filamentous algae	*Cladophora* spp.	A
	Yellow Water-lily	*Nuphar lutea*	O
	Ivy-leaved Duckweed	*Lemna trisulca*	O

Table A4. Continued

Sample	Common name	Latin name	Abundance (DAFOR)
G10A	Mare's-tail	*Hippuris vulgaris*	D
	Ivy-leaved Duckweed	*Lemna trisulca*	R
	Greater Water-moss	*Fontinalis antipyretica*	O
G10B	Yellow Water-lily	*Nuphar lutea*	F
	Filamentous algae	*Cladophora* spp.	F
	Greater Water-moss	*Fontinalis antipyretica*	F
	Ivy-leaved Duckweed	*Lemna trisulca*	O
G10C	Spiked Water-milfoil	*Myriophyllum spicatum*	F
	Mare's-tail	*Hippuris vulgaris*	F
	Canadian Waterweed*	*Elodea canadensis**	F
	Yellow Water-lily	*Nuphar lutea*	O
	Stonewort	*Chara* spp.	R
G11A	Canadian Waterweed*	*Elodea canadensis**	D
	Greater Water-moss	*Fontinalis antipyretica*	F
	Stonewort	*Chara* spp.	R
G11B	Greater Water-moss	*Fontinalis antipyretica*	D
G12A	Canadian Waterweed*	*Elodea canadensis**	D
	Yellow Water-lily	*Nuphar lutea*	R
	Spiked Water-milfoil	*Myriophyllum spicatum*	O
G12B	Yellow Water-lily	*Nuphar lutea*	D
G12C	Filamentous algae	*Cladophora* spp.	D
	Canadian Waterweed*	*Elodea canadensis**	O
	Yellow Water-lily	*Nuphar lutea*	R
G12D	Filamentous algae	*Cladophora* spp.	A
	Yellow Water-lily	*Nuphar lutea*	F
	Broad-leaved Pondweed	*Potamogeton natans*	O
	Unbranched Bur-reed	*Sparganium emersum*	R
G12E	Mare's-tail	*Hippuris vulgaris*	D
	Stonewort	*Chara vulgaris*	F
G13A	Spiked Water-milfoil	*Myriophyllum spicatum*	A
	Mare's-tail	*Hippuris vulgaris*	F
	Canadian Waterweed*	*Elodea canadensis**	R
	Yellow Water-lily	*Nuphar lutea*	R
G13B	Yellow Water-lily	*Nuphar lutea*	D
	Water-crowfoot	*Ranunculus* spp.	R
G13C	Yellow Water-lily	*Nuphar lutea*	D
	Canadian Waterweed*	*Elodea canadensis**	O
G13D	Mare's-tail	*Hippuris vulgaris*	F
	Various-leaved Pondweed	*Potamogeton gramineus*	F
	Yellow Water-lily	*Nuphar lutea*	O
	Unbranched Bur-reed	*Sparganium emersum*	O
	Canadian Waterweed*	*Elodea canadensis**	R
	Nuttall's Waterweed*	*Elodea nuttallii**	R

Table A4. Continued

Sample	Common name	Latin name	Abundance (DAFOR)
G14A	Yellow Water-lily	*Nuphar lutea*	A
	Spiked Water-milfoil	*Myriophyllum spicatum*	F
	Canadian Waterweed*	*Elodea canadensis**	R
G14B	Mare's-tail	*Hippuris vulgaris*	A
	Yellow Water-lily	*Nuphar lutea*	F
	Canadian Waterweed*	*Elodea canadensis**	R
	Spiked Water-milfoil	*Myriophyllum spicatum*	R
	Filamentous algae	*Cladophora* spp.	O
G14C	Yellow Water-lily	*Nuphar lutea*	A
	Filamentous algae	*Cladophora* spp.	A
G14D	Yellow Water-lily	*Nuphar lutea*	D
	Spiked Water-milfoil	*Myriophyllum spicatum*	R
G14E	Canadian Waterweed*	*Elodea canadensis**	A
	Yellow Water-lily	*Nuphar lutea*	A
	Spiked Water-milfoil	*Myriophyllum spicatum*	O
G14F	Yellow Water-lily	*Nuphar lutea*	A
	Unbranched Bur-reed	*Sparganium emersum*	O
	Canadian Waterweed*	*Elodea canadensis**	O
	Mare's-tail	*Hippuris vulgaris*	O
	Nuttall's Waterweed*	*Elodea nuttallii**	R
G15A	Mare's-tail	*Hippuris vulgaris*	A
	Spiked Water-milfoil	*Myriophyllum spicatum*	A
G15B	Mare's-tail	*Hippuris vulgaris*	F
	Spiked Water-milfoil	*Myriophyllum spicatum*	F
	Stonewort	*Chara globularis*	F
	Yellow Water-lily	*Nuphar lutea*	O
G15C	Mare's-tail	*Hippuris vulgaris*	A
	Spiked Water-milfoil	*Myriophyllum spicatum*	F
	Canadian Waterweed*	*Elodea canadensis**	O

*Invasive species

Table A5. Invasive terrestrial plants recorded along the Royal Canal within the study area

Latin name	Section	ITM
Cotoneaster spp.	S1 Talbot Bridge & 12th Lock to Granard Bridge	708558 738160
Buddleja davidii	S2 Granard Bridge to Kirkpatrick Bridge	708422 738095
Rhododendron ponticum	S2 Granard Bridge to Kirkpatrick Bridge	707099 737622
Rhododendron ponticum	S2 Granard Bridge to Kirkpatrick Bridge	707283 737696
Cotoneaster franchetii	S2 Granard Bridge to Kirkpatrick Bridge	707357 737740
Cotoneaster spp.	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706465 737658
Symphoricarpos albus	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706097 737783
Cotoneaster spp.	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706609 737577
Cotoneaster spp.	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706468 737657
Buddleja davidii	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706247 737737
Prunus laurocerasus	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706192 737754
Symphoricarpos albus	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706109 737790
Prunus laurocerasus	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706182 737765
Cotoneaster franchetii	S3 Kirkpatrick Bridge to Kennan/Neville Bridge	706778 737584
Petasites fragrans	S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	706086 737805
Prunus laurocerasus	S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	706038 737814
Cotoneaster spp.	S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	706038 737814
Prunus laurocerasus	S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	706019 737820
Petasites fragrans	S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	705096 738084
Prunus laurocerasus	S4 Kennan/Neville Br. to Callaghan/Carhampton Br.	705950 737831
Symphoricarpos albus	S6 Dublin & Meath Railway Br. to Pakenham Br.	704043 738384
Fallopia japonica	S6 Dublin & Meath Railway Br. to Pakenham Br.	703794 738253
Fallopia japonica	S6 Dublin & Meath Railway Br. to Pakenham Br.	703794 738253
Fallopia japonica	S6 Dublin & Meath Railway Br. to Pakenham Br.	703827 738282
Buddleja davidii	S7 Pakenham Bridge to Collins Bridge	703709 738173
Prunus laurocerasus	S8 Collins Bridge to Dublin-Kildare county boundary	701731 737016
Cotoneaster spp.	S8 Collins Bridge to Dublin-Kildare county boundary	701780 737008
Cotoneaster spp.	S10 Cope Bridge to Ryewater aqueduct	699574 737036
Cotoneaster spp.	S10 Cope Bridge to Ryewater aqueduct	700570 737119
Buddleja davidii	S11 Ryewater aqueduct to Leixlip Spa & Louisa Br.	699381 736598
Buddleja davidii	S11 Ryewater aqueduct to Leixlip Spa & Louisa Br.	699333 736550
Cotoneaster spp.	S11 Ryewater aqueduct to Leixlip Spa & Louisa Br.	699323 736559
Fallopia japonica	S11 Ryewater aqueduct to Leixlip Spa & Louisa Br.	699349 736606
Fallopia japonica	S11 Ryewater aqueduct to Leixlip Spa & Louisa Br.	699337 736608
Fallopia japonica	S11 Ryewater aqueduct to Leixlip Spa & Louisa Br.	699351 736606
Cotoneaster spp.	S13 Deey Br. & Lock 13 to Carton Wharf & Pike Br.	696111 737395
Prunus laurocerasus	S13 Deey Br. & Lock 13 to Carton Wharf & Pike Br.	697803 737014
Lonicera nitida	S13 Deey Br. & Lock 13 to Carton Wharf & Pike Br.	697574 737082
Cotoneaster spp.	S13 Deey Br. & Lock 13 to Carton Wharf & Pike Br.	696113 737400
Symphoricarpos albus	S14 Carton Wharf & Pike Br. to Mullen Bridges	694870 737598
Cotoneaster spp.	S14 Carton Wharf & Pike Br. to Mullen Bridges	696053 737403
Symphoricarpos albus	S14 Carton Wharf & Pike Br. to Mullen Bridges	694761 737622
Symphoricarpos albus	S14 Carton Wharf & Pike Br. to Mullen Bridges	694877 737602
Cotoneaster spp.	S14 Carton Wharf & Pike Br. to Mullen Bridges	696056 737404
Prunus laurocerasus	S15 Mullen Bridges to Maynooth Harbour	693751 737424

Table A6. Non-volant mammal activity along the Royal Canal within the study area by section

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species															
Otter	-	-	X	-	-	-	X	X	-	-	-	-	X	-	-
Badger	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Fox	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-
Rabbit	-	-	-	X	-	X	-	-	-	-	X	X	-	X	-
Rat	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Grey squirrel	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
American mink	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-

Table A7. Location of otter signs on the Royal Canal within the study area.

Description	Location	ITM
Spraint (old)	S3 Kirkpatrick Br. – Kennan or Neville Br.	706097 737798
Spraint (fresh)	S7 Pakenham Br. – Collins Br.	703088 737323
Spraint (fresh)	S7 Pakenham Br. – Collins Br.	702980 737162
Spraint (fresh)	S7 Pakenham Br. – Collins Br.	702777 736877
Spraint (fresh)	S8 Collins Br. – Dublin-Kildare county boundary	701819 737000
Spraint (old)	S8 Collins Br. – Dublin-Kildare county boundary	702452 736749
Spraint (old)	S13 Deey Br. & Lock 13 – Carton Wharf & Pike Br.	696071 737395

Table A8. Bat species by section along the Royal Canal within the study area

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species															
Common pipistrelle	X	X	X	-	-	-	-	X	X	X	X	X	X	X	-
Soprano pipistrelle	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X
Daubenton's bat	X	X	-	X	-	-	X	X	X	X	X	X	-	X	-
Leisler's bat	-	-	-	-	-	X	X	X	-	X	-	X	X	X	X

Table A9. Bird species recorded by frequency of occurrence on Royal Canal within study area

Common name	Latin name	No. of sections	% Frequency of occurrence
Wood Pigeon	*Columba palumbus*	15	100
Blackbird	*Turdus merula*	13	87
Wren	*Troglodytes troglodytes*	13	87
Great Tit	*Parus major*	12	80
Robin	*Erithacus rubecula*	12	80
Swallow	*Hirundo rustica*	12	80
Chaffinch	*Fringilla coelebs*	11	73
Mallard	*Anas platyrhynchos*	11	73
Magpie	*Pica pica*	10	67
Rook	*Corvus frugilegus*	10	67
Jackdaw	*Corvus monedula*	9	60
Moorhen	*Gallinula chloropus*	9	60
Blue Tit	*Cyanistes caeruleus*	8	53
Chiffchaff	*Phylloscopus collybita*	8	53
House Sparrow	*Passer domesticus*	8	53
Hooded Crow	*Corvus cornix*	6	40
Lesser Black-backed Gull	*Larus fuscus*	5	33
Willow Warbler	*Phylloscopus trochilus*	5	33
Bullfinch	*Pyrrhula pyrrhula*	4	27
Dunnock	*Prunella modularis*	4	27
Greenfinch	*Carduelis chloris*	4	27
Long-tailed Tit	*Aegithalos caudatus*	4	27
Starling	*Sturnus vulgaris*	4	27
Goldfinch	*Carduelis carduelis*	3	20
Grey Heron	*Ardea cinerea*	3	20
Mute Swan	*Cygnus olor*	3	20
Buzzard	*Buteo buteo*	2	13
Collared Dove	*Streptopelia decaocto*	2	13
Little Grebe	*Tachybaptus ruficollis*	2	13
Mistle Thrush	*Turdus viscivorus*	2	13
Pheasant	*Phasianus colchicus*	2	13
Pied Wagtail	*Motacilla alba*	2	13
Song Thrush	*Turdus philomelos*	2	13
Swift	*Apus apus*	2	13
Kingfisher	*Atthis alcedo*	1	7
Blackcap	*Sylvia atricapilla*	1	7
Cormorant	*Phalacrocorax carbo*	1	7
Grey Wagtail	*Motacilla cinerea*	1	7
Reed bunting	*Emberiza schoeniclus*	1	7
Yellowhammer	*Emberiza citrinella*	1	7

Table A10. Bird species occurrence by section on Royal Canal within study area

Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Species															
Blackbird	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X
Blackcap	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Blue Tit	-	-	X	-	-	X	X	X	X	X	X	X	-	-	-
Bullfinch	-	-	-	-	-	-	X	X	X	-	-	X	-	-	-
Buzzard	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-
Chaffinch	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-
Chiffchaff	-	-	X	X	-	-	-	X	X	X	X	X	-	X	-
Collared Dove	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-
Cormorant	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Dunnock	-	X	-	-	-	-	X	X	-	-	-	X	-	-	-
Goldfinch	-	X	-	-	-	-	X	-	-	-	-	-	-	X	-
Great Tit	-	X	X	X	X	X	X	X	-	X	-	X	X	X	X
Greenfinch	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-
Grey Heron	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-
Grey Wagtail	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Hooded Crow	-	-	-	-	-	-	X	-	X	X	X	-	X	X	-
House Sparrow	-	X	-	-	-	-	X	X	X	X	X	X	-	X	-
Jackdaw	-	X	-	X	-	-	-	X	-	X	X	X	X	X	X
Kingfisher	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Lesser Black-backed Gull	-	-	-	-	-	X	-	X	-	X	X	X	-	-	-
Little Grebe	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
Long-tailed Tit	X	X	-	-	-	X	-	-	-	X	-	-	-	-	-
Magpie	X	X	X	-	X	-	X	X	-	X	X	X	-	X	-
Mallard	X	X	-	-	-	-	X	X	X	X	X	X	X	X	X
Mistle Thrush	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-
Moorhen	-	X	-	-	-	-	X	X	X	X	X	X	-	X	X
Mute Swan	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-
Pheasant	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
Pied Wagtail	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X
Reed bunting	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Robin	X	X	X	X	X	-	X	X	X	X	X	X	X	-	-
Rook	X	X	-	X	-	X	X	X	X	-	X	X	-	-	X
Song Thrush	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-
Starling	-	-	-	-	-	-	X	-	-	-	X	X	-	X	-
Swallow	-	-	X	X	X	X	X	X	X	X	X	X	-	X	X
Swift	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-
Willow Warbler	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-
Wood Pigeon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wren	X	X	X	X	X	X	X	X	X	X	-	X	-	X	X
Yellowhammer	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-

Table A11. Location of ant hills along Royal Canal within study area

Section	Location	ITM
S2 Granard Br. to Kirkpatrick Br.	Railway embankment	707539 737799
S2 Granard Br. to Kirkpatrick Br.	Between canal and path	707415 737750
S2 Granard Br. to Kirkpatrick Br.	Between canal and path	707531 737800
S3 Kirkpatrick Br. to Kennan or Neville Br.	Between canal and path	706386 737692
S12 Leixlip Spa & Louisa Br. to Deey Br. & Lock 13	In area of GS1 off towpath	699211 736499

Table A12. Results of 2011 IFI electro-fishing survey between Collins Bridge and 13th Lock

Species	CPUE (Fish/100 m)			Length (cm)				Mean Wt	%	Total Biomass	%
	No.	Mean	SE	Mean	Max	Min	SE	(kg)	Popn	(kg)	Biomass
Roach	3336	97.9	13.94	14.65	26	5	0.07	0.05	80.2	166.8	68.5
Bream	3	0.09	0.04	24	39	14	7.64	0.247	0.1	0.7	0.3
RoxBr*	71	2.09	0.73	22.11	28	7	0.58	0.19	1.7	13.5	5.5
Tench	7	0.2	0.07	25.43	41	10	5.24	0.295	0.2	2.1	0.8
Pike	233	6.72	0.59	25.71	87	9	1.14	0.113	5.6	26.3	10.8
Perch	474	13.62	3.17	14.35	24	5	0.16	0.047	11.4	22.3	9.1
Eel	37	1.06	0.26	52.31	72	36	1.81	0.321	0.9	11.9	4.9

*RoxBr = Roach x Bream hybrid

Table A13. Results of 2009 IFI aquatic macroinvertebrate sampling on the Royal Canal within the study area. (Locations of sample sites described in Section 4.2.10)

Order	Species	Site	
		RCE19	RCE22
Crustacea	*Asellus aquaticus*	88	333
	Crangonyx pseudogracilis	3	131
Hemiptera	Corixidae	-	2
	Notonectidae	8	6
	Notonecta glauca	-	3
Ephemeroptera	*Caenis horaria*	62	-
	Caenis luctuosa	139	-
Megaloptera	*Sialis lutaria*	2	-
Trichoptera	Limnephilidae	-	20
	Limnephilus flavicornis/marmoratus	-	1
	Limnephilus lunatus	15	14
	Limnephilus marmoratus	9	2
	Anabolia nervosa	9	-
	Halesus radiatus	-	3
	Leptoceridae	-	1
	Mystacides longicornis	1	-
	Triaenodes bicolor	-	1
	Athripsodes aterrimus	2	-
	Phryganeidae	-	4
Odonata	Coenagrioniidae	3	1
Mollusca	*Bithynia leachii*	2	21
	Bithynia tentaculata	10	23
	Physa fontinalis	-	3
	Lymnaea stagnalis	-	1
	Radix balthica	-	1
	Valvata cristata	-	1
	Sphaerium corneum	11	27
	Pisidium sp.	60	25
Hirudinea	*Alboglossiphonia heteroclita*	2	-
	Glossiphonia complanata	-	1
	Helobdella stagnalis	3	4
Arachnida	Hydracarina	5	6
Diptera	Empididae	1	-
	Limoniidae	1	-
	Chironomidae	28	10
	Ceratopogonidae	3	-
Lepidoptera	Pyralidae	1	-
Oligochaeta	Oligochaeta	-	3

Table A14. Environmentally Sensitive Areas along the Royal Canal within the study area.

Section	Fossitt	Description	ITM
2	WN2	Oak-Ash-Hazel woodland	707081 737610
2	WD1	Mixed broadleaved woodland	707153 737662
2	WN2	Oak-Ash-Hazel woodland	707220 737656
2	WN2	Oak-Ash-Hazel woodland	707303 737693
2	WN2	Oak-Ash-Hazel woodland	707589 737851
2	WN2	Oak-Ash-Hazel woodland	707600 737827
3	FP1	Calcareous Spring	706155 737768
3	WN2	Oak-Ash-Hazel woodland	706176 737777
3	WN2	Oak-Ash-Hazel woodland	706188 737751
3	WN2	Oak-Ash-Hazel woodland	706449 737657
3	WN2	Oak-Ash-Hazel woodland	706491 737677
4	WN2	Oak-Ash-Hazel woodland	705414 737951
4	GS2	Meadow with indicators for the Annex I habitat 6510	705658 737925
4	WN2	Extensive area of Oak-Ash-Hazel woodland	705552 737925
4	WN2	Oak-Ash-Hazel woodland	705957 737816
5	GM1	Canal edge dominated by forbs typical of marsh	704279 738364
5	WN2	Oak-Ash-Hazel woodland	704518 738273
5	GS2	Meadow with indicators for the Annex I habitat 6510	704589 738277
5	GS2	Meadow with indicators for the Annex I habitat 6510	704639 738262
5	WN2	Oak-Ash-Hazel woodland	704834 738174
6	GS2	Species-rich grassy verge with orchids	703919 738335
6	WN2	Oak-Ash-Hazel woodland	704154 738337
8	WN2	Oak-Ash-Hazel woodland	701670 736983
8	WN6	Wet woodland	701906 737007
8	GS4	Wet grassland	702005 736979
8	WN2	Oak-Ash-Hazel woodland	702046 736893
8	WN2	Oak-Ash-Hazel woodland	702068 736956
8	FS2	Hydrophilous tall herb community (6430)	702115 736861
8	FS1	Tall reed swamp with *Schoenoplectus lacustris*	702188 736830
8	FS2	Hydrophilous tall herb community (6430)	702349 736753
8	FS2	Tall herb swamp habitat	702593 736779
9	WN2	Oak-ash-hazel woodland	701626 736987
10	WN2	Oak-ash-hazel woodland	699569 737070
10	FW3	Extensive *Hippuris* and *Nuphar* aquatic community	699628 737121
10	WN6	Annex I woodland Residual Alluvial Forest (91E0)	699645 737094
10	WN2	Oak-ash-hazel woodland	699782 737184
10	GS2	Grassy verge containing Annex I 6210 species	700128 737194
11	WN2	Oak-ash-hazel woodland	699491 736905
12	GS1	Species-rich calcareous grassland	697928 736957
12	WD1	Mixed broadleaved woodland	698152 736813
12	GS1	Species-rich calcareous grassland	698301 736668
12	GS2	Species-rich grassy verge	698555 736568
12	WN2	Oak-ash-hazel woodland	698575 736577
12	GS1	Species-rich calcareous grassland	698582 736561
12	GS2	Species-rich grassy verge	698641 736546
12	WD1	Mixed broadleaved woodland	698750 736531
12	GS2	Species-rich grassy verge	698785 736511

Table A14. Continued

Section	Fossitt	Description	ITM
12	WN6	Wet woodland	699181 736490
12	GS1	Overgrown calcareous grassland with numerous anthills	699213 736503
12	FS1	Tall sedge swamp	699231 736511
13	WD1	Mixed broadleaved woodland	696443 737349
13	WD1	Mixed broadleaved woodland	696805 737282
13	WD1	Mixed broadleaved woodland	697458 737124
14	GS2	Species-rich grassy verge	694698 737616
14	GS2	Species-rich grassy verge	694713 737626
14	GS2	Species-rich grassy verge	694840 737605

Appendix V – Plates

	
Plate 1 Greater Spearwort – Restricted distribution	Plate 2 Salad Burnett – Restricted distribution
	
Plate 3 Japanese Knotweed – Invasive	Plate 4 – Cotoneaster - Invasive
	
Plate 5 Snowberry – Invasive	Plate 6 Winter Heliotrope - Invasive

	
Plate 7 Cherry Laurel - Invasive	Plate 8 Buddleja - Invasive
	
Plate 9 Otter Spraint under Pike Bridge (S13)	

Appendix VI – Bat survey report

BAT ECO SERVICES

Royal Canal:
M50 (Talbot Br) to Maynooth Railway Station

Bat Survey

Dr Tina Aughney

2013

Report prepared for:

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SUMMARY

Site:	Royal Canal from M50 (Talbot Bridge) to Maynooth Railway Station
Development:	Proposed Cycle/Walking Route Enhancement Works
Grid reference:	Various – see main section of report for details
Proposed work:	Various works – see main section of report for details
Survey by:	Dr Tina Aughney
Bat species recorded:	Four species of bat: common pipistrelle, soprano pipistrelle, Daubenton's bat and Leisler's bat.

1. Introduction

A 15 km stretch of the Royal Canal was surveyed by Dr Tina Aughney, Bat Eco Services, in relation to bat activity and potential bat roosts. 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. Therefore a bat survey was requested to determine the bat usage of the canal in view of the fact all bat species are protected under Irish and EU legislation.

1.1 Site description

A full site description of the 15 km stretch of the Royal Canal is described according to the following table which breaks down the survey area according to distances between particular bridges. In addition, each bridge structure and other structure along the canal surveyed are described in relation to bat roosting potential.

Section	Starting point of section surveyed	Distance (km)

1	Talbot Bridge & Lock 12, Blanchardstown	0.3
2	Granard Bridge, Castleknock Road	1.55
3	Kirkpatrick Bridge, Carpenterstown	0.9
4	Kennan or Neville Bridge, Porterstown	1.2
5	Callaghan or Carhampton Bridge, Clonsilla	0.85
6	Dublin & Meath Railway Bridge	0.4
7	Pakenham Bridge, Barberstown	1.8
8	Collins Bridge, Coldblow	1.05
9	Dublin-Kildare county boundary, boat slip & amenity area	0.9
10	Cope Bridge	1.4
11	Ryewater aqueduct	0.45
12	Leixlip Spa and Louisa Bridge	1.6
13	Deey Bridge & Lock 13	1.85
14	Carton Wharf & Pike Bridge	2.15
15	Mullen Bridges	0.15

2. Survey Methodology

This report presents the results of a site visit by Dr Tina Aughney carried out in June 2013 during which a series of bat surveys were completed. A daytime survey was undertaken to identify any Potential Bat Roosts (PBRs) in the structures. Using a 4-point classification system for bridges, the structures were inspected using this system. The survey methodology follows that of Billington and Norman (1997) and each bridge is categorised as follows:

0 = no potential (no suitable crevices)
1 = crevices present may be of use to bats
2 = crevices ideal for bats but no evidence of usage
3 = evidence of bats (e.g. bat present, droppings etc.)

Evidence of bats is in the form of actual bats (visible or audible), bat droppings, urine staining, grease marks (oily secretions from glands present on stonework) and claw marks. In addition, the presence of bat fly pupae (bat parasite) also indicates that bat usage of a crevice has occurred in the past. To complete this grading inspection, each structure was inspected using a high-powered narrow beamed torch to inspect crevices, holes, cracks and joints within the structures. Where necessary, this inspection is assisted by using a fiberscope to check deep crevices not visible using a torch.

A Passive Monitoring System of bat detection was employed for these surveys where the bat detector is effectively used as a bat activity data logger. One unit was employed for each survey. The unit would have been located under the arch of the bridge, if possible, to detect and record any emerging bat species. The use of these recording devices results in a far greater sampling effort over a shorter period of time. Bat detectors are employed as the ultrasonic calls produced by bats cannot be heard by human hearing.

Bat surveying was completed using units of the Frequency Division AnaBat Detector System (AnaBat SD1 Flash Card Bat Detector). Frequency Division is a technique used to convert the inaudible bat echolocation calls to audible sounds. The AnaBat unit also uses Zero-Crossing Analysis (ZCA) to make the real-time recorded calls visible for display purposes. It is these sonograms (2-d sound pictures) that are digitally stored on the CF card and downloaded for analysis. Each time a bat is detected, an individual time-stamped (date and time to the second) file is recorded.

Bats are identified by their ultrasonic calls. This detector system records bat ultrasonic calls on a continuous basis and stores the information onto an internal CF card. Data was then downloaded and analysed using Analook (sound software for the AnaBat system). Each time-stamped AnaBat file was analysed and the species of bat recorded was noted as a bat pass. Some files may have recorded more than one species. In this instance, a bat pass is noted for each species (e.g. two species identified in a time-stamped file which corresponded to one soprano pipistrelle bat pass and one common pipistrelle bat pass). However, in the light of two individuals of the same species being recorded in the same time-stamped file, only one bat pass was noted for this time-stamped file.

To support the Passive Monitoring Programme, dusk and dawn surveying was also completed on each of the survey dates for details using a bat detector (Pettersson 240x Time Expansion and Heterodyne Bat Detector). Dusk surveys were completed during the hours of 10:00 p.m. to 2:00 a.m. and involved a general walkabout of the site. Dawn surveys were undertaken from 3.30 a.m. to 5.00 a.m.

2.1 Survey Constraints

This survey was undertaken inside the preferred summer months as specified in tender document. There were no survey constraints with regards to the current structure inspections and bat surveys.

Section	Starting point of section surveyed	Distance (km)	Survey Date
1	Talbot Bridge & Lock 12, Blanchardstown	0.3	20/6/2013
2	Granard Bridge, Castleknock Road	1.55	20/6/2013
3	Kirkpatrick Bridge, Carpenterstown	0.9	20/6/2013
4	Kennan or Neville Bridge, Porterstown	1.2	20/6/2013
5	Callaghan or Carhampton Bridge, Clonsilla	0.85	20/6/2013
6	Dublin & Meath Railway Bridge	0.4	20/6/2013
7	Pakenham Bridge, Barberstown	1.8	20/6/2013
8	Collins Bridge, Coldblow	1.05	19/6/2013
9	Dublin-Kildare county boundary, boat slip & amenity area	0.9	19/6/2013
10	Cope Bridge	1.4	19/6/2013
11	Ryewater aqueduct	0.45	19/6/2013
12	Leixlip Spa and Louisa Bridge	1.6	19/6/2013
13	Deey Bridge & Lock 13	1.85	19/6/2013
14	Carton Wharf & Pike Bridge	2.15	19/6/2013
15	Mullen Bridges	0.15	19/6/2013

Table 1: Dates on which the daytime inspection of route and of named structures was completed.

Section	Starting point of section surveyed	Distance (km)	Survey Date
1	Talbot Bridge & Lock 12, Blanchardstown	0.3	21/6/2013
2	Granard Bridge, Castleknock Road	1.55	21/6/2013
3	Kirkpatrick Bridge, Carpenterstown	0.9	21/6/2013
4	Kennan or Neville Bridge, Porterstown	1.2	21/6/2013
5	Callaghan or Carhampton Bridge, Clonsilla	0.85	21/6/2013
6	Dublin & Meath Railway Bridge	0.4	20/6/2013
7	Pakenham Bridge, Barberstown	1.8	20/6/2013
8	Collins Bridge, Coldblow	1.05	20/6/2013

9	Dublin-Kildare county boundary, boat slip & amenity area	0.9	20/6/2013
10	Cope Bridge	1.4	20/6/2013
11	Ryewater aqueduct	0.45	20/6/2013
12	Leixlip Spa and Louisa Bridge	1.6	19/6/2013
13	Deey Bridge & Lock 13	1.85	19/6/2013
14	Carton Wharf & Pike Bridge	2.15	19/6/2013
15	Mullen Bridges	0.15	19/6/2013

Table 2: Dates on which the night-time bat survey of route was completed.

A further survey was completed at additional buildings for potential bat roosts on the 4/7/2013 and 5/7/2013 at dusk and dawn respectively.

KEY TO SPECIES CODES

CP = common pipistrelle *Pipistrellus pipistrellus*

SP = soprano pipistrelle *Pipistrellus pygmaeus*

Leis = Leisler's bat *Nyctalus leisleri*

Daub = Daubenton's bat *Myotis daubentonii*

Myotis = *Myotis* species (family group consisting of Natterer's bat, Daubenton's bat and whiskered bat species)

3. Results

3.1 Bat Survey Results – Inspection of structures

Structure Name	Collins Bridge	**Grid Reference**	ITM 702685 736809
			
Survey Date	19/06/2013	**Weather**	Dry, calm, patchy cloud cover, 18^{0}C
Surveys completed	Daytime Inspection	Dusk Survey	None deployed
4-point Grade	**Roosts Recorded**	**Bat Species**	**Bat Species**
2 – suitable	None	CP, Leis foraging in area	Not applicable
Bat Assessment	Crevices suitable for individual bats, none present during current survey.		
Mitigation Measures	1. Retain crevices for bat usage. 2. If any crevices are to be filled, they should be hand filled and checked prior to filling to ensure that there is no residing wildlife. 3. Ensure that impact on adjacent habitats is kept to a minimum.		
Bat Survey Work	None required.		

Structure Name	Leixlip Confey (Cope Br)	**Grid Reference**	ITM 700801 737066





Survey Date	19/06/2013	**Weather**	Dry, calm, clear sky, 15^0C
Surveys completed	Daytime Inspection	Dawn Survey	None deployed
4-point Grade	**Roosts Recorded**	**Bat Species**	**Bat Species**
2 – suitable	None	SP, Daubs foraging	Not applicable
Bat Assessment	Crevices suitable for individual bats, none present during current survey.		
Mitigation Measures	1. Retain crevices for bat usage. 2. If any crevices are to be filled, they should be hand filled and checked prior to filling to ensure that there is no residing wildlife. 3. Ensure that impact on adjacent habitats is kept to a minimum.		
Bat Survey Work	None required.		

Structure Name	Building	**Grid Reference**	ITM 699560 736949





Survey Date	04/07/2013	**Weather**	Dry, calm, clear sky, 17^0C
Surveys completed	Daytime Inspection	Dusk Survey	None deployed
Roost Potential	**Roosts Recorded**	**Bat Species**	**Bat Species**
Yes	None	None	Not applicable
Bat Assessment	Crevices suitable for individual bats, none present during current survey.		
Mitigation Measures	1. Retain crevices for bat usage. 2. Suitable building for bat mitigation. The internal space of this structure could be used to erect bat tubes, thereby providing some roosting sites for bats, in particular, *Myotis* species.		
Bat Survey Work	None required.		

Structure Name	Private Building	**Grid Reference**	ITM 703854 738185



Survey Date	5/07/2013	**Weather**	Dry, calm, clear sky, 15^0C
Surveys completed	No	Dawn Survey	None deployed
Roost Potential	**Roosts Recorded**	**Bat Species**	**Bat Species**
Yes	Roost	Soprano pipistrelle	Not applicable
Bat Assessment	This building provides a roosting site for soprano pipistrelles – maternity roost.		
Mitigation Measures	There are no planned works for this site, the building was surveyed as a result of surveying the canal route.		
Bat Survey Work	None required. Additional note – American mink spotted exiting the canal adjacent to this building.		

The following bridges were inspected during the daytime, but were deemed unsuitable for roosting bats and therefore dusk or dawn bat survey were not completed at the named sites (i.e. on the 4-point assessment, all given 0).

a) Louisa Bridge – no suitable crevices for roosting bats.

b) Deey Bridge – no suitable crevices for roosting bats.

c) Lock 13 – crevices sealed.

d) Pike Bridge – some crevices but too shallow for roosting bats.

e) Mullen Bridges – no suitable crevices for bats.

f) Pakenham Bridge– no suitable crevices for bats.

g) Talbot Bridge – no suitable crevices for bats.

h) Granard Bridge – no suitable crevices for bats.

i) Kirkpatrick Bridge – no suitable crevices for bats.

j) Kennan or Neville Bridge – no suitable crevices for bats.

k) Callaghan or Carhampton Bridge – no suitable crevices for bats.

3.2 Walkabout Bat Detector Survey

The entire length of the canal from Talbot Bridge to Maynooth Harbour was surveyed using Pettersson D240x Time Expansion and Heterodyne bat detector. Any encounters with bats were noted on maps. These recordings are presented in the following tables. For each section as presented in Table 1 and Table 2, the grid reference point (ITM) where bats were detected along each section of the canal is detailed.

Survey Date: 19/6/2013 22:00hrs to 20/6/2013 01.30 hrs. Weather was dry, clear sky and calm with air temperature ranging from 21-17^{0}C.

Section 8 Collins Bridge, Coldblow to Dublin-Kildare County Boundary (1.5 km)

This section of the canal was surveyed from 01:10 hrs to 01:30 hrs. Reduced bat activity compared to Sections 14 & 15 due to the fact that bats have dispersed into the landscape at this time of the night.

Easting	Northing	Species	Details
701630	737002	Leisler's bat	Individual foraging over treeline/ towpath.
701630	737002	Common pipistrelle	Individual foraging along treeline/ towpath.
702678	736806	Daubenton's bat	Individual foraging over canal surface.
702678	736806	Common pipistrelle	Individual foraging along treeline/ towpath.

Section 9 Dublin-Kildare County Boundary to Cope Bridge (0.9 km)

This section of the canal was surveyed from 00:50 hrs to 01:10 hrs. Reduced bat activity compared to Sections 14 & 15 due to the fact that bats have dispersed into the landscape at this time of the night.

Easting	Northing	Species	Details
701302	737015	Common pipistrelle	Individual foraging along treeline/ towpath.
701227	737029	Daubenton's bat	Individual foraging over canal surface.
701227	737029	Common pipistrelle	Individual foraging along treeline/ towpath.

Section 10 Cope Bridge to Ryewater aquaduct (0.9 km)

This section of the canal was surveyed from 00:30 hrs to 00:50 hrs. Reduced bat activity compared to Sections 14 & 15 due to the fact that bats have dispersed into the landscape at this time of the night.

Easting	Northing	Species	Details
700450	737131	Leisler's bat	Individual foraging over treeline/ towpath.
700450	737131	Common pipistrelle	Individual foraging along treeline/ towpath.
700805	737065	Daubenton's bat	Individual foraging over canal surface.
700805	737065	Soprano pipistrelle	Individual foraging along treeline/ towpath.

Section 11 Ryewater aquaduct to Leixlip Spa & Louisa Bridge (1.4 km)

This section of the canal was surveyed from 00:10 hrs to 00:30 hrs. Reduced bat activity compared to Sections 14 & 15 due to the fact that bats have dispersed into the landscape at this time of the night. An American mink was also recorded swimming in the canal water at Louisa Bridge.

Easting	Northing	Species	Details
699692	737174	Soprano pipistrelle	Individual foraging along treeline/ towpath.
699692	737174	Common pipistrelle	Individual foraging along treeline/ towpath.
699692	737174	Daubenton's bat	Individual foraging over canal surface.
700330	737149	Common pipistrelle	Individual foraging along treeline/ towpath.
700330	737149	Daubenton's bat	Individual foraging over canal surface.
700805	737072	Common pipistrelle	Individual foraging at bridge.
700805	737072	Soprano pipistrelle	Individual foraging at bridge.

Section 12 Leixlip Spa & Louisa Bridge to Deey Bridge & Lock 13 (1.6 km)

This section of the canal was surveyed from 23:50 hrs to 00:10 hrs. Reduced bat activity compared to Sections 14 & 15 due to the fact that bats have dispersed into the landscape at this time of the night. An American mink was also recorded swimming in the canal water at Louisa Bridge.

Easting	Northing	Species	Details
698147	736787	Soprano pipistrelle	Individual foraging along treeline/ towpath.
698147	736787	Common pipistrelle	Individual foraging along treeline/ towpath.
698463	736578	Leisler's bat	Individual foraging over treeline/ towpath and canal.
698463	736578	Soprano pipistrelle	Individual foraging along treeline/ towpath.
698463	736578	Common pipistrelle	Individual foraging along treeline/ towpath.
699322	736543	Soprano pipistrelle	Individual foraging along treeline/ towpath.
699322	736543	Daubenton's bat	Individual foraging over canal surface.
699322	736543	Common pipistrelle	Individual foraging along treeline/ towpath.

Section 13 Deey Bridge & Lock 13 to Carton Wharf & Pike Bridge (1.85 km)

This section of the canal was surveyed from 23:20 hrs to 23:50 hrs. Reduce bat activity compared to Sections 14 & 15 due to the fact that bats have dispersed into the landscape at this time of the night.

Easting	Northing	Species	Details
696105	737410	Soprano pipistrelle	2 individuals foraging street lights adjacent to canal.

696163	737370	Soprano pipistrelle	Foraging at entrance of Carton Hs.
696163	737370	Leisler's bat	Foraging in Carton House Estate.
696393	737354	Soprano pipistrelle	Individual foraging along treeline/ towpath.
696393	737354	Common pipistrelle	2 individuals foraging along treeline/ towpath.
696393	737354	Leisler's bat	Commuting from Maynooth along and above treeline heading into Carton House Estate.
696774	737267	Soprano pipistrelle	Individual foraging along treeline/ towpath.
696774	737267	Common pipistrelle	Individual foraging along treeline/ towpath.
697314	737164	Leisler's bat	Individual foraging over treeline/ towpath.
697314	737164	Soprano pipistrelle	Individual foraging along treeline/ towpath.
697406	737137	Common pipistrelle	Individual foraging along treeline/ towpath.
697642	737055	Common pipistrelle	Individual foraging along treeline/ towpath.
697642	737055	Leisler's bat	Individual foraging over treeline/ towpath.
697642	737055	Soprano pipistrelle	Individual foraging along treeline/ towpath.
697885	736976	Common pipistrelle	Individual foraging along treeline/ towpath.
697885	736976	Soprano pipistrelle	Individual foraging along treeline/ towpath.

Section 14 Carton Wharf & Pike Bridge to Mullen Bridges (2.15 km)

This section of the canal was surveyed from 22:30 hrs to 23:20 hrs. A lot of bat activity was recorded reflecting bats commuting to the canal from roosts in the town. Once on the canal, the bats dispersed into the landscape using the canal as a commuting corridor.

Easting	Northing	Species	Details
694144	737476	Soprano pipistrelle	2 individuals foraging along treeline/ towpath.
694234	737500	Soprano pipistrelle	Individual foraging along treeline/ towpath.
694538	737582	Soprano pipistrelle	2 individuals foraging along treeline/ towpath.
694538	737582	Leisler's bat	Commuting from Maynooth along and above treeline heading east.
694890	737576	Soprano pipistrelle	>2 individuals foraging along the canal and commuting east. High level of bat activity.
695152	737534	Common pipistrelle	Individual foraging along the canal and commuting east.
695152	737534	Soprano pipistrelle	Individual foraging along the canal.
695430	737487	Common pipistrelle	Individual commuting east along the canal.
695605	737465	Soprano pipistrelle	Foraging along treelines.
695829	737431	Leisler's bat	Commuting over treelines – heading east.
695829	737431	Daubenton's bat	Foraging over surface of water.
695829	737431	Soprano pipistrelle	>2 individuals foraging along the canal. High level of bat activity.
696073	737394	Soprano pipistrelle	>2 individuals foraging adjacent to bridge.

			High level of bat activity.

Section 15 Mullen Bridges to Maynooth Harbour (0.15 km)

This section of the canal was surveyed from 22:00 hrs to 22:30 hrs. A lot of bat activity was recorded reflecting bats commuting to the canal from roosts in the town. Once on the canal, the bats dispersed into the landscape using the canal as a commuting corridor.

Easting	Northing	Species	Details
693692	737315	Leisler's bat	Commuting from W to E over harbour
693692	737315	Soprano pipistrelle	Commuting from W to E over harbour
693774	737402	Soprano pipistrelle	Commuting onto canal from Maynooth, roost likely to be located adjacent to railway station.
693946	737415	Soprano pipistrelle	>5 individuals foraging along the canal adjacent to the railway bridge. High level of bat activity.
693946	737415	Leisler's bat	2 individuals over the railway bridge.

Survey Date: 20/6/2013 22:15hrs to 21/6/2013 02.30 hrs. Weather was dry, clear sky and calm with air temperature ranging from 20-14^{0}C.

Section 1 Talbot Bridge & Lock 12, Blanchardstown to Granard Bridge, Castleknock Road (0.3 km)

This section of the canal was surveyed from 02:20 hrs to 02:30 hrs. A lot of light in this area but wide stretch of canal and plenty of smooth water.

Easting	Northing	Species	Details
708551	738122	Soprano pipistrelle	Individual foraging over treeline/ towpath.
708551	738122	Common pipistrelle	Individual foraging along treeline/ towpath.
708551	738122	Daubenton's bat	Individual foraging over canal surface.

Section 2 Granard Bridge, Castleknock Road to Kirkpatrick Bridge, Carpenterstown (1.55 km)

This section of the canal was surveyed at two periods during this night-time suvey: from 22:15 hrs to22:50 hrs and 02:00 hrs to 2:20 hrs. A lot of lighting was recorded in the area around the railway station.

Easting	Northing	Species	Details
708241	738051	Soprano pipistrelle	Individual foraging over treeline/ towpath.
708241	738051	Common pipistrelle	Individual foraging along treeline/ towpath.
708241	738051	Daubenton's bat	Individual foraging over canal surface.
707426	737758	Soprano pipistrelle	Individual foraging along treeline/ towpath.

707062	737610	Soprano pipistrelle	Individual foraging along treeline/ towpath.

Section 3 Kirkpatrick Bridge, Carpenterstown to Kennan or Neville Bridge, Porterstown (0.9 km)

This section of the canal was surveyed from 22:50 hrs to 23:10 hrs.

Easting	Northing	Species	Details
706709	737592	Soprano pipistrelle	Individual foraging over treeline/ towpath.
706570	737630	Common pipistrelle	Individual foraging along treeline/ towpath.
706570	737630	Soprano pipistrelle	Individual foraging along treeline/ towpath.

Section 4 Kennan or Neville Bridge, Porterstown to Callaghan or Carhampton Bridge (1.2 km)

This section of the canal was surveyed from 23:10 hrs to 23:40 hrs.

Easting	Northing	Species	Details
706090	737790	Soprano pipistrelle	Individual foraging over treeline/ towpath.
705942	737822	Soprano pipistrelle	Individual foraging along treeline/ towpath.
704844	738138	Soprano pipistrelle	Individual foraging along treeline/ towpath.
704844	738138	Daubenton's bat	Individual foraging over canal surface.

Section 5 Callaghan or Carhampton Bridge to Dublin Meath Railway Bridge (0.85 km)

This section of the canal was surveyed from 23:40 hrs to 00:10 hrs.

Easting	Northing	Species	Details
704383	738295	Soprano pipistrelle	Individual foraging over treeline/ towpath.
704383	738295	Soprano pipistrelle	Individual foraging along treeline/ towpath.

Section 6 Dublin Meath Railway Bridge to Pakenham Bridge (0.4 km)

This section of the canal was surveyed from 00:10 hrs to 00:30 hrs.

Easting	Northing	Species	Details
703799	738244	Leisler's bat	Individual foraging over treeline/ towpath.
703799	738244	Soprano pipistrelle	Individual foraging along treeline/ towpath.

Section 7 Pakenham Bridge to Collins Bridge (1.8 km)

This section of the canal was surveyed from 00:30 hrs to 01:20 hrs.

Easting	Northing	Species	Details

703628	738071	Leisler's bat	Individual foraging over treeline/ towpath.
703628	738071	Soprano pipistrelle	Individual foraging along treeline/ towpath.
703526	737942	Leisler's bat	Individual foraging over treeline/ towpath.
703488	737892	Soprano pipistrelle	Individual foraging along treeline/ towpath.
703260	737560	Leisler's bat	Individual foraging over treeline/ towpath.
703260	737560	Soprano pipistrelle	Individual foraging along treeline/ towpath.
703131	737375	Daubenton's bat	Individual foraging over canal surface.
702875	736992	Daubenton's bat	Individual foraging over canal surface.
702687	736816	Soprano pipistrelle	Individual foraging along treeline/ towpath.

3.3 Passive Monitoring Survey

Survey Site A consisted of a mature treeline line across from Carton House. A Songmeter was located on the stonewall boundary between the canal and the treeline.

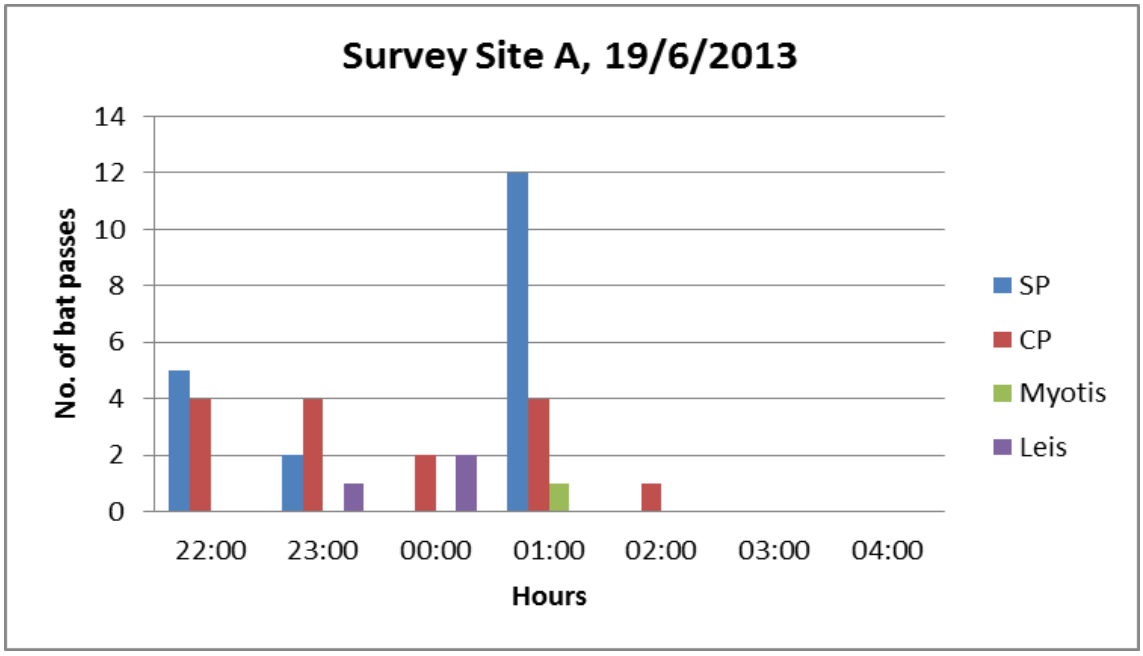


Figure 1: Survey Site A, grid reference 696774 737267.

Survey Site B was at Lock 13. A Songmeter was located on the stonewall boundary between the canal and the treeline/hedgerow.

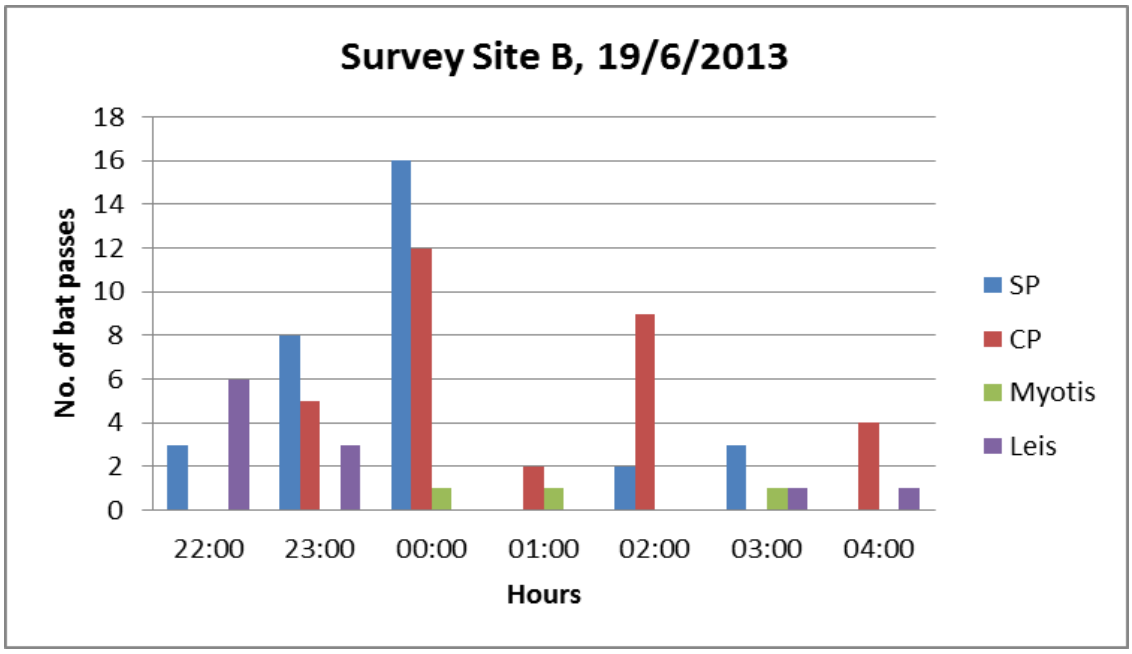


Figure 2: Survey Site B, grid reference 697875 736966.

Survey Site C was at Collins Bridge. An AnaBat SDI unit was located adjacent to the bridge.

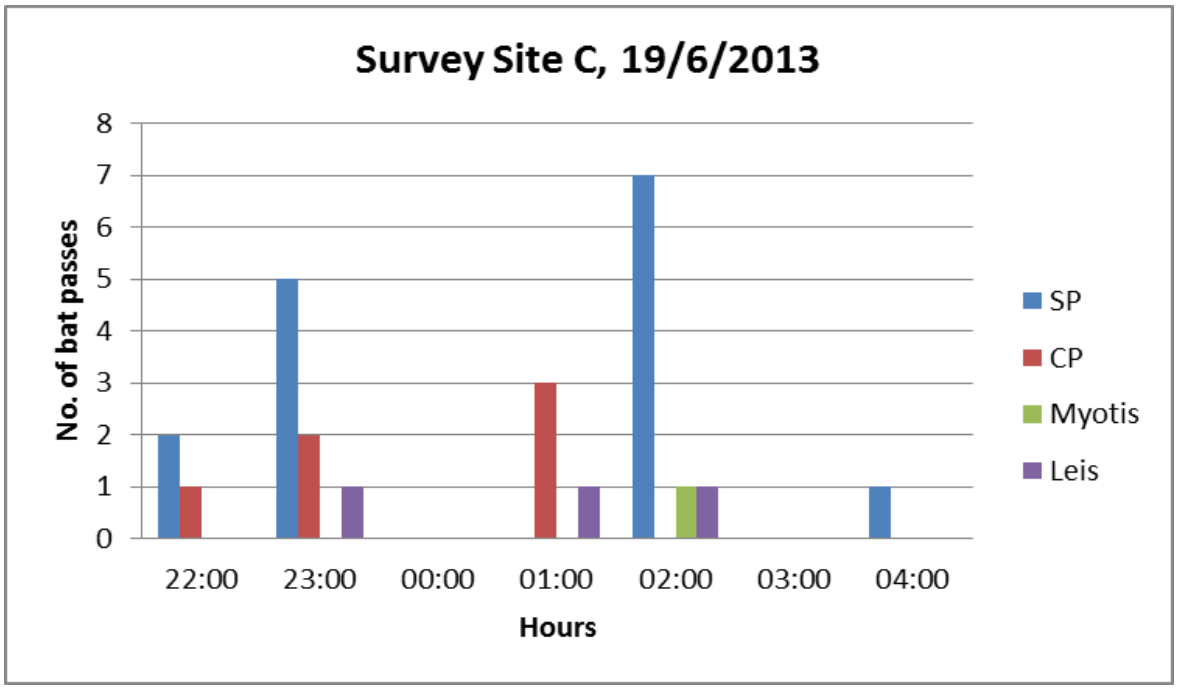


Figure 3: Survey Site C, grid reference 702685 736791.

As expected, soprano pipistrelle is the most frequently encountered species of the three passive recording points. The three locations sampled represent the different types of habitats located along the canal route surveyed. Site A represented tall mature treelines/woodland habitats found on both sides of the canal principally found in vicinity of Maynooth, Carton House and Deep Sinking area. Site B represented the typical area along the canal route where there was a treeline/hedgerow on one side

of the canal and a more open habitat structure on the opposite bank. Here, more species activity was recorded especially in relation to Leisler's bat due to the more open space which this species prefers to forage in. Site C was located at a bridge structure (many of which are located along the length of the route surveyed) and often results in more building structures and less vegetation being present.

3.4 Potential Bat Roosts in Trees

There is a large array of trees located along the 15 km route. There are pockets of mature trees/woodland at sections of the canal particularly towards the Maynooth end of the canal (e.g. adjacent to Carton House Estate). As a consequence there are trees with heavy ivy growth and trees with dead limbs and/or tree holes that would provide roosting sites for bats. It is therefore important that any removal of vegetation to facilitate widening the current towpath should consider that type of trees that may require removal or trimming.



Plate 1: Examples of trees located along the canal route deemed suitable as potential bat roosts (PBRs)

The importance of trees to bats varies with species, season and foraging behaviour. For Leisler's bats, trees are essential for both summer and winter roosts while Daubenton's and Natterer's bats utilise trees more often during the summer months. Other species such as brown long-eared bats and

pipistrelle bats avail of trees in the winter months. In general, individual males throughout the season use tree roosts, more often, while females will use trees for temporary night roosts or night perches for consuming prey. Hollow trees are widely used by bats for both summer and winter roosts (weather dependent) and bats will roost in 'sound' trees in crevices, holes and under split bark. Bats rest, give birth, raise young and hibernate in tree holes, crevices and beneath loose bark. Species of trees utilised by bats include oak, ash, beech and Scots pine. Trees, especially native ones also play host to numerous insect species which are prey items for bat species. Trees also provide shelter for swarming insects which bats will avail of. In addition, trees are important commuting routes for bats. A gap in a hedge/treeline of greater than 10m may force some species of bats to seek an alternative commuting route.

It is recommended that any trees proposed to be felled or subject to tree surgery works should be subjected to a bat survey to ensure that trees are felled with harming potentially roosting bats.

3.5 Bat Conservation Ireland Database Records

A database search was completed for the 1 km radius search at 3 km intervals along the surveyed route. Bat conservation Ireland records are comprised of three types of recordings – Roosts, Transects (e.g. All Ireland Daubenton's Bat Waterways Monitoring transects) and Ad Hoc (i.e. bat detector records). Within these radii, the summary of bat records are as follows (Please see Appendix for full details):

Roosts – Five roosts

Transects – Six 1 km All Ireland Daubenton's Bat Waterways Monitoring transects

Ad Hoc records – 19 records.

All of these records reconfirm that the four species recorded in this survey were also recorded during previous surveys within a 1 km radius of the canal. Additional species recorded include brown long-eared bats, Nathusius' pipistrelle and whiskered bats.

4. Management in view of Bat Fauna recorded

This report will draw on guidelines already available in Europe and will use the following documents:

- *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.*
- *National Biodiversity Plan. Department of Arts, Heritage, Gealtacht and the Islands.*
- *The status of EU protected habitats and species in Ireland: Conservation status in Ireland of habitats and species listed in the European Council Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.*

4.1 Ecological Assessment

The following bat species have been recorded during this bat survey: common pipistrelle, soprano pipistrelle, Daubenton's bat and Leisler's bats.

In summary, the proposed development will need to consider the following:

a. Bats and their bat roosts are protected by Irish legislation (Wildlife Act 1976 and 2000 Amendment) which make it an offence to wilfully interfere with or destroy the breeding or resting place of these species. All species of bats are listed in Schedule 5 of the 1976 Act and therefore are subject to the provisions of Section 23.

b. The EU Habitats Regulations Directive 1992 seeks to protect rare and vulnerable species, including all species of bats. All ten species of bat are protected with the lesser horseshoe bat listed as an Annex II species while all other bats (commonly known as vesper bats) are listed as Annex IV species.

c. Local Planning Authorities are required to give consideration to nature conservation interests under the guidance of the SEA Directive 2001/42/EC. This directive states that the protected status afforded to bats means that planning authorities must

consider their presence in order to reduce the impact of developments through mitigation measures.

d. The National Biodiversity Plan confers general responsibilities on all participants in the development process to take into account of protected species. "*The overall objective is to secure the conservation, and where possible the enhancement, and sustainable use of biological diversity in Ireland and contribute to conservation and sustainable use of biodiversity globally".*

NPWS Conservation Status Assessment report for each of the species recorded is presented in a summary below the species list:

Leisler's bat *Nyctalus leisleri* (Species Code 1331)

Common pipistrelle *Pipistrellus pipistrellus* (Species Code 1309)

Soprano pipistrelle *Pipistrellus pygmaeus* (Species Code 5009)

Daubenton's bats *Myotis daubentonii (*Species Code 1314*)*

All Irish bat species are given a Favourable Status in Republic of Ireland. The Irish Leisler's bat population is of International Importance. The principal pressures on Irish bat species 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
- speleology and vandalism
- communication routes: roads
- forestry management

Commentary on Results

1. A greater level of bat activity was recorded on the first night and as consequence on the section of the canal between Maynooth and Collins Bridge. Bat activity was particularly high around Maynooth and is considered by the author a consequence of potentially numerous bat

roost sites located within the town. The canal was used by the bats as a commuting route to allow bats to disperse into the landscape. Primary feeding areas are likely to be Carton Estate (including the Rye Water) and while only located a couple of kilometres outside Maynooth town, the canal allowed bats to safely commute to it. While a degree of foraging activity was recorded on the canal, bats were more often than not flying without a high level of feeding. There are two All Ireland Daubenton's Bat Waterway Monitoring transects within Carton Estate on the Rye Water and a much higher bat activity, particularly for Daubenton's bat, has been recorded in this area compared to transects located along the Royal Canal.

2. There are some stretches along the canal where distance from boundary to boundary of the canal is relatively wide (e.g. Pakenham Bridge to Collins Bridge) and at this point much higher levels of Leisler's bat activity was recorded. This is primarily due to the openness of the canal at this point. The lack of street lighting at this point also meant the Daubenton's bats were recorded on the canal surface.

3. The stretch of canal along the Deep Sinking is surrounded by dense tall vegetation. Little bat activity was recorded along this section and this is surprising considering the amount of suitable foraging area and the lack of lighting. However, as the canal seems to be primarily a commuting route for local bat populations, it is likely that the low-lying branches of trees into the narrow space of the canal may impede bats flying along the canal at this point or that there are few roosts located in the area to avail of foraging along this section of the canal.

4. The section of the canal approaching the eastern end of the survey area had less bat activity compared to the Maynooth end of the canal. Phoenix Park is located south of the canal between Castleknock and Ashtown sections of the canal. It is possible, the bats roosting in these areas prefer to traverse to this large park which provides ample foraging for bats of all species and therefore only a reduce bat activity is likely to be recorded in other suitable areas.

4.2 Predicted Impacts

All bat species recorded during this bat survey are Annex IV species under the EU Habitats Directive and all have a Favourable Status in Ireland. The likely impact of widening the canal towpaths to facilitate walking and cycling routes will reduce the degree of vegetation along the boundary of the canal route. This will lead to a more open habitat and a reduction in vegetation and potentially less insect association. However, the primary concern would be more in relation to potential light spillage in urban areas along the route. In addition, there is a tendency to light up new pathways and this would have a much greater impact on foraging species such as Daubenton's bats.

4.3 Mitigation Measures

Mitigation is best achieved through avoidance. It is proposed that the following measures be put in place to avoid or lessen the degree of impacts.

Mitigation by avoidance

1. Limit the amount of lighting to be in place along the canal route, along treelines/hedgerows and adjacent to potential roosts in structures and mature trees.
2. Treelines/hedgerows should remain in-situ and remain protected from proposed development and any infrastructure to support the development. Mature trees with dead wood and crevices should be retained.

The measures described below are also additional general recommendations to inform the managers of other elements that are likely impact on bat populations.

1 Removal of linear habitats

a) Removal of treeline/hedgerow/woodland should be to a minimum amount. Any landscaping works proposed for the development site should be native shrubs and tree species only and reflect the species present in the adjacent landscape.

2 Mature trees

a) Trees, which are to be removed, will be felled during the autumn months of September, October or November (felling during the spring or autumn months avoids the periods when the bats are most active).

b) Any trees showing crevices, hollows etc., should not be removed at all.

c) Any ivy covered trees which require felling will be left to lie for 24 hours after cutting to allow any bats beneath the cover to escape. This measure applies to the majority of trees identified on-site.

d) A full tree survey is recommended for any trees proposed to be felled.

3 Future planting

Native tree and shrub species are recommended to be planted along the perimeter of the canal, if the need arises – tree species found in the local area e.g. hawthorn, ash, oak and blackthorn.

4 Lighting

Lighting should not be installed as part of the proposed works as it deters some bat species from foraging. Studies have shown that illumination levels as low as 0.06 lux can have an effect on the behaviour of bats. Even a full moon night (0.02 lux) can reduce bat activity to more sheltered, darker wildlife corridors and foraging areas (e.g. woodlands). The slower flying broad-winged species (Natterer's bats, Daubenton's bats, whiskered bats, Brandt's bats, lesser horseshoe bats and brown long-eared bats) have been shown to avoid street lights. In a study of a roost in Suffolk, UK, the numbers of Natterer's bats, whiskered bats, Daubenton's bats and brown long-eared bats fell after the installation of street lights adjacent to the roost being monitored.

A study on the above controls was undertaken by Emery (2008) and concluded that shielding and masking of street lights can reduce light spillage by as much as 40%. While internal and external louvers are more effective, the external louvers can reduce light spillage by as much as 97%.

- It is important to maintain Dark Zones for foraging bats in areas where lighting is not necessary. However, where lighting is required, this lighting should be placed at a minimum height using the lowest lux value permitted for health and safety.

- The lighting should be directional on to the buildings only with no spillage of light to adjoining habitats. To reduce light spillage from luminaries, lights that are designed not to emit light at angles greater than 70^{o} from the vertical plane should be used. Consequently a flat glass protector is often used to reduce light spillage. Other methods to control light spillage:

a. Shields: these can be mounted on lamps to control direction of the light

b. Masking: part of the luminaries is painted to block light to control the direction of the light

c. Louvers': either as internal or external slates organized in rows or at angles depending on the direction of light control.

- No white light should be permitted as this has the greatest impact on bats. Low pressure sodium lights have a minimum impact on bats. Lighting that has little or no UV content have the least impact on bats.

5 Stone crevices

Crevices in stonework are often used as temporary roosts. Ensure that crevices on the interior and exterior walls of buildings are checked prior to filling. Crevices should only be hand-filled and where possible, retain some crevices on the exterior walls to allow usage for individual bats. Where re-pointing of stonework is required, care should be taken not to entomb bats within the crevices. It is important to listen for bats and observe for any signs of dropping or urine stains to ensure that no bats are present. Suitable crevices are 10cm wide, 2cm tall and 10cm deep. Please consult a bat specialist for any clarification of this measure.

If a bat is encountered during the process please remove gently with a pair of gloves and return to a safe crevice in another wall or remove to a bat box. A woodcrete bat box should be erected on a mature tree adjacent to the structure on a mature tree, if possible. Or consult the bat specialist or local NPWS Conservation Ranger.

6 Bat Box Scheme

Bats are very transient mammals and move around buildings changing roosting sites regularly, especially male bats and especially during the spring and autumn months. Therefore constant vigilance is required when under taking proposed works. In the event of a bat being located during works (outside the maternity season), a bat box should be erected on a mature tree. This bat box should be used to re-locate bats if found during works. In such events, please contact bat specialist or NPWS Conservation Ranger for advise on the such situations.

Details of sourcing these boxes and erection can be supplied. 'Schwegler' woodcrete bat boxes are recommended but other designs are available – timber, concrete and concrete/sawdust).

A bat box scheme could also be considered as a management tool, especially to encourage bats roosting along the canal length. Bat boxes can be hung on poles or erected on mature trees. Bat tubes are also suitable to erect on vertical walls of structures located along the canal.

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Appendices

Bat ecology – general

The bat is the only mammal that is capable of true flight. There are over 1,100 species worldwide, representing almost a quarter of all mammal species. There are 47 species in Europe - in Ireland, ten species of bat are currently known to exist, which are classified into two families, the Rhinolophidae (Horseshoe bats) and the Vespertilionidae (Common bats).

Prey

All the European bat species feed exclusively on insects. A Pipistrelle, weighing only 4 to 8 grammes, will eat up to 3000 insects every night, ensuring a build up of fat in the bat's body to allow it to survive the winter deep in hibernation.

Breeding and longevity

Irish bats can produce one young per year but, more usually, only one young is born every two years (Boyd & Stebbings, 1989). This slow rate of reproduction inhibits repopulation in areas of rapid decline. Although bats have been known to live for twenty or more years, this is rare as most die in their first and the average lifespan, in the wild, is four years.

Threats

All bat species are in decline as they face many threats to their highly developed and specialised lifestyles. Many bats succumb to poisons used as woodworm treatments within their roosting sites (Racey & Swift, 1986). Agricultural intensification, with the loss of hedgerows, treelines, woodlands and species-rich grasslands have impacted bat species also. Habitual roosting or hibernation sites in caves, mines, trees and disused buildings are also often lost to development. Summer roosts are prone to disturbance from vandals. Agricultural pesticides accumulate in their prey, reaching lethal doses (Jefferies, 1972). Chemical treatments in cattle production sterilise dung thus ensuring that no insects can breed within it to be fed upon by bats. Likewise, river pollution, from agricultural runoff, reduces the abundance of aquatic insects. Road building, with the resultant loss of foraging and roosting sites is a significant cause in the reduction of bat populations across Europe.

Extinction

As recently as 1992, the greater mouse-eared bat *Myotis myotis* became the first mammal to become extinct in Britain since the wolf in the 18th century.

Ireland Red List No. 3: Terrestrial Mammals

Bats

Species: Common Name	Irish Status	European Status	Global Status
Brandt's bat	Data deficient	Least Concern	Least Concern
Daubenton's bat	Least Concern	Least Concern	Least Concern
Whiskered bat	Least Concern	Least Concern	Least Concern
Natterer's bat	Least Concern	Least Concern	Least Concern
Leisler's bat	Near threatened	Least Concern	Least Concern
Nathusius' pipistrelle	Least Concern	Least Concern	Least Concern
Common pipistrelle	Least Concern	Least Concern	Least Concern
Soprano pipistrelle	Least Concern	Least Concern	Least Concern
Brown long-eared bat	Least Concern	Least Concern	Least Concern
Lesser horseshoe bat	Least Concern	Least Concern	Least Concern

Marnell, F., Kingston, N. & Looney, D. (2009) *Ireland Red List No. 3: Terrestrial Mammals*, National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland.

Bat Conservation Ireland Database Search
Database Searches
Search 1: O090382 (M50)

ROOSTS (1)

Name	Grid reference	Address	Species
Blanchardstown Hospital	O0839	Dublin 15	*Pipistrellus pygmaeus*, *Pipistrellus* spp. (45kHz/55kHz)

TRANSECTS (4)

Name	Grid reference start	Species
Abbotstown Bridge Transect	O0930038300	*Myotis daubentonii*, Unidentified bat
Castleknock Transect, Spot 10	O0826538006	*Myotis* spp., *Pipistrellus pipistrellus* (45kHz), *Pipistrellus* pygmaeus, *Pipistrellus* spp. (45kHz/55kHz)
Castleknock Transect, Spot 8	O0803437956	*Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Pipistrellus* spp. (45kHz/55kHz), Unidentified bat
Castleknock Transect, Spot 9	O0815437985	*Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Pipistrellus* spp. (45kHz/55kHz)

AD-HOC OBSERVATIONS (4)

Survey	Grid reference	Date	Species
EIS Surveys	O0900038000	2005-06-22	*Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
EIS Surveys	O083389	2008-08-11	*Myotis daubentonii*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
EIS Surveys	O095380	2007-10-09	*Pipistrellus pipistrellus* (45kHz)
EIS Surveys	O087384	2007-10-09	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Plecotus auritus*

Search 2: O070375 (Carpenstown)

TRANSECTS (7)

Name	Grid reference start	Species
Castleknock	O0731237646	*Myotis daubentonii*, Unidentified bat

Transect		
Castleknock Transect, Spot 2	O0742037740	
Castleknock Transect, Spot 3	O0752137740	*Myotis* spp., *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Pipistrellus* spp. (45kHz/55kHz), Unidentified bat
Castleknock Transect, Spot 4	O0762137780	*Myotis* spp., *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
Castleknock Transect, Spot 5	O0772337822	*Myotis* spp., *Nyctalus leisleri*, *Pipistrellus nathusii*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, Pipistrellus spp. (45kHz/55kHz)
Castleknock Transect, Spot 6	O0782637869	*Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Pipistrellus* spp. (45kHz/55kHz)
Castleknock Transect, Spot 7	O0792937914	*Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Pipistrellus* spp. (45kHz/55kHz)

AD-HOC OBSERVATIONS (3)

Survey	Grid reference	Date	Species
BATLAS 2010	O0637	2008-08-15	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
BATLAS 2010	O062366	2008-09-25	*Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
EIS Surveys	O0836	2008-06-11	*Myotis* spp., *Nyctalus leisleri*, *Pipistrellus* spp. (45kHz/55kHz)

Search 3: O050382 (Clonsilla)

ROOSTS (1)

Name	Grid reference	Address	Species
Private	O0445538942	Clonsilla	*Pipistrellus pipistrellus* (45kHz)

AD-HOC OBSERVATIONS (5)

Survey	Grid reference	Date	Species
BATLAS 2010	O0438	2008-08-15	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
BATLAS 2010	O0637	2008-08-15	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
BATLAS 2010	O0537	2008-08-15	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
EIS Surveys	O0450038150	2005-09-03	*Myotis daubentonii*, *Myotis mystacinus*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz),

			Pipistrellus pygmaeus, *Plecotus auritus*
EIS Surveys	O0400038000	2007-05-02	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pygmaeus*

Search 4: O030374 (Collins Bridge)

ROOSTS (1)

Name	Grid reference	Address	Species
Private	O0436	Lucan, County Dublin	Pipistrellus spp. (45kHz/55kHz), Plecotus auritus

TRANSECTS (1)

Name	Grid reference start	Species
Collins Bridge Transect	O0280036750	*Myotis daubentonii*, Unidentified bat

AD-HOC OBSERVATIONS (3)

Survey	Grid reference	Date	Species
BATLAS 2010	O0438	2008-08-15	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
EIS Surveys	O0300038000	2007-05-02	*Myotis* spp., *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*
EIS Surveys	O0400038000	2007-05-02	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pygmaeus*

Search 5: O010370 (Cope Bridge)

ROOSTS (2)

Name	Grid reference	Address	Species
Private	O0036	Leixlip, County Kildare	*Nyctalus leisleri*
Private	O016360	Leixlip, County Kildare	*Pipistrellus* pipistrellus (45kHz)

AD-HOC OBSERVATIONS (3)

Survey	Grid reference	Date	Species

BATLAS 2010	O016368	2008-09-30	*Pipistrellus pygmaeus*
BATLAS 2010	O010361	2008-09-30	*Myotis daubentonii*, *Nyctalus leisleri*, *Pipistrellus pygmaeus*
EIS Surveys	O010360	2002-07-08	*Nyctalus leisleri*, *Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*, *Plecotus auritus*

Search 6: N990364 (Lousia Bridge, adjacent)

ROOSTS (1)

Name	Grid reference	Address	Species
Private	O0036	Leixlip, County Kildare	*Nyctalus leisleri*

AD-HOC OBSERVATIONS (1)

Survey	Grid reference	Date	Species
Dublin Bat Group surveys	N982367	2001-02-04	*Pipistrellus pipistrellus* (45kHz), *Pipistrellus pygmaeus*

Search 7: N970373 (Blakestown)

TRANSECTS (2)

Name	Grid reference start	Species
Deey Bridge Transect	N979374	*Myotis daubentonii*, Unidentified bat
Pike Bridge Transect	N9612637359	*Myotis daubentonii*, Unidentified bat

Search 8: N950375 (Maynooth)

TRANSECTS (1)

Name	Grid reference start	Species
Smullen Bridge Transect	N9410037400	*Myotis daubentonii*, Unidentified bat

KPMG

Royal Canal Urban Greenway

Environmental Impact Assessment Report

Appendix 8.5 Additional Non-JBA surveys

October 2026



Fingal County Council
Comhairle Contae Fhine Gall

ROYAL CANAL URBAN GREENWAY

BIODIVERSITY ASSESSMENT 2018

Report to Fingal County Council

October 2018

Version 4



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Contents

1 INTRODUCTION 1-4
1.1 OVERVIEW OF THE PROJECT 1-4
1.2 CONSULTATIONS 1-4
2 ASSESSMENT METHODOLOGY 2-5
2.1 DESK REVIEW 2-5
2.2 FIELD SURVEYS PRIOR TO 2018 2-5
2.3 FIELD SURVEYS DURING 2018 2-5
2.3.1 Woodland survey 2-5
2.3.2 Grassland survey 2-6
2.3.3 Breeding waterbird survey 2-6
2.3.4 Bat survey of bridges 2-6
2.3.5 Assessment of lighting on bats on the Ashtown to M50 section 2-6
2.3.6 Mollusc survey 2-7
3 EXISTING ENVIRONMENT 3-8
3.1 BEC SURVEYS 2013 3-8
3.1.1 Habitats 3-8
3.1.2 Plant species 3-8
3.1.3 Rare/protected plant species 3-9
3.1.4 Invasive plant species 3-10
3.1.5 Bryophytes (mosses and liverworts) 3-10
3.1.6 Mammals (excluding bats) 3-10
3.1.7 Bats 3-11
3.1.8 Birds 3-11
3.1.9 Ant hills 3-11
3.1.10 Fish 3-11
3.1.11 Aquatic macroinvertebrates 3-12
3.1.12 Environmentally sensitive areas 3-12
3.2 GRASSLAND SURVEY 2018 3-12
3.2.1 Survey results 3-12
3.2.2 Recommendations for grasslands 3-13
3.3 WOODLAND SURVEY 2018 3-13
3.3.1 Survey results 3-13
3.3.2 Discussion 3-14
3.4 BREEDING WATERBIRD SURVEY 2018 3-15
3.4.1 Survey Results 3-15
3.4.2 Discussion 3-16
3.5 BAT SURVEYS OF SECTIONS 1 TO 3 IN 2018 3-16
3.5.1 Survey Results 3-17

DRAFT

3.6 BAT SURVEY OF ASHTOWN TO M50 SECTION 2018 3-18
3.6.1 Survey Results 3-18
3.6.2 Review of the effects of lighting on bats 3-20
3.6.3 Recommendations for bats 3-21
3.7 MOLLUSC SURVEY 2018 3-22
3.7.1 Introduction 3-22
3.7.2 Survey Results 3-24
3.7.3 Discussion 3-24
3.8 OTHER SENSITIVE HABITATS 3-25
3.8.1 Calcareous spring 3-25
3.8.2 Ant hills 3-25
4 EVALUATION 4-27
REFERENCES 4-28
APPENDIX 1: NATURAL HERITAGE AREA SITE SYNOPSIS 4-30
APPENDIX 2: LITERATURE REVIEW OF EFFECTS OF LIGHTING ON BATS 4-31

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1 INTRODUCTION

This report assesses the biodiversity value (habitats and species) of the route for the proposed Royal Canal Urban Greenway. The methodologies for the surveys are presented. The existing ecological environment of the proposed development is described. The Royal Canal is a proposed Natural Heritage Area (pNHA) under the Wildlife Acts 1976 to 2012. Its importance lies in the diversity of the habitats along the canal corridor rather than the presence of rare habitats or species. The National Parks and Wildlife Service (NPWS) site synopsis for the site is presented in Appendix I.

1.1 Overview of the Project

The proposed Royal Canal Urban Greenway runs alongside the Royal Canal from the 12th Lock (Blanchardstown) to the Kildare County boundary (Figure 1). It is entirely within the jurisdiction of Fingal County Council. The proposed development will be largely confined to the existing towpath but at certain points will diverge from the canal corridor where there are significant constraints. The route is crossed by six old canal bridges, a railway bridge and a high-level concrete road bridge.

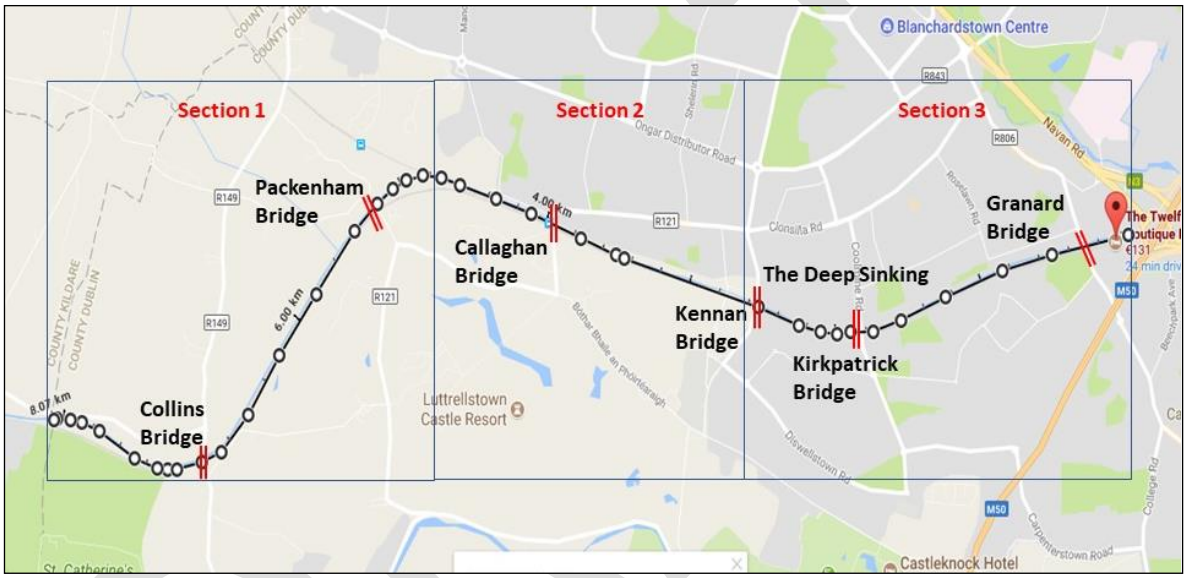


Figure 1. Location of the proposed Royal Canal Urban Greenway

1.2 Consultations

Consultations were undertaken throughout the project with Fingal County Council Biodiversity Officer. At his request additional surveys of molluscs (in particular of the snail group *Vertigo)* and of the impacts of lighting on existing sections of the footpath to the east of the M50 motorway.

Written consultations were also undertaken with the Department of Culture, Heritage and the Gaeltacht. A scoping response dated 20th June 2018 was received from the Department. This outlined the value of the Royal Canal pNHA corridor for biodiversity. It also recommended a series of items that should be included in an ecological survey and impact assessment. Some further issues including alien invasive species, hedgerows and protected species, rivers and wetlands and water quality were highlighted. These issues have been addressed in the biodiversity assessment which follows.

2 ASSESSMENT METHODOLOGY

2.1 Desk review

A desk review was undertaken of all relevant documentation for this section of the Royal Canal. This included reports of surveys undertaken prior to 2018, the database of the National Biodiversity Data Centre and the synopsis for the Royal Canal proposed Natural Heritage Area (NHA). Of particular importance was the baseline survey carried out by BEC Consultants (Brophy & Devaney 2013). All route options were considered and assessed in terms of their potential impacts on biodiversity.

2.2 Field surveys prior to 2018

A detailed survey of the Royal Canal was carried out in 1989/90 (Dromey *et al*., 1991), to identify and map habitats and species along the full length of the canal (Dublin to Longford), highlighting areas and species of ecological value. This included some sections that were navigable and others that were derelict and it coincided with the main period of restoration by the Office of Public Works which began in 1988. The full length of the canal, from the River Liffey to the River Shannon, was reopened in 2010.

In 2013 BEC Consultants Ltd was contracted by the National Transport Authority (NTA) to undertake a comprehensive ecological survey of the Royal Canal between Talbot Bridge (12th Lock), Blanchardstown, Co. Dublin and Maynooth Train Station, Maynooth, Co. Kildare (Brophy & Devaney 2013). It thus covered the entire length of the proposed Royal Canal Urban Greenway in Fingal County as well as sections further west in Co Kildare. The aim of this survey was to collect data on the flora, fauna and habitats that exist within these sections of the Royal Canal in order to help inform any future plans for development along the canal. The field surveys mapped and classified the habitats, recorded plants (including bryophytes), bird and mammal species, while highlighting habitats and species of particular importance (e.g. rare or protected habitats and species) within the study area. The surveys included both the waterbody itself and the terrestrial habitats marginal to the canal. A summary of the results of the 2013 surveys are given in section 2.4.1 below.

2.3 Field surveys during 2018

In order to supplement the 2013 surveys by BEC Consultants some more detailed surveys were conducted in 2018 by Natura Environmental Consultants and specialist contractors. These included:

- Habitat surveys of the woodland in the Deep Sinking.
- Habitat surveys of grassland in the western sections of the study area.
- Breeding waterbird surveys along the full length of the study area.
- Bat surveys of the bridges in the study area including bat activity.
- Bat activity surveys of the section between Ashtown station and the M50 for comparison with an earlier bat survey to examine the effects of lighting.
- Survey of terrestrial molluscs on the full length of the study area.

The methodologies for these surveys are described below:

2.3.1 Woodland survey

A survey of semi-natural woodland in the area known as the Deep Sinking (between Kennan Bridge and Granard Bridge in Section 3) was conducted during the spring 2018. This was carried out by ecologists Richard Nairn and Tim Nairn on various dates in March-April 2018 before all trees were in leaf and when the undergrowth was low, allowing better access. The woodland types were described using the classification of Fossitt (2000). Dominant tree species were recorded by species and relative age. This ecological survey was supplemented by a full tree survey that recorded the species, age, condition of mature trees and groups of trees along the entire route (Blackstock 2018).

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2.3.2 Grassland survey

The grassland on the towpath between Pakenham Bridge and Collins Bridge was surveyed by botanist Katharine Duff and Richard Nairn on 22 June 2018. This included a habitat survey (using the classification of Fossitt 2000), a general species list and a relevé on the canal bank. The criteria and indicators for classification of grasslands listed in Annex I of the EU Habitats Directive are given in the report of the National Grassland Survey (O'Neill *et al.* 2013). This survey was undertaken in fine warm conditions when the majority of species were in flower.

2.3.3 Breeding waterbird survey

Waterbirds in freshwater are generally regarded as those species dependent on permanent surface water and include, among others, the swans, ducks, waders, gulls and a few passerines that are linked to waterways. The methodology for the breeding waterbird survey followed broadly the British Trust for Ornithology (BTO) Waterways Breeding Bird Survey. Bird registrations were made using direct sightings. Standard nomenclature was that given by Svenssen *et al.* (2009). A field ornithologist carried out two breeding water bird surveys in May 2018. Bird registrations were entered on aerial photograph overlays, using standard BTO species codes. All field records were transferred to summary maps and retained for future reference. Weather conditions were excellent for all surveys with light winds and no significant rain. Each survey was carried out within one day in the period between 09:00 to 14:00 BST. The dates of the surveys were Visit 1: 01 May 2018; Visit 2: 22 May 2018. A preliminary survey was undertaken on 06 March 2018.

All waterbird species present were recorded and breeding species were determined by observation of their behaviour against a table of standardised indicators. These are the same indicators used in the *Bird Atlas 2007-2011* (Balmer *et al.* 2014). Passerine birds in the study area were not recorded. For example, Swallows frequently flew along the canal foraging but did not breed or rest there.

2.3.4 Bat survey of bridges

A bat survey of bridges along the canal was undertaken in 2018 by Tina Aughney. Night-time bat surveying was completed using bat detectors on various dates: Surveyor 1: Wildlife Acoustics EchoMeter Touch 2 Pro (with an android mobile phone) and Pettersson D200 Heterodyne Bat Detector. Surveyor 2: Wildlife Acoustics EchoMeter Touch (with an iPad 2) and Pettersson D200 Heterodyne Bat Detector.

Bridges were inspected during the daytime (13th July 2018) using a high-powered torch to determine the extent of crevices available for roosting. The bridges were then surveyed for 90 minutes from sunset to determine if bats emerged from the crevices under the arches of the bridges. In relation to bats, a daytime survey was undertaken to identify any Potential Bat Roosts (PBRs) in the structures with the arches examined. Using a 4-point classification system for bridges, the arches were inspected using this system. The survey methodology follows that of Billington and Norman (1997), the bridge is categorised as follows:
0 = no potential (no suitable crevices)
1 = crevices present may be of use to bats
2 = crevices ideal for bats but no evidence of usage
3 = evidence of bats (e.g. bat present, droppings etc.)

Evidence of bats is in the form of actual bats (visible or audible), bat droppings, urine staining, grease marks (oily secretions from glands present on stonework) and claw marks. In addition, the presence of bat fly pupae (bat parasite) also indicated that bat usage of a crevice has occurred in the past. To complete this grading inspection, the bridge structure was inspected using a high-powered narrow beamed torch to inspect crevices, holes, cracks and joints within the structures. Where necessary, this inspection was assisted using a fiberscope to check deep crevices not visible using a torch.

2.3.5 Assessment of lighting on bats on the Ashtown to M50 section

The bat activity levels along approximately 2km length of the Royal Canal between Ashtown and M50 were investigated by Tina Aughney on 5th-6th July 2018. This survey was undertaken on a section of the canal adjacent to the current study area in order to determine if the lighting installed here has had any impacts on bat activity. This study involved a literature review; a walking transect (2km); and 20 survey points.

Night-time bat surveying was completed using bat detectors: Walking Transects - Wildlife Acoustics EchoMeter Touch 2 Pro (with an android mobile phone) and Pettersson D200 Heterodyne Bat Detector. The walking transect involved a continuous walking survey along the entire length of the survey area starting at sunset. This was undertaken at a slow to medium walking pace from Ashtown Railway Station to the M50. This started at sunset and any bat species encountered was noted. The purpose of this survey was to record commuting bats, particularly the early emerging bats such as Leisler's bats. This transect took 1 hour to complete.

Survey Spots were recorded using Wildlife Acoustics EchoMeter Touch (with an iPad 2) and Pettersson D200 Heterodyne Bat Detector. Twenty survey spots were marked along a 2km transect (mapping was completed during the daytime). The interval between each survey spot was approximately 100m. Each survey spot was surveyed for 4 minutes (following the methodology of the All Ireland Daubenton's Bat Waterways Survey (Aughney *et al.,* 2012). This survey was completed from the M50 to Ashtown Railway Station and was undertaken directly after the walking transect was completed. Any bat species heard on the bat detectors during the 4-minute slot was noted. The purpose of this survey was to record foraging bats. The start time, approximately 1hr after sunset, coincided with the period when all Irish bat species would have emerged for foraging.

The LUX level was measures by placing the LUX meter (ETI – 8051 model, www.etiltd.com) on the ground at the location of the survey spot (approximately 1m from the standing position of the surveyor and ensuring that the surveyor did not cast a shadow over the LUX meter). LUX levels were also randomly recorded directly below the lamp posts and 1m and 5m intervals in front of the lamp posts located along the canal.

2.3.6 Mollusc survey

A survey of the non-marine molluscs on this section of the Royal Canal was undertaken on 4th and 5th July 2018 by Evelyn Moorkens and Anton Krastev. This was specifically designed to determine if any of the whorl snail *(Vertigo)* species were present as they are protected under the EU Habitats Directive (Annex 1).

Each section of the canal was visited, with particular reference to the locations mapped by Brophy & Devaney (2013). Where potential *Vertigo* habitat was found, a total of ten samples were taken by banging overhanging vegetation onto a white field survey tray and examining all molluscs through appropriate optical lenses. Species were identified in the field and an amalgamated sample from each distinguishable habitat area was removed for further processing for smaller species. The samples taken were dried, sieved through two mesh sizes, 3mm and 0.5mm. The contents of each sieve were examined for snails. An Olympus 40X binocular microscope was used to examine the smaller species.

3 EXISTING ENVIRONMENT

3.1 BEC Surveys 2013

The following is a brief summary of the findings of the various comprehensive surveys carried out BEC Consultants in 2013 (Brophy & Devaney 2013). Given the fact that very little change in management of the canal and towpath has occurred since 2013 it is considered that these findings are still valid. Thus, the additional surveys undertaken in 2018 were designed to supplement this information and to give more precision to the results. It should be noted that sections 1 to 8 of the 15 sections included in the BEC study are included in the route proposed by Fingal County Council.

3.1.1 Habitats

The 2013 BEC survey recorded 26 habitat types (as classified by Fossitt 2000) in the full study area (Table 1). Sections in Fingal (Dublin) had an average of 11 habitats recorded within them. The section between Granard Bridge and Kirkpatrick Bridge was the most diverse with 15 habitats while the Talbot Bridge & 12th Lock to Granard Bridge section had the least (6 habitats). These habitats were accurately mapped in 2013 and the present survey has confirmed that these boundaries remain unchanged in 2018.

Table 1. List of habitats recorded within the Royal Canal study area in 2013 (Brophy & Devaney 2013).

Habitat code[1]	Habitat type	Number of sections in which habitat recorded[2]
BC1	Arable crops	1
BC4	Flower beds and borders	1
BL1	Stone walls and other stonework	11
BL2	Earth banks	1
BL3	Buildings and artificial surfaces	15
ED2	Spoil and bare ground	10
ED3	Recolonising bare ground	3
ER2	Exposed calcareous rock	3
FP1	Calcareous springs	1
FS1	Reed and large sedge swamps	11
FS2	Tall-herb swamps	1
FW3	Canals	15
FW4	Drainage ditches	4
GA2	Amenity grassland (improved)	13
GM1	Marsh	1
GS1	Dry calcareous and neutral grassland	3
GS2	Dry meadows and grassy verges	14
GS4	Wet grassland	6
WD1	(Mixed) broadleaved woodland	3
WD5	Scattered trees and parkland	1
WL1	Hedgerows	12
WL2	Treelines	14
WN2	Oak-ash-hazel woodland	10
WN6	Wet willow-alder-ash woodland	3
WS1	Scrub	12
WS3	Ornamental/non-native shrub	2

1. Codes are those given by Fossitt (2000)
2. Note: The Royal Canal Urban Greenway includes only 1-8 of the 15 sections included in this survey

3.1.2 Plant species

A total of 372 plant species (including bryophytes, aquatic and invasive species) were recorded in the course of the 2013 survey. Forbs were the most abundant plant group (170 species), followed by woody species (trees, shrubs, woody climbers) (79 species), bryophytes (59 species), grasses (30 species), sedges (13 species), ferns (9 species), rushes (5 species), algae (4 species) and the fern-allies, horsetails

(3 species). Due to access difficulties (primarily the presence of the railway track) only one side of the canal for each section could be surveyed in detail, however the other side of the canal was viewed from the opposite bank, by binoculars when necessary, to ensure no obvious plant species were missed. While every effort was made to identify horticultural shrubs and garden escapes, the main focus of the plant survey was on species naturally found in the wild.

Grapnel sampling of the submerged aquatic vegetation of the Royal Canal was carried out in all sections within the study area in 2013. Due to a lack of aquatic vegetation, most likely caused by heavy shading, and difficulty of access, limited sampling was carried out in the Deep Sinking. A total of 49 grapnel samples were taken across the 15 sections, with 14 species recorded (including stoneworts and algae). The invasive species Canadian Waterweed *(Elodea canadensis)* was the most frequently recorded species in the grapnel samples (55%) followed by Yellow Water-lily *(Nuphar lutea)* (51%). Other species recorded in the course of the sampling were Ivy-leaved Duckweed *(Lemna trisulca),* Mare's Tail *(Hippuris vulgaris),* the invasive species Nuttall's Waterweed *(Elodea nuttallii)* and Unbranched Bur-reed *(Sparganium emersum).* The aquatic vegetation of the Royal Canal is largely similar within the study area, with the exception of the Deep Sinking, where heavy shading from the trees combined with the steep rock banks, restrict the distribution of aquatic vegetation, both submerged and emergent.



Figure 2. Pyramidal orchid in species-rich grassland in Section 1

3.1.3 Rare/protected plant species

No legally protected plants were recorded in the course of the 2013 survey. The Marsh Pea *(Lathyrus palustris)* and Cowslip *(Primula veris)* are scarce but neither species is protected under Irish law. Prickly Lettuce *(Lactuca serriola),* is rare in Ireland, but as it is a recent introduction, it is not protected. The Greater Spearwort *(Ranunculus lingua),* which was commonly recorded in the emergent vegetation along the canal edge, and Salad Burnet *(Poterium sanguisorba (=Sanguisorba minor)),* which was recorded in areas of calcareous grassland along the canal bank, are notable species due to their rather restricted distribution in Ireland. The native Hoary Ragwort *(Senecio erucifolius),* although widespread throughout Co. Dublin, is nationally rare and is therefore also notable.

Opposite-leaved Pondweed *(Groenlandia densa),* which is listed on the Flora Protection Order 1999 (S.I. 94/1999), has been recorded on the Royal Canal within Dublin City, but none was recorded within the study area in 2013. Tassel Stonewort *(Tolypella intricata),* listed in the Red Data Book as being Vulnerable in Ireland, has been recorded in the Royal Canal in Dublin; the only site in Ireland where it is now found. Again, this was not found within the study area during the 2013 survey.

3.1.4 Invasive plant species

Alien invasive plant species are a major and increasing threat to biodiversity in Ireland. A number of species that are considered invasive, both terrestrial and aquatic, were recorded within the study area in 2013. These included Japanese Knotweed *(Fallopia japonica),* cotoneasters *(Cotoneaster* spp.), Snowberry *(Symphoricarpos albus),* Winter Heliotrope *(Petasites fragrans),* Cherry Laurel *(Prunus laurocerasus),* Buddleja *(Buddleja davidii),* Wilson's Honeysuckle *(Lonicera nitida),* Sycamore *(Acer pseudoplatanus),* Canadian Waterweed *(Elodea canadensis)* and Nuttall's Waterweed *(Elodea nuttallii).* Due to the widespread distribution of Sycamore throughout the study area, no specific locations were recorded for this species.

Of these invasive species only the following two are listed in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011. This places certain restrictions on the spread of plants, seeds or soil from these areas. If site clearance is required, then a licence is required to disturb the site and this material needs to be sent to licenced landfill for deep burial.

- *Rhododendron ponticum* (Rhododendron)
- *Fallopia japonica* (Japanese Knotweed)

The remainder are invasive alien plants but not so problematic as they can be removed without licence. However, it is recommended that soils where the following occur should not be spread elsewhere.

- *Buddleja davidii* (Buddleia)
- *Cotoneaster* spp.
- *Symphoricarpos albus* (Snowberry)
- *Prunus laurocerasus* (Cherry laurel)
- *Petasites fragrans* (Winter heliotrope).

The Japanese Knotweed recorded by BEC near to Pakenham Bridge in Section 1 does not occur in this area presently. A further stand of Japanese Knotweed was located by Dr. Blackstock during the tree survey. It is on the northern side of Hansfield Road immediately west of Callaghan Bridge in Section 2. This is separated from the canal by a public road and will not be disturbed during the construction or operation of the proposed cycleway and footpath.

3.1.5 Bryophytes (mosses and liverworts)

The 2013 survey of the bryophyte flora of the study area recorded 59 species. These species were, for the most part, found growing on stone walls and surfaces, exposed soil and rock faces, and trees. Section 3 had the highest proportion of bryophytes recorded (38 species), while Section 1 had none recorded. The majority of the bryophytes collected from Section 3 were taken from the Calcareous springs (FP1) habitat and surrounding Treelines (WL2) and Oak-ash-hazel woodland (WN2). Section 3 runs through the Deep Sinking. This is an ideal spot for bryophytes as it is shaded, sheltered and humid, providing an excellent array of habitats for bryophytes.

The four most frequent species were Bird's-claw Beard-moss *(Barbula unguiculata),* Rough-stalked Feather-moss *(Brachythecium rutabulum),* Common Feather-moss *(Kindbergia praelonga)* and Swartz's Feather-moss *(Oxyrrhynchium hians).* Scarce Notchwort *(Leiocolea badensis)* and Claw-leaved Hook-moss *(Palustriella falcata =Palustriella commutata v. falcata)* are new vice-county records for Dublin (both found in Section 3).

3.1.6 Mammals (excluding bats)

Sightings of Rabbit *(Oryctolagus cuniculus)* and Brown Rat *(Rattus norvegicus),* as well as American Mink *(Mustela vison)* and Grey Squirrel *(Sciurus carolinensis)* (both invasive) were made during the 2013 survey, while definite evidence of Otter *(Lutra lutra)* was also found at a number of sites in the form of spraints (droppings). Feeding signs, likely to be Red Fox *(Vulpes vulpes),* were recorded along the canal bank, while Badger *(Meles meles)* feeding signs and two badger setts were also recorded. In addition to sightings of Rabbits, burrows and droppings were noted at a number of locations along the canal, mainly in treeline/hedgerow embankments and areas of woodland. The woodlands and hedgerows of the Royal

Canal are also likely to support other mammal species, such as Wood Mouse *(Apodemus sylvaticus)* and Hedgehog *(Erinaceus europaeus),* though these were not observed at the time of the survey.

The majority of the non-flying mammals so far recorded are not sensitive to disturbance from pedestrians and cyclists. Badgers and Otters are predominantly nocturnal so would not be active during construction periods or when the majority of people are using the final route. Otters occur widely in many heavily disturbed areas including city centres. Provided that there is no interference with the canal banks, immediately adjacent to the water, then it is unlikely that otter activity in the area will be impacted.

3.1.7 Bats

Four species of bat were recorded in the course of the 2013 survey carried out by Dr Tina Aughney of Bat Eco Services. These were Common Pipistrelle *(Pipistrellus pipistrellus),* Soprano Pipistrelle *(Pipistrellus pygmaeus),* Leisler's Bat *(Nyctalus leisleri)* and Daubenton's Bat *(Myotis daubentonii).* These species were recorded foraging or commuting along the canal corridor, along treelines and hedgerows and over the canal surface itself. Collins Bridge and Cope Bridge both had suitability for bats, while the building at Leixlip Spa had roost potential and the house at Pakenham Bridge provides a roosting site for Soprano Pipistrelles. The remaining bridges had no bat potential owing to the lack of suitable crevices for bats. A number of large, ivy-covered trees within the study area were identified as Potential Bat Roosts (PBRs).

In addition to the four bat species recorded in the course of the 2013 survey, three other bat species have been recorded on the Bat Conservation Ireland database as occurring along or close to the canal: Brown Long-eared Bat *(Plecotus auritus),* Nathusius' Pipistrelle *(Pipistrellus nathusii)* and Whiskered Bat *(Myotis mystacinus).*

3.1.8 Birds

A total of 40 bird species were recorded in the course of the 2013 survey, with commonly recorded species including Wood Pigeon, Blackbird, Wren, Great Tit, Robin, Swallow, Chaffinch, Mallard, Magpie and Rook. Kingfisher, listed under Annex I of the Bird Directive (2009/147/EC) and on the Birds of Conservation Concern in Ireland (BoCCI) Amber List, was recorded between Kirkpatrick Bridge and Kennan/Neville Bridge, while seven other species recorded are also on the Amber List (House Sparrow, Lesser Black-backed Gull, Little Grebe, Mute Swan, Starling, Swallow and Swift). One species listed on the BoCCI Red List was recorded in the course of the survey – Yellowhammer. The hedgerows, treelines and small areas of woodland provide nesting and feeding habitat for many terrestrial bird species, while the emergent vegetation of the canal provides cover vital to aquatic birds like Mallard, Moorhen and Little Grebe. A further survey of breeding waterbirds was undertaken in 2018 (see section

3.1.9 Ant hills

Ant hills were recorded in 2013 at a number of locations along the Royal Canal in the Deep Sinking. Sections 2 and 3 of the study area supported numerous ant hills between the path and the canal bank. The ants recorded here were identified as the yellow Meadow Ant *(Lasius flavus),* which is the main mound-building ant. Well-developed ant hills are a sign that a grassland has remained undisturbed for some time, increasing the likelihood that the habitat supports high species diversity and may be of conservation value.

3.1.10 Fish

The fish community of the Royal Canal is entirely comprised of coarse fish (excepting the occasional stray salmonid that may enter the system from nearby rivers), with six species and one hybrid recorded during an electro-fishing survey in 2011 between Collins Bridge and the 13th Lock (Paul McLoone, IFI, pers. comm.). Roach *(Rutilus rutilus)* completely dominated the fish community in this section, in terms of both numbers and biomass, followed by Perch *(Perca fluviatilis),* Pike *(Esox lucius),* Roach-Bream hybrid *(R. rutilus x Abramis brama)* and Eel *(Anguilla anguilla).* Small numbers of Tench *(Tinca tinca)* and Bream

(A. brama) were also recorded. Roach, Perch, Pike and Eel were all seen in the course of the 2013 survey, along with numerous shoals of juvenile fish.

3.1.11 Aquatic macroinvertebrates

Inland Fisheries Ireland carried out sampling of the aquatic macroinvertebrate population of the Royal Canal in spring 2009 (Tara Gallagher, IFI, pers. comm.). Samples were taken just upstream of Granard Bridge, Blanchardstown, Co. Dublin. The most common species recorded in this sample was the water slater Asellus aquaticus, with the invasive freshwater shrimp Crangonyx pseudogracilis also abundant. Other common species included the mussels Sphaerium corneum and Pisidium spp. and the snails Bithynia tentaculata and B. leachii.

3.1.12 Environmentally sensitive areas

The 2013 BEC survey labelled a number of the canal sections as environmentally sensitive areas (ESAs). Some of these habitats are of higher ecological value than others and in need of greater protection. These include stretches of the canal bank supporting grassland of high species diversity (Sections 4, 5, 6), all types of woodland (mixed broadleaved, oak-ash-hazel and wet willow-alder-ash woodland) (Sections 2, 3, 4, 5, 6, 8), reed and large sedge swamp (Section 8), tall-herb swamp (Section 8), calcareous springs (Section 3), some areas of freshwater marsh (Section 5) and wet grassland (Section 8). All woodland areas within the study area were deemed to be ESAs due to the fact that semi-natural woodland in Ireland today tends to be limited in extent and scattered in distribution. The woodland habitats within the survey area provide a valuable habitat for flora and fauna, particularly when the larger landscape of intensively managed farmland and urban areas surrounding the study area is considered.

A number of areas of high-quality grassland were identified as ESAs owing to their close correspondence to Annex I habitats such as 6210 calcareous grassland and 6510 lowland hay meadows. As with the areas of woodland, such grasslands are important in the context of the intensively managed farmland and urban areas surrounding the study area. The Hydrophilous tall herb community (6430) is an Annex I habitat that is rare within the study area, and as such is considered an ESA.

3.2 Grassland survey 2018

3.2.1 Survey results

The grassland habitat bordering the canal is generally categorised as unimproved dry meadows and grassy verges (GS2). It is relatively species-rich and has not been grazed. In the centre of the towpath there is an area of heavily trampled grassland that contains species such as Italian rye-grass *(Lolium perenne)* that have colonised from surrounding agricultural grassland.

A 4m x 1m relevé was located on the canal bank at GPS reference 03283 37484 between Pakenham Bridge and Collins Bridge. This contained 25 species of grasses and forbs with more than 40% cover of forbs. The species present included Pyramidal orchid *(Anacamptis pyramidalis),* Birds foot trefoil *(Lotus corniculatus),* Bulbous buttercup *(Ranunculus bulbosus),* Marjoram *(Origanum vulgare)*, Lady's bedstraw *(Galium verum)* and Glaucous sedge *(Carex flacca).* This combination of species corresponds to the habitat 'Lowland hay meadows *(Alopecurus pratensis, Sanguisorba officinalis)'* Code 6510 as listed in Annex 1 of the EU Habitats Directive (Directive 92/43/EEC, amended by Directive 97/62/EC). The criteria and indicators for this classification are given by O'Neill *et al.* (2013).

The Annex 1 habitat 'Lowland Hay Meadows' occurs in both Sections 1 and 2 between Collins Bridge and Kennan Bridge. The locations of the Annex 1 grassland (code 6510) are indicative only (see Table 2) and were shown on the 2013 maps as there were indicators of this habitat type among the Dry meadows and grassy verges (Code GS2). It is not feasible to map precisely the 6510 habitat as it forms a mosaic with the more common GS2.

Table 2: Indicative locations of Annex 1 grassland Lowland Hay Meadow (code 6510) recorded in 2013 and 2018.

Habitat type	*GPS co-ordinates*	*Canal section*
GS2 Meadows with indicators for the Annex I habitat 6510	ITM 705658 737925	2 (Kennan Bridge to Callaghan Bridge)
GS2 Meadows with indicators for the Annex I habitat 6510	ITM 704589 738277	2 (Callaghan Bridge to Railway Bridge)
GS2 Meadows with indicators for the Annex I habitat 6510	ITM 704639 738262	2 (Callaghan Bridge to Railway Bridge)
GS2 Species-rich grassy verges with orchids	ITM 703919 738335	1 (Railway Bridge to Pakenham Bridge)
GS2 Meadows with indicators for the Annex I habitat 6510	IO 03283 IG 37484	1 (Pakenham Bridge to Collins Bridge)

This shows that much of the grassland has potential to be restored to species-rich meadow given the correct management. Optimum management would involve a single late summer cut (early September) per year followed by removal of the hay cuttings. It would be possible to diversify the grassland to produce a species-rich sward over much of the area. This could be done after cutting by using a tractor-mounted scarifier followed by immediate sowing with Yellow Rattle *(Rhinanthus minor).* This species parasitizes the roots of certain grasses, opening up the sward and allowing other more sensitive species to colonise. Sowing should be done by hand at 2 grams (c.600 seeds) per 2m x 2m patch. The seed is mixed with lime-free sand and sown when the soil is moist. A local source of seed is the OPW managed estate at Castletown House, Celbridge.

3.2.2 Recommendations for grasslands

This sample survey indicates that some of the grasslands in the western section of the proposed Royal Canal Urban Greenway route are of high conservation value, especially those pockets containing the Annex 1 habitat 'Lowland hay meadows'. This habitat type is now rare in Ireland and especially in Fingal where the majority have been converted to improved agricultural grasslands. Where the proposed route is located in these sections of the canal towpath it should be set back at least 1m from the water's edge and no disturbance should be permitted to the grassland habitat on the canal bank during construction. Following construction of the Greenway, much of this marginal habitat could be converted to a species-rich grassland using the methods proposed above.

3.3 Woodland survey 2018

3.3.1 Survey results

The main woodland habitats in the study area are in the Deep Sinking area (Section 3), mainly located on the north side of the canal where they vary from a narrow line of trees to a band up to 50m in width. The main categories of woodland found are Oak-Ash-Hazel Woodland (WN2), Mixed Broadleaved/Conifer Woodland (WD2) with small areas of Scrub (WS1) and Scattered Trees and Parkland (WD5). These have been mapped accurately by the BEC survey (Brophy & Devaney 2013). While the Oak-Ash-Hazel Woodland is classified as semi-natural with native trees dominant, it does contain some non-natives such as Sycamore, Sweet Chestnut, Beech and a few conifer species.



Figure 3. Semi-natural woodland on the north bank of the canal west of Kirkpatrick Bridge

3.3.1.1 Kennan Bridge to Kirkpatrick Bridge

North Bank: The dominant tree species here are Ash, Alder, Willow and Hawthorn with some introduced Beech and Sycamore. Ages of the trees vary from immature (5-10 years) to mature (30-40 years). There is some mature Cherry Laurel at the western end between Kennan Bridge and the Clonsilla road bridge. This is an invasive species and needs to be controlled as it can cast a dense shade retarding natural woodland regeneration. The topography is uneven and a steep bank occurs in the middle of this section close to Sheepmoor Lane.

South Bank: The tree cover here is predominantly a single line of Alder, Ash, Sycamore, Sweet Chestnut and Hawthorn. This has been repeated trimmed to allow access for boats along the canal and pedestrians on the towpath.

3.3.1.2 Kirkpatrick Bridge to Granard Bridge

North Bank: The woodland on the north bank consists primarily of mixed broadleaved/conifer woodland with a dense stand of Ash, Sycamore, Alder, Holly, Hawthorn and various conifers which vary from 5 to 45 years in age. The topography here is very uneven with intermittent very steep banks which are not suitable for public access. On the north bank just east of Kirkpatrick Bridge there is an area of young Rhododendron. This is also an invasive species and needs to be controlled.

South Bank: This is fringed by a single tree line comprised mainly of Alder, Ash, Sycamore and Hawthorn with a maximum age of 25 years. Coppicing is regularly carried out here to facilitate access.

3.3.2 Discussion

The woodland on the northern bank of the Royal Canal in the Deep Sinking area is mainly classified as semi-natural although it contains a mixture of native and non-native tree species. The woodland is extensive in some areas and has a typical associated ground flora. It also provides a valuable corridor of semi-natural vegetation through essentially urban areas for the movement of animal species including mammals, birds and insects. The areas of Oak-Ash-Hazel Woodland (WN2) are of high conservation value and should be avoided by the proposed development, where possible.

3.4 Breeding waterbird survey 2018

3.4.1 Survey Results

A total of three water bird species were recorded along this section of the canal over two surveys. Mallard was the most abundant species with 40 registrations. Grey Wagtail was the least abundant with only one registration. In Table 3 the number of registrations for each species is given. Figure 5 shows a map of the survey area and the distribution of waterbird registrations.



Figure 4. Mallards roosting on the canal bank

Table 3: Summary of waterbird registrations in May 2018 within the Royal Canal study area (from 12th Lock to Kildare County boundary)

Species	No. Of Registrations	Breeding Status	Level of Conservation Concern[1]
Mallard	40 (incl. 13 juveniles)	Confirmed breeding	Green
Moorhen	4	Probable breeding	Not listed
Grey Wagtail	1	Unconfirmed breeding	Red

Birds of Conservation Concern in Ireland (Colhoun and Cummins 2013): Red = High conservation concern; Amber = Moderate conservation concern; Green = Low conservation concern.

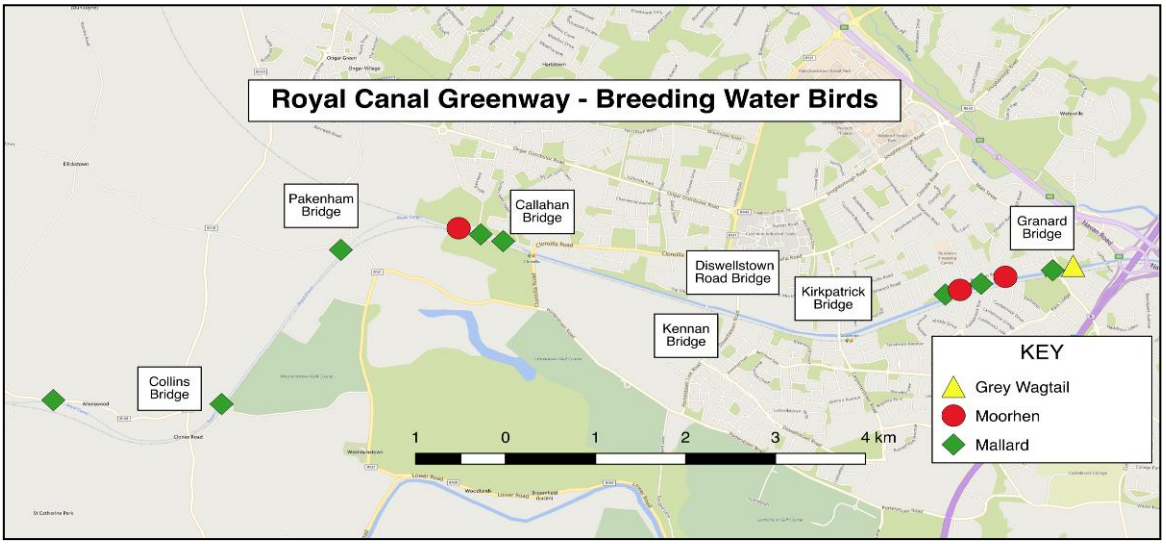


Figure 5: Map of Royal Canal survey area from 12th lock to Kildare County Boundary showing water bird distribution

3.4.2 Discussion

The breeding waterbird community on this section of the Royal Canal is typical of canals in general and of other sections of this waterway (Smiddy & Nairn 2012). The number of species is low and density is also low, largely because of the lack of vegetation cover in the waterway. Mallard occur frequently and generally nest in areas with a reed fringe. Moorhens select dense emergent vegetation or tree branches in the water for nesting. Grey Wagtails tend to nest in crevices in stonework or among tree roots or ivy invariably close to the water (Ferguson-Lees *et al.* 2011). The Grey Wagtail found in this survey was present at the 12th Lock on 22nd May 2018 and was likely to be nesting in the stonework around the canal close to this location Mute Swans and Grey Heron were present on the western section of the route during the preliminary survey in March 2018 but there was no evidence of either species breeding here in May. Grey Wagtail is of high conservation concern in Ireland because its population is estimated to have declined by at least 50% over the period 1998-2011 (Colhoun & Cummins 2013).

The waterbird species recorded breeding on this stretch of the canal are largely confined to the waterbody itself and are habituated to human disturbance. It is not expected that the development of a pedestrian path and cycleway parallel to the canal would have any significant impacts on them provided that the vegetation in the canal water is not disturbed.

3.5 Bat surveys of sections 1 to 3 in 2018

A full bat survey of this section of the Royal Canal was undertaken in 2013 (Aughney 2013). This included a survey of bat activity along the waterway. The results are summarised in Table 4. Four species were found with Soprano Pippistrelle being most widespread. The entire canal forms a significant foraging and commuting corridor for bats and this is likely to continue in 2018.

The old stone bridges were examined in 2013 for potential bat roosts. This survey was repeated between 13th and 18th July 2018 in order to update the assessment carried out in 2013 and to confirm if bats were present in any of the old bridge structures along the route.

Table 4: Summary of bat activity on the Royal Canal in June 2013

Section	Western limit	Eastern limit	Common Pippistrelle	Soprano Pippistrelle	Daubentons Bat	Leislers Bat
1	County Boundary	Collins Bridge	●		●	●
	Collins Bridge	Pakenham Bridge		●	●	●
	Pakenham Bridge	Railway Bridge		●		●
2	Railway Bridge	Callaghan Bridge		●		
	Callaghan Bridge	Kennan Bridge		●	●	
3	Kennan Bridge	Kirkpatrick Bridge	●	●		
	Kirkpatrick Bridge	Granard Bridge	●	●	●	
	Granard Bridge	Talbot Bridge/Lock 12	●	●	●	

3.5.1 Survey Results

Granard Bridge (Bridge No. 1)
This is a low single arch bridge with the canal towpath located under the arch. There are long narrow crevices under the arch of this bridge. The crevices are deemed suitable for roosting bats. A dusk emergence survey was completed on 18th July 2018 from 21:45 hrs to 23:15 hrs (Weather conditions: patchy cloud cover, dry, light wind and 16^{o}C). No bats were detected emerging from the crevices. The following bat species were recorded foraging adjacent to the bridge: Common Pipistrelle, Soprano Pipistrelle and Leisler's bat.

Kirkpatrick Bridge (Bridge No. 2)
This is a high single arch bridge and the only access to underneath the bridge is by scrambling down a steep bank towards the canal. There are a number of crevices under the arch of this bridge. The crevices are deemed suitable for roosting bats. A dusk emergence survey was completed on 16th July 2018 from 21:45 hrs to 23:15 hrs (Weather conditions: patchy cloud cover, dry, light wind and 14^{o}C). A single bat was detected emerging from a crevice and identified as a *Myotis* species, likely to have been a Daubenton's bat. The following bat species were recorded foraging adjacent to the bridge: Common Pipistrelle, Daubenton's Bat, Soprano Pipistrelle and Leisler's Bat.

Kennan Bridge (Bridge No. 3)
This is a high single arch bridge. There are no crevices deemed suitable for roosting bats. Therefore, a dusk survey was not undertaken at this bridge.

Callaghan Bridge (Bridge No. 4)
This is a low single arch bridge with the canal towpath located under the arch (Figure 6). There are a number of crevices under the arch of this bridge. The crevices are deemed suitable for roosting bats. A dusk emergence survey was completed on 14th July 2018 from 21:45 hrs to 23:15 hrs (Weather conditions: full cloud cover, dry, calm and 15.5^{o}C). No bats were detected emerging from the crevices. The following bat species were recorded foraging adjacent to the bridge: Common Pipistrelle and Leisler's bat.

Pakenham Bridge (Bridge No. 5)
This is a low single arch bridge with the canal towpath located under the arch allowing for ease of inspection. There are some shallow crevices under the arch of this bridge. These crevices were checked with a torch and no bats were recorded within the crevices. Therefore, a dusk survey was not completed.

Collins Bridge (Bridge no. 6)
This is a low single arch bridge with the canal towpath located under the arch. There are a number of crevices under the arch of this bridge. The crevices are deemed suitable for roosting bats. A dusk emergence survey was completed on 13th July 2018 from 21:45 hrs to 23:15 hrs (Weather conditions: patchy cloud cover, dry, calm and 16OC). No bats were detected emerging from the crevices. The following bat species were recorded foraging adjacent to the bridge: Daubenton's bat, soprano pipistrelle and Leisler's bat.



Figure 6. Callaghan Bridge in Section 2

The author surveyed these bridges in 2013. It is interesting to note that in the five years since the previous surveys the bat roosting potential of the bridges has changed as shown in Table 4.

Table 4. Comparison between the bat roosting potential of bridges on the Royal Canal Urban Greenway route in 2013 and 2018.

Bridge name	2013 survey	2018 survey
1. Granard Bridge	No suitable crevices	Suitable crevices
2. Kirkpatrick Bridge	No suitable crevices	Suitable crevices, bat roost present
3. Kennan Bridge	No suitable crevices	No suitable crevices
4. Callaghan Bridge	No suitable crevices	Suitable crevices
5. Pakenham Bridge	No suitable crevices	Shallow crevices
6. Collins Bridge	Suitable crevices, no bats recorded	Suitable crevices

3.6 Bat survey of Ashtown to M50 section 2018

3.6.1 Survey Results

This survey was commissioned to investigate the effect of street lighting on the section of the Royal Canal between Ashtown Railway Station and the M50 (Figure 7) which was installed in the last 10 years. A full literature review of the impact of lighting on bats is given in Appendix 2.

Bat activity during the walking transect (60 minutes) was very low. Bats were only recorded on one occasion (Common Pipistrelle) approximately 300m from the Ashtown end or the start of the walking transect. Table 4 lists the bat species recorded at the survey spots (2 hrs and 1 minute of surveying). Bats were only recorded at 6 of the 20 survey spots (30%). Overall the level of bat activity was low and only common bat species were recorded; Leisler's Bat, Common Pipistrelle and Soprano Pipistrelle (Table 5).



Figure 7. Ashtown to M50 section of the Royal Canal paralleled by the Dublin-Kildare Railway

Bat activity was not recorded around the lamp posts but was generally along the tall vegetation on the far-side of the canal tow path where the lamp posts are not located. Leisler's Bats were only recorded commuting through the area. There were no feeding passes noted. Common and Soprano Pipistrelles were occasionally recorded feeding during the survey. No *Myotis* bat species or Brown Long-eared Bats were recorded. Overall only 8 bat encounters were recorded in 3 hours of surveying (both the walking transect and the survey spot surveys combined). The LUX level at 1m height off the ground and directly below the lamp posts was 5 LUX. The LUX level in the middle of the path at 1m off the ground was 10 LUX. A glare from the lamp posts spilled out onto the canal water surface.

Table 5. Bat species recorded at survey spots on the Ashtown to M50 section of the canal

No.	Survey spot location/description	Survey time	Species recorded	LUX
1	Survey spot at LP 63 starting at M50 end	22:59		2
2	Plus 100 paces. Survey spot at security post beside LP59	23:05		0
3	Plus 100 paces. Survey spot at LP 56	23:11	Leis	1
4	Plus 100 paces. Survey spot at LP 53	23:17		2
5	Plus 100 paces. Survey spot at Lock 2 from LP50	23:23		0
6	Plus 100 paces. Survey spot at black railing	23:29		0
7	Plus 100 paces. Survey spot at LP43	23:35		0
8	Plus 100 paces. Survey spot at halfway between LP39/40	23:41		0
9	Plus 100 paces. Survey spot at halfway between LP39/40	23:48		0
10	Plus 100 paces. Survey spot at security post between LP33/34	23:53		0
11	Plus 100 paces. Survey spot at 30	23:59	Cp, Leis	0
12	Plus 100 paces. Survey spot at 27	00:08		1
13	Plus 100 paces. Survey spot at 24	00:14		1
14	Plus 100 paces. Survey spot at black gate	00:19		0
15	Plus 100 paces. Survey spot at halfway between LP17/18	00:25		0
16	Plus 100 paces. Survey spot at ESB pylon	00:31	Cp	0
17	Plus 100 paces. Survey spot at LP11	00:37		0
18	Plus 100 paces. Survey spot at LP8	00:42	Sp	2
19	Plus 100 paces. Survey spot at black railing	00:48		0
20	Plus 100 paces. Survey spot at Lock 10 sign adjacent to Ashtown Railway Station	00:54	Cp	0

Bat species: Leis = Leisler's Bat; Cp = Common Pippistrelle; SP = Soprano Pippistrelle. LP = Lamp post

3.6.2 Review of the effects of lighting on bats

A previous bat survey was completed on this section of the canal in 2004 (Keeley, 2004) and this report was provided for review after the 2018 survey was completed. Bat detection work was undertaken here between July and October 2004 on three nights prior to the installation of lighting on this section of the towpath (Keeley 2004). In addition, a further bat survey was undertaken here by Keeley and Mullen (2013, prior to the construction of the existing greenway). Table 6 gives a comparison of bat species recorded in all three surveys.

Table 6. Bat species recorded on the Ashtown to M50 section of the Royal Canal 2004 and 2018.

Species	2004	2013	2018
Soprano pipistrelle *Pipistrellus pygmaeus*	Present	Present	Present
Common pipistrelle *Pipistrellus pipistrellus*	Present	Present	Present
Leisler's bat *Nyctalus leisleri*	Present	Present	Present
Daubenton's bat *Myotis daubentoni*	Present	Present	Not recorded
Brown long-eared bat *Plecotus auritus*	Present	Not recorded	Not recorded
Whiskered bat *Myotis mystacinus*	Present	Not recorded	Not recorded

The level of bat activity in summer 2018 was low. This, in addition to the absence of bat species considered to be light sensitive e.g. *Myotis* bat species, indicates that the lighting regime is impacting on local bat populations. As noted by Keeley (2004) two *Myotis* species and the Brown Long-eared Bat was recorded when there was no lighting present.

There is a dense treeline along much of the section of the canal surveyed. This is an ideal habitat to encourage bats along a waterway and has been shown to be the principal habitat that encourages the presence of Daubenton's bats along rivers and canals in Ireland (Aughney *et al.,* 2017). While the survey transect is located in an urban zone, bats will utilise urban areas once there is a continuous dark zone for them to travel through. It is likely that the lighting regime of the survey area reduces the suitability of the canal for foraging and commuting bats.

The results of the previous survey completed along this section of the canal prior to the installation of the lighting was available for review post 2018 surveying. As stated above, this 2004 survey recorded six bat species, three of which were not recorded in the 2018 survey. While the surveying protocol is different between the two surveys, the level of bat activity noted in the 2004 survey exceeds the level of bat activity for all bat species recorded in the 2018 survey. This was similar for the 2013 survey. Four species of bat was recorded in 2013, one more bat species than the 2018 survey. However, the 2013 survey was completed along a longer section of the canal but within the same survey area, the Daubenton's bat was recorded in the 2013 survey but not in the 2018 survey. This may be due to the increased lighting along the canal. Thus, the survey of the Ashtown-M50 section appears to show that there has been a decrease in bat activity along that section since the installation of lighting, although this is not conclusive. The three species not recorded in 2018 are all known to be deterred from foraging in areas with artificial lighting.

Recently published guidance on bats and artificial lighting in the UK (ILP-BCT 2018) states that illuminating a bat roost can cause disturbance and this may result in the bats deserting the roost or even becoming entombed within it. Light falling on a roost access point will at least delay bats from emerging and this shortens the amount of time available to them for foraging. As the main peak of nocturnal insect abundance occurs at and soon after dusk, a delay in emergence means this vital time for feeding is missed. This has been shown to have direct impacts on bats' reproductive ecology, such as slower growth rates and starvation of young. In addition, the associated flightpath to and from the access point is just as valuable and vulnerable as the roost itself. Severing a key flightpath some distance from the roost could cause desertion in its own right.

In addition to causing disturbance to bats at the roost, artificial lighting can also affect the feeding behaviour of bats. Many night-flying species of insect are attracted to light, especially those light sources that emit an ultraviolet component or have a high blue spectral content. Studies have shown that Leisler's Bat and Pipistrelle Bats can congregate around white mercury street lights and white metal halide lamps feeding on the insects attracted to the light. However, slower flying, broad-winged species such as Long-eared Bats, *Myotis* species (which include Brandt's Bat, Whiskered Bat, Daubenton's Bat and Natterer's Bat) generally avoid all street lights. Consequently, bat species less tolerant of light are put at a

competitive disadvantage and are less able to forage successfully and efficiently. This can have a significant impact upon fitness and breeding success in the latter species. In addition, studies have shown that continuous lighting in the landscape, such as along roads or waterways, creates barriers which many bat species cannot cross, especially the slower-flying species even at very low light levels. In Ireland it has been found the Daubenton's Bat is less likely to occur on waterways where there are artificial night lights (Aughney *et al.* 2012). A literature review of the impacts of lighting on bats is given in Appendix 2.

3.6.3 Recommendations for bats

3.6.3.1 Retain crevices for roosting bats

Due to the number of open crevices, a selection of crevices should be retained for bat usage if any repointing works are required. In preparation for this, a bat inspection is required prior to construction and the crevices to be retained should be filled with bubble wrap. Once works are finished, the bubble wrap should be removed to allow bat usage (Figure 8).



Figure 8: Example of a bat-suitable crevice filled/blocked with bubble wrap to prevent bat occupancy during proposed works (Photograph courtesy of Caroline Shiel).



Figure 9: Example of a bat tube incorporated into a stone wall.

Where crevices cannot be retained, then bat tubes should be erected in the vicinity of the bridge (Figure 9). The exact location depends on the bridge (Please seek advice from a bat specialist). Any lighting scheme planned for the proposed greenway should not be erected in vicinity of the bridges, especially under the arches. It is of great importance that a dark corridor is present the entire length of the greenway to allow nocturnal wildlife, including bats, to commute through the landscape. Section 1.3.6 contains the results of the investigation of the impact of lighting scheme on bats along the Ashtown to M50 section of the Royal Canal. A full literature review of the impact of lighting on bats is given in Appendix 2.

3.6.3.2 General Recommendations for Bats

1. Do not remove trees and shrubs along waterway banks adjacent to the bridge structures. Protect this habitat from any potential damage as a result of the proposed development works.
2. Treelines and shrubs should remain in-situ and remain protected from potential management work.
3. Minimise damage to the hedgerow habitat adjacent to the bridge.
4. Ensure that all equipment, construction materials are stored on the roadway and not in adjacent habitats to the bridges.
5. Avoid the use of chemicals (weed killers etc.) within the development zone. Undertake physical removal of weed species only.
6. Open areas required to facilitate works should be limited to areas where tree and hedgerows are not present. Lighting of such work spaces can also disrupt traditional foraging grounds for bats and therefore should be limited and should not occur during foraging period (30 minutes prior to sunset to 30 minutes after sunrise).

7. Permanent lighting on the Greenway should be of the high-pressure sodium type to avoid significant impacts on bats (see Appendix 2).
8. It is recommended that a survey, using a similar methodology to that used in the 2018 survey of the Ashtown to M50 section, should be completed along the 12th Lock to Kildare border sections of the canal which are proposed for lighting. A number of 2km walking transects and 20 survey spots should be set up and data gathered prior to any lighting installation to provide a pre-construction baseline against which to measure the effects of any lighting installed here. This would be best done in the summer season before construction so that the 'before-after' interval is short. This would help to rule out other impacts such as land use changes in the surrounding area. Ideally, further survey of this section should be completed on a seasonal basis to collate data on bat activity for each month of the year and then this would provide a better dataset for comparison.
9. Static bat recording could also be put in place prior to construction at a number of points to record continuous bat activity levels over a period of five nights in the main bat survey season (April to September). This would provide further baseline information. Additional collation of LUX levels should be undertaken from the canal water surface level and where possible from the far-side of the canal bank.

3.7 Mollusc survey 2018

3.7.1 Introduction

This mollusc survey was undertaken in 2018 in order to assess the quality of the relevant potential habitats that could support *Vertigo* whorl snail species, in particular the three Annex II species *Vertigo moulinsiana, V. angustior* and *V. geyeri.* The survey was assisted by the benefit of an ecological study undertaken by BEC Consultants Ltd (BEC 2013), which provided the locations of habitats that have the potential to support *Vertigo* species.

The Royal Canal is a proposed Natural Heritage Area (pNHA) under the Wildlife Acts 1976 to 2012. Areas close to the canal west of the current study area (Blanchardstown Talbot Bridge to the Dublin/Kildare border) support important populations of *Vertigo moulinsiana* and *V. angustior*, so it is important to assess the potential for these species along the pNHA, particularly where management changes or development may be proposed.

The BEC study of the Royal Canal (Brophy & Devaney 2013) listed only five habitats that could potentially support *Vertigo* species (Table 7).

Table 7. List of habitats recorded within the Royal Canal study area by BEC (2013) with potential to support *Vertigo* species

Habitat code	Habitat type	Comment
FP1	Calcareous springs	Discounted as it is not associated with fen habitat
FS1	Reed and large sedge swamps	Common habitat along the study area
FS2	Tall-herb swamps	Limited to Section 8
FW4	Drainage ditches	Limited to Sections 7 and 8
GM1	Marsh	Limited to Section 5
GS4	Wet grassland	Transitional habitat along the study area

The study area was divided into 8 sections to match those referred to in the BEC study (Brophy & Devaney 2013) (Table 8).

Table 8. Survey sections as demarcated by Royal Canal distance markers (from BEC 2013).

Section no.	From	To	Distance (km)
1	Talbot Bridge & Lock 12, Blanchardstown	Granard Bridge, Castleknock Road	0.30
2	Granard Bridge, Castleknock Road	Kirkpatrick Bridge, Carpenterstown	1.55
3	Kirkpatrick Bridge, Carpenterstown	Kennan or Neville Bridge, Porterstown	0.90
4	Kennan or Neville Bridge, Porterstown	Callaghan or Carhampton Bridge, Clonsilla	1.20

Section no.	From	To	Distance (km)
5	Callaghan or Carhampton Bridge, Clonsilla	Dublin & Meath Railway Bridge	0.85
6	Dublin & Meath Railway Bridge	Pakenham Bridge, Barberstown	0.40
7	Pakenham Bridge, Barberstown	Collins Bridge, Coldblow	1.80
8	Collins Bridge, Coldblow	Dublin-Kildare county boundary, boat slip	1.05

Some examples of reed and large sedge swamp (FS1) were surveyed, but they are all within the canal fringe open water, and not sloped into transition habitat, thus snails here are reliant on living and feeding within the stem and leaf areas of vegetation and cannot retreat to root or litter areas (Figure 10). The total submergence of the vegetation was noted by BEC in 2013, and this was confirmed to be unsuitable habitat for *Vertigo* within the study area, except where a small area of tall herb swamp (FS2) formed a transition zone in Section 8.



Figure 10. Reed and large sedge swamp in the canal west of Pakenham Bridge (Section 1).

Tall herb swamps (FS2) were investigated in the only recorded area of Section 8. The habitat supported plants such as Meadowsweet *(Filipendula ulmaria),* Common Valerian *(Valeriana officinalis)* and Wild Angelica *(Angelica sylvestris).*

Drainage ditches (FW4) can support tall herb and sedge species in a transitional pattern, where parts of ditches maintain open water areas while others support damp sedge litter, and these habitats are ideal for *Vertigo moulinsiana.* These drainage ditches need to still support open water or high groundwater. The ditch areas noted by BEC (2013) in Sections 7 and 8 were investigated.

Marsh (GM1) was recorded by BEC (2013) in Section 5 only and was noted as an Environmentally Sensitive Area. The marsh habitat existed just above the water level of the canal and broadleaved herbs, such as Hemp-agrimony *(Eupatorium canabinum)* and Meadowsweet, accounted for greater than 50% of the vegetation. Wet grassland (GS4) was recorded by BEC in 2013 across a number of sections, and as often present in a narrow area between the grassy verges (GS2) and reed swamp (FS1) fringing the canal. It was noted that it reflected a transitional zone rather than a distinct GS4 habitat. This is a positive indication for *Vertigo* species, as it indicates potential for these snail species to move upslope to prevent inundation and downslope into conditions that prevent desiccation through the seasons. The habitat / transition zone was characterised by Hard Rush *(Juncus inflexus),* Meadowsweet, Yellow Iris *(Iris pseudacorus),* Wild Angelica *(Angelica sylvestris)* and Hemp-agrimony.

As *Vertigo* species favour transitional habitats, samples were taken across habitat zones, and so sampling points do not easily divide into the above habitat categories.

3.7.2 Survey Results

Very few snail species (12) were found during the survey, and none of the genus *Vertigo*. The sites are given in Table 9, and the results in Table 10.

Table 9. Sites surveyed for Molluscs.

Site no.	Area	Habitats surveyed
1	Talbot Bridge and Lock 12, Blanchardstown to start of 2	No suitable habitat
2	Granard Bridge, Castleknock to start of 3	Limited transition habitat, not suitable
3	Kirkpatrick Bridge, Carpenterstown to start of 4	No suitable habitat
4	Kennan Bridge, Porterstown to start of 5	Very dry transition, some emergent *Glyceria*, some dry litter N bank
5	Callaghan Bridge, Clonsilla to start of 6	5a – fringe transition GS4/FS1 5b – marsh habitat GM1 N bank
6	Dublin & Meath Railway Bridge to start of 7	Fringe transition GS4/FS1 N bank
7	Pakenham Bridge, Barberstown to start of 8	7a – drainage ditch FW4 7b - fringe transition GS4/FS1
8	Collins Bridge, Coldblow to slipway at Kildare border	8a – drainage ditch FW4 N bank 8b - fringe transition GS4/FS1 N bank 8c – tall herb swamps FS2 S bank

Table 10. Molluscan species found in the survey (nomenclature follows Anderson (2005))

Species	1	2	3	4	5a	5b	6	7a	7b	8a	8b	8c
Oxyloma elegans						X		X		X		X
Carychium minimum											X	
Cochlicopa lubrica					X		X		X		X	X
Arion vulgaris							X				X	
Vitrea contracta											X	X
Nesovitrea hammonis											X	
Oxychilus cellarius							X			X		
Oxychilus alliarius						X						
Clausilia bidentata				X	X							
Ashfordia granulata									X		X	
Trochilus striolatus				X				X	X	X		X
Cepaea nemoralis		X						X		X		X
Total = 12 species	**0**	**1**	**0**	**2**	**2**	**2**	**3**	**3**	**3**	**4**	**6**	**5**
Total species per section	**0**	**1**	**0**	**2**	**4**		**3**	**5**		**11**		

3.7.3 Discussion

The molluscan survey of the canal was undertaken during a prolonged dry spell, which meant that the survey conditions were very good for locating permanent damp and wet habitats that are conducive to *Vertigo* species. Very few snail species were found in the study, because the survey was targeting the habitats required for rare and protected species, rather than tolerant and widespread species that would occur in drier habitats.

No *Vertigo* species were found in the survey, and no habitats with potential to support the damp and gentle transition needed for them were found. There were areas where there were the combinations of wet grassland with reed and sedge swamps below, but the steepness of the canal bank in all areas prevented the conditions that would be required by *Vertigo* species on a year-round basis.

The most interesting species recorded was *Ashfordia granulata*, the silky snail, from 7b (found in the field at O 03800 38161) and at 8b (found in the field at O 02281 36801). This species is known from both Dublin and Kildare, but this adds two 1km^2 records for this near-threatened species, for which Ireland holds approximately 20% of the world population (Byrne *et al*. 2009). This snail is likely to follow the tree line and woodland areas along the canal.

The habitats improve from east to west, getting much better in section 8 towards the Kildare border. There are better snail habitats known from the Kildare side of the canal (Moorkens 1995, 2007a and b; Moorkens & Killeen 2011). The aquatic habitats of the Royal Canal also improve in this area of the canal, with the rare aquatic glutinous snail *Myxas glutinosa* recorded from the Dublin-Kildare border slipway to Collins Bridge (Moorkens & Killeen, 2005). There are no particular management recommendations for this section of canal, other than ensuring that any construction activity does not result in discharges which could pollute the aquatic habitat. The limited fringe habitats are robust and unlikely to be unduly affected by works, except for the specific locations noted as being Environmentally Sensitive Areas by BEC (2013).

3.8 Other sensitive habitats

3.8.1 Calcareous spring

A single calcareous spring was located in the canal bank in the Deep Sinking area at GPS reference 706155 737768 by the BEC survey in 2013. The spring was in a rock face created by the construction works of the canal (in the 19th century). The spring contained abundant moss and liverwort species, including *Eucladium verticillatum, Palustriella falcata, Aneura pinguis* and *Leiocolea badensis*. This type of calcareous spring corresponds to the priority Annex I habitat: Petrifying springs with tufa formation (Cratoneurion) (7220). The spring is on the north bank of the canal and should be avoided during any construction works for the proposed Greenway.

3.8.2 Ant hills

Ant hills were recorded in the 2013 BEC survey at a number of locations along the Royal Canal in the Deep Sinking (Table 11). This area supported numerous ant hills between the path and the canal bank. The ants recorded here were identified as the Yellow Meadow Ant *(Lasius flavus)*, which is the main mound-building ant and is considered widespread in Ireland (Niechoj, 2011).

Table 11. Location of ant hills along the Royal Canal in the study area (Brophy & Devaney 2013).

Section no.	Section	Location	ITM grid reference
3	Granard Bridge to Kirkpatrick Bridge	Railway embankment	707539 737799
3	Granard Bridge to Kirkpatrick Bridge	Between canal and path	707415 737750
3	Granard Bridge to Kirkpatrick Bridge	Between canal and path	707531 737800
3	Kirkpartrick Bridge to Kennan Bridge	Between canal and path	706386 737692



Figure 11. Typical anthill in undisturbed grassland

Well-developed ant hills are a sign that a grassland has remained undisturbed for some time, increasing the likelihood that the habitat supports high species diversity and may be of conservation value. It is likely that the abundance of ant hills in the Deep Sinking is due to the inaccessibility of the area for machinery, resulting in lower maintenance compared to the towpath further west. The use of tractor-mounted mowers on the towpath and other path maintenance works in Section 1 appear to have prevented the development of large ant hills despite the presence of the Yellow Meadow Ant in these areas also. The limited area of undisturbed semi-natural grassland in Dublin and Kildare means that there are few areas that will support ant hills (Brophy & Devaney 2013).

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4 EVALUATION

The habitats along the full section of the proposed Royal Canal Urban Greenway were mapped and described in the BEC survey (Brophy & Devaney 2013). The present survey has confirmed the continued presence of these habitats. Table 10 provides an evaluation of those habitat types that could potentially be affected by the Greenway development and a list of general constraints to be taken into account during construction and operation.

Table 12. Evaluation of habitats with constraints and mitigation for proposed Royal Canal Urban Greenway development

Ecological evaluation	Habitat types (Fossitt 2000)	Criteria for evaluation	Constraints and Mitigation
High Value	WN2 Oak-ash-hazel woodland	Areas of the habitat types listed in Annex I of the Habitats Directive but which do not satisfy the criteria for valuation as of International or National importance.	Avoid *any* adverse impacts either direct or indirect, during construction or operation. No other mitigation is recommended.
	FP1 Calcareous spring	Semi-natural habitat types with high biodiversity in a regional context and a high degree of naturalness, or populations of species that are uncommon within the County.	Avoid *any* adverse impacts either direct or indirect, during construction or operation. No other mitigation is recommended.
	GS2 Dry meadows and grassy verges with indicators for Annex 1 habitat	Includes some areas of habitat that correspond to the habitat 'Lowland hay meadows *(Alopecurus pratensis, Sanguisorba officinalis)'* listed in Annex 1 of the EU Habitats Directive	Set back the pathway at least 1m from the edge of the canal. Avoid any impacts on this fringe vegetation during construction or maintenance of the pathway.
	BL1 Stonework in bridges and walls	Potential for bat roosts	Survey for bat roosts prior to construction. Implement mitigation recommended in section 1.3.7 above
Moderate Value	FS1 Reed and large sedge swamp FS2 Tall-herb swamp WD1 Mixed broadleaved woodland GM1 Marsh GS4 Wet grassland	Semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon within the local area	Limit adverse impacts to minimum required to complete the scheme. Avoid removal of these habitats where possible. Do not remove vegetation during the period 1st March to 31st August to avoid impacts on breeding birds. Implement standard pollution controls during construction. Implement mitigation to reduce impacts. Where impacts cannot be avoided implement habitat restoration or creation.
Low Value	FW3 Canal water body FW4 Drainage Ditches WL1 Hedgerows WL2 Treelines WS1 Scrub	Habitats that are relatively common in the local area but are unimproved.	Implement standard pollution controls during construction. Do not remove vegetation during the period 1st March to 31st August to avoid impacts on breeding birds.

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Appendix 1: Natural heritage area site synopsis

SITE NAME: ROYAL CANAL pNHA

SITE CODE: 002103

The Royal Canal is a man-made waterway linking the River Liffey at Dublin to the River Shannon near Tarmonbarry. There is a branch line from Kilashee to Longford Town. The canal pNHA comprises the central channel and the banks on either side of it. The main water supply is from Lough Owel (also an NHA) via a feeder channel into the canal at Mullingar. The Royal Canal was closed to navigation in 1961. The section of canal west of Mullingar was allowed to dry out, and the eastern section silted up and became overgrown. Restoration began in 1988, and is still in progress.

A number of different habitats are found within the canal boundaries - hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland. The hedgerow, although diverse, is dominated by Hawthorn *(Crataegus monogyna).* On the limestone soils of the midlands Spindle *(Euonymus europaeus)* and Guelder-rose *(Viburnum opulus)* are present. The vegetation of the towpath is usually dominated by grass species. Crested Dog's-tail *(Cynosurus cristatus),* Quaking Grass *(Briza media)* and Sweet Vernal-grass (Anthoxanthum odoratum) are typical species of the calcareous grasslands of the midlands. Where the canal was built through a bog, soil (usually calcareous) was brought in to make the banks. The contrast between the calcicolous species of the towpath and the calcifuge species of the bog is very striking.

Otter spraints are found along the towpath, particularly where the canal passes over a river or stream. The Rare and legally protected Opposite-leaved Pondweed *(Groenlandia densa)* (Flora Protection Order 1987) is present at one site in Dublin, between Locks 4 and 5. *Tolypella intricata* (a stonewort listed in the Red Data Book as being Vulnerable) is also in the Royal Canal in Dublin, the only site in Ireland where it is now found.

The ecological value of the canal lies more in the diversity of species it supports along its linear habitats than in the presence of rare species. It crosses through agricultural land and therefore provides a refuge for species threatened by modern farming methods.

13th February, 1995.

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Appendix 2: Literature review of effects of lighting on bats

The following are summaries or extracts from a selection of research papers on the potential impact of lighting on bats. Anthropogenic light pollution is an increasing global problem, affecting ecological interactions across a range of taxa and impacting negatively upon critical animal behaviours including foraging, reproduction, and communication. Almost all bats are nocturnal and previous studies have shown that bat species adapted to foraging in open environments feed on insects attracted to lamps of varying lighting regimes.

Artificial lighting can affect bats in different ways. For many species, including bats, the natural light regime is a cue that synchronizes their window of activity with the environment. The artificial illumination of maternity roosts can delay the emergence of female bats, which has important fitness costs for reproductive females as they miss the peak abundance of insects at dusk. Artificial lighting can also modify resource availability and change species foraging patterns. Slow-flying species adapted to prey on insects in cluttered vegetation, such as *Rhinolophus* spp*., Myotis* spp., and *Plecotus* spp., appear to completely avoid illuminated areas. In contrast, fast-flying species adapted to hunt insects in the open air, such as *Pipistrellus pipistrellus*, appear to benefit from new and predictable foraging opportunities provided by streetlights. Studies on the effects of light intensity on bat activity have highlighted that even low levels of Artificial Light At Night (ALAN) have a detrimental effect on the activity of light-averse species.

The attractiveness of lighting to insects, and therefore to bats that exploit these congregations of prey, is linked to the amount of short-wavelength light produced, particularly ultraviolet (UV). Traditional mercury vapour lamps produced large amounts of UV light and had high attractiveness. There is also evidence that the acoustic defences of tympanate (hearing) moths, which allow them to evade hunting bats, are compromised at mercury vapour lights. By contrast, the replacement orange low-pressure sodium lamps are effectively monochromatic, producing no UV, and are therefore much less attractive to insects or bats. The newer pinkish-yellow high-pressure sodium lights have a broader spectral composition, but still relatively little short-wavelength emissions. Like low-pressure sodium, they are therefore much less attractive to insects than mercury vapour: several studies report that insect abundance is around 50% lower, and moths 75% lower at high-pressure sodium compared with mercury vapour lights.

Stone *et al.* (2009) erected high-pressure sodium lights that mimic the intensity and light spectra of streetlights along commuting routes of lesser horseshoe bats *(Rhinolophus hipposideros).* Experimental hedges were illuminated with high-pressure sodium (HPS) streetlights to an average of 53.09 lux (SD = 2.73, range = 47.3–60.2, n = 36). Their experiments demonstrated that bat activity was reduced dramatically and the onset of commuting behaviour was delayed in the presence of lighting, with no evidence of habituation to the presence of such lighting over a period of time. These results demonstrate that light pollution may have significant negative impacts upon the selection of flight routes by bats. But their experiments also showed that once a hedgerow is lit up, the unlit side of the linear habitat feature is also not used. This they consider unsurprising that few bats flew along the unlit side of the hedge, given that light levels on the unlit side on lit nights (mean 4.17 lux) were significantly higher than those along dark hedges (mean 0.45 lux); even these relatively low light levels may make established routes unsuitable for commuting.

In addition, Stone *et al.* (2009) reported that bat activity commenced significantly later on lit nights (mean 78.6 min after sunset) compared to the control treatments. The results from this study imply that light pollution may fragment the network of *R. hipposideros* commuting routes, causing bats to alter their commuting behaviour, which could have significant conservation consequences. Disruption of animal spatial behaviour can decrease energetic gains and increase costs by increasing flight time and stress and cortisol levels, which may in turn reduce survival and reproductive success. For bats, such effects are likely to be more pronounced during periods of high energetic demand such as during the maternity season.

Stone *et al.* (2009) showed that LED street lights caused a reduction in activity of slow-flying bats (such as *Rhinolophus hipposideros* and *Myotis* spp.). Both *R. hipposideros* and *Myotis* spp. activities were significantly reduced even during low light levels of 3.6 lux. There was no effect of LED lighting on the relatively fast-flying *Pipistrellus pipistrellus, Pipistrellus pygmaeus* and *Nyctalus/Eptesicus* spp. This study showed that LED lights can potentially fragment commuting routes for bats with associated negative conservation consequences.

Azam *et al.* (2018) showed that while streetlight attraction effect was mostly limited to a 10m radius for *Pipistrellus* sp. and *Nyctalus* sp., streetlight avoidance was detected at up to 25 and 50m for *Myotis* sp. and *Eptesicus serotinus,* respectively. Streetlight effects on *Myotis* sp. and *Nyctalus* sp. remained after lamps were turned-off. The study showed that illuminance had a negative effect on *Myotis* sp. below 1 lux, a mixed effect on *E. serotinus*, and a positive effect on the other species, although a peak of activity was observed between 1 and 5 lux for *P. pipistrellus* and *N. leisleri*. The authors recommend separating streetlights from ecological corridors by at least 50m and avoiding vertical light trespass beyond 0.1 lux to ensure their use by light-sensitive bats.

The negative effect of Artificial Light At Night (ALAN) on four species of bats was investigated as part this study by Azam *et al*. (2016). Artificial Light At Night (ALAN) is defined as an urban-induced pollution that affects a substantial part of world and it is considered to be increasing on average by 6 % per annum worldwide. However, the responses of bats to ALAN at a landscape scale are unclear. At a local scale, bat responses to ALAN vary among species according to their foraging strategy and flight abilities. In general, it is considered that slow-flying species, that are adapted to prey on insects in cluttered vegetation, such as *Rhinolophus* spp. and *Myotis* spp., are more likely to be affected by illuminance. In contrast, fast-flying species adapted to hunt insects at dusk in the open air, such as *Pipistrellus* spp. and *Nyctalus* spp., can benefit from new and predictable foraging opportunities provided by streetlights which can attract a large proportion of the surrounding flying insect biomass.

In this context, ALAN is likely to be a driver of habitat loss and fragmentation for slow-flying species while creating new and predictable foraging opportunities in the landscape for fast-flying species. However, movements and gap-crossing behaviours of fast-flying species can also be altered by ALAN in urban landscapes, suggesting that an increase in landscape-scale level of ALAN may reduce landscape connectivity for all species regardless of their foraging strategy. Such an increase may also reduce the availability of suitable dark roosting sites in the landscape although essential for the reproduction of all bat species. The authors characterized the landscape-scale impacts of ALAN on 4 insectivorous bat species *Pipistrellus pipistrellus, Pipistrellus kuhlii, Eptesicus serotinus, Nyctalus leisleri,* and compared the extent of their effects to other major land-use pressures. The impact was significant for *P. pipistrellus, P. kuhlii* and *E. serotinus,* but not for *N. leisleri*. This suggests that even if a streetlight can present foraging advantages for some species of bats locally, at a landscape-scale level, ALAN generates a landscape ‘‘filter’’ that negatively influences the occurrence and activity of bats in a given place.

Mathews *et al.* (2015) investigated the implications of lighting for abundant and widespread bats with important ecosystem functions. *Pipistrellus pipistrellus, P. pygmaeus, N. noctula, N. leisleri* and *E. serotinus* are all generally considered light-attracted, potentially using the insect congregations that accumulate at street lamps. However, in the largest investigation to date, this study showed that their activity is not increased, except possibly for *N. leisleri* and for *P. pipistrellus* under certain habitat conditions. For *P. pipistrellus*, activity was actually lower in the lit habitats studied in the English transect study except for where dense tree cover was available, and in the widest scale study (Irish transect study) we found no evidence for increased activity of pipistrelles in transects with lights.

Although part-night lighting schemes have been adopted by many local authorities across Europe to reduce the carbon footprint and save energy, their effects on biodiversity are unknown. This was investigated by Azam *et al*. (2015). It has been suggested that this measure, so-called part-night lighting, is unlikely to limit the impacts of artificial lighting on biodiversity because it does not coincide with the activity peaks of most nocturnal organisms, which occur at dusk when public demand for outdoor lighting is very high. There was significantly more activity on part-night lighting sites compared to full-night lighting sites for the late-emerging, light-sensitive *Plecotus* spp., and a similar pattern was observable for *Myotis* spp., although not significant. In contrast, part-night lighting did not influence the activity of early emerging bat species around streetlights, except for *Pipistrellus pipistrellus* for which there was significantly less activity on part-night lighting sites than on full-night lighting sites. Overall, no significant difference in activity between part- and full-night lighting sites were observed in 5 of the 8 species studied, suggesting that current part-night lighting schemes fail to encompass the range of activity of most bat species. We recommend that such schemes start earlier at night to effectively mitigate the adverse effects of artificial lighting on light-sensitive species, particularly along ecological corridors that are especially important to the persistence of biodiversity in urban landscapes.

Many local authorities are replacing old lighting stock such as low-pressure sodium (LPS) and high-pressure sodium (HPS) street lights with light-emitting diode (LED) street lights [5]. LED street lights offer

a number of advantages over older lighting technologies, including increased energy efficiency, flexibility and longevity. Rowse *et al.* (2018) conducted a field experiment to determine how light intensity affects the activity of the light-opportunistic *Pipistrellus pipistrellus* and light-averse bats in the genus *Myotis*. Four lighting levels controlled under a central management system at existing street lights in a suburban environment (0, 25, 50 and 100% of the original output). Higher light intensities (50 and 100% of original output) increased the activity of light-opportunistic species but reduced the activity of light-averse bats. Compared to the unlit treatment, the 25% lighting level did not significantly affect either *P. pipistrellus* or *Myotis spp*. The results suggest that it is possible to achieve a light intensity that provides both economic and ecological benefits by providing sufficient light for human requirements while not deterring light-averse bats. At the low lighting level (25%), as less light was distributed from the light source, it is likely that dark corridors were created that light-averse species, such as *Myotis* spp., could fly along, either as a more efficient commuting route or even to forage. However, once the street light intensities exceeded 11.35 lux, the perceived threat of predation becomes too great, significantly reducing the number of Myotis spp. passes near the street lights.

Even when LED street lights were dimmed to a low level (mean 3.6 lux, range 2.90–4.86 lux), there were significantly fewer passes from the light-averse bats *Myotis* spp. and *Rhinolophus hipposideros* than on unlit nights. However, dimming street lights to intensity below 3.6 lux may not be feasible: street lights exist for human safety and if humans cannot see their surroundings clearly because the light intensity is too low, this nullifies the benefits of having street lights.

The All Ireland Daubenton's bat Waterways Survey has collated lighting details along 1km transects and has shown that the level of Daubenton's bat activity is reduced by up to 15% in the presence of lighting (Aughney *et al*. 2012, Aughney *et al*. 2017). Linear habitat features are important for many bat species at the landscape level. Many other slow-flying bat species avoid open areas, typically flying within vegetation cover, commuting along hedgerows or tree lines between roosts and foraging areas. Bats use linear landscape features for increased insect abundance, shelter from wind and rain, acoustic orientation, and predator avoidance. Reliance on linear habitat features makes bats vulnerable to habitat fragmentation.

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Royal Canal (1st to 16th lock) macrophyte survey 2023

Prepared by Triturus Environmental Ltd. for

Roughan & O' Donovan Consulting Engineers

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Table of contents

1. Introduction 3

1.1 Project background 3

1.2 Study area description 3

2. Methodology 4

2.1 Desktop review 4

2.2 Macrophyte survey 4

2.3 Species accumulation curve 4

2.4 Biosecurity 5

3. Desktop review (rare/protected species) 7

4. Results 14

4.1 Aquatic vegetation communities & diversity 14

4.2 Rare or protected species 18

4.3 Invasive species 18

5. Discussion 26

5.1 *Tolypella* spp. 26

5.2 *Nitella mucronata* 27

5.3 *Groenlandia densa* 27

6. References 29

7. Appendix A – macrophyte species list & cover 31

8. Appendix B – survey site characteristics 36

1. Introduction

1.1 Project background

Triturus Environmental Ltd. were commissioned by Roughan & O' Donovan Consulting Engineers (ROD) to undertake an annual baseline aquatic macrophyte (aquatic plant) survey of the Royal Canal between the 1st lock (Spencer Dock, Dublin City) and the 16th lock (Kilcock, Co. Kildare). The survey area encompassed a total of 33km of the Royal Canal (**Figure 2.1**). In light of the known presence of several rare and or protected macrophyte species in the Royal Canal, in addition to the various proposed infrastructural projects in the vicinity of the canal (primarily the Royal Canal Greenway), it was deemed pertinent to complete annual baseline assessments of aquatic vegetation to better inform development design, mitigation and conservation in the coming years.

The baseline survey helped to identify, catalogue and map macrophyte assemblages along the Royal Canal, inclusive rare and or protected species and aquatic bryophytes (mosses and liverworts). The surveys would sample and identify all macrophytes (to species level, where possible) but there was a focus on high conservation value Red-listed species (e.g. Stewart & Church, 1992) and those listed under the Flora (Protection) Order, 2022. Invasive macrophyte species were also identified and recorded.

The findings of this report would build on and update previous surveys completed along the Royal Canal (e.g. Invas, 2021; BEC, 2011; EcoServe, 2011). This report constitutes the first of four annual monitoring reports (2023-2026 inclusive), with the survey undertaken in the April-June 2023 period.

1.2 Study area description

The Royal Canal is some 150km long and links the River Liffey in Dublin City with the River Shannon in Co. Longford. The canal is fed by Lough Owel, Co. Westmeath and flows east to Dublin and west to the Shannon. Though originally constructed for transport of goods (work was completed in 1817), the Royal Canal was closed to typical navigation in 1961. The present-day canal serves as a highly valuable recreational amenity site and regionally important ecological corridor. The entire length of the Royal Canal is designated as a proposed Natural Heritage Area (pNHA) (site code: 002103) (NPWS, 1995).

The Royal Canal is known to support a high diversity of submerged and emergent macrophyte species with aquatic vegetation communities typically dominated by whorled water-milfoil (*Myriophyllum verticillatum*), unbranched bur-reed (*Sparganium emersum*), reed sweet-grass (*Glyceria maxima*), bristly stonewort (*Chara hispida*) and the invasive Nuttall's pondweed (*Elodea nuttallii*) (Invas, 2021, 2017). Also present are a low number of high conservation value species, such as the near threatened opposite-leaved pondweed (*Groenlandia densa*) (Wyse-Jackson et al., 2016) and nationally rare pointed stonewort (*Nitella mucronata*) (Sewart & Church, 1992) (see section 3).

In terms of water quality, the Royal Canal within and outside of the survey area was of good WFD status in the 2016-2021 period.

2. Methodology

2.1 Desktop review

A desktop review of published and unpublished data for the Royal Canal was undertaken in respect of macrophyte and aquatic bryophyte species. Records for rare and or protected species held by the Botanical Society of Britain and Ireland (BSBI), National Parks and Wildlife Service (NPWS) and the National Biodiversity Data Centre (NBDC) were also reviewed.

2.2 Macrophyte survey

Macrophyte samples were collected at a total of 20 no. 100m transect sites to determine the community composition and detect any other rare/protected species (**Figure 2.1**). The survey area comprised approximately 33km of contiguous canal between the 1st level (Croke Park) and the 16th lock at Kilcock, Co. Kildare and encompassed a total of 43 no. 1km grid squares, or monads (**Table 2.1, Figure 2.1**). The April to June survey period ensured rare charophyte species, which often demonstrate early spring growth and summer disappearance, would be detected.

Samples were collected at each 100m transect by hand and or using a handheld grapnel from both the bank and or boat. A total of 10 no. grapnel throws were made within each 100m transect (i.e. every c.10m) to maximise the number of meso-habitats sampled. An estimate of the percentage cover (see below) occupied by each species was made using a combination of the grapnel samples and a visual assessment.

Cover for aquatic macrophyte species was assessed relative to the canal width and expressed on a version of the DAFOR scale:

- D - Dominant (>70% cover)
- A - Abundant (31-70% cover)
- F - Frequent (11-30% cover)
- O - Occasional (3-10% cover)
- R - Rare (<3% cover)

Species nomenclature was according to Stace (2019). Rare species as per national Red lists (Wyse-Jackson et al., 2016; Lockhart et al., 2012; Stewart & Church, 1992) were identified in the field with the assistance of Paul Green (BSBI).

2.3 Species accumulation curve

Species accumulation curves are used to describe the increase of species with the increase in sampling effort and serve as an indicator of the validity and adequacy of sampling (Ugland et al., 2003). Sites with a high proportion of rare species and few abundant species have a species accumulation curve with a low inflection point on the y-axis and a long upward sloping line to the asymptote, whereas sites with a high proportion of relatively abundant species have a steep rising initial slope, plateau early and provide an accurate estimate of species richness with less sampling effort than when there is a higher proportion of rare species (Thompson & Withers, 2003). The cumulative number of species

recorded was plotted against the number of sampling sites to interrogate the macrophyte and bryophyte data collected.

2.4 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=20 macrophyte survey sites along the Royal Canal, 2023

Site no.	Location	X (ITM)	Y (ITM)
1	Croke Park	716029	735928
2	Between 2nd & 3rd lock	715688	736059
3	Between 3rd & 4th lock	715425	736151
4	Cross Guns Bridge	715085	736272
5	Cross Guns Quay, Phibsborough	714865	736363
6	6th lock	714588	736479
7	Cabra West	713991	736847
8	Broombridge station	713251	737176
9	R805 road crossing	712689	737359
10	11th lock	709852	737849
11	Granard Bridge	708376	738086
12	Pakenham Bridge	703843	738284
13	Collin's Bridge	702735	736842
14	Confey slipway	701575	736997
15	Cope Bridge	700861	737068
16	Leixlip Louisa Bridge	699242	736491
17	300m east of Pike Bridge	696397	737339
18	Maynooth Harbour	693782	737401
19	Jackson's Bridge	691578	737700
20	Harbour Road, Kilcock	688949	739402

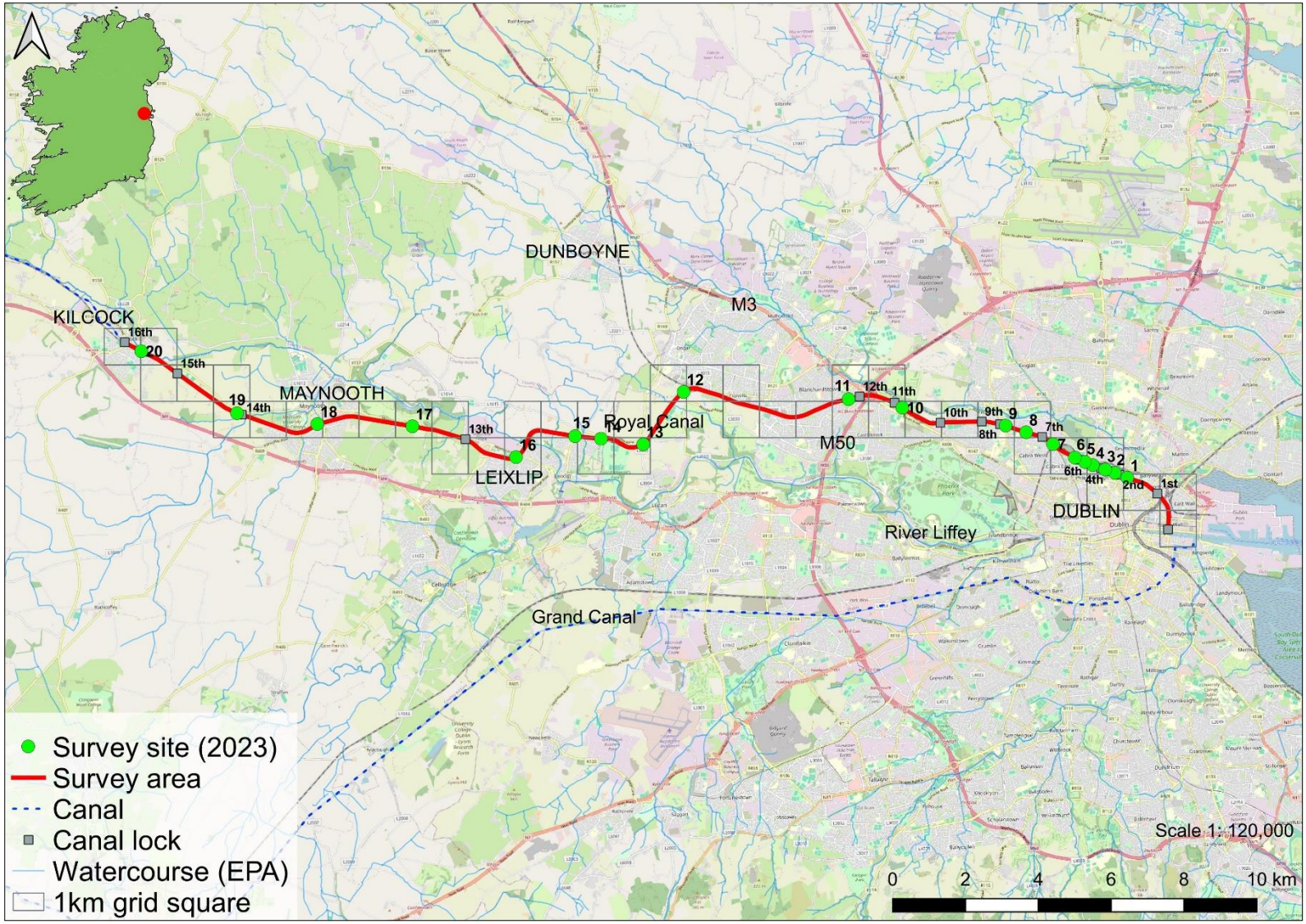


Figure 2.1 Overview of the Royal Canal macrophyte survey area and monitoring sites, 2023 (covering 43 no. 1km grid squares/monads)

3. Desktop review (rare/protected species)

A review of BSBI data for the survey area (totalling 43 no. 1km grid squares, or monads) revealed the presence of records for a low number of rare and or protected aquatic species within the Royal Canal. Macrophyte records were available for 17 no. 1km grid squares.

There was a very high number of records (>250) for the near threatened (Wyse-Jackson et al., 2016) and FPO species opposite-leaved pondweed (*Groenlandia densa*) (mostly BSBI data but also BEC, 2011). The vast majority of these records were from the 2010-2023 period and were confined to between the 1st lock and 6th lock (**Figure 3.1**). Records invariably represented individual plants present in larger stands, thus resulting in large overlap with regards to longitudinal distribution.

A total of 9 no. records were available for the vulnerable tassel stonewort (*Tolypella intricata*) (Stewart & Church, 1992)[1] within the survey area (**Figure 3.2**). However, all were historical only (1991-1992) with records scattered between Binn's Bridge and Louisa Bridge, Leixlip. Nash & King (1993) recorded *T. intricata* between Granard Bridge and Cross Gun's Bridge, typically within 1m metre from the bank growing in silt in 0.5m water depth.

Records for pointed stonewort (*Nitella mucronata*) were available for 2018 between Spencer Dock and the 6th lock and also between the 11th lock and Talbot Bridge (**Figure 3.3**). This species is nationally rare in Ireland (Stewart & Church, 1992).

A total of 13 no. contemporary records (2018) were available for clustered stonewort (*Tolypella glomerata*) between Phibsborough and Leixlip (**Figure 3.4**). A low number of historical records were also available between Ashtown and Leixlip (1991-1992, data not shown). Whilst not protected or Red-listed, this species is considered rare in Ireland.

A low number of records (7 no.) for narrow-leaved water-plantain (*Alisma lanceolatum*) were available for the survey area, between Phibsborough and Maynooth in 2018 (**Figure 3.5**). Again, whilst not a protected or Red-listed species, the plant is uncommon at a national level.

The Red-listed (vulnerable) dwarf stonewort *Nitella tenuissima* is known from several locations of the Royal (and Grand) Canal (e.g. recorded at Kelly's Bridge, Co. Westmeath in 2019; Invas, 2021), where it appears to favour open areas of shallows with a clay substrate (Caffrey & Monahan, 1994). However, no records are known from the current survey area.

[1] Please note that at the time of writing a new Chara red list was in preparation but was not currently available at the time of writing the current report (N. Stewart, pers. comm.)

Table 3.1 Summary of the high conservation value macrophyte species known from the Royal Canal survey area prior to this survey, covering 43 no. 1km grid squares (monads) (BSBI data)

Common name	Species	Monads present (of 43)	Conservation status
Opposite-leaved pondweed	*Groenlandia densa*	4	Near threatened (Wyse-Jackson et al., 2016); Flora (Protection) Order, 2022
Tassel stonewort	*Tolypella intricata*	9	Vulnerable (Stewart & Church, 1992)
Pointed stonewort	*Nitella mucronata*	2	Rare (Stewart & Church, 1992)
Clustered stonewort	*Tolypella glomerata*	11	None (but nationally rare)
Narrow-leaved water-plantain	*Alisma lanceolatum*	7	None (but nationally uncommon)

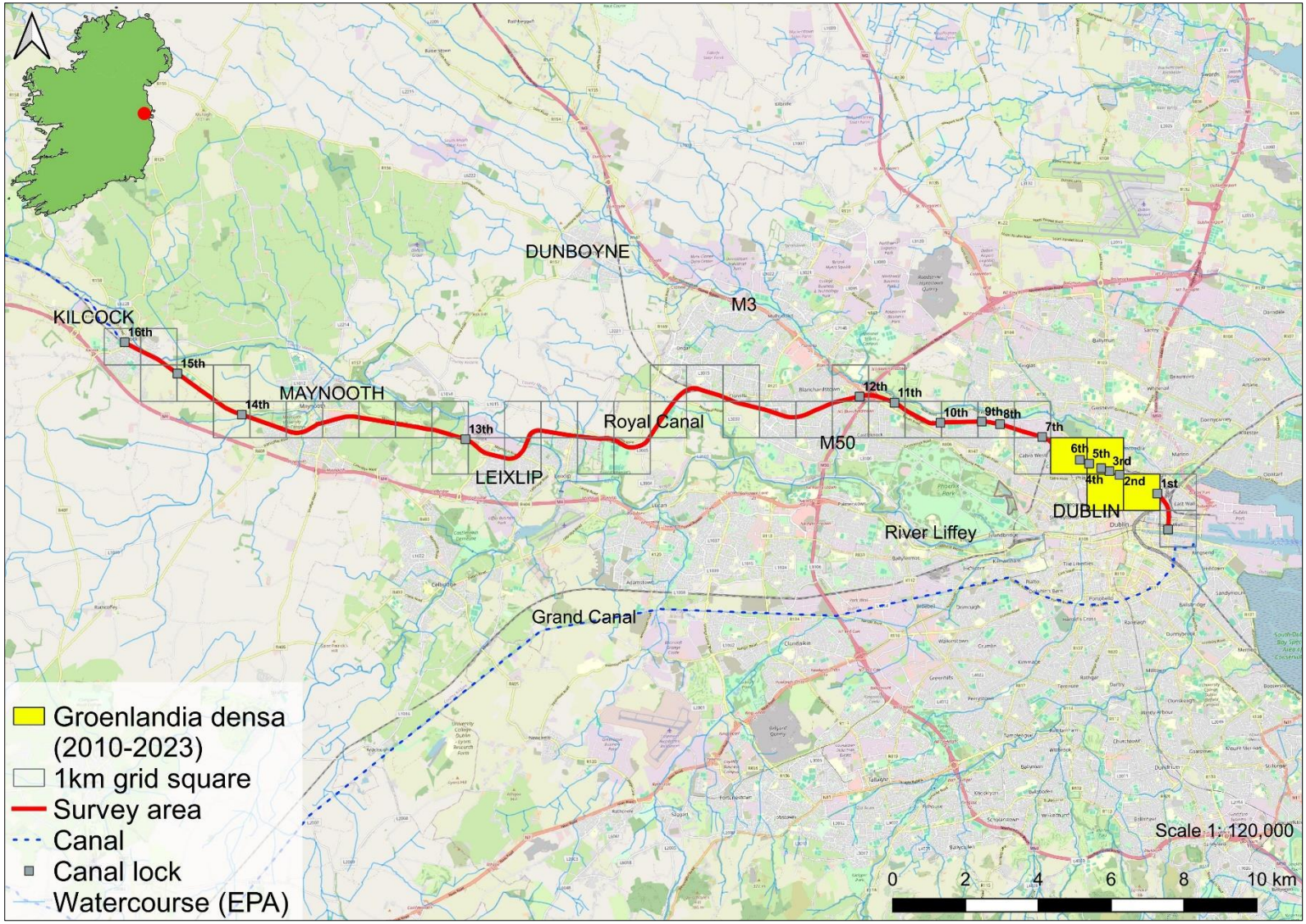


Figure 3.1 Known distribution of opposite-leaved pondweed (*Groenlandia densa*) in the current survey area (source: BSBI)

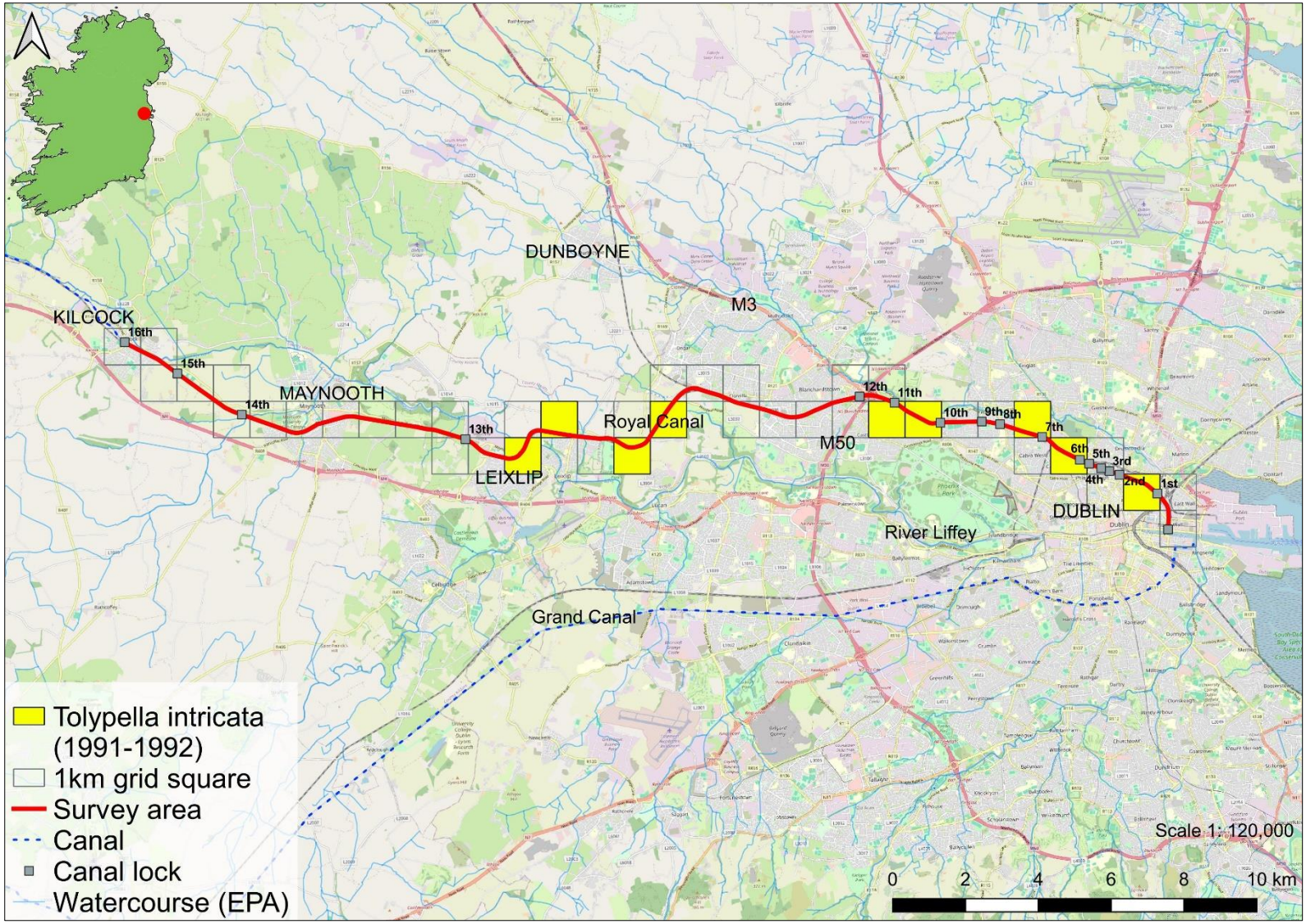


Figure 3.2 Known distribution of tassel stonewort (*Tolypella intricata*) in the current survey area (source: BSBI)



Figure 3.3 Known distribution of pointed stonewort (*Nitella mucronata*) in the current survey area (source: BSBI)

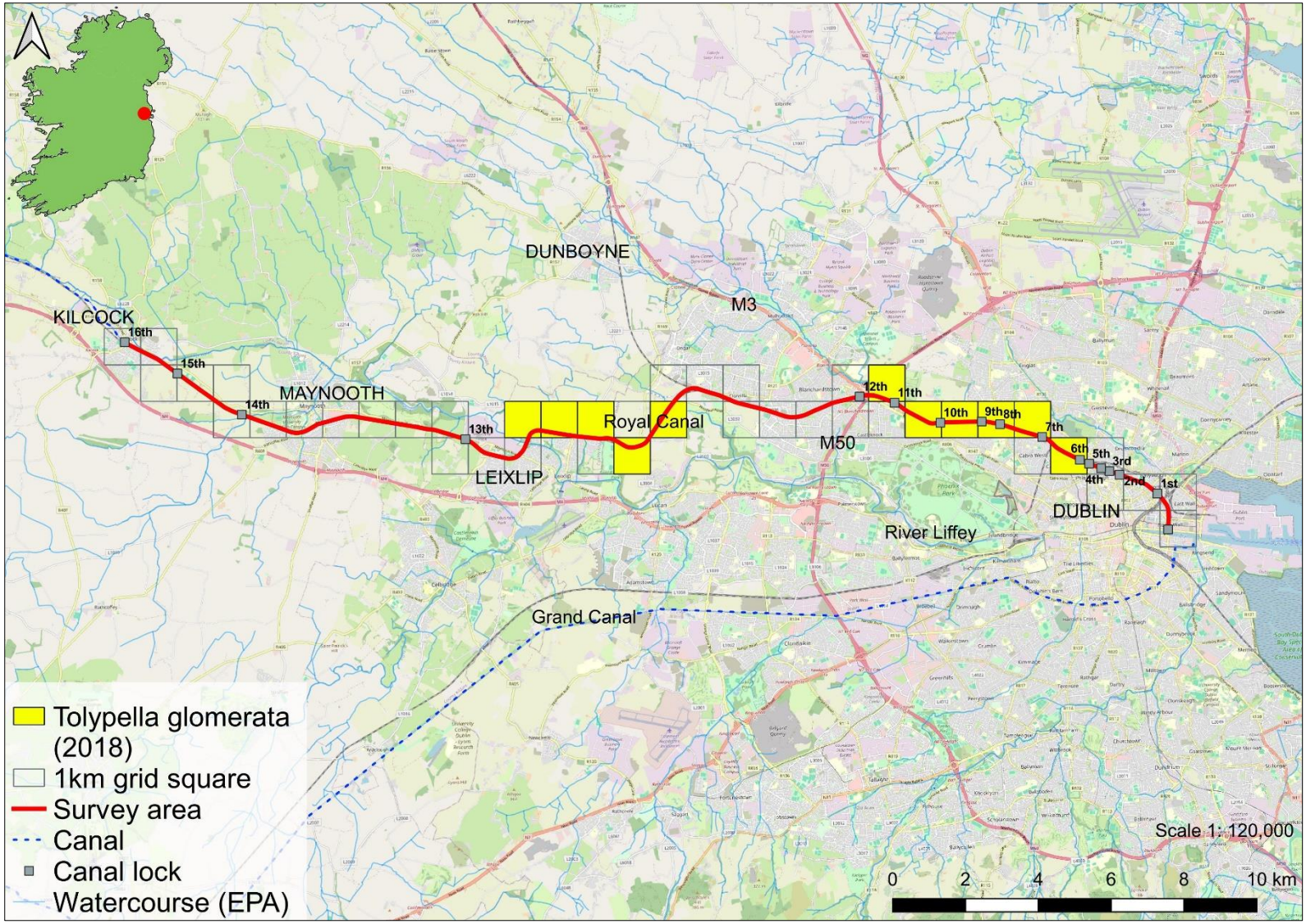


Figure 3.4 Known distribution of clustered stonewort (*Tolypella glomerata*) in the current survey area (source: BSBI)

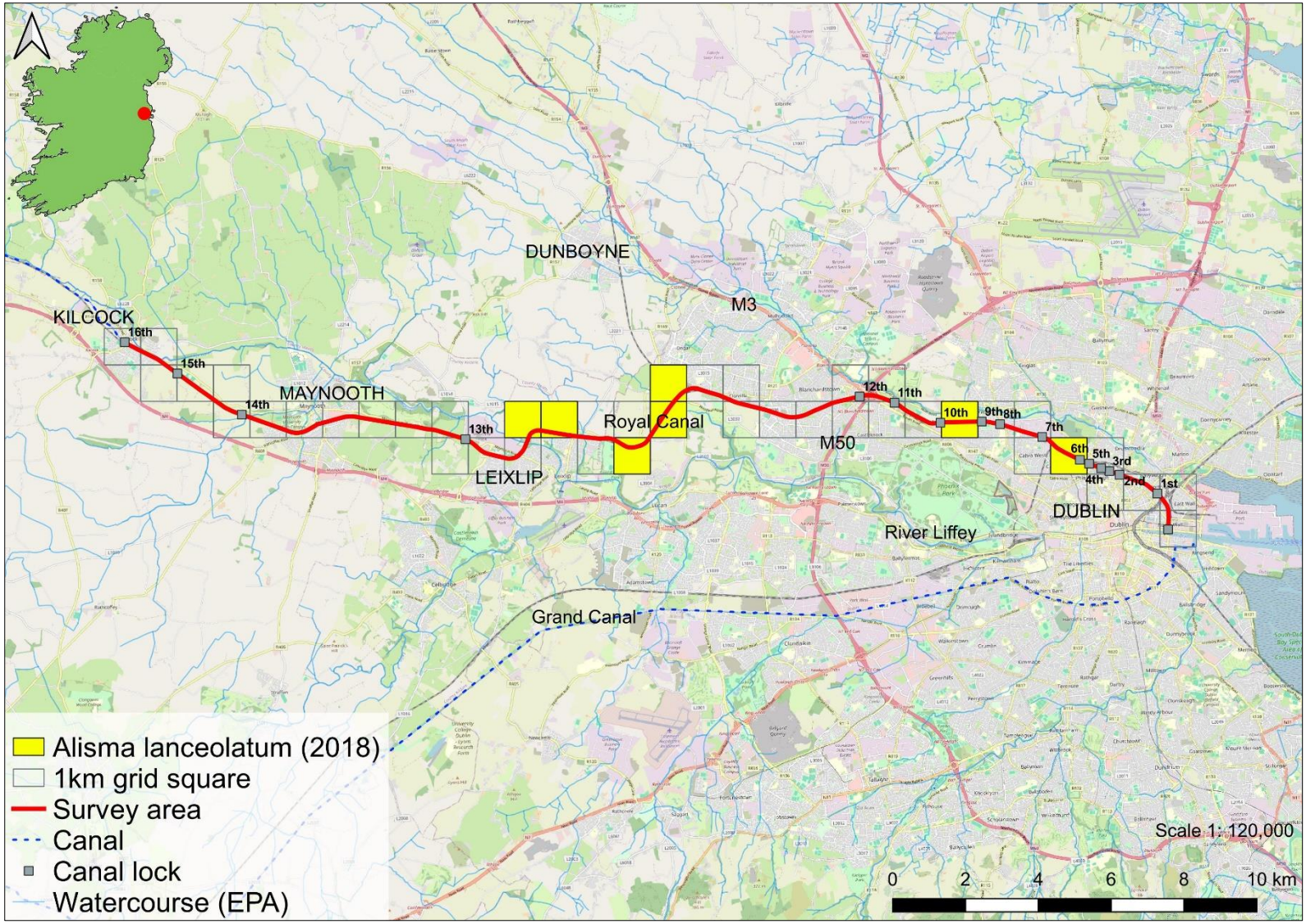


Figure 3.5 Known distribution of narrow-leaved water-plantain (*Alisma lanceolatum*) in the current survey area (source: BSBI)

4. Results

4.1 Aquatic vegetation communities & diversity

A total of *n*=38 macrophyte species and *n*=1 no. aquatic bryophytes were recorded during the current survey (**Appendix A**). This included a low number of protected species, namely *Groenlandia densa* and *Nitella mucronata* (see 4.2 below) (**Table 4.1**). A full site-by-site summary of macrophyte species and their relative percentage cover (DAFOR) is provided in **Appendix A**.

Whilst macrophyte communities naturally varied between sites/canal sections, the most widespread submerged/floating species were (in order of occurrence) the invasive *Elodea canadensis* (89% of sites) followed by *Nuphar lutea*, *Lemna trisulca*, *Hippuris vulgaris*, *Myriophyllum verticillatum* and *Alisma plantago-aquatica* (**Table 4.1; Appendix A**). The most frequent emergent species, often present as a narrow marginal fringe, were *Sparganium erectum*, *Glyceria maxima*, *Iris psuedacorus* and *Schoenoplectus lacustris* (**Table 4.1**).

Stoneworts were more restricted in their distributions, with a total of 8 no. species recorded (**Table 4.1; Appendix A**). The most frequent of these were *Tolypella glomerata* (37% of sites) and *Chara globularis* (32%). The Red-listed *Nitella mucronata* was recorded at sites 2 and 17 (**Figure 4.4**). Other stonewort species recorded were *Chara vulgaris, Chara virgata, Chara contraria, Chara hispida and Nitella opaca*.

A number of macrophyte species were infrequent and were recorded at a single site only, namely small pondweed (*Potamogeton pusillus*), the hybrid species long-leaved pondweed (*Potamogeton* × *angustifolius*), rigid hornwort (*Ceratophyllum demersum*), floating sweet-grass (*Glyceria fluitans*), white water lily (*Nymphae alba*), bulrush (*Typha latifolia*), reed canary grass (*Phalaris arundinacea*), great fen-sedge (*Cladium mariscus*) and the dark stonewort (*Nitella opaca*) (**Table 4.2; Appendix A**).

The river moss *Fontinalis antipyretica* was the only aquatic bryophyte recorded during the survey. This was often present on lock walls, quay walls or, occasionally, instream structure such as large boulders or fallen trees (i.e. sites 1, 2, 5, 6, 16 & 17).

In terms of macrophyte diversity, the species richness (number of species) at each survey site ranged from 7 (site 7) to 15 (sites 1 & 5) (mean 11.1 ±2.2SD, median 11) (**Figure 4.1**). The species richness was typically similar across sites moving east to west, although slightly higher numbers of species were present between Croke Park and Phibsborough and Granard Bridge to Confey slipway. The frequency of charophytes typically increased west of Granard Bridge (Castleknock) (**Appendix A**).

Plotting the number of species against sampling effort (number of sampling sites = 19) the cumulative species richness curve (**Figure 4.2**) indicates the true number of species in the survey area may be slightly underestimated, i.e. the curve has not yet fully reached (but is approaching) its asymptote. The curve produced rises steeply and begins to plateau early as would be expected for study areas with a high proportion of relatively abundant and widespread species (Thompson & Withers, 2003).

Table 4.1 Summary of the macrophyte species recorded from the Royal Canal, April-June 2023

Common name	Species	Conservation status	No. sites	% occurrence
Submerged/floating				
Canadian pondweed	*Elodea canadensis*	**Invasive species (S.I. 477/2011)**	17	89%
Yellow water lily	*Nuphar lutea*		14	74%
Ivy-leaved duckweed	*Lemna trisulca*		13	68%
Mare's-tail	*Hippuris vulgaris*		13	68%
Whorled water-milfoil	*Myriophyllum verticillatum*		9	47%
Common water plantain	*Alisma plantago-aquatica*		9	47%
Nuttall's pondweed	*Elodea nuttallii*	**Invasive species (S.I. 477/2011)**	8	42%
Spiked water-milfoil	*Myriophyllum spicatum*		6	32%
Fennel pondweed	*Stuckenia pectinata*		6	32%
Amphibious bistort	*Persicaria amphibia*		5	26%
Horned pondweed	*Zannichellia palustris*		4	21%
Arrowhead	*Sagittaria sagittifolia*		4	21%
Curled pondweed	*Potamogeton crispus*		3	16%
Opposite-leaved pondweed	*Groenlandia densa*	**Near threatened (Stewart & Church, 1992); FPO**	2	11%
Fan-leaved water-crowfoot	*Ranunculus circinatus*		2	11%
Small pondweed	*Potamogeton pusillus*		1	5%
Long-leaved pondweed	*Potamogeton × angustifolius*		1	5%
Rigid hornwort	*Ceratophyllum demersum*		1	5%
Floating sweet-grass	*Glyceria fluitans*		1	5%
White water lily	*Nymphae alba*		1	5%
Emergent				
Branched bur-reed	*Sparganium erectum*		13	68%
Reed sweet-grass	*Glyceria maxima*		10	53%
Iris	*Iris psuedacorus*		10	53%
Common clubrush	*Schoenoplectus lacustris*		8	42%
Bottle sedge	*Carex rostrata*		5	26%
Water mint	*Mentha aquatica*		4	21%

Hemlock water-dropwort	*Oenanthe crocata*		3	16%
Bulrush	*Typha latifolia*		1	5%
Reed canary grass	*Phalaris arundinacea*		1	5%
Great fen-sedge	*Cladium mariscus*		1	5%
Bryophytes				
River moss	*Fontinalis antipyretica*		6	32%
Charophytes				
Clustered stonewort	*Tolypella glomerata*		7	37%
Fragile stonewort	*Chara globularis*		6	32%
Common stonewort	*Chara vulgaris*		4	21%
Bristly stonewort	*Chara hispida*		4	21%
Delicate stonewort	*Chara virgata*		2	11%
Opposite stonewort	*Chara contraria*		2	11%
Pointed stonewort	*Nitella mucronata*	**Rare (Stewart & Church, 1992)**	2	11%

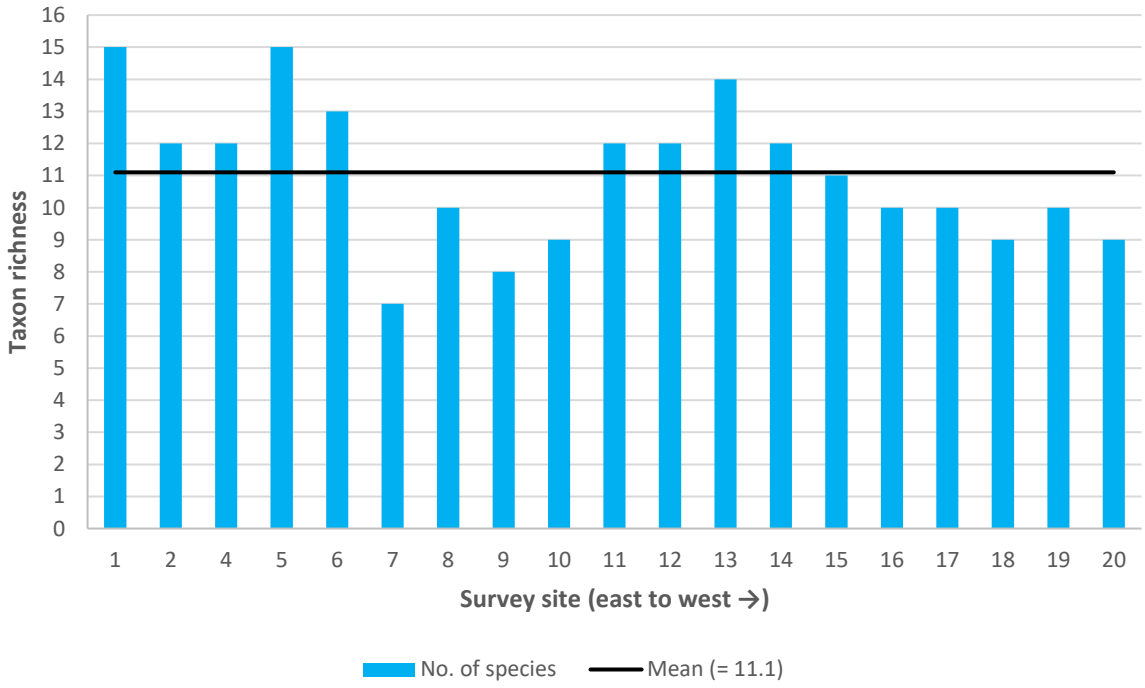


Figure 4.1 Longitudinal macrophyte species richness (no. species) per survey site[2], April-June 2023

[2] site 3 located between the 3rd and 4th locks was not accessible for survey in April-June 2023 due to construction works

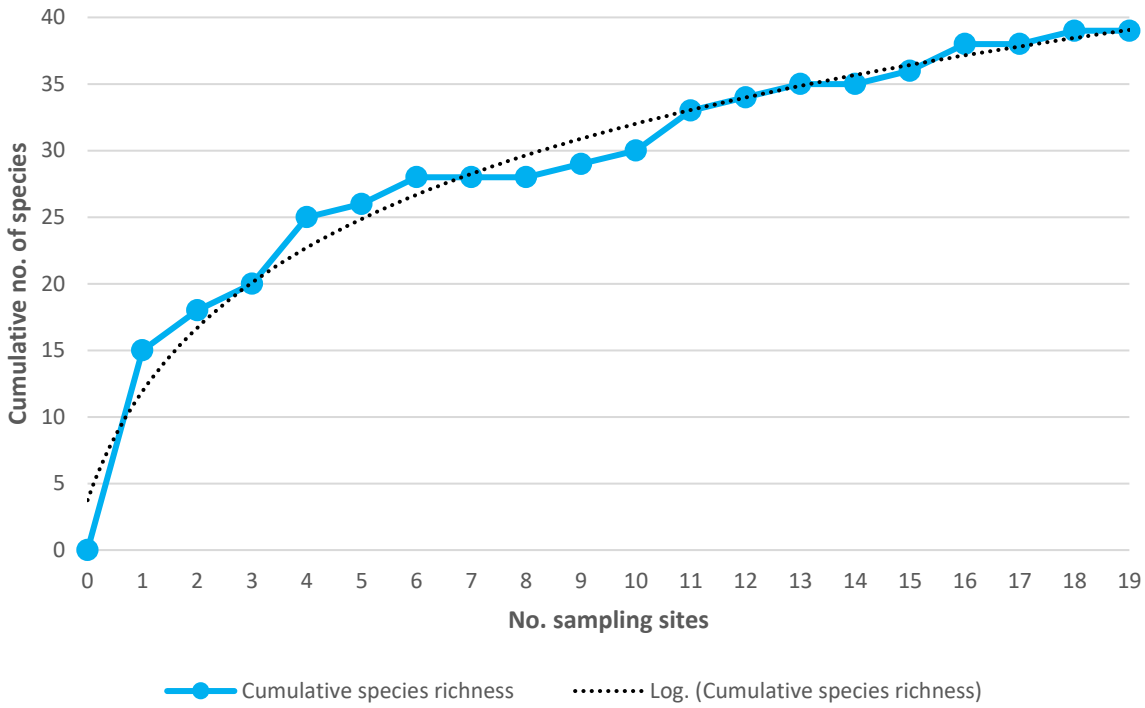


Figure 4.2 Cumulative macrophyte species richness curve (east to west) for the 2023 survey sites

Table 4.2 Summary of the high conservation value macrophyte species recorded from the Royal Canal, April-June 2023

Common name	Species	Conservation status	Sites recorded (DAFOR)
Opposite-leaved pondweed	*Groenlandia densa*	Near threatened (Wyse-Jackson et al., 2016); Flora (Protection) Order, 2022	1 (R), 2 (R)
Pointed stonewort	*Nitella mucronata*	Rare (Stewart & Church, 1992)	2 (F), 17 (R)
Clustered stonewort	*Tolypella glomerata*	None (but nationally rare)	1 (O), 6 (R), 11 (R), 13 (O), 14 (O), 15 (O), 16 (R)

4.2 Rare or protected species

The near threatened and FPO species opposite-leaved pondweed (*Groenlandia densa*) was recorded from sites 1 and 2 only, between the 1st and 2nd locks and the 2nd and 3rd locks respectively (**Table 4.2**; **Figure 4.3**). A small, dense stand of opposite-leaved pondweed was identified alongside the wall of the 2nd lock (site 2) (**Plate 4.2**), whilst the species was sparsely scattered at site 1.

The nationally rare, Red-listed pointed stonewort (*Nitella mucronata*) was recorded from site 2 (near Binn's Bridge) and site 17 (near Pike Bridge) (**Figure 4.4**). Whilst the species was frequent at site 2, being well scattered on exposed areas of silt throughout the 100m transect, it was rare at site 17, being confined to a large bay east of Pike Bridge.

No examples of the vulnerable tassel stonewort (*Tolypella intricata*) were identified during the survey despite previous records within the survey area (**Figure 3.1**).

4.3 Invasive species

The two invasive pondweed species Canadian pondweed (*Elodea canadensis*) and Nuttal's pondweed (*Elodea nuttallii*) were recorded at multiple sites in the current survey, being present at 17 no. and 8 no. sites respectively (**Table 4.1; Appendix A**). Both of these widespread species are listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and are considered high-risk invasive species in Ireland (O' Flynn et al., 2014).

Whilst spreading rapidly on the adjacent Grand Canal (pers. obs.), no stands of New Zealand pigmyweed (*Crassula helmsii*) was recorded during the survey, in keeping with the known distribution of this species in Irish waters.



Plate 4.1 The nationally rare (but not protected) clustered stonewort (*Tolypella glomerata*) recorded from site 6 at Phibsborough, May 2023



Plate 4.2 Characteristic habitat for clustered stonewort (*Tolypella glomerata*) at Phibsborough – exposed clay in the upper littorals with no competition from other macrophytes



Plate 4.3 Small stand of the near threatened, FPO species opposite-leaved pondweed (*Groenlandia densa*) recorded from site 2 adjacent the 2nd lock, May 2023



Plate 4.4 Fragment of *Groenlandia densa* (centre) and *Nitella mucronata* (left) recorded from site 2, May 2023



Plate 4.5 Macro shot of *Nitella mucronata* recorded at site 2, May 2023 (ultimate segment of branchlets 2-3 celled with at least one cell well developed; as per Stewart, 2010)



Plate 4.6 Abundant mare's-tail (*Hippuris vulgaris*) with high cover of filamentous algal mats at Broombridge, May 2023



Plate 4.7 Typically narrow riparian fringe along the Royal Canal near Pakenham Bridge



Plate 4.8 *Chara* spp. in the uppermost littorals on the Royal Canal at site 14, April 2023



Plate 4.9 Chara rich bay west of Pike Bridge

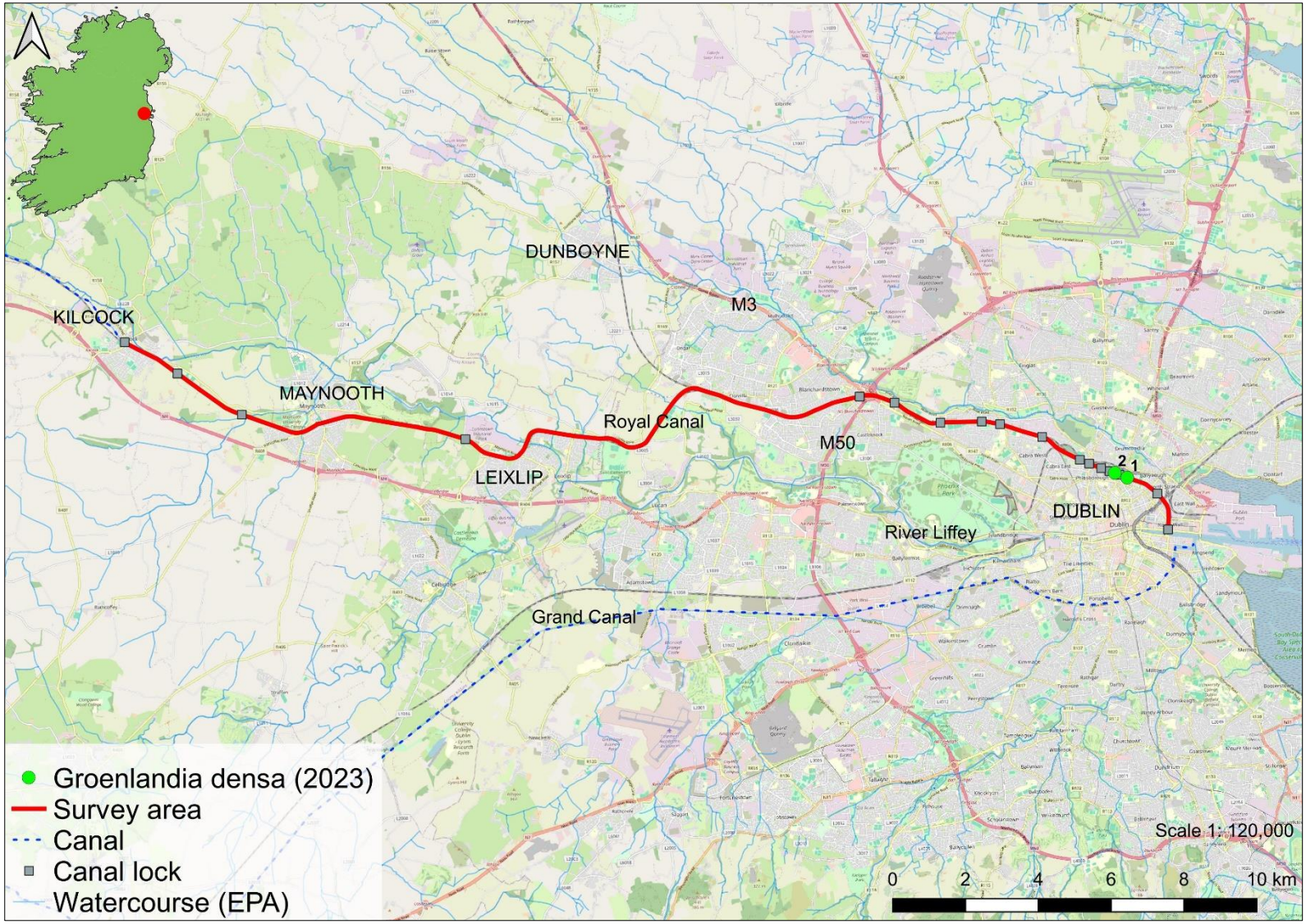


Figure 4.3 Positive *Groenlandia densa* sites in the Royal Canal survey area, April-June 2023

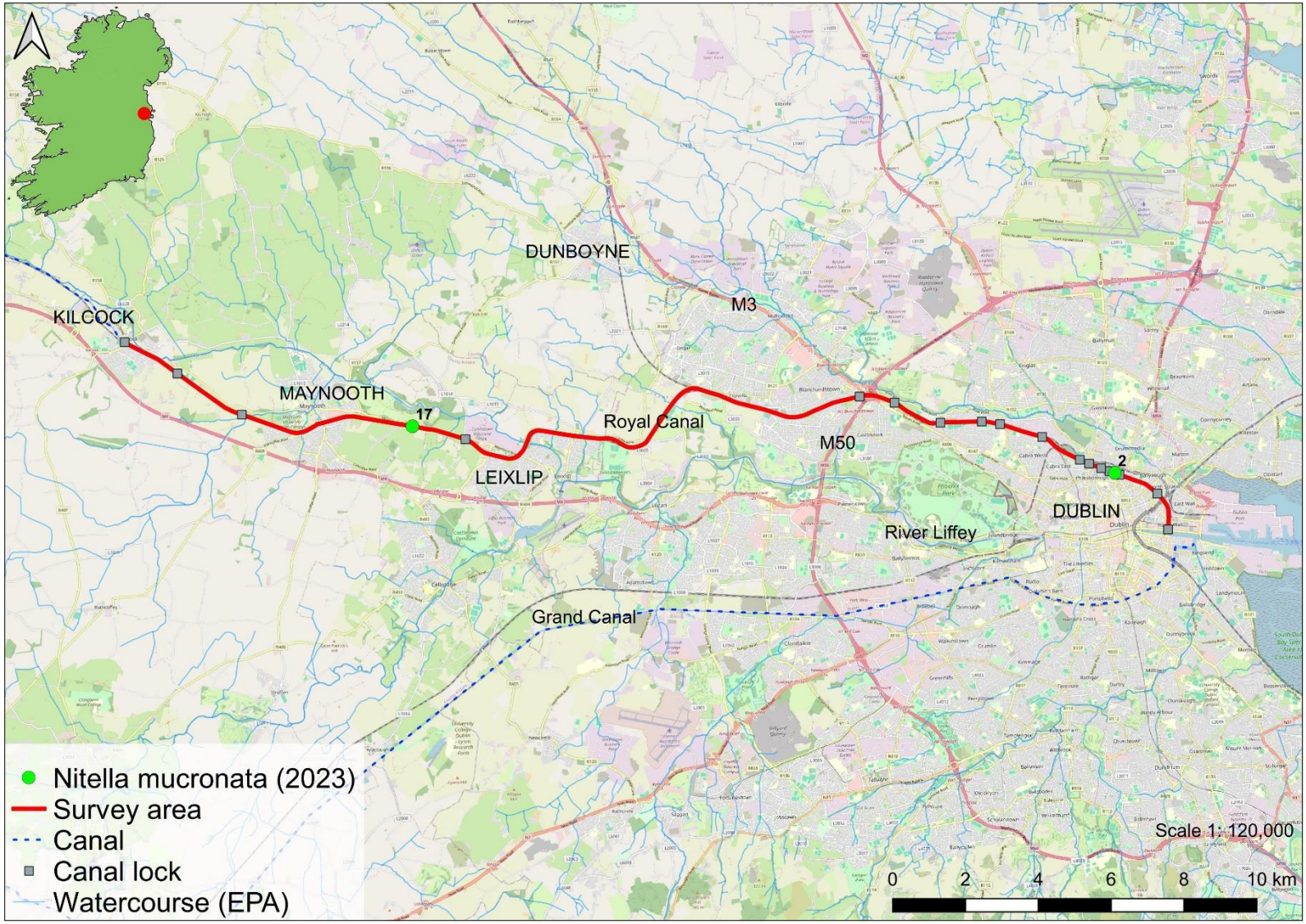


Figure 4.4 Positive *Nitella mucronata* sites in the Royal Canal survey area, April-June 2023

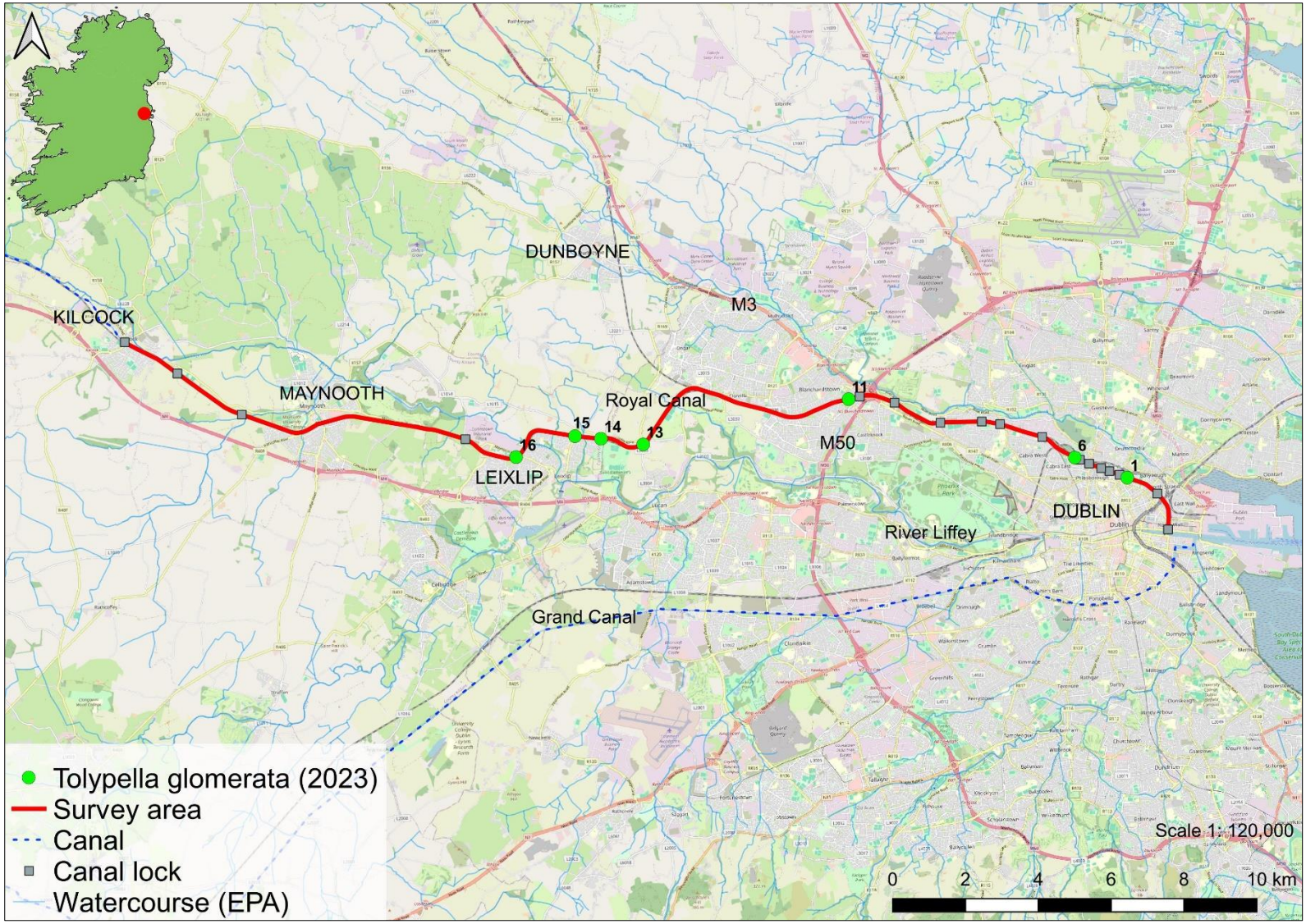


Figure 4.5 Positive *Tolypella glomerata* sites in the Royal Canal survey area, April-June 2023

5. Discussion

The current survey of macrophyte communities along 33km of the Royal Canal has provided a robust, contemporary baseline with which future data can be compared with, helping to identify potential trends in populations and assemblages as well as the occurrence of rare or protected and invasive species.

The Royal Canal, which is typically shallow with clear water, base-rich conditions and low instream disturbance levels (e.g. infrequent boat traffic), provides conditions amenable to diverse and often abundant macrophyte communities (Caffrey et al., 2006; Caffrey, 1991). A total of *n*=39 macrophyte and aquatic bryophyte species across 18 no. families were recorded during the current survey, with most survey transects dominated by common submerged species such as Canadian pondweed (invasive), yellow lily, ivy-leaved duckweed, mare's-tail, whorled water-milfoil and common water plantain (**Table 4.1; Appendix A**). The current survey identified a single protected macrophyte species that was previously known from the survey area, namely *Groenlandia densa* and Red-listed *Nitella mucronata*. The nationally rare stonewort *Tolypella glomerata* was also recorded (see below).

The distribution of aquatic vegetation in the Royal Canal is influenced by several factors, chiefly instream and bankside maintenance, including weed control to ameliorate recreational activities (Invas, 2021; Caffrey et al., 2006; Monahan & Caffrey, 1996). This is particularly relevant regarding the growth of charophyte species which thrive in the euphotic zone and whose distribution is strongly influenced by competition for light and nutrients with canopy-forming macrophyte species such as *Myriophyllum* spp. and pondweeds (Garland et al., 2022; Pełechaty et al., 2014). As such, charophytes typically *benefit* from disturbance, including water draw-downs and weed removal operations, and are among the first colonisers of disturbed habitats (pioneer species), including in Irish canals (Caffrey & Monahan, 1997). The frequency of charophytes (albeit localised) typically increased west of Granard Bridge (Castleknock) where small areas of exposed marginal clay and silt not dominated by competitive macrophytes became more common (**Appendix A**).

Species richness was typically highest in the Croke Park to Phibsborough area (*n*=12-15, sites 1-6 inclusive) and between Granard Bridge and Confey slipway (*n*=12-14, sites 11-14 inclusive). The canal from Pakenham Bridge to Leixlip was typically more macrophyte-rich and less urbanised than the sections either side, thus providing a more varied range of micro-habitats. The cumulative species richness curve (**Figure 4.2**) indicates the true number of species in the survey area is being slightly underestimated, i.e. the curve has not yet reached (but is approaching) its asymptote. This would suggest that a slight increase in the number of sampling sites for subsequent annual monitoring would better detect the full range of macrophyte species within the Royal Canal, including rare species. Variations in annual survey sites (transects) would also provide a more comprehensive dataset for the survey area.

5.1 *Tolypella* spp.

No examples of the vulnerable tassel stonewort (*Tolypella intricata*) were identified during the survey despite previous records (1991-1992) within the survey area (**Figure 3.1**). This species favours

disturbance[3] and seasonally fluctuating waterbodies (Cirujano Bracamonte et al., 2013) although it has been previously recorded in shallow littorals of the Royal Canal (≤0.5m; Nash & King, 1993). Much of the survey area is not conducive to the growth of this species due to depths, unsuitably steep marginal slopes and competition from other macrophyte species. However, *T. intricata* spores are known for their long-term viability (Corillion, 1957) and the species periodically re-establishes following significant disturbance of the seed bank (Nash & King, 1993; Stewart & Church, 1992) but typically disappear as competing vegetation increases (Stewart & Hatton-Ellis, 2020). Canal repair/maintenance works undertaken in Dublin City during the current survey (2nd to 5th locks) may result in the reappearance of this species in future monitoring years.

In contrast, the clustered stonewort (*Tolypella glomerata*) was recorded from 7 no. sites during the current survey (**Figure 4.5**), with its distribution broadly overlapping with previous data (**Figure 3.4**). *Tolypella glomerata* is a pioneer species (Caffrey & Monahan, 1997) that can inhabit a range of seasonal and shallow, permanent habitats (Cirujano Bracamonte et al., 2013). In the current survey, this species was recorded in localised stands on exposed silt or clay, often but not always (e.g. site 1) in the upper littorals of the canal where competition from other macrophytes was low or absent (**Plate 4.2**).

5.2 *Nitella mucronata*

The Red-listed pointed stonewort (*Nitella mucronata*) was recorded from site 2 (near Binn's Bridge) and site 17 (near Pike Bridge) (**Figure 4.4**). The species is often associated with a diverse aquatic flora but usually occurs in the gaps among denser vegetation or where the vegetation becomes sparser at the lower edge of the photic zone (Stewart & Hatton-Ellis, 2020). Such conditions were present at sites 2 and 17, respectively. Whilst *Nitella mucronata* is listed as rare in the current Irish Red list (Stewart & Church, 1992), the species is increasing across Ireland[4] and is likely to be removed from the imminent updated Irish Red list for charophytes (Nick Stewart pers. comm.).

5.3 *Groenlandia densa*

In keeping with the known distribution of opposite-leaved pondweed (*Groenlandia densa*), the species was recorded from sites 1 and 2 only, between the 1st and 2nd locks and the 2nd and 3rd locks respectively (**Table 4.2**; **Figure 4.3**). The absence of opposite-leaved pondweed from other known sites of occurrence (e.g. the 5th lock) is possibly due to depth constraints/steep margins and or the currently high cover of competing species such as *Lemna trisulca* and *Myriophyllum* spp.

In Ireland, opposite-leaved pondweed is typically associated with tidal stretches of rivers and other periodically disturbed watercourses including canals and drains, where it ostensibly benefits from the reduction in competition with other macrophytes through disturbance (Reynolds et al., 2006). This calcicolous species is often referred to as a ruderal or pioneer species, especially following dredging operations where it can colonise or recolonise disturbed or bare areas rapidly (e.g. Henry & Amoros, 1996) given its densely-packed ramets and high growth rates (Greulich & Bornette, 1999). Similar to other opportunist species such as *Tolypella* spp., canal maintenance works in the survey area may

[3] Records for the 1991-92 period coincided with canal restoration works and dredging, thus allowing *Tolypella intricata* to establish temporarily due to low competition with other macrophytes (Nick Stewart pers. comm.)
[4] this spread is attributed to the non-indigenous *N. mucronata* var. *gracillima*

result in the re-establishment and or spread of this species in future monitoring years. Opposite-leaved pondweed has declined in Ireland (Preston, 2003; Preston et al., 2002) due to land drainage and reclamation, pollution, peat run-off and loss of habitat due to infilling of watercourses. Consequently, it is protected under the Wildlife Acts (1976-2023) and is listed on Schedule A of the Flora (Protection) Order, 2015 (S.I. No. 235/2022). Due to a reduction in its area of occupancy, the plant is also classified as 'near threatened' on the Ireland Red List for vascular plants (Wyse Jackson et al., 2016).

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7. Appendix A – macrophyte species list & cover

Table 7.1a Macrophyte species and % cover (DAFOR scale) recorded at survey sites 1-10 on the Royal Canal, April-June 2023

Family	Common name	Species	1	2	3[5]	4	5	6	7	8	9	10
Hydrocharitaceae	Canadian pondweed	*Elodea canadensis*	O	D	n/a	R	A	F	F	F	O	F
Nymphaeaceae	Yellow water lily	*Nuphar lutea*			n/a			O	F	F	O	F
Araceae	Ivy-leaved duckweed	*Lemna trisulca*	A	A	n/a	F	F	R	F	A	A	A
Plantaginaceae	Mare's-tail	*Hippuris vulgaris*	R		n/a		O	D		F	O	A
Haloragaceae	Whorled water-milfoil	*Myriophyllum verticillatum*	A	D	n/a	A		R		R		R
Alismataceae	Common water plantain	*Alisma plantago-aquatica*			n/a		R	R				
Hydrocharitaceae	Nuttall's pondweed	*Elodea nuttallii*	O		n/a	D	A					
Haloragaceae	Spiked water-milfoil	*Myriophyllum spicatum*			n/a		A	R	R	R		
Potamogetonaceae	Fennel pondweed	*Stuckenia pectinata*	O	O	n/a	O	O					
Polygonaceae	Amphibious bistort	*Persicaria amphibia*	R		n/a	R		R			R	
Potamogetonaceae	Horned pondweed	*Zannichellia palustris*	R	R	n/a		F					
Alismataceae	Arrowhead	*Sagittaria sagittifolia*	R		n/a							R
Potamogetonaceae	Curled pondweed	*Potamogeton crispus*	R		n/a	R	F					
Potamogetonaceae	Opposite-leaved pondweed	*Groenlandia densa*	R	R	n/a							
Ranunculaceae	Fan-leaved water-crowfoot	*Ranunculus circinatus*	R	R	n/a							
Potamogetonaceae	Small pondweed	*Potamogeton pusillus*	R	R	n/a		R					
Potamogetonaceae	Long-leaved pondweed	*Potamogeton × angustifolius*			n/a							
Ceratophyllaceae	Rigid hornwort	*Ceratophyllum demersum*			n/a		R					
Poaceae	Floating sweet-grass	*Glyceria fluitans*			n/a				R			
Nymphaeaceae	White water lily	*Nymphae alba*			n/a				R			
Typhaceae	Branched bur-reed	*Sparganium erectum*		R	n/a	R		R	R	R	R	
Poaceae	Reed sweet-grass	*Glyceria maxima*			n/a	R				R	R	R

[5] site 3 located between the 3rd and 4th locks was not accessible for survey in April-May 2023 due to construction works

Family	Common name	Species	1	2	3[5]	4	5	6	7	8	9	10
Iridaceae	Iris	*Iris psuedacorus*			n/a	R				R	R	R
Cyperaceae	Common clubrush	*Schoenoplectus lacustris*			n/a							
Cyperaceae	Bottle sedge	*Carex rostrata*	R	R	n/a							R
Lamiaceae	Water mint	*Mentha aquatica*	R	R	n/a							
Apiaceae	Hemlock water-dropwort	*Oenanthe crocata*			n/a		O			R		
Typhaceae	Bulrush	*Typha latifolia*			n/a							
Poaceae	Reed canary grass	*Phalaris arundinacea*			n/a	R						
Cladium mariscus	Great fen-sedge	*Cladium mariscus*			n/a							
Fontinalaceae	River moss	*Fontinalis antipyretica*	O	O	n/a		O	O				
Characeae	Clustered stonewort	*Tolypella glomerata*	O		n/a			R				
Characeae	Fragile stonewort	*Chara globularis*			n/a							
Characeae	Common stonewort	*Chara vulgaris*		R	n/a	R	F	R				
Characeae	Bristly stonewort	*Chara hispida*			n/a							
Characeae	Delicate stonewort	*Chara virgata*			n/a							
Characeae	Opposite stonewort	*Chara contraria*			n/a		A	R				
Characeae	Pointed stonewort	*Nitella mucronata*		F	n/a							
Characeae	Dark stonewort	*Nitella opaca*			n/a							
Species richness			**15**	**12**	n/a	**12**	**15**	**13**	**7**	**10**	**8**	**9**
Cumulative species richness			12	18	n/a	20	25	26	28	28	28	29

Table 7.1b Macrophyte species and % cover (DAFOR scale) recorded at survey sites 11-19 on the Royal Canal, April-June 2023

Family	Common name	Species	11	12	13	14	15	16	17	18	19
Hydrocharitaceae	Canadian pondweed	*Elodea canadensis*	O		O	O	F	F	O		F
Nymphaeaceae	Yellow water lily	*Nuphar lutea*	O	F	A	A	A	F	F		F
Araceae	Ivy-leaved duckweed	*Lemna trisulca*	A		A			A	A		
Plantaginaceae	Mare's-tail	*Hippuris vulgaris*	R	O	F	A	A	F		A	
Haloragaceae	Whorled water-milfoil	*Myriophyllum verticillatum*								D	A
Alismataceae	Common water plantain	*Alisma plantago-aquatica*	R	A	A	A	F				R
Hydrocharitaceae	Nuttall's pondweed	*Elodea nuttallii*		R	R	R	R			O	
Haloragaceae	Spiked water-milfoil	*Myriophyllum spicatum*	F	O							
Potamogetonaceae	Fennel pondweed	*Stuckenia pectinata*	R							R	
Polygonaceae	Amphibious bistort	*Persicaria amphibia*									R
Potamogetonaceae	Horned pondweed	*Zannichellia palustris*								R	
Alismataceae	Arrowhead	*Sagittaria sagittifolia*		R							
Potamogetonaceae	Curled pondweed	*Potamogeton crispus*									
Potamogetonaceae	Opposite-leaved pondweed	*Groenlandia densa*									
Ranunculaceae	Fan-leaved water-crowfoot	*Ranunculus circinatus*			F				O		
Potamogetonaceae	Small pondweed	*Potamogeton pusillus*									
Potamogetonaceae	Long-leaved pondweed	*Potamogeton × angustifolius*							R		
Ceratophyllaceae	Rigid hornwort	*Ceratophyllum demersum*									
Poaceae	Floating sweet-grass	*Glyceria fluitans*									
Nymphaeaceae	White water lily	*Nymphae alba*									
Typhaceae	Branched bur-reed	*Sparganium erectum*	R		F	F	R	F			O
Poaceae	Reed sweet-grass	*Glyceria maxima*	R		R		R				
Iridaceae	Iris	*Iris psuedacorus*	R	O	R	R		R		R	
Cyperaceae	Common clubrush	*Schoenoplectus lacustris*		O	A	A	A		F	O	F

Family	Common name	Species	11	12	13	14	15	16	17	18	19
Cyperaceae	Bottle sedge	*Carex rostrata*		R	R	R				A	
Lamiaceae	Water mint	*Mentha aquatica*	R	O		R	R				
Apiaceae	Hemlock water-dropwort	*Oenanthe crocata*									
Typhaceae	Bulrush	*Typha latifolia*									R
Poaceae	Reed canary grass	*Phalaris arundinacea*									
Cladium mariscus	Great fen-sedge	*Cladium mariscus*						R			
Fontinalaceae	River moss	*Fontinalis antipyretica*						O	O		
Characeae	Clustered stonewort	*Tolypella glomerata*	R		O	O	O	R			
Characeae	Fragile stonewort	*Chara globularis*		R	O			R		F	O
Characeae	Common stonewort	*Chara vulgaris*									
Characeae	Bristly stonewort	*Chara hispida*				F	O		F		
Characeae	Delicate stonewort	*Chara virgata*		R							R
Characeae	Opposite stonewort	*Chara contraria*									
Characeae	Pointed stonewort	*Nitella mucronata*							R		
Characeae	Dark stonewort	*Nitella opaca*							O		
Species richness			**12**	**12**	**14**	**12**	**11**	**10**	**10**	**9**	**10**
Cumulative species richness			30	33	34	35	35	36	38	38	39

8. Appendix B – survey site characteristics

Table 8.1 Summary characteristics of Royal Canal survey sites, April-June 2023

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
1	Croke Park	*Myriophyllum verticillatum* (A) *Lemna trisulca* (A) *Elodea canadensis* (O) *Elodea nuttallii* (O) *Stuckenia pectinata* (O) *Fontinalis antipyretica* (O) *Tolypella glomerata* (O) *Hippuris vulgaris* (R) *Persicaria amphibia* (R) *Zannichellia palustris* (R) *Sagittaria sagittifolia* (R) *Potamogeton crispus* (R) *Groenlandia densa* (R) *Sparganium erectum* (R) *Glyceria maxima* (R)	Homogenous, deep, heavily vegetated, modified section with retaining walls, steep margins, >1.8m average depth	Dominated by silt with scattered boulder & occasional clay patches	716029	735928
2	Between 2nd & 3rd lock	*Myriophyllum verticillatum* (D) *Elodea canadensis* (D) *Lemna trisulca* (A) *Nitella mucronata* (F) *Stuckenia pectinata* (O) *Fontinalis antipyretica* (O) *Chara vulgaris* (R) *Zannichellia palustris* (R) *Groenlandia densa* (R) *Sparganium erectum* (R) *Glyceria maxima* (R) *Oenanthe crocata* (R)	Homogenous, deep, heavily vegetated, modified section with retaining walls, steep margins, >1.6m average depth	Dominated by silt with scattered clay patches along margins	715688	736059
3	Between 3rd & 4th lock	n/a	n/a	n/a	715425	736151
4	Cross Guns Bridge	*Elodea nuttallii* (D) *Myriophyllum verticillatum* (A) *Lemna trisulca* (F) *Stuckenia pectinata* (O) *Elodea canadensis* (R) *Persicaria amphibia* (R) *Potamogeton crispus* (R)	Deep, heavily vegetated, homogenous section with retaining walls & low diversity of macrophytes, >1.8m average depth	Dominated by silt	715085	736272

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Sparganium erectum (R) *Glyceria maxima* (R) *Iris psuedacorus* (R) *Phalaris arundinacea* (R) *Chara vulgaris* (R)				
5	Cross Guns Quay, Phibsborough	*Elodea canadensis* (A) *Elodea nuttallii* (A) *Myriophyllum spicatum* (A) *Chara contraria* (A) *Zannichellia palustris* (F) *Potamogeton crispus* (F) *Chara vulgaris* (F) *Lemna trisulca* (F) *Hippuris vulgaris* (O) *Oenanthe crocata* (O) *Fontinalis antipyretica* (O) *Stuckenia pectinata* (O) *Alisma plantago-aquatica* (R) *Potamogeton pusillus* (R) *Ceratophyllum demersum* (R)	Deep, heavily vegetated, homogenous section with retaining walls & steep margins, >2m average depth	Dominated by silt with scattered boulder & clay patches along steep margins	714865	736363
6	6th lock	*Hippuris vulgaris* (D) *Elodea canadensis* (F) *Fontinalis antipyretica* (O) *Nuphar lutea* (O) *Lemna trisulca* (R) *Myriophyllum verticillatum* (R) *Alisma plantago-aquatica* (R) *Myriophyllum spicatum* (R) *Persicaria amphibia* (R) *Sparganium erectum* (R) *Tolypella glomerata* (R) *Chara vulgaris* (R) *Chara contraria* (R)	Heavily vegetated, homogenous section with shallow sloping margins & very narrow marginal fringes, 1.6-2m deep	Dominated by silt with scattered boulder & regular clay patches along margins	714588	736479
7	Cabra West	*Elodea canadensis* (F) *Nuphar lutea* (F) *Lemna trisulca* (F) *Myriophyllum spicatum* (R) *Glyceria fluitans* (R)	Heavily vegetated, homogenous section with shallow sloping margins & narrow marginal fringes, 1.4-1.6m deep	Dominated by silt with scattered boulder & occasional clay patches along margins	713991	736847

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Nymphae alba (R) *Sparganium erectum* (R)				
8	Broombridge station	*Lemna trisulca* (A) *Elodea canadensis* (F) *Nuphar lutea* (F) *Hippuris vulgaris* (F) *Myriophyllum verticillatum* (R) *Myriophyllum spicatum* (R) *Sparganium erectum* (R) *Glyceria maxima* (R) *Iris psuedacorus* (R) *Oenanthe crocata* (R)	Deep, heavily vegetated, homogenous section with steep margins & narrow marginal fringes, 1.6m average depth, up to 2.2m	Dominated by silt with scattered boulder & gravels	713251	737176
9	R805 road crossing	*Lemna trisulca* (A) *Elodea canadensis* (O) *Nuphar lutea* (O) *Hippuris vulgaris* (O) *Persicaria amphibia* (R) *Sparganium erectum* (R) *Glyceria maxima* (R) *Iris psuedacorus* (R)	Shallow section with sparse cover of macrophytes & narrow marginal fringes, 1.2-1.5m average depth	Dominated by exposed silt & clay	712689	737359
10	11th lock	*Lemna trisulca* (A) *Hippuris vulgaris* (A) *Elodea canadensis* (F) *Nuphar lutea* (F) *Myriophyllum verticillatum* (R) *Sagittaria sagittifolia* (R) *Glyceria maxima* (R) *Iris psuedacorus* (R) *Carex rostrata* (R)	Mature section with high average depth & high macrophyte cover & narrow marginal fringes, 1.4->2m deep	Dominated by silt with mixed gravels and scattered boulder & cobble	709852	737849
11	Granard Bridge	*Lemna trisulca* (A) *Myriophyllum spicatum* (F) *Elodea canadensis* (O) *Nuphar lutea* (O) *Hippuris vulgaris* (R) *Alisma plantago-aquatica* (R) *Stuckenia pectinata* (R) *Sparganium erectum* (R) *Glyceria maxima* (R)	Mature deep section with higher water turbidity due to boat traffic (marina), >1.6m average depth, up to 2.5m	Dominated by deep, often anoxic silt with localised clay & gravel patches	708376	738086

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Iris psuedacorus (R) *Mentha aquatica* (R) *Tolypella glomerata* (R)				
12	Pakenham Bridge	*Alisma plantago-aquatica* (A) *Nuphar lutea* (F) *Myriophyllum spicatum* (O) *Hippuris vulgaris* (O) *Iris psuedacorus* (O) *Schoenoplectus lacustris* (O) *Mentha aquatica* (O) *Sagittaria sagittifolia* (R) *Elodea nuttallii* (R) *Carex rostrata* (R) *Chara globularis* (R) *Chara virgata* (R)	Relatively shallow site with shallow sloping margins & narrow marginal fringes, <1.6m average depth	Dominated by soft flocculent silt with localised marginal clay patches	703843	738284
13	Collin's Bridge	*Alisma plantago-aquatica* (A) *Nuphar lutea* (A) *Lemna trisulca* (A) *Schoenoplectus lacustris* (A) *Hippuris vulgaris* (F) *Ranunculus circinatus* (F) *Sparganium erectum* (F) *Elodea canadensis* (O) *Tolypella glomerata* (O) *Chara globularis* (O) *Elodea nuttallii* (R) *Glyceria maxima* (R) *Iris psuedacorus* (R) *Carex rostrata* (R)	Mature site with abundant macrophytes, well developed marginal fringes & high habitat heterogeneity, >1.8m average depth	Dominated by soft silt with localised marginal clay & gravel patches	702735	736842
14	Confey slipway	*Nuphar lutea* (A) *Hippuris vulgaris* (A) *Alisma plantago-aquatica* (A) *Schoenoplectus lacustris* (A) *Chara hispida* (F) *Sparganium erectum* (F) *Elodea canadensis* (O) *Tolypella glomerata* (O) *Iris psuedacorus* (R)	Deep, homogenous site with abundant macrophytes, narrow but mature marginal fringes, 1.5-2m deep, locally to 2.4m	Dominated by soft silt with localised marginal clay patches & mixed substrata	701575	736997

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Carex rostrata (R) *Mentha aquatica* (R) *Elodea nuttallii* (R)				
15	Cope Bridge	*Nuphar lutea* (A) *Hippuris vulgaris* (A) *Schoenoplectus lacustris* (A) *Alisma plantago-aquatica* (F) *Elodea canadensis* (F) *Tolypella glomerata* (O) *Chara hispida* (O) *Mentha aquatica* (R) *Elodea nuttallii* (R) *Sparganium erectum* (R) *Glyceria maxima* (R)	Mature, heavily vegetated section with narrow marginal fringes, >1.6m average depth	Dominated by deep soft silt with localised marginal clay, gravels & boulder	700861	737068
16	Leixlip Louisa Bridge	*Lemna trisulca* (A) *Elodea canadensis* (F) *Nuphar lutea* (F) *Hippuris vulgaris* (F) *Sparganium erectum* (F) *Fontinalis antipyretica* (O) *Iris psuedacorus* (R) *Cladium mariscus* (R) *Tolypella glomerata* (R) *Chara globularis* (R)	Mature, heavily vegetated shallow section with narrow marginal fringes & shallow sloping margins, >1-1.5m depth	Dominated by deep soft silt with localised marginal clay & gravel patches	699242	736491
17	300m east of Pike Bridge	*Lemna trisulca* (A) *Nuphar lutea* (F) *Schoenoplectus lacustris* (F) *Chara hispida* (F) *Elodea canadensis* (O) *Ranunculus circinatus* (O) *Fontinalis antipyretica* (O) *Nitella opaca* (O) *Potamogeton × angustifolius* (R) *Nitella mucronata* (R)	Semi-natural section with large shallow bay supporting abundant charophytes, 1-1.7m deep	Dominated by deep soft silt with localised marginal clay & gravel patches	696397	737339
18	Maynooth Harbour	*Myriophyllum verticillatum* (D) *Hippuris vulgaris* (A) *Carex rostrata* (A) *Chara globularis* (F)	Shallow, artificial harbour basin with high macrophyte cover, 0.5-1.8m deep	Dominated by deep soft silt with localised clay & gravel patches	693782	737401

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Schoenoplectus lacustris (O) *Elodea nuttallii* (O) *Stuckenia pectinata* (R) *Zannichellia palustris* (R) *Iris psuedacorus* (R)				
19	Jackson's Bridge	*Myriophyllum verticillatum* (A) *Elodea canadensis* (F) *Nuphar lutea* (F) *Schoenoplectus lacustris* (F) *Sparganium erectum* (O) *Chara globularis* (O) *Typha latifolia* (R) *Alisma plantago-aquatica* (R) *Persicaria amphibia* (R) *Chara virgata* (R)	Mature homogenous section with high macrophyte cover & steeply sloping margins, 1-1.8m deep	Dominated by soft silt with localised clay & gravel patches on steep margins	691578	737700
20	Harbour Road, Kilcock	*Myriophyllum verticillatum* (A) *Elodea canadensis* (F) *Nuphar lutea* (F) *Glyceria maxima* (F) *Alisma plantago-aquatica* (O) *Sagittaria sagittifolia* (O) *Schoenoplectus lacustris* (O) *Chara globularis* (O) *Chara hispida* (O)	Homogenous section with high macrophyte cover & narrow marginal fringes, >1.6m average depth	Dominated by soft silt with localised clay & gravel patches on steep margins	688949	739402



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Royal Canal (1st to 16th lock) macrophyte survey 2024

Prepared by Triturus Environmental Ltd. for

Roughan & O' Donovan Consulting Engineers

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Table of contents

1.	**Introduction**	**3**
1.1	Project background	3
1.2	Study area description	3
2.	**Methodology**	**4**
2.1	Desktop review	4
2.2	Macrophyte survey	4
2.3	Species accumulation curve	4
2.4	Biosecurity	5
3.	**Desktop review (rare/protected species)**	**7**
4.	**Results**	**14**
4.1	Aquatic vegetation communities & diversity	14
4.2	Rare or protected species	18
4.3	Invasive alien plant species	18
5.	**Discussion**	**29**
5.1	2024 observations & trends	29
5.2	Rare / protected macrophytes & charophytes	30
6.	**References**	**34**
7.	**Appendix A – macrophyte species list & cover**	**37**
8.	**Appendix B – survey site characteristics**	**42**

1. Introduction

1.1 Project background

Triturus Environmental Ltd. were commissioned by Roughan & O' Donovan Consulting Engineers (ROD) to undertake an annual baseline aquatic macrophyte (aquatic plant) survey of the Royal Canal between the 1st lock (Spencer Dock, Dublin City) and the 16th lock (Kilcock, Co. Kildare). The survey area encompassed a total of 33km of the Royal Canal (**Figure 2.1**). In light of the known presence of several rare and or protected macrophyte species in the Royal Canal, in addition to the various proposed infrastructural projects in the vicinity of the canal it was deemed pertinent to complete annual baseline assessments of macrophyte vegetation to better inform development design, mitigation and conservation in the coming years.

The baseline survey helped to identify, catalogue and map macrophyte assemblages along the Royal Canal, inclusive rare and or protected species and aquatic bryophytes (mosses and liverworts). The surveys would sample and identify all macrophytes (to species level, where possible) but there was a focus on high conservation value Red-listed species (e.g. Stewart & Church, 1992) and those listed under the Flora (Protection) Order, 2022. Invasive macrophyte species were also identified and recorded.

The findings of this report would build on and update previous surveys completed along the Royal Canal (e.g. INVAS, 2021-2024; BEC, 2011; EcoServe, 2011). This report constitutes the second of four annual monitoring reports (2023-2026 inclusive), with the survey undertaken in the April-June 2024 period.

1.2 Study area description

The Royal Canal is some 150km long and links the River Liffey in Dublin City with the River Shannon in Co. Longford. The canal is fed by Lough Owel, Co. Westmeath and flows east to Dublin and west to the Shannon. Though originally constructed for transport of goods (work was completed in 1817), the Royal Canal was closed to typical navigation in 1961. The present-day canal serves as a highly valuable recreational amenity site and regionally important ecological corridor. The entire length of the Royal Canal is designated as a proposed Natural Heritage Area (pNHA) (site code: 002103) (NPWS, 1995).

The Royal Canal is known to support a high diversity of submerged and emergent macrophyte species with aquatic vegetation communities typically dominated by whorled water-milfoil (*Myriophyllum verticillatum*), unbranched bur-reed (*Sparganium emersum*), reed sweet-grass (*Glyceria maxima*), bristly stonewort (*Chara hispida*) and the invasive Nuttall's pondweed (*Elodea nuttallii*) (INVAS, 2021, 2017). Also present are a low number of high conservation value species, such as the near threatened opposite-leaved pondweed (*Groenlandia densa*) (Wyse-Jackson et al., 2016) and nationally rare pointed stonewort (*Nitella mucronata*) (Sewart & Church, 1992) (see section 3).

In terms of water quality, the Royal Canal within and outside of the survey area was of good WFD status in the 2016-2021 period.

2. Methodology

2.1 Desktop review

A desktop review of published and unpublished data for the Royal Canal was undertaken in respect of macrophyte and aquatic bryophyte species. Records for rare and or protected species held by the Botanical Society of Britain and Ireland (BSBI), National Parks and Wildlife Service (NPWS) and the National Biodiversity Data Centre (NBDC) were also reviewed.

2.2 Macrophyte survey

Macrophyte samples were collected at a total of 20 no. 100m transect sites to determine the community composition and detect any other rare/protected species (**Figure 2.1**). Transects were located at the same points as the previous 2023 survey (Triturus, 2024). The survey area comprised approximately 33km of contiguous canal between the 1st level (Croke Park) and the 16th lock at Kilcock, Co. Kildare and encompassed a total of 43 no. 1km grid squares, or monads (**Table 2.1, Figure 2.1**). The April to June 2024 survey period ensured rare charophyte species, which often demonstrate early spring growth and summer disappearance, would be detected.

Samples were collected at each 100m transect by hand and or using a handheld grapnel from both the bank and or boat. A total of 10 no. grapnel throws were made within each 100m transect (i.e. every c.10m) to maximise the number of meso-habitats sampled. An estimate of the percentage cover (see below) occupied by each species was made using a combination of the grapnel samples and a visual assessment.

Cover for aquatic macrophyte species was assessed relative to the canal width and expressed on a version of the DAFOR scale:

- D - Dominant (>70% cover)
- A - Abundant (31-70% cover)
- F - Frequent (11-30% cover)
- O - Occasional (3-10% cover)
- R - Rare (<3% cover)

Species nomenclature was according to Stace (2019). Rare species as per national Red lists (Wyse-Jackson et al., 2016; Lockhart et al., 2012; Stewart & Church, 1992) were identified in the field with the assistance of botanist Paul Green (former BSBI Ireland Officer).

2.3 Species accumulation curve

Species accumulation curves are used to describe the increase of species with the increase in sampling effort and serve as an indicator of the validity and adequacy of sampling (Ugland et al., 2003). Sites with a high proportion of rare species and few abundant species have a species accumulation curve with a low inflection point on the y-axis and a long upward sloping line to the asymptote, whereas sites with a high proportion of relatively abundant species have a steep rising initial slope, plateau early and provide an accurate estimate of species richness with less sampling effort than when there is a higher proportion of rare species (Thompson & Withers, 2003). The cumulative number of species

recorded was plotted against the number of sampling sites to interrogate the macrophyte and bryophyte data collected.

2.4 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=20 macrophyte survey sites (100m transects) along the Royal Canal, 2024

Site no.	Location	X (ITM)	Y (ITM)
1	Croke Park	716029	735928
2	Between 2nd & 3rd lock	715688	736059
3	Between 3rd & 4th lock	715425	736151
4	Cross Guns Bridge	715085	736272
5	Cross Guns Quay, Phibsborough	714865	736363
6	6th lock	714588	736479
7	Cabra West	713991	736847
8	Broombridge station	713251	737176
9	R805 road crossing	712689	737359
10	11th lock	709852	737849
11	Granard Bridge	708376	738086
12	Pakenham Bridge	703843	738284
13	Collin's Bridge	702735	736842
14	Confey slipway	701575	736997
15	Cope Bridge	700861	737068
16	Leixlip Louisa Bridge	699242	736491
17	300m east of Pike Bridge	696397	737339
18	Maynooth Harbour	693782	737401
19	Jackson's Bridge	691578	737700
20	Harbour Road, Kilcock	688949	739402

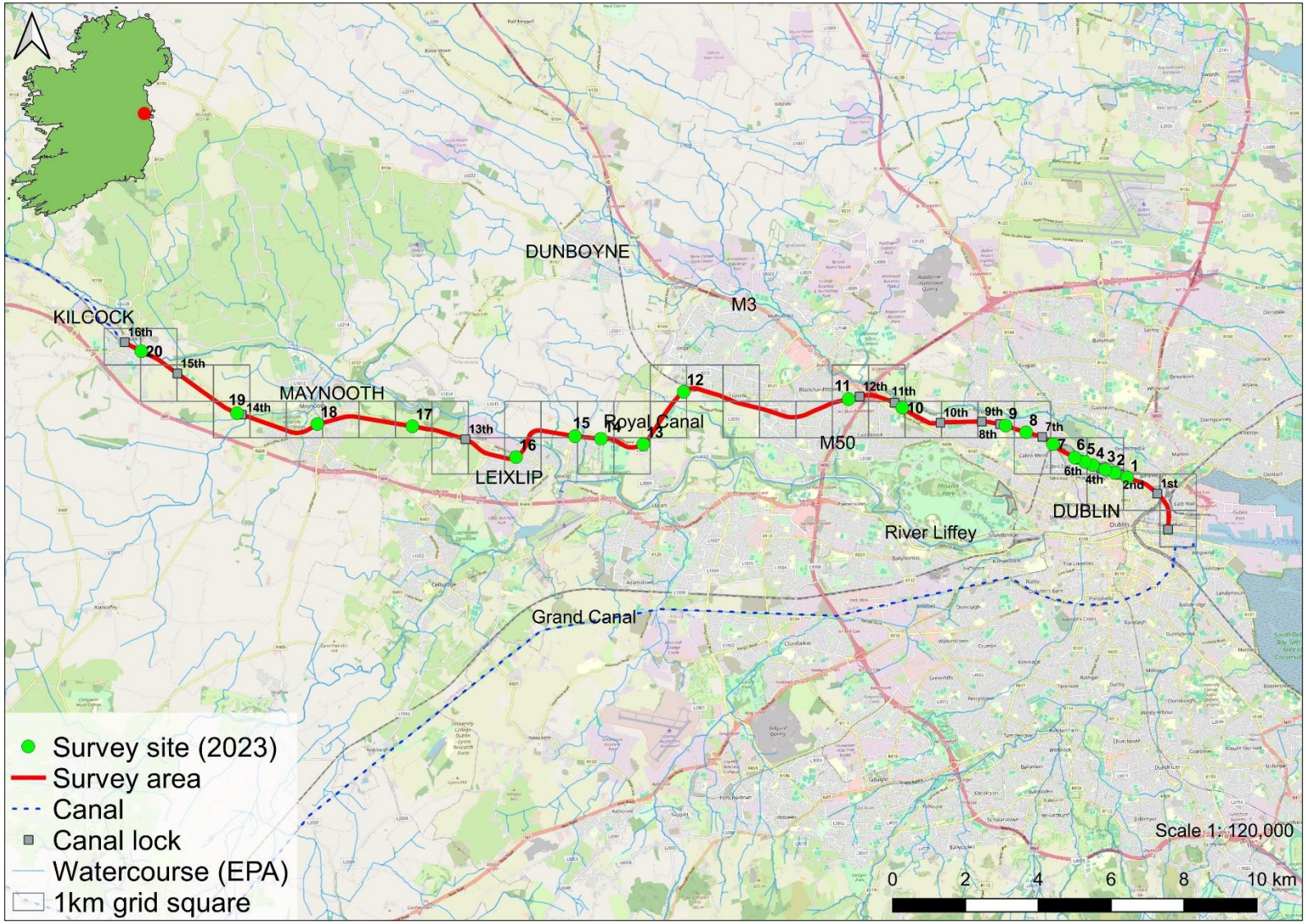


Figure 2.1 Overview of the Royal Canal macrophyte survey area and monitoring sites in 2024 (covering 43 no. 1km grid squares/monads)

3. Desktop review (rare/protected species)

A review of Triturus and BSBI data for the survey area (totalling 43 no. 1km grid squares, or monads) revealed the presence of records for a low number of rare and or protected aquatic species within the Royal Canal. BSBI macrophyte records were available for 17 no. 1km grid squares.

There was a very high number of records (>250) for the near threatened (Wyse-Jackson et al., 2016) and FPO species opposite-leaved pondweed (*Groenlandia densa*) (mostly BSBI data but also BEC, 2011). The vast majority of these records were from the 2010-2023 period and were confined to between the 1st lock and 6th lock (**Figure 3.1**). Records invariably represented individual plants present in larger stands, thus resulting in large overlap with regards to longitudinal distribution. Opposite-leaved pondweed was recorded at two sites in the 2023 survey, located between the 1st and 2nd locks and the 2nd and 3rd locks respectively (Triturus, 2024).

The vulnerable tassel stonewort (*Tolypella intricata*) (Stewart & Church, 1992)[1] was recorded in low abundance on the Royal Canal at Castleknock in 2022 (and likely in 2021; INVAS, 2022). However, no examples of species were identified here or elsewhere in the survey area during 2023 surveys (Triturus, 2024; INVAS, 2024). A single patch (10x1m) of *Tolypella intricata* was recorded on the Royal Canal in May 2022 approximately 180m west of Broom Bridge (Denyer, 2022). A total of 9 no. other records were available for tassel stonewort (*Tolypella intricata*) (Stewart & Church, 1992) within the survey area (**Figure 3.2**). However, these were historical only (1991-1992) with records scattered between Binn's Bridge and Louisa Bridge, Leixlip. Nash & King (1993) recorded *T. intricata* between Granard Bridge and Cross Gun's Bridge, typically within 1m metre from the bank growing in silt in 0.5m water depth.

The Red-listed pointed stonewort (*Nitella mucronata*) was recorded from site 2 (near Binn's Bridge) and site 17 (near Pike Bridge) during the 2023 survey (Triturus, 2024). Records for pointed stonewort were also available for 2018 between Spencer Dock and the 6th lock and also between the 11th lock and Talbot Bridge (**Figure 3.3**). This species is nationally rare in Ireland (Stewart & Church, 1992).

The clustered stonewort (*Tolypella glomerata*) was recorded from 7 no. sites during the 2023 survey (Triturus, 2024) with its distribution broadly overlapping with previously available data. A total of 13 no. other contemporary records (2018) were available for clustered stonewort between Phibsborough and Leixlip (**Figure 3.4**). A low number of historical records were also available between Ashtown and Leixlip (1991-1992, data not shown). Whilst not protected or Red-listed, this species is considered rare in Ireland.

A low number of records (7 no.) for narrow-leaved water-plantain (*Alisma lanceolatum*) were available for the survey area, between Phibsborough and Maynooth in 2018 (**Figure 3.5**). Again, whilst not a protected or Red-listed species, the plant is uncommon at a national level.

The Red-listed (vulnerable) dwarf (or compact) stonewort *Nitella tenuissima* is known from several locations of the Royal (and Grand) Canal (e.g. recorded at Kelly's Bridge, Co. Westmeath in 2019;

[1] Please note that at the time of writing a new Chara red list was in preparation but was not currently available at the time of writing the current report (N. Stewart, pers. comm.)

INVAS, 2021), where it appears to favour open areas of shallows with a clay substrate (Caffrey & Monahan, 1994). However, no records are known from the current survey area.

Table 3.1 Summary of the high conservation value macrophyte species known from the Royal Canal survey area prior to this survey, covering 43 no. 1km grid squares (monads) (Triturus (2024) & BSBI data)

Common name	Species	Monads present (of 43)	Conservation status
Opposite-leaved pondweed	*Groenlandia densa*	4	Near threatened (Wyse-Jackson et al., 2016); Flora (Protection) Order, 2022
Tassel stonewort	*Tolypella intricata*	9	Vulnerable (Stewart & Church, 1992)
Pointed stonewort	*Nitella mucronata*	4	Rare (Stewart & Church, 1992)
Clustered stonewort	*Tolypella glomerata*	15	None (but nationally rare)
Narrow-leaved water-plantain	*Alisma lanceolatum*	7	None (but nationally uncommon)

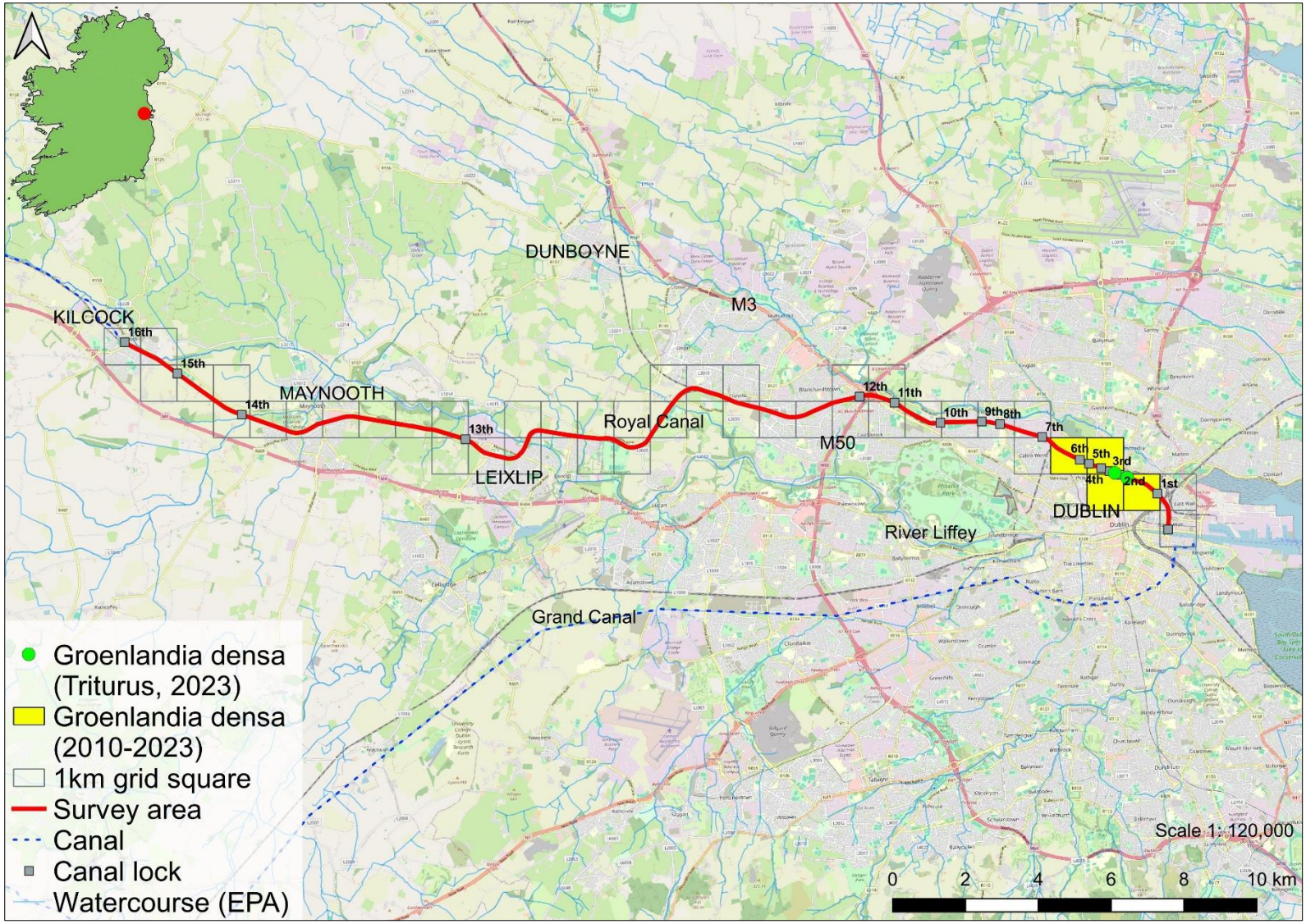


Figure 3.1 Known distribution of opposite-leaved pondweed (*Groenlandia densa*) in the current survey area (source: Triturus (2024) & BSBI)

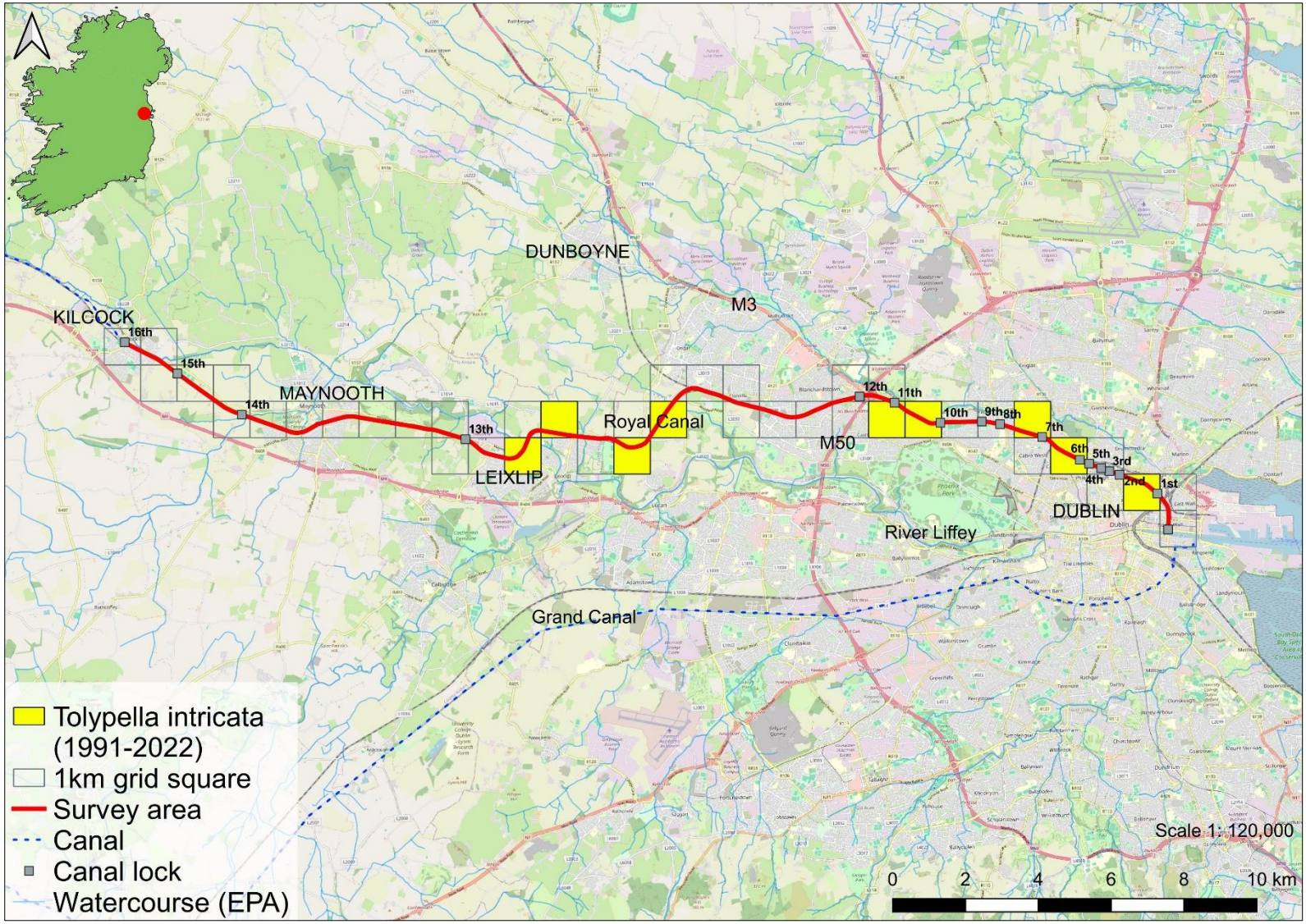


Figure 3.2 Known distribution of tassel stonewort (*Tolypella intricata*) in the current survey area (source: BSBI)



Figure 3.3 Known distribution of pointed stonewort (*Nitella mucronata*) in the current survey area (source: Triturus (2024) & BSBI)

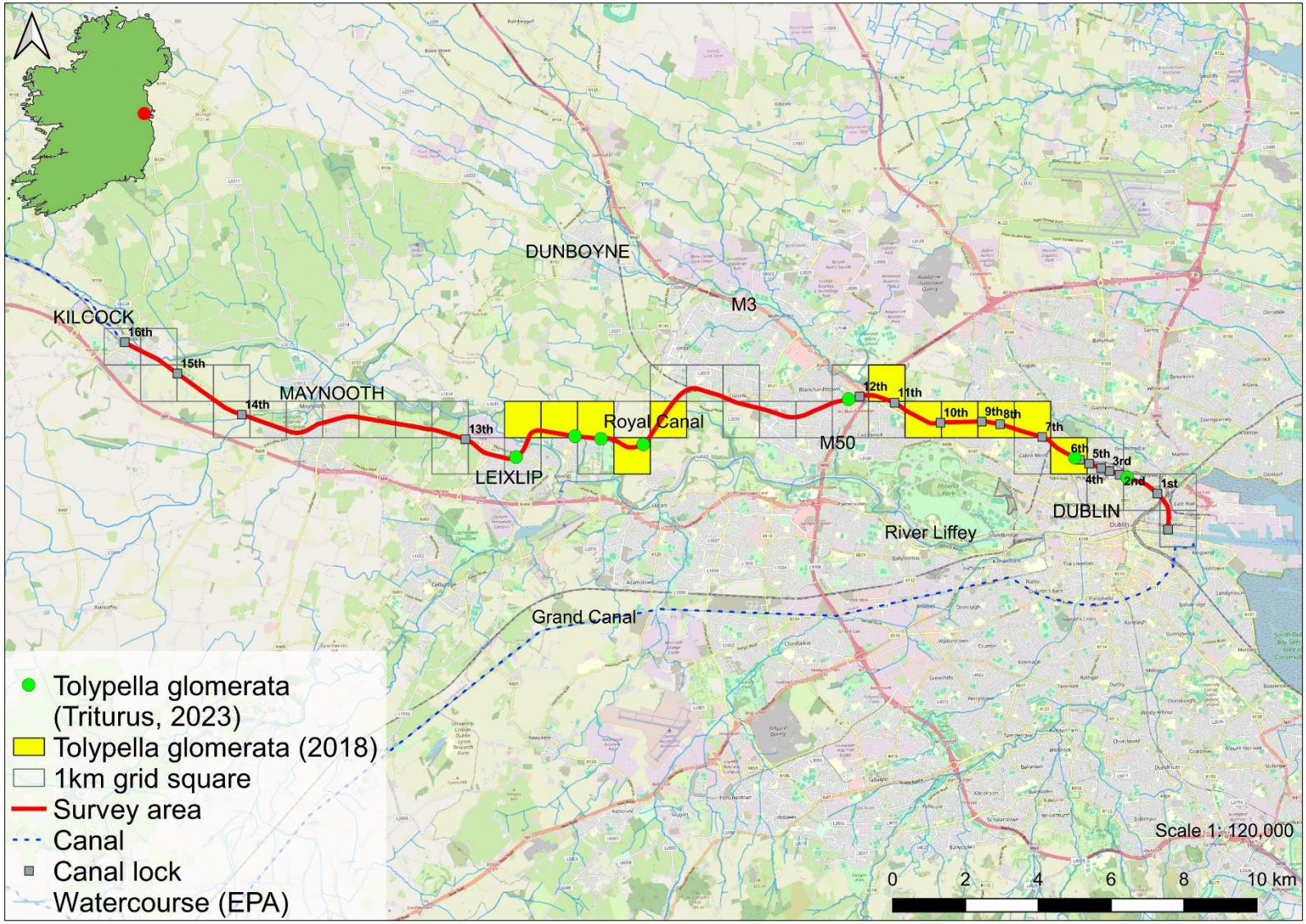


Figure 3.4 Known distribution of clustered stonewort (*Tolypella glomerata*) in the current survey area (source: Triturus (2024) & BSBI)

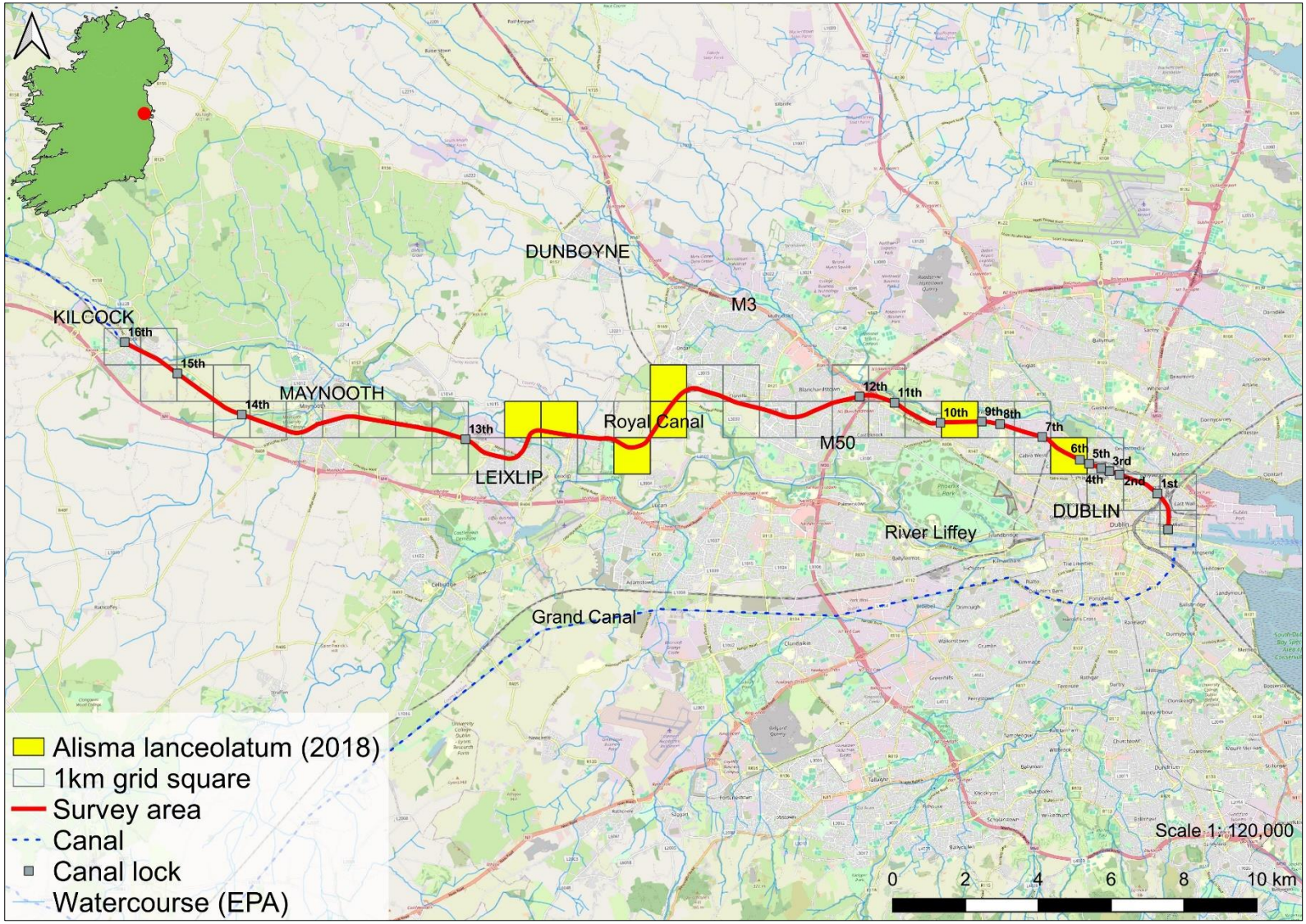


Figure 3.5 Known distribution of narrow-leaved water-plantain (*Alisma lanceolatum*) in the current survey area (source: BSBI)

4. Results

4.1 Aquatic vegetation communities & diversity

A total of *n*=36 macrophyte species and *n*=1 aquatic bryophytes were recorded during the current survey (**Appendix A**). As per 2023, this included a low number of protected species, namely *Groenlandia densa* and *Nitella mucronata* (see 4.2 below) (**Table 4.1**). A full site-by-site summary of macrophyte species and their relative percentage cover (DAFOR) is provided in **Appendix A**.

Species abundance and diversity in 2024 (*n*=37 plant species) was very similar when compared with the 2023 survey (*n*=39 species). However, a total of 6 no. species not identified during the 2023 survey were recorded in 2024, including rugged stonewort (*Chara subspinosa*, formerly *C. rudis*) and red pondweed (*Potamogeton alpinus*) (**Table 4.2**). Eight species recorded in 2023 were not recorded in 2024, including rigid hornwort (*Ceratophyllum demersum*) and delicate stonewort (*Chara virgata*) (**Table 4.2**).

Whilst macrophyte communities naturally varied between sites/canal sections, the most widespread submerged/floating species were (in order of occurrence) *Lemna trisulca* (95% of sites), the invasive *Elodea canadensis* and *Elodea nuttallii* (89% & 84% of sites, respectively), followed by *Hippuris vulgaris* and *Nuphar lutea* (**Table 4.3; Appendix A**). As per 2023 findings, the most frequent emergent species, often present as a narrow marginal fringe, were *Sparganium erectum*, *Glyceria maxima*, *Iris psuedacorus* and *Schoenoplectus lacustris* (**Table 4.3**).

As per 2023, stoneworts were more restricted in their distributions, with a total of 9 no. species recorded (compared to 8 in 2023) (**Table 4.3; Appendix A**). The most frequent of these were *Chara globularis* (58% of sites), *Chara hispida* (42%) and *Tolypella glomerata* (32%). The Red-listed *Nitella mucronata* was recorded at sites 2 and 17 only, as per the 2023 survey (**Figure 4.4**). Other stonewort species recorded were *Chara subspinosa, Chara globularis, Chara contraria, Nitella translucens* and *Nitella opaca*. The river moss *Fontinalis antipyretica* was the only aquatic bryophyte recorded during the survey (9 no. sites). This was often present on lock walls, quay walls or, occasionally, instream structure such as large boulders or fallen trees (i.e. sites 2, 3, 6, 7, 8, 15, 16, 17 & 20).

A number of species were infrequent and were recorded at a single survey site only, namely horned pondweed (*Zannichellia palustris*), curled pondweed (*Potamogeton crispus*), broad-leaved pondweed (*Potamogeton natans*), red pondweed (*Potamogeton alpinus*), water starwort (*Callitriche* sp.), white water lily (*Nymphae alba*), opposite stonewort (*Chara contraria*), translucent stonewort (*Nitella translucens*) and the dark stonewort (*Nitella opaca*) (**Table 4.3; Appendix A**).

In terms of macrophyte diversity, the species richness (number of species) at each survey site ranged from *n*=8 (site 5) to *n*=17 (sites 14, 17 & 20) (mean species richness 13.4 ±2.SD, median 14) (**Figure 4.1**). Overall the species richness was slightly higher than in 2023. As per 2023, the species richness was relatively similar across sites and typically increased moving east to west. Noticeably lower species diversity was present at sites 4 (*n*=10) and 5 (*n*=8) near Cross Gun's Quay, Phibsborough and site 9 near the R805 road crossing (*n*=9) (**Figure 4.1**). The frequency and coverage of charophytes increased west of Collins Bridge (Westmanstown) (**Appendix A**).

Plotting the number of species against sampling effort (19 no. sampling sites accessible in 2024) the

cumulative species richness curve (**Figure 4.2**) indicates the true number of species in the survey area may be slightly underestimated, i.e. the curve is non-asymptotic, and has not yet fully reached (but is approaching) its asymptote. The curve produced rises steeply and begins to plateau early as would be expected for study areas with a high proportion of relatively abundant and widespread species (Thompson & Withers, 2003).

Table 4.1 Summary of the high conservation value macrophyte species recorded from the Royal Canal in April-June 2024 and April-June 2023

			Sites where recorded (DAFOR)	
Common name	**Species**	**Conservation status**	**2024**	**2023**
Opposite-leaved pondweed	*Groenlandia densa*	Near threatened (Wyse-Jackson et al., 2016); Flora (Protection) Order, 2022	2 (O) [2]	1 (R), 2 (R)
Pointed stonewort	*Nitella mucronata*	Rare (Stewart & Church, 1992)	2 (F), 17 (R)	2 (F), 17 (R)
Clustered stonewort	*Tolypella glomerata*	None (but nationally rare)	4 (R), 6 (R), 11 (R), 13 (R), 15 (R), 19 (R)	1 (O), 6 (R), 11 (R), 13 (O), 14 (O), 15 (O), 16 (R)

Table 4.2 Summary of variation in macrophyte species recorded from the Royal Canal in 2023 and 2024

Species present in 2024 but not 2023	Species present in 2023 but not 2024
• Broad-leaved pondweed (*Potamogeton natans)* • Red pondweed (*Potamogeton alpinus)* • Water starwort (*Callitriche* spp.) • Lesser pond sedge (*Carex acutiformis)* • Rugged stonewort (*Chara subspinosa)* • Translucent stonewort (*Nitella translucens)*	• Small pondweed (*Potamogeton pusillus*) • Long-leaved pondweed (*Potamogeton × angustifolius*) • Rigid hornwort (*Ceratophyllum demersum*) • Floating sweet grass (*Glyceria fluitans*) • Bulrush (*Typha latifolia*) • Reed canary grass (*Phalaris arundinacea*) • Great fen sedge (*Cladium mariscus*) • Delicate stonewort (*Chara virgata*)

[2] Previously known from site 1 but this location was inaccessible during the survey period due to ongoing construction works

Table 4.3 Summary of the macrophyte species recorded from the 19 no. sites sampled on the Royal Canal, April-June 2024 (ranked in order of % occurrence)

Common name	Species	Conservation status	No. sites	% occurrence
Submerged/floating				
Ivy-leaved duckweed	*Lemna trisulca*		18	95%
Canadian pondweed	*Elodea canadensis*		17	89%
Mare's-tail	*Hippuris vulgaris*		17	89%
Yellow water lily	*Nuphar lutea*		16	84%
Nuttall's pondweed	*Elodea nuttallii*	**Invasive species (S.I. 477/2011)**	16	84%
Common water plantain	*Alisma plantago-aquatica*		14	74%
Amphibious bistort	*Persicaria amphibia*		11	58%
Whorled water-milfoil	*Myriophyllum verticillatum*		7	37%
Spiked water-milfoil	*Myriophyllum spicatum*		6	32%
Fennel pondweed	*Stuckenia pectinata*		5	26%
Arrowhead	*Sagittaria sagittifolia*		4	21%
Fan-leaved water-crowfoot	*Ranunculus circinatus*		3	16%
Horned pondweed	*Zannichellia palustris*		1	5%
Curled pondweed	*Potamogeton crispus*		1	5%
Opposite-leaved pondweed	*Groenlandia densa*	**Near threatened (Stewart & Church, 1992); Flora (Protection) Order, 2022**	1	5%
Broad-leaved pondweed	*Potamogeton natans*		1	5%
Red pondweed	*Potamogeton alpinus*		1	5%
Water starwort	*Callitriche* spp.		1	5%
White water lily	*Nymphaea alba*		1	5%
Emergent				
Reed sweet-grass	*Glyceria maxima*		16	84%
Branched bur-reed	*Sparganium erectum*		15	79%
Iris	*Iris psuedacorus*		13	68%
Common clubrush	*Schoenoplectus lacustris*		9	47%
Water mint	*Mentha aquatica*		7	37%
Bottle sedge	*Carex rostrata*		4	21%
Hemlock water-dropwort	*Oenanthe crocata*		4	21%

Lesser pond sedge	*Carex acutiformis*		2	11%
Bryophytes				
River moss	*Fontinalis antipyretica*		6	32%
Charophytes				
Common stonewort	*Chara vulgaris*		7	37%
Bristly stonewort	*Chara hispida*		6	32%
Clustered stonewort	*Tolypella glomerata*		4	21%
Rugged stonewort	*Chara subspinosa*			
Fragile stonewort	*Chara globularis*			
Pointed stonewort	*Nitella mucronata*	**Rare (Stewart & Church, 1992)**		
Opposite stonewort	*Chara contraria*		4	21%
Translucent stonewort	*Nitella translucens*		2	11%
Dark stonewort	*Nitella opaca*		2	11%
Alage				
Filamentous algae	n/a		19	100%

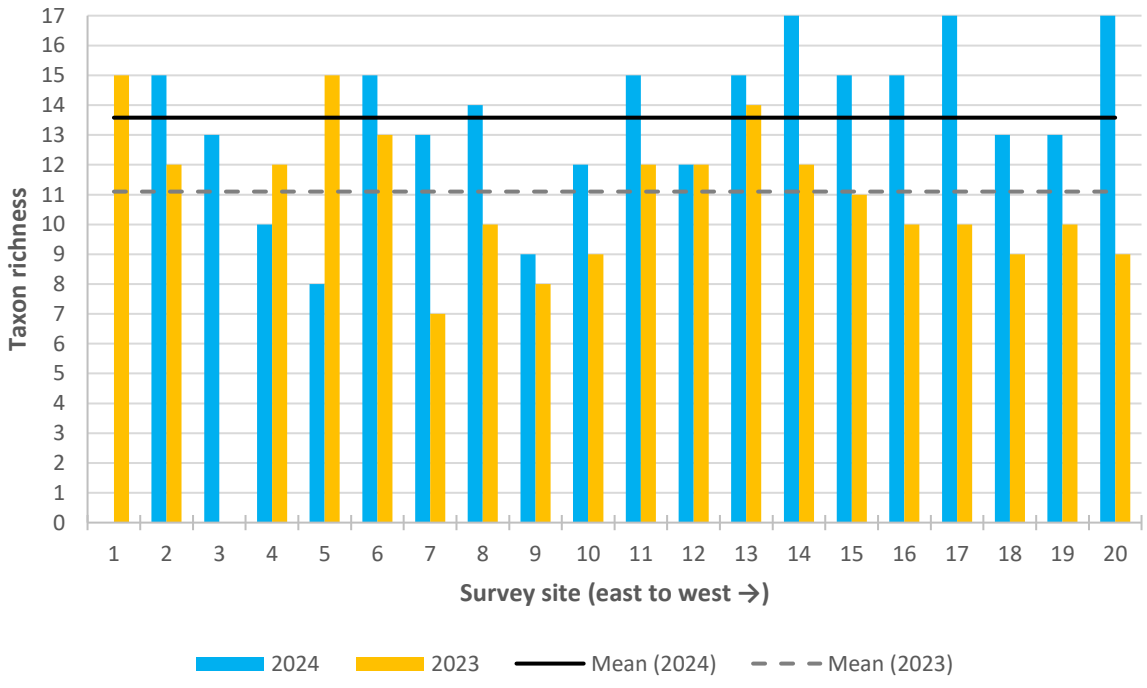


Figure 4.1 Longitudinal macrophyte species richness (no. species) per survey site[3] in 2023 & 2024

[3] site 1 located between the 1st and 2nd locks was not accessible for survey in 2024 due to ongoing construction works

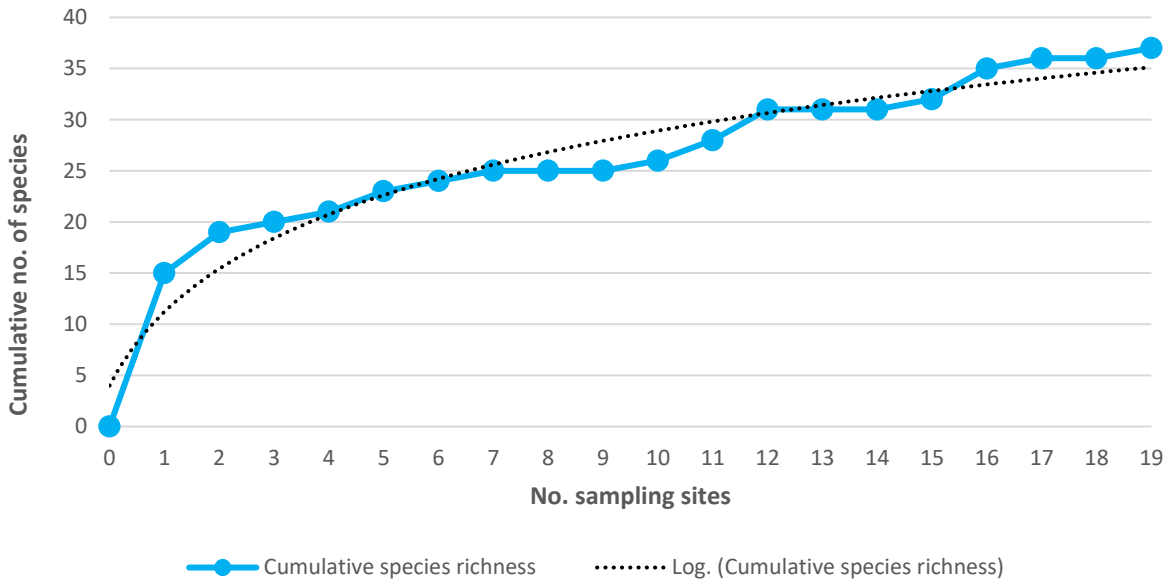


Figure 4.2 Cumulative macrophyte species richness curve (east to west) for the 2024 survey sites

4.2 Rare or protected species

As per 2023, the nationally rare, Red-listed pointed stonewort (*Nitella mucronata*) was recorded from site 2 (near Binn's Bridge) and site 17 (near Pike Bridge) (**Figure 4.4**). Whilst the species was frequent at site 2, being well scattered on exposed areas of silt throughout the 100m transect, it was rare at site 17, being confined to a large bay east of Pike Bridge (as per 2023 observations).

The near threatened and FPO species opposite-leaved pondweed (*Groenlandia densa*) was recorded from site 2 only[4], located between the 2nd and 3rd locks (**Table 4.2**; **Figure 4.3**). The previously large patch of opposite leaved pondweed identified near the 2nd lock in 2023 was restricted to only a few stands against the wall in 2024 amongst abundant *Chara vulgaris* and scattered *Nitella mucronata* (ITM 715785, 736031) (**Plate 4.3**). Recently disturbed margins as part of Greenway works along the south bank also supported scattered stands of opposite-leaved pondweed (**Plate 4.2**).

4.3 Invasive Alien Plant Species (IAPS)

The two invasive pondweed species Canadian pondweed (*Elodea canadensis*) and Nuttall's pondweed (*Elodea nuttallii*) were recorded at multiple sites in the current survey, being present at 17 no. and 16 no. sites respectively (**Table 4.3; Appendix A**). *Elodea nuttallii* had increased its distribution considerably compared with the 2023 survey (16 sites vs. 8 sites). Both of these widespread species are listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and are considered high-risk invasive species in Ireland (O' Flynn et al., 2014).

Whilst spreading on the adjacent Grand Canal (INVAS, 2024) no stands of the highly invasive New Zealand pigmyweed (*Crassula helmsii*) were recorded during the current survey, in keeping with the known distribution of this species in Irish waters.

[4] Previously known from site 1 but this location was inaccessible during the survey period



Plate 4.1 Significant works on the Royal Canal near Binn's Bridge with Croke Park in the background - survey site 1 was not accessible for survey in 2024



Plate 4.2 Recently disturbed margins between the 2nd and 3rd locks which supported opposite-leaved pondweed and charophytes



Plate 4.3 Strands of opposite-leaved pondweed (*Groenlandia densa*) growing amongst *Chara vulgaris* and Red-listed *Nitella mucronata* along recently disturbed clay margins between the 2nd and 3rd locks (survey site 2), June 2024



Plate 4.4 A Red-listed European eel (*Anguilla anguilla*) elver captured amongst *Chara vulgaris* during grapnel sampling at site 2 on the Royal Canal near Binn's Bridge, June 2024.



Plate 4.5 Typical species assemblage from the urban reaches of the Royal Canal at survey site 3. From top left, clockwise: Nuttall's pondweed, ivy-leaved duckweed, mare's-tail, arrowhead (submerged leaves), small pondweed & Canadian pondweed



Plate 4.6 Small stand of white water lily (*Nymphaea alba*) growing alongside yellow water lily (*Nuphar lutea*) on the Royal Canal at survey site 7 (Cabra West), June 2024



Plate 4.7 The nationally rare (but not protected) clustered stonewort (*Tolypella glomerata*) recorded from site 15 near Leixlip Confey station, May 2024



Plate 4.8 Abundant filamentous algal mats at survey site 9 near Broombridge, May 2024 (indicative of significant eutrophication)



Plate 4.9 Large stand of mare's-tail with yellow lily in the Royal Canal at site 10 near Ashtown, April 2024



Plate 4.10 Example of *Chara globularis* recorded in small stands at site 12 near Castleknock, May 2024



Plate 4.11 Heavily vegetated section of canal with narrow but mature riparian fringes at site 14 near Confey Slipway, May 2024



Plate 4.12 Red-listed *Nitella mucronata* recorded at site 17, June 2024 (ultimate segment of branchlets 2-3 celled with at least one cell well developed; as per Stewart, 2010)



Plate 4.13 Stand of *Chara vulgaris* with interspersed *Tolypella glomerata* (rare) growing in characteristic shallow clay littorals at site 19 near Jackson's Bridge, May 2024



Plate 4.14 Example of fan-leaved water crowfoot (*Ranunculus circinatus*) recorded at site 16 near Leixlip Louisa Bridge, May 2024

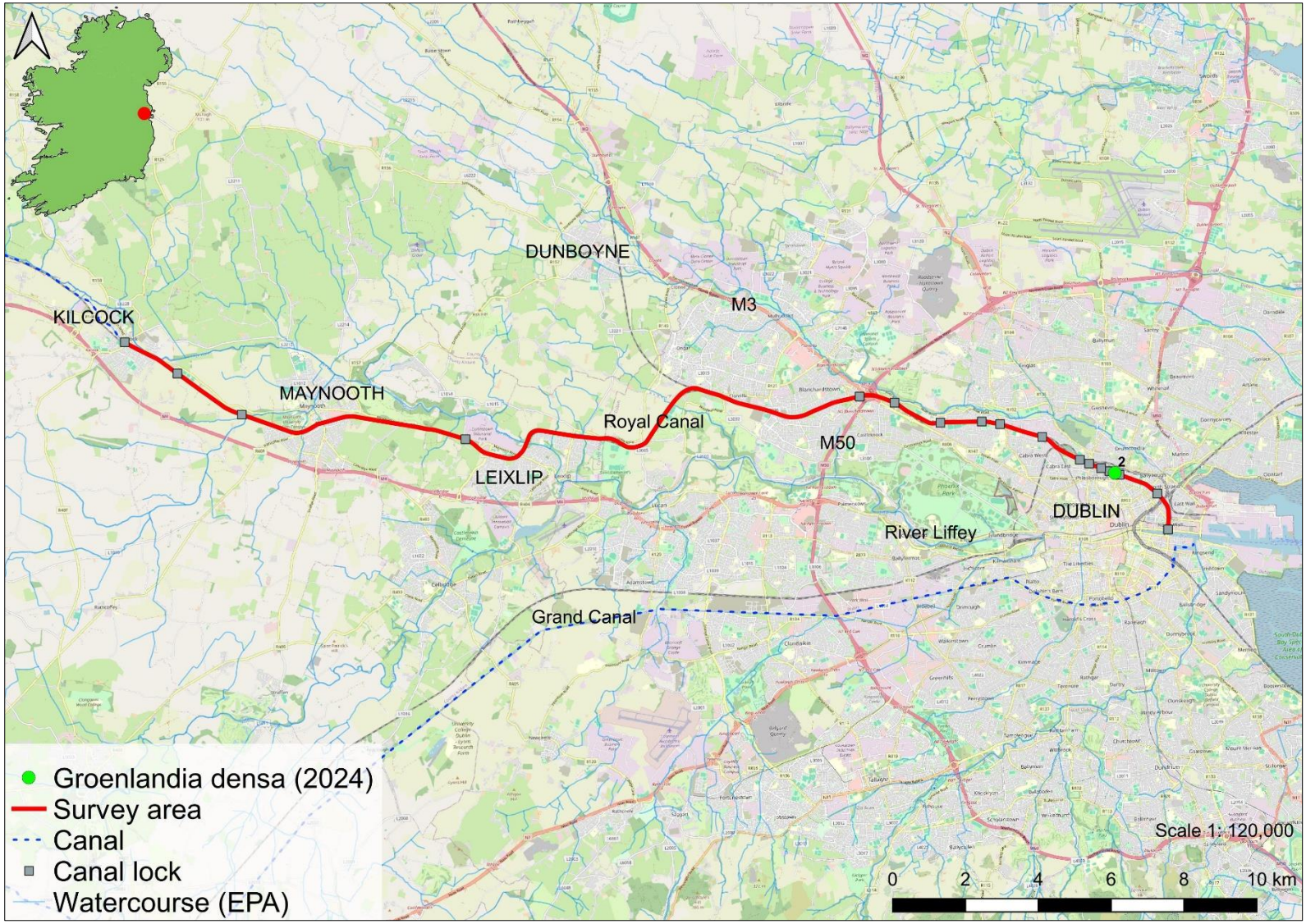


Figure 4.3 Positive *Groenlandia densa* sites in the Royal Canal survey area, April-June 2024

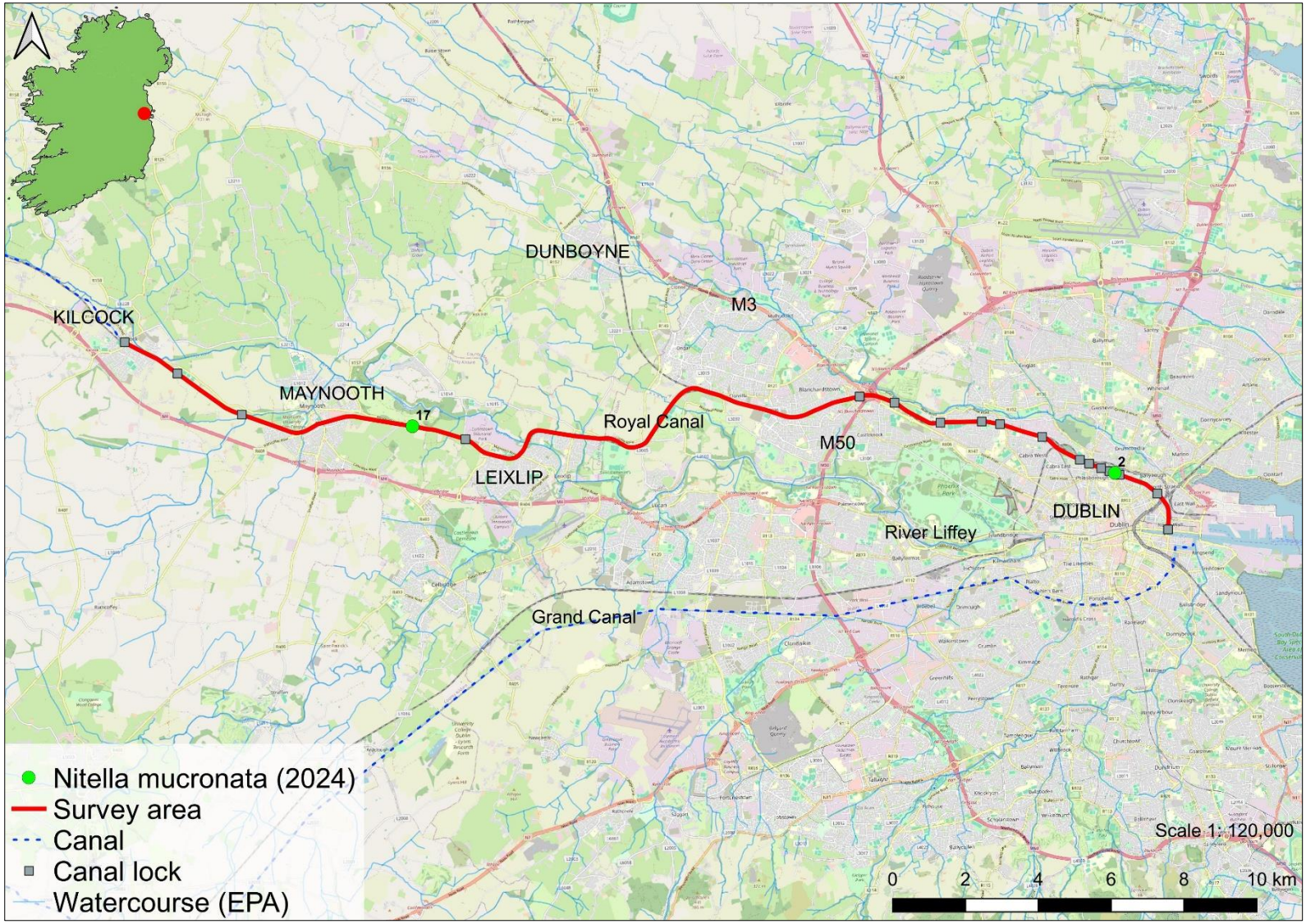


Figure 4.4 Positive *Nitella mucronata* sites in the Royal Canal survey area, April-June 2024

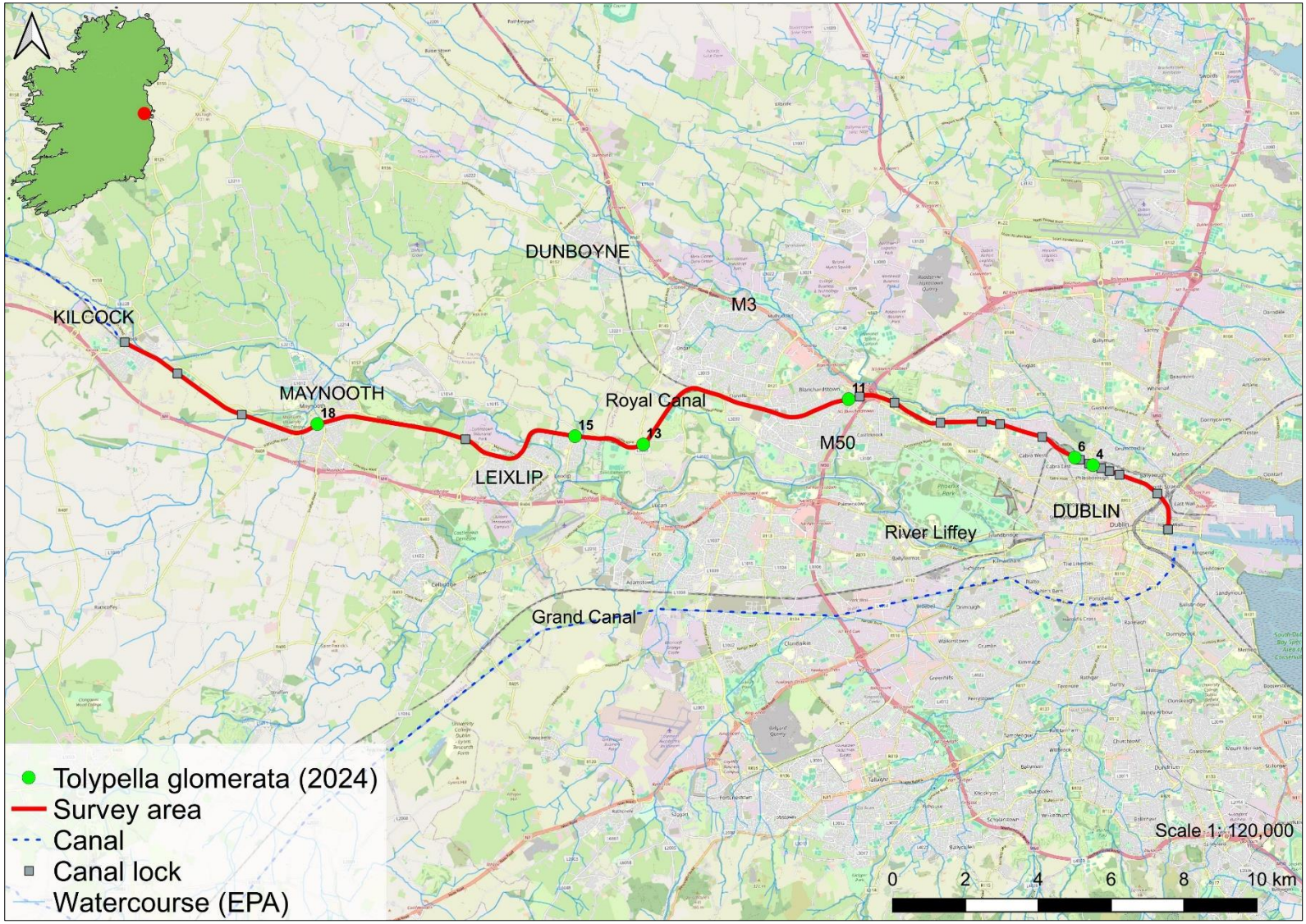


Figure 4.5 Positive *Tolypella glomerata* sites in the Royal Canal survey area, April-June 2024

5. Discussion

The current baseline survey of macrophyte communities along 33km of the Royal Canal has added to the previous 2023 survey, further helping to identify potential trends in populations and assemblages as well as the occurrence of rare/protected and invasive species.

The Royal Canal, which is typically shallow with clear water, base-rich conditions and low instream disturbance levels (e.g. infrequent boat traffic), provides conditions amenable to diverse and often abundant macrophyte communities (Triturus, 2023; Caffrey et al., 2006; Caffrey, 1991). A total of *n*=37 macrophyte and aquatic bryophyte species across 17 no. families were recorded during the current survey, with most survey transects dominated by common submerged species such as ivy-leaved duckweed, Canadian pondweed (invasive), Nuttall's pondweed (invasive), yellow lily, mare's-tail and common water plantain (**Table 4.3; Appendix A**). The 2024 survey identified two protected species that were previously known from the survey area, namely *Groenlandia densa* and Red-listed *Nitella mucronata*. The nationally rare stonewort *Tolypella glomerata* was also recorded at numerous sites (see below).

5.1 2024 observations & trends

The 2024 findings were broadly similar to that of the previous year, with local fluctuations and changes noted for several species. For example, 8 no. species recorded in 2023 were not recorded in 2024, including rigid hornwort (*Ceratophyllum demersum*) and delicate stonewort (*Chara virgata*) (**Table 4.2**). Both species appear to occupy a highly localised distribution in the survey area. In contrast, six species not identified during the 2023 survey were recorded in 2024, including rugged stonewort (*Chara subspinosa*) (sites 13, 14, 16) and red pondweed (*Potamogeton alpinus*) (site 17) (**Table 4.2**). Whilst neither of these species are rare or protected in Ireland, red pondweed is uncommon outside of northern catchments (BSBI data), with *Chara subspinosa* ubiquitous in alkaline/marl lakes (Roden et al., 2020).

Such annual variability in recording the presence of certain species, particularly at sites where a species might be present in low abundance (e.g. charophytes), is not uncommon when sampling aquatic species (INVAS, 2024). Furthermore, aquatic plants often demonstrate inherently patchy distributions within habitats (Dar et al., 2014). Annual variability in macrophyte communities is expected, with many synergistic variables including nutrient dynamics, inter and intra-specific competition, water temperature, water quality (e.g. sedimentation), turbidity (e.g. algal blooms, boat traffic, dredging), wind exposure, flow/water levels, light availability (for photosynthesis), grazing pressures (e.g. fish, invertebrates), disturbance (e.g. for maintenance), invasive/non-native species and, in the longer term, climate change (Navarro Law et al., 2024; Kumar et al., 2023; Lind et al., 2022; Bornette, & Puijalon, 2011).

The distribution of aquatic vegetation in the Royal Canal is also influenced by other factors such as instream and bankside maintenance (including weed control) to ameliorate recreational activities (INVAS, 2021; Caffrey et al., 2006; Monahan & Caffrey, 1996). This is particularly relevant regarding the growth of charophyte species which thrive in the euphotic zone and whose distribution is strongly influenced by competition for light and nutrients with canopy-forming macrophyte species such as *Myriophyllum* spp. and pondweeds (Garland et al., 2022; Pełechaty et al., 2014). As such, charophytes

typically *benefit* from disturbance, including water draw-downs and weed removal operations, and are among the first colonisers of disturbed habitats (pioneer species), including in Irish canals (Caffrey & Monahan, 1997). The frequency of charophytes (albeit localised) typically increased west of Collins Bridge (Westmanstown) where small littoral areas of exposed clay and silt not dominated by competing macrophytes became more common (**Appendix A**).

Species richness was highest (*n*=17) at sites west of Leixlip (e.g. sites 14, 17). Species richness had evidently decreased in the Croke Park to Phibsborough area, presumably due to instream works and maintenance activities (including water draw-downs since the previous survey). As previously noted, the canal from Pakenham Bridge to Leixlip/Maynooth was typically more macrophyte-rich and less urbanised than the sections either side, thus providing a more varied range of micro-habitats.

The cumulative species richness curve (**Figure 4.2**) indicates the true number of species in the survey area is being slightly underestimated, i.e. the curve is non-asymptotic, and has not yet fully reached (but is approaching) its asymptote. This would suggest that a slight increase in the number of sampling sites for subsequent annual monitoring would better detect the full range of macrophyte species within the Royal Canal, including rare species. Variations in annual survey sites (transects) would also provide a more comprehensive dataset for the survey area.

5.2 Rare / protected macrophytes & charophytes

5.2.1 *Tolypella* species

No examples of the vulnerable tassel stonewort (*Tolypella intricata*) were identified during the survey despite previous historical (1991-1992) and contemporary (2022) records within the survey area (**Figure 3.1**). This species favours disturbance[5] and seasonally fluctuating waterbodies (Cirujano Bracamonte et al., 2013) although it has been previously recorded in shallow littorals of the Royal Canal in ≤0.5m (Denyer, 2022; Nash & King, 1993). Much of the survey area is not conducive to the growth of this species due to depths, unsuitably steep marginal slopes and competition from other macrophyte species. However, *T. intricata* spores are known for their long-term viability (Corillion, 1957) and the species periodically re-establishes following significant disturbance of the seed bank (Nash & King, 1993; Stewart & Church, 1992) but typically disappear as competing vegetation increases (Stewart & Hatton-Ellis, 2020). A prime example of this trait is the recent discovery of *T. intricata* growing in dredged spoil pools along the Royal Canal near Cloncurry Bridge, Enfield in 2024 by Donncha O Catháin and Fionn Murphy (Waterways Ireland) (**Plate 5.1**). Canal repair/maintenance works undertaken in Dublin City during the current survey (1st to 5th locks) may result in the reappearance of this species in future monitoring years.

Clustered stonewort (*Tolypella glomerata*) was widespread in the survey area, being recorded from 6 no. sites in 2024 (**Figure 4.5**). The distribution of this nationally rare species broadly overlapped with 2023 and other previous data. *Tolypella glomerata* is a pioneer species (Caffrey & Monahan, 1997) that can inhabit a range of seasonal and shallow, permanent habitats (Cirujano Bracamonte et al.,

[5] Records for the 1991-92 period coincided with canal restoration works and dredging, thus allowing *Tolypella intricata* to establish temporarily due to low competition with other macrophytes (Nick Stewart pers. comm.)

2013). As per 2023, this species was recorded in localised stands on exposed silt or clay in the upper littorals of the canal where competition from other macrophytes was low or absent (**Plate 4.7**).



Plate 5.1 The vulnerable tassel stonewort (*Tolypella intricata*) was recently recorded (by Donncha Ó Catháin & Fionn Murphy, Waterways Ireland ©) growing in temporary dredged spoil pools along the Royal Canal near Cloncurry Bridge (c.8km west of current survey area)

5.2.2 *Nitella mucronata*

The Red-listed pointed stonewort (*Nitella mucronata*) was recorded from site 2 (near Binn's Bridge) and site 17 (near Pike Bridge) (**Figure 4.4; Plate 4.12**). The species was also present at these two sites in the 2023 survey. *N. mucronata* is often associated with a diverse aquatic flora but usually occurs in the gaps among denser vegetation or where the vegetation becomes sparser at the lower edge of the photic zone (Stewart & Hatton-Ellis, 2020). Such conditions were again present at sites 2 and 17, as per 2023. Whilst *Nitella mucronata* is listed as rare in the current Irish Red list (Stewart & Church, 1992), the species is increasing across Ireland[6] and is likely to be removed from the imminent updated Irish Red list for charophytes (Nick Stewart pers. comm.).

5.2.3 *Groenlandia densa*

The Flora (Protection) Order 2022 species opposite-leaved pondweed (*Groenlandia densa*) was recorded from site 2 only where it was scattered along recently disturbed littorals (south bank) (Plate 4.2, 4.3) and also grew near the 2nd lock (**Table 4.3**; **Figure 4.3**). The species is also known from site 1 (Triturus, 2024) but this location was inaccessible during the survey period due to ongoing long term construction works. The absence of opposite-leaved pondweed from other previously known sites (e.g. the 5th lock) is possibly due to depth constraints/steep margins and or the currently high cover of competing species such as *Lemna trisulca* and *Myriophyllum* spp.

[6] this spread is attributed to the non-indigenous *N. mucronata* var. *gracillima*

In Ireland, opposite-leaved pondweed is typically associated with tidal stretches of rivers and other periodically disturbed watercourses including canals and drains, where it ostensibly benefits from the reduction in competition with other macrophytes through disturbance (Reynolds et al., 2006). This calcicolous species is often referred to as a ruderal or pioneer species, especially following dredging operations where it can colonise or recolonise disturbed or bare areas rapidly (e.g. Henry & Amoros, 1996) given its densely-packed ramets and high growth rates (Greulich & Bornette, 1999). Similar to other opportunist species such as *Tolypella* spp., canal maintenance works in the survey area may result in the re-establishment and or spread of this species in future monitoring years. As such, establishment of this species can often be fleeting, i.e. prior to competition from other species. The previously large patch of opposite leaved pondweed identified near the 2nd lock in 2023 (**Plate 5.2**) was restricted to only a few stands against the wall in 2024 amongst abundant *Chara vulgaris* and scattered *Nitella mucronata* (**Plate 5.3**) and this stand may disappear in the coming seasons.

Opposite-leaved pondweed has declined in Ireland (Preston, 2003; Preston et al., 2002) due to land drainage and reclamation, pollution, peat run-off and loss of habitat due to infilling of watercourses. Consequently, it is protected under the Wildlife Acts (1976-2023) and is listed on Schedule A of the Flora (Protection) Order, 2022 (S.I. No. 235/2022). Due to a reduction in its area of occupancy, the plant is also classified as 'near threatened' on the Ireland Red List for vascular plants (Wyse Jackson et al., 2016).



Plate 5.2 Large patch of opposite-leaved pondweed growing at the 2nd lock of the Royal Canal, May 2023



Plate 5.3 Only scattered strands of opposite-leaved pondweed growing at the same location at the 2nd lock in June 2024, with abundant charophyte growth

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7. Appendix A – macrophyte species list & cover

Table 7.1a Macrophyte species and % cover (DAFOR scale) recorded at survey sites 1-10 on the Royal Canal, April-June 2024

Family	Common name	Species	1[7]	2	3	4	5	6	7	8	9	10
Araceae	Ivy-leaved duckweed	*Lemna trisulca*	n/a	A	A		O	O	F	A	A	A
Hydrocharitaceae	Canadian pondweed	*Elodea canadensis*	n/a	O	O	R	D	F	F	D	D	A
Hydrocharitaceae	Nuttall's pondweed	*Elodea nuttallii*	n/a	D	D	D	R		O	R	R	O
Plantaginaceae	Mare's-tail	*Hippuris vulgaris*	n/a	R	R		O	D		R	O	O
Nymphaeaceae	Yellow water lily	*Nuphar lutea*	n/a				O	O	F	D	O	D
Nymphaeaceae	White water lily	*Nymphaea alba*	n/a						R			
Alismataceae	Common water plantain	*Alisma plantago-aquatica*	n/a		O		R	R	R	R		R
Alismataceae	Arrowhead	*Sagittaria sagittifolia*	n/a		R							R
Polygonaceae	Amphibious bistort	*Persicaria amphibia*	n/a	O		R	R	O	R	R	R	R
Haloragaceae	Whorled water-milfoil	*Myriophyllum verticillatum*	n/a	R		R		R				R
Haloragaceae	Spiked water-milfoil	*Myriophyllum spicatum*	n/a					O	R	R		
Potamogetonaceae	Fennel pondweed	*Stuckenia pectinata*	n/a	D	D	D						
Potamogetonaceae	Horned pondweed	*Zannichellia palustris*	n/a	R								
Potamogetonaceae	Curled pondweed	*Potamogeton crispus*	n/a		O							
Potamogetonaceae	Opposite-leaved pondweed	*Groenlandia densa*	n/a	O								
Potamogetonaceae	Broad-leaved pondweed	*Potamogeton natans*	n/a									
Potamogetonaceae	Red pondweed	*Potamogeton alpinus*	n/a									
Ranunculaceae	Fan-leaved water-crowfoot	*Ranunculus circinatus*	n/a									
Plantaginaceae	Water starwort	*Callitriche spp.*	n/a									
Poaceae	Reed sweet-grass	*Glyceria maxima*	n/a	F	F	R		R	R	R	R	R
Typhaceae	Branched bur-reed	*Sparganium erectum*	n/a	R	R	R	R	R	O	O	O	
Iridaceae	Iris	*Iris psuedacorus*	n/a		R	R			R	R	R	R

[7] Site 1 located between the 1st and 2nd locks was not accessible for survey in 2024 due to construction works

Family	Common name	Species	1[7]	2	3	4	5	6	7	8	9	10
Cyperaceae	Common clubrush	*Schoenoplectus lacustris*	n/a									
Cyperaceae	Bottle sedge	*Carex rostrata*	n/a									
Cyperaceae	Lesser pond sedge	*Carex acutiformis*	n/a									
Lamiaceae	Water mint	*Mentha aquatica*	n/a							R		R
Apiaceae	Hemlock water-dropwort	*Oenanthe crocata*	n/a	R	R					R		
Fontinalaceae	River moss	*Fontinalis antipyretica*	n/a	R	R			R	R	R		
Characeae	Common stonewort	*Chara vulgaris*	n/a	A		O		R	R			
Characeae	Bristly stonewort	*Chara hispida*	n/a									
Characeae	Clustered stonewort	*Tolypella glomerata*	n/a			R		R				
Characeae	Rugged stonewort	*Chara rudis*	n/a									
Characeae	Fragile stonewort	*Chara globularis*	n/a									
Characeae	Pointed stonewort	*Nitella mucronata*	n/a	R								
Characeae	Opposite stonewort	*Chara contraria*	n/a					R				
Characeae	Translucent stonewort	*Nitella translucens*	n/a									
Characeae	Dark stonewort	*Nitella opaca*	n/a									
	Filamentous algae	sp. indet.	n/a	A	A	D	F	A	F	D	A	A
Species richness (excl. algae)			**n/a**	**15**	**13**	**10**	**8**	**14**	**13**	**14**	**9**	**12**
Cumulative species richness (excl. algae)			n/a	15	19	20	21	23	24	25	25	25

Table 7.1b Macrophyte species and % cover (DAFOR scale) recorded at survey sites 11-19 on the Royal Canal, April-June 2024

Family	Common name	Species	11	12	13	14	15	16	17	18	19	20
Araceae	Ivy-leaved duckweed	*Lemna trisulca*	A	R	A	F	R	F	F	O	O	O
Hydrocharitaceae	Canadian pondweed	*Elodea canadensis*	F	R	F	F	A		A		O	R
Hydrocharitaceae	Nuttall's pondweed	*Elodea nuttallii*			O	F	R	F	O	F	F	F
Plantaginaceae	Mare's-tail	*Hippuris vulgaris*	R	O	O	O	F	F	O	O	A	A
Nymphaeaceae	Yellow water lily	*Nuphar lutea*	O	F	A	O	F	O	O	R	O	F
Nymphaeaceae	White water lily	*Nymphaea alba*										
Alismataceae	Common water plantain	*Alisma plantago-aquatica*	R	F	O	O	O		R		O	R
Alismataceae	Arrowhead	*Sagittaria sagittifolia*			R					R		
Polygonaceae	Amphibious bistort	*Persicaria amphibia*	R			R		R				
Haloragaceae	Whorled water-milfoil	*Myriophyllum verticillatum*								F	R	O
Haloragaceae	Spiked water-milfoil	*Myriophyllum spicatum*	F	O			R					
Potamogetonaceae	Fennel pondweed	*Stuckenia pectinata*	R	R								
Potamogetonaceae	Horned pondweed	*Zannichellia palustris*										
Potamogetonaceae	Curled pondweed	*Potamogeton crispus*										
Potamogetonaceae	Opposite-leaved pondweed	*Groenlandia densa*										
Potamogetonaceae	Broad-leaved pondweed	*Potamogeton natans*							R			
Potamogetonaceae	Red pondweed	*Potamogeton alpinus*							R			
Ranunculaceae	Fan-leaved water-crowfoot	*Ranunculus circinatus*			O	R		R				
Plantaginaceae	Water starwort	*Callitriche spp.*										R
Poaceae	Reed sweet-grass	*Glyceria maxima*	R			O	R	F	F	O	O	F
Typhaceae	Branched bur-reed	*Sparganium erectum*	R		F	R	R	F	F		R	
Iridaceae	Iris	*Iris psuedacorus*	R	O	R	O		O		O		O
Cyperaceae	Common clubrush	*Schoenoplectus lacustris*		O	A	O	F	O	R	O	F	F
Cyperaceae	Bottle sedge	*Carex rostrata*			R	R				R		R

Family	Common name	Species	11	12	13	14	15	16	17	18	19	20
Cyperaceae	Lesser pond sedge	*Carex acutiformis*						R	R			
Lamiaceae	Water mint	*Mentha aquatica*	R	R		R	R					R
Apiaceae	Hemlock water-dropwort	*Oenanthe crocata*										R
Fontinalaceae	River moss	*Fontinalis antipyretica*					R	O	R			R
Characeae	Common stonewort	*Chara vulgaris*				O	R	O	O	R	O	R
Characeae	Bristly stonewort	*Chara hispida*	R			O	R	O	O	R	F	R
Characeae	Clustered stonewort	*Tolypella glomerata*	R		R		R				R	
Characeae	Rugged stonewort	*Chara rudis*			R	R		R				
Characeae	Fragile stonewort	*Chara globularis*		R	O							
Characeae	Pointed stonewort	*Nitella mucronata*							R			
Characeae	Opposite stonewort	*Chara contraria*										
Characeae	Translucent stonewort	*Nitella translucens*								F		
Characeae	Dark stonewort	*Nitella opaca*							O			
	Filamentous algae	sp. indet.	A	F	R	R	R	R	R	R	R	O
Species richness (excl. algae)			**14**	**11**	**15**	**17**	**15**	**15**	**17**	**13**	**13**	**17**
Cumulative species richness (excl. algae)			26	28	31	31	31	32	35	36	36	37

8. Appendix B – survey site characteristics

Table 8.1 Summary characteristics of Royal Canal survey sites, April-June 2024

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
1	Croke Park	Not accessible for survey due to long term construction works	n/a	n/a	716029	735928
2	Between 2nd & 3rd lock	*Lemna trisulca* (A) *Elodea canadensis* (O) *Elodea nuttallii* (D) *Hippuris vulgaris* (R) *Persicaria amphibia* (O) *Myriophyllum verticillatum* (R) *Stuckenia pectinata* (D) *Zannichellia palustris* (R) *Groenlandia densa* (O) *Glyceria maxima* (F) *Sparganium erectum* (R) *Oenanthe crocata* (R) *Fontinalis antipyretica* (R) *Chara vulgaris* (A) *Nitella mucronata* (R) Filamentous algae (A)	Deep section with ongoing bank works/regrading and very low riparian cover, >1.6m average depth	Dominated by silt with localised exposed clay in upper littorals	715688	736059
3	Between 3rd & 4th lock	*Lemna trisulca* (A) *Elodea canadensis* (O) *Elodea nuttallii* (D) *Hippuris vulgaris* (R) *Alisma plantago-aquatica* (O) *Sagittaria sagittifolia* (R) *Stuckenia pectinata* (D) *Potamogeton crispus* (O) *Glyceria maxima* (F) *Sparganium erectum* (R) *Iris psuedacorus* (R) *Oenanthe crocata* (R) *Fontinalis antipyretica* (R) Filamentous algae (A))	Relatively shallow (<1.5m average), heavily vegetated low-diversity section with abundant filamentous algae, very narrow riparian fringes	Dominated by silt with localised exposed clay in upper littorals	715425	736151
4	Cross Guns Bridge	*Elodea canadensis* (R) *Elodea nuttallii* (D) *Persicaria amphibia* (R) *Myriophyllum verticillatum* (R)	Deep, heavily vegetated, homogenous section with retaining walls & low	Dominated by silt	715085	736272

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Stuckenia pectinata (D) *Glyceria maxima* (R) *Sparganium erectum* (R) *Iris psuedacorus* (R) *Chara vulgaris* (O) *Tolypella glomerata* (R) Filamentous algae (D)	diversity of macrophytes, >1.8m average depth			
5	Cross Guns Quay, Phibsborough	*Lemna trisulca* (O) *Elodea canadensis* (D) *Elodea nuttallii* (R) *Hippuris vulgaris* (O) *Nuphar lutea* (O) *Alisma plantago-aquatica* (R) *Persicaria amphibia* (R) *Sparganium erectum* (R) Filamentous algae (F)	Deep, heavily vegetated, homogenous section with retaining walls & steep margins, >2m average depth	Dominated by silt with scattered boulder & clay patches along steep margins	714865	736363
6	6th lock	*Lemna trisulca* (O) *Elodea canadensis* (F) *Hippuris vulgaris* (D) *Nuphar lutea* (O) *Alisma plantago-aquatica* (R) *Persicaria amphibia* (O) *Myriophyllum verticillatum* (R) *Myriophyllum spicatum* (O) *Glyceria maxima* (R) *Sparganium erectum* (R) *Fontinalis antipyretica* (R) *Chara vulgaris* (R) *Tolypella glomerata* (R) *Chara contraria* (R) Filamentous algae (A)	Heavily vegetated, homogenous section with shallow sloping margins & very narrow marginal fringes, 1.6-2m deep	Dominated by silt with scattered boulder & regular clay patches along margins	714588	736479
7	Cabra West	*Lemna trisulca* (F) *Elodea canadensis* (F) *Elodea nuttallii* (O) *Nuphar lutea* (F) *Nymphaea alba* (R) *Alisma plantago-aquatica* (R) *Persicaria amphibia* (R)	Heavily vegetated, homogenous section with shallow sloping margins & narrow marginal fringes, 1.4-1.6m deep	Dominated by silt with scattered boulder & occasional clay patches along margins	713991	736847

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Myriophyllum spicatum (R) *Glyceria maxima* (R) *Sparganium erectum* (O) *Iris psuedacorus* (R) *Fontinalis antipyretica* (R) *Chara vulgaris* (R) Filamentous algae (F)				
8	Broombridge station	*Lemna trisulca* (A) *Elodea canadensis* (D) *Elodea nuttallii* (R) *Hippuris vulgaris* (R) *Nuphar lutea* (D) *Alisma plantago-aquatica* (R) *Persicaria amphibia* (R) *Myriophyllum spicatum* (R) *Glyceria maxima* (R) *Sparganium erectum* (O) *Iris psuedacorus* (R) *Mentha aquatica* (R) *Oenanthe crocata* (R) *Fontinalis antipyretica* (R) Filamentous algae (D)	Deep, heavily vegetated, homogenous section with steep margins & narrow marginal fringes, 1.6m average depth, up to 2.2m	Dominated by silt with scattered boulder & gravels	713251	737176
9	R805 road crossing	*Lemna trisulca* (A) *Elodea canadensis* (D) *Elodea nuttallii* (R) *Hippuris vulgaris* (O) *Nuphar lutea* (O) *Persicaria amphibia* (R) *Glyceria maxima* (R) *Sparganium erectum* (O) *Iris psuedacorus* (R) Filamentous algae (A)	Shallow section with sparse cover of macrophytes & narrow marginal fringes, 1.2-1.5m average depth	Dominated by exposed silt & clay	712689	737359
10	11th lock	*Lemna trisulca* (A) *Elodea canadensis* (A) *Elodea nuttallii* (O) *Hippuris vulgaris* (O) *Nuphar lutea* (D) *Alisma plantago-aquatica* (R)	Mature section with high average depth & high macrophyte cover & narrow marginal fringes, 1.4->2m deep	Dominated by silt with mixed gravels and scattered boulder & cobble	709852	737849

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Sagittaria sagittifolia (R) *Persicaria amphibia* (R) *Myriophyllum verticillatum* (R) *Glyceria maxima* (R) *Iris psuedacorus* (R) *Mentha aquatica* (R) Filamentous algae (A)				
11	Granard Bridge	*Lemna trisulca* (A) *Elodea canadensis* (F) *Hippuris vulgaris* (R) *Nuphar lutea* (O) *Alisma plantago-aquatica* (R) *Persicaria amphibia* (R) *Myriophyllum spicatum* (F) *Stuckenia pectinata* (R) *Glyceria maxima* (R) *Sparganium erectum* (R) *Iris psuedacorus* (R) *Chara hispida* (R) *Tolypella glomerata* (R) Filamentous algae (A)	Mature deep section with higher water turbidity due to boat traffic (marina), >1.6m average depth, up to 2.5m	Dominated by deep, often anoxic silt with localised clay & gravel patches	708376	738086
12	Pakenham Bridge	*Lemna trisulca* (R) *Elodea canadensis* (R) *Hippuris vulgaris* (O) *Nuphar lutea* (F) *Alisma plantago-aquatica* (F) *Myriophyllum spicatum* (O) *Stuckenia pectinata* (R) *Iris psuedacorus* (O) *Schoenoplectus lacustris* (O) *Mentha aquatica* (R) *Chara globularis* (R) Filamentous algae (F)	Relatively shallow site with shallow sloping margins & narrow marginal fringes, <1.6m average depth	Dominated by soft flocculent silt with localised marginal clay patches	703843	738284
13	Collin's Bridge	*Lemna trisulca* (A) *Elodea canadensis* (F) *Elodea nuttallii* (O) *Hippuris vulgaris* (O) *Nuphar lutea* (A)	Mature site with abundant macrophytes, well developed marginal fringes & high habitat	Dominated by soft silt with localised marginal clay & gravel patches	702735	736842

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Alisma plantago-aquatica (O) *Sagittaria sagittifolia* (R) *Ranunculus circinatus* (O) *Sparganium erectum* (F) *Iris psuedacorus* (R) *Schoenoplectus lacustris* (A) *Carex rostrata* (R) *Tolypella glomerata* (R) *Chara globularis* (O) Filamentous algae (R)	heterogeneity, >1.8m average depth			
14	Confey slipway	*Lemna trisulca* (F) *Elodea canadensis* (F) *Elodea nuttallii* (F) *Hippuris vulgaris* (O) *Nuphar lutea* (O) *Alisma plantago-aquatica* (O) *Persicaria amphibia* (R) *Ranunculus circinatus* (R) *Glyceria maxima* (O) *Sparganium erectum* (R) *Iris psuedacorus* (O) *Schoenoplectus lacustris* (O) *Carex rostrata* (R) *Mentha aquatica* (R) *Chara vulgaris* (O) *Chara hispida* (O) *Chara rudis* (R) Filamentous algae (R)	Deep, homogenous site with abundant macrophytes, narrow but mature marginal fringes, 1.5-2m deep, locally to 2.4m	Dominated by soft silt with localised marginal clay patches & mixed substrata	701575	736997
15	Cope Bridge	*Lemna trisulca* (R) *Elodea canadensis* (A) *Elodea nuttallii* (R) *Hippuris vulgaris* (F) *Nuphar lutea* (F) *Alisma plantago-aquatica* (O) *Myriophyllum spicatum* (R) *Glyceria maxima* (R) *Sparganium erectum* (R) *Mentha aquatica* (R)	Mature, heavily vegetated section with narrow marginal fringes, >1.6m average depth	Dominated by deep soft silt with localised marginal clay, gravels & boulder	700861	737068

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Fontinalis antipyretica (R) *Chara vulgaris* (R) *Chara hispida* (R) *Tolypella glomerata* (R) Filamentous algae (R)				
16	Leixlip Louisa Bridge	*Lemna trisulca* (F) *Elodea nuttallii* (F) *Hippuris vulgaris* (F) *Nuphar lutea* (O) *Persicaria amphibia* (R) *Ranunculus circinatus* (R) *Glyceria maxima* (F) *Sparganium erectum* (F) *Iris psuedacorus* (O) *Schoenoplectus lacustris* (O) *Carex rostrata* (R) *Fontinalis antipyretica* (O) *Chara vulgaris* (O) *Chara hispida* (O) *Chara rudis* (R) Filamentous algae (R)	Mature, heavily vegetated shallow section with narrow marginal fringes & shallow sloping margins, >1-1.5m depth	Dominated by deep soft silt with localised marginal clay & gravel patches	699242	736491
17	300m east of Pike Bridge	*Lemna trisulca* (F) *Elodea canadensis* (A) *Elodea nuttallii* (O) *Hippuris vulgaris* (O) *Nuphar lutea* (O) *Alisma plantago-aquatica* (R) *Potamogeton natans* (R) *Potamogeton alpinus* (R) *Glyceria maxima* (F) *Sparganium erectum* (F) *Schoenoplectus lacustris* (R) *Carex rostrata* (R) *Carex acutiformis* (R) *Fontinalis antipyretica* (R) *Chara vulgaris* (O) *Chara hispida* (O) *Nitella mucronata* (R)	Semi-natural section with large shallow bay supporting abundant charophytes, 1-1.7m deep	Dominated by deep soft silt with localised marginal clay & gravel patches	696397	737339

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Nitella opaca (O) Filamentous algae (R)				
18	Maynooth Harbour	*Lemna trisulca* (O) *Elodea nuttallii* (F) *Hippuris vulgaris* (O) *Nuphar lutea* (R) *Sagittaria sagittifolia* (R) *Myriophyllum verticillatum* (F) *Glyceria maxima* (O) *Iris psuedacorus* (O) *Schoenoplectus lacustris* (O) *Carex rostrata* (R) *Chara vulgaris* (R) *Chara hispida* (R) *Nitella translucens* (F) Filamentous algae (R)	Shallow, artificial harbour basin with high macrophyte cover, 0.5-1.8m deep	Dominated by deep soft silt with localised clay & gravel patches	693782	737401
19	Jackson's Bridge	*Lemna trisulca* (O) *Elodea canadensis* (O) *Elodea nuttallii* (F) *Hippuris vulgaris* (A) *Nuphar lutea* (O) *Alisma plantago-aquatica* (O) *Myriophyllum verticillatum* (R) *Glyceria maxima* (O) *Sparganium erectum* (R) *Schoenoplectus lacustris* (F) *Chara vulgaris* (O) *Chara hispida* (F) *Tolypella glomerata* (R) Filamentous algae (R)	Mature homogenous section with high macrophyte cover & steeply sloping margins, 1-1.8m deep	Dominated by soft silt with localised clay & gravel patches on steep margins	691578	737700
20	Harbour Road, Kilcock	*Lemna trisulca* (O) *Elodea canadensis* (R) *Elodea nuttallii* (F) *Hippuris vulgaris* (A) *Nuphar lutea* (F) *Alisma plantago-aquatica* (R) *Myriophyllum verticillatum* (O) *Callitriche spp.* (R)	Homogenous section with high macrophyte cover & narrow marginal fringes, >1.6m average depth	Dominated by soft silt with localised clay & gravel patches on steep margins	688949	739402

Site	Location	Macrophyte species recorded (DAFOR)	Site summary	Substrata	ITM x	ITM y
		Glyceria maxima (F) *Iris psuedacorus* (O) *Schoenoplectus lacustris* (F) *Carex rostrata* (R) *Mentha aquatica* (R) *Oenanthe crocata* (R) *Fontinalis antipyretica* (R) *Chara vulgaris* (R) *Chara hispida* (R) Filamentous algae (O)				



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Royal Canal (1st to 16th lock) aquatic macro-invertebrate survey 2023

Prepared by Triturus Environmental Ltd. for

Roughan & O' Donovan Consulting Engineers

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Table of contents

1. Introduction 3

1.1 Project background 3

1.2 Study area description 3

2. Methodology 4

2.1 Desktop review 4

2.2 Macro-invertebrate survey 4

2.3 Species diversity 4

2.4 Species accumulation curve 5

2.5 Biosecurity 5

3. Desktop review 8

4. Results 10

4.1 Aquatic macro-invertebrate communities 10

4.2 Rare or protected species 11

5. Discussion 16

5.1 Rare and or protected species 16

5.2 Potentially invasive species 17

6. References 18

7. Appendix A – macro-invertebrate species list 20

1. Introduction

1.1 Project background

Triturus Environmental Ltd. were commissioned by Roughan & O' Donovan Consulting Engineers (ROD) to undertake annual baseline aquatic macro-invertebrate surveys of the Royal Canal between the 1st lock (Spencer Dock, Dublin City) and the 16th lock (Kilcock, Co. Kildare). The survey area encompassed a total of 33km of the Royal Canal (**Figure 2.1**). In light of the known presence of several rare and or protected macro-invertebrate species in the Royal Canal, in addition to the various proposed infrastructural projects in the vicinity of the canal, it was deemed pertinent to complete annual baseline assessments of macro-invertebrates to better inform development design, mitigation and conservation in the coming years.

The baseline survey helped to identify, catalogue and map macro-invertebrate communities along the Royal Canal, inclusive of rare and or protected species. The surveys would sample and identify all macro-invertebrates (to species level, where possible) but there was a focus on high conservation value species such as the endangered glutinous snail (*Myxas glutinosa*) (Byrne et al., 2009).

The findings of this report would build on and update previous invertebrate surveys completed along the Royal Canal, e.g. Invas (2021); Moorkens & Killeen (2003). This report constitutes the first of four annual monitoring reports (2023-2026 inclusive), with the survey undertaken in the April-May 2023 period.

1.2 Study area description

The Royal Canal is some 150km long and links the River Liffey in Dublin City with the River Shannon in Co. Longford. The canal is fed by Lough Owel, Co. Westmeath and flows east to Dublin and west to the Shannon. Though originally constructed for transport of goods (work was completed in 1817), the Royal Canal was closed to typical navigation in 1961. The present-day canal serves as a highly valuable recreational amenity site and regionally important ecological corridor. The entire length of the Royal Canal is designated as a proposed Natural Heritage Area (pNHA) (site code: 002103) (NPWS, 1995).

The Royal Canal is known to support a number of high conservation value macro-invertebrate species, including the endangered glutinous snail (*Myxas glutinosa*) (Byrne et al., 2009) and Annex II white-clawed crayfish (*Austropotamobius pallipes*)[1].

In terms of water quality, the Royal Canal within and outside of the survey area was of good WFD status in the 2016-2021 period.

[1] The current survey did not target white-clawed crayfish but would make note of their occurrence in sweep samples

2. Methodology

2.1 Desktop review

A desktop review of published and unpublished data for the Royal Canal and associated habitats was undertaken in respect of macro-invertebrate species. Records for rare and or protected species held by the National Parks and Wildlife Service (NPWS), National Biodiversity Data Centre (NBDC) and Environmental Protection Agency (EPA) was also reviewed.

2.2 Macro-invertebrate survey

Macro-invertebrate sweep samples were collected at a total of 20 no. survey sites to determine the community composition and detect any other rare/protected species. This approach included the 12 no. sites in the current survey area sampled by Moorkens & Killeen (2003), with an additional 8 no. sites added to address any longitudinal lacunae (**Figure 2.1**). The survey area comprised approximately 33km of contiguous canal between the 1st level (Croke Park) and the 16th lock at Kilcock, Co. Kildare (**Table 2.1, Figure 2.1**).

A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the canal bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was employed. To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey sites to get a representative sample for sub-habitats. Apart from *Myxas glutinosa*[2], the contents of samples were fixed in 70% ethanol for subsequent laboratory identification. Species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley et al., 2020) and other relevant taxa (i.e. Byrne et al., 2009; Nelson et al., 2011).

Targeted surveys for the endangered glutinous snail (*Myxas glutinosa*) (Byrne et al., 2009) were also undertaken using the same approach, given the known presence of this species in the Royal Canal, including within the survey area. Surveys focused on preferred habitats of this species such as macrophyte vegetation, soft sediments and exposed hard substrata (Anderson, 2016; Willing et al. 2014; Holyoak, 2004; Whitfield et al., 1998).

2.3 Species diversity

Species diversity (the effective number of species) was measured using Hill–Shannon diversity (^1D, ℓ=1[3]), the geometric mean rarity, or the exponential of the Shannon entropy (H') (Shannon, 1948) where e is the natural log, Σ is the sum of species, p_i is the proportion of each species in the sample, and $ln\ p_i$ is the natural logarithm of this proportion.

[2] this species can easily be identified in the field because the mantle extends almost entirely over the exterior of the shell when the animals are active (Anderson, 2016; Willing et al. 2014)

[3] When ℓ=1, the species are weighed in proportion to their frequencies, and ^1D can be interpreted as the effective number of common or "typical" species (i.e., species with typical abundances) in the assemblage

$$e^{-\sum_{i=1}^{S} p_i \ln(p_i)}$$

Hill–Shannon diversity emphasises neither rare nor common species (Jost, 2006) and is accepted as a more robust measure of diversity than other metrices. The geometric mean affords leverage to extreme values according to their proportional, not absolute, difference from the mean. The Hill–Shannon diversity retains some of the sensitivity of Hill diversities with higher exponents (such as richness), and also the robustness to sampling and sample standardization of Hill diversities with lower exponents (such as Hill–Simpson diversity which emphasises common species). As a result, Hill–Shannon may be a good choice for characterizing gradients in biodiversity in an ecologically meaningful way (Roswell et al., 2021). Generic mean values increase with the number of species and the 'evenness' (relativity) of their abundance (i.e. the higher the value of ${}^{1}D$, the more diverse the species community is at a particular site/habitat).

2.4 Species accumulation curve

Species accumulation curves are used to describe the increase of species with the increase in sampling effort and serve as an indicator of the validity and adequacy of sampling (Ugland et al., 2003). Sites with a high proportion of rare species and few abundant species have a species accumulation curve with a low inflection point on the y-axis and a long upward sloping line to the asymptote, whereas sites with a high proportion of relatively abundant species have a steep rising initial slope, plateau early and provide an accurate estimate of species richness with less sampling effort than when there is a higher proportion of rare species (Thompson & Withers, 2003). The cumulative number of species recorded was plotted against the number of sampling sites to interrogate the macro-invertebrate data collected.

2.5 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=20 macro-invertebrate survey sites along the Royal Canal, 2023

Site no.	Location	X (ITM)	Y (ITM)
1	Croke Park	716029	735928
2	Between 2nd & 3rd lock	715688	736059
3	Between 3rd & 4th lock	715425	736151
4	Cross Guns Bridge	715085	736272
5	Cross Guns Quay, Phibsborough	714865	736363
6	6th lock	714588	736479
7	Cabra West	713991	736847
8	Broombridge station	713251	737176
9	R805 road crossing	712689	737359
10	11th lock	709852	737849
11	Granard Bridge	708376	738086
12	Pakenham Bridge	703843	738284
13	Collin's Bridge	702735	736842
14	Confey slipway	701575	736997
15	Cope Bridge	700861	737068
16	Leixlip Louisa Bridge	699242	736491
17	300m east of Pike Bridge	696397	737339
18	Maynooth Harbour	693782	737401
19	Jackson's Bridge	691578	737700
20	Harbour Road, Kilcock	688949	739402

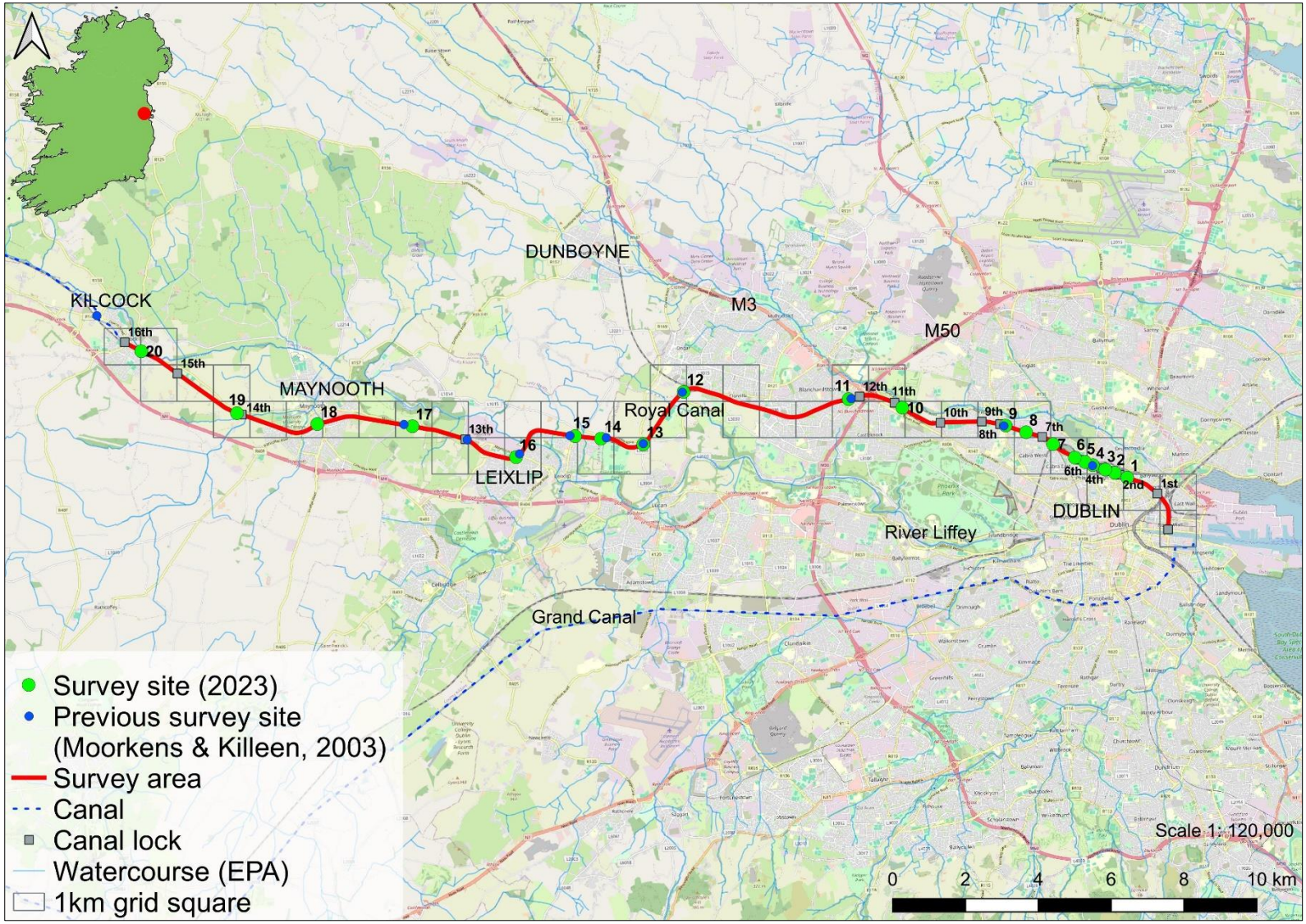


Figure 2.1 Overview of the Royal Canal macro-invertebrate survey area and monitoring sites, 2023

3. Desktop review

Several rare or declining aquatic molluscs have been recorded from the Royal Canal (Moorkens & Killeen, 2003) including the vulnerable (Byrne et al., 2009) whirlpool ramshorn snail (*Anisus vortex*), a species that has its stronghold in the River Shannon.

Two rare pea mussel species (*Pisidium* sp.) have been recorded from the Royal Canal (Moorkens & Killeen, 2003). The false orb pea mussel (*Pisidium pseudosphaerium*) has been recorded from several sites from east of Longford to Ballynacarrigy, Co. Westmeath but also at Leixlip Confey Station (within current survey area) (**Figure 3.1**; Moorkens & Killeen, 2003). The pygmy pea mussel (*Pisidium moitessierianum*) was recorded from a single site at Kilmore Bridge near Enfield (outside current survey area). Both species are listed as endangered (Byrne et al., 2009). The distribution of both these *Pisidium* species in the Royal Canal appears to have declined (Moorkens & Killeen, 2003).

The ICUN endangered glutinous snail (*Myxas glutinosa*), one of Europe's rarest freshwater molluscs, is also known from the Royal Canal but occupies a limited distribution, with previous contemporary records available from 5 no. sites in the vicinity of Leixlip from Dewey Bridge to Collins Bridge (**Figure 3.1**; Moorkens & Killeen, 2003). Both the Royal and Grand Canals are an Irish stronghold for this species. Historical records (1911-1971; NBCD data) are available throughout much of the canal's length.

Duck mussel (*Anodonta anatina*) are known throughout the Royal Canal, with swan mussel (*Anodonta cygnea*) more localised (Moorkens & Killeen, 2003: NBDC data). Both species are listed as vulnerable in Ireland (Byrne et al., 2009).

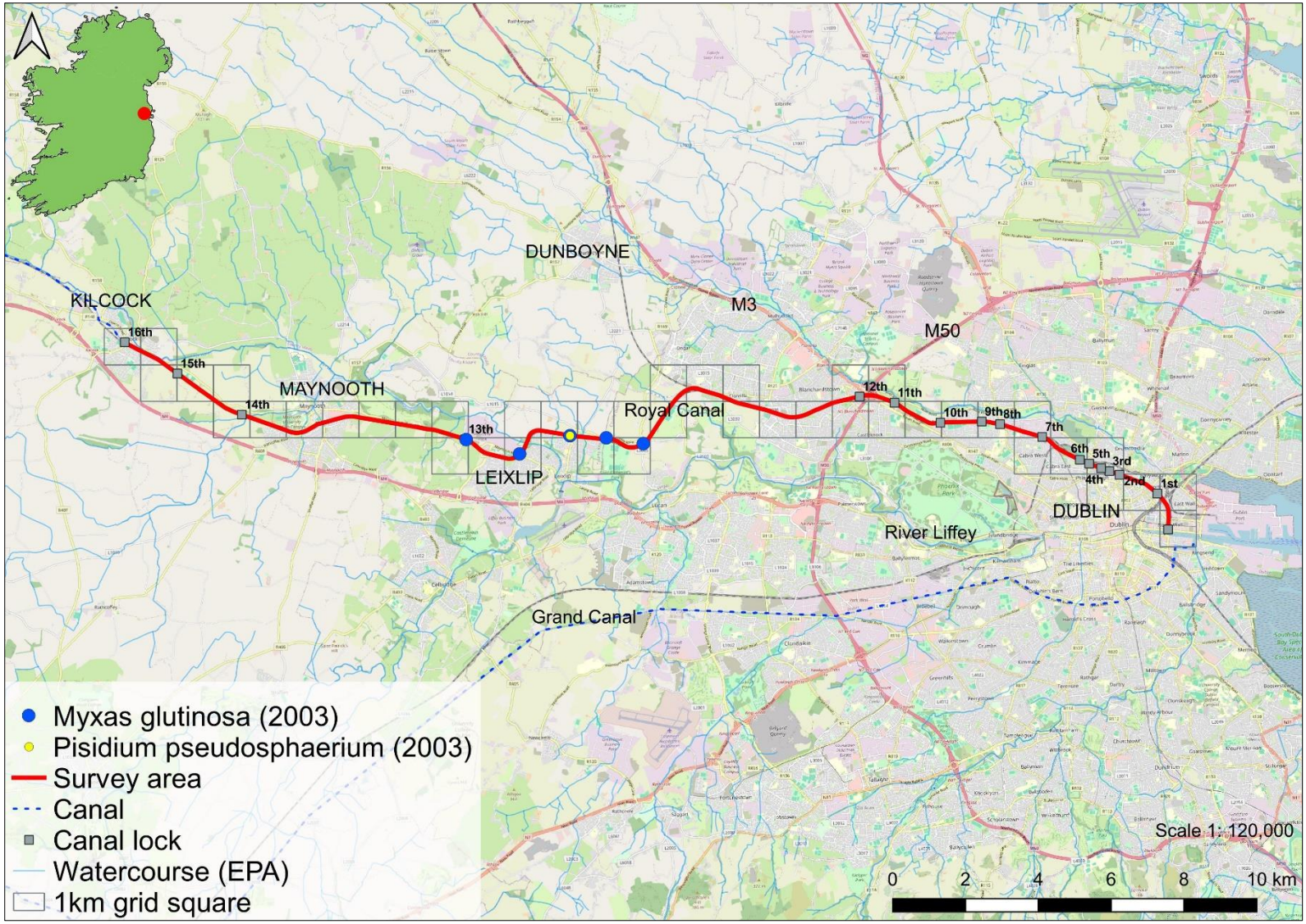


Figure 3.1 Contemporary records for rare/protected macro-invertebrate species in the current survey area (source: Moorkens & Killeen, 2003)

4. Results

4.1 Aquatic macro-invertebrate communities

A total of *n*=62 species across 37 no. families were recorded during the current survey (**Appendix A**). This included a low number of rare and or protected species, namely *Haliplus lineolatus* and *Myxas glutinosa* (see below) (**Table 4.1**). A full site-by-site summary of macro-invertebrate species and abundances is provided in **Appendix A**.

Please note that Sphaeriidae family pea mussels (including endangered *Pisidium* sp.) were not speciated in the current survey but will be speciated by molluscan specialist Dr. Evelyn Moorkens in the 2024 round of monitoring. Also note that site 3 located between the 3rd and 4th locks (**Figure 2.1**) was not accessible for survey in April-May 2023 due to construction works. The site will be included in the next round of annual monitoring (2024).

The macro-invertebrate sweep samples were typically dominated by common species of macrophyte-rich habitats such as freshwater hoglouse (*Asellus aquaticus*), Coenagrionidae species damselflies, Leptoceridae and Limnephilidae species cased caddis, biting midge larvae (non-*Chironomus* spp.), pea mussels (Sphaeriidae) and other mollusc species such as *Bithynia tentaculata* and *Planorbis planorbis* (**Appendix A**).

The taxon richness (number of species) at each survey site ranged from 7 (site 5) to 22 (site 1) (mean 16.26 ±3.7SD, median 17). The taxon richness was typically similar across sites moving east to west, although sites 5, 6, 18 and 19 supported a lower diversity of species compared with other sites (**Figure 4.1**). The Hill-Shannon diversity index (geometric mean rarity) followed a broadly similar pattern with sites 6, 9, 10, 17 and 18 supporting the lowest diversities ($^1D \leq 3.88$) (**Figure 4.1**). Sites 1, 12, 13, 15 and 20 supported the highest diversities ($^1D \geq 8.93$).

Plotting the number of species against sampling effort (number of sampling sites, 19) the cumulative species richness curve (**Figure 4.2**) indicates the true number of species in the survey area is being slightly underestimated, i.e. the curve has not yet reached (but is approaching) its asymptote. The curve produced rises steeply and begins to plateau early as would be expected for study areas with a high proportion of relatively abundant species (Thompson & Withers, 2003).

The non-native shrimp (Gammarid) species *Crangonyx* sp. showed a widespread distribution, being recorded from a total of 15 of 20 no. sampling sites throughout the survey area (i.e. sites 1, 2, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19 & 20) (**Appendix A**).

Table 4.1 Summary of the high conservation value aquatic macro-invertebrate species recorded in the Royal Canal survey area, April-May 2023

Common name	Species	Sites present	Conservation status
Glutinous snail	*Myxas glutinosa*	13 (live), 15 (dead shell)	Endangered (Byrne et al., 2009)
Hydravore crawler water beetle	*Haliplus lineolatus*	14, 15	Near threatened (Foster et al., 2009)
Caddis fly	*Leptocerus tineiformis*	1, 2	None (but nationally uncommon)

4.2 Rare or protected species

The endangered glutinous snail (*Myxas glutinosa*) was recorded from site 13 near Collin's Bridge (**Plate 4.1, 4.2**). Two live individuals were identified in the field and released. A single dead *Myxas glutinosa* shell was recorded from site 15 near Leixlip Confey station.

The hydravore crawler water beetle (*Haliplus lineolatus*) was recorded at sites 14 and 15 near Leixlip. This species is listed as 'near threatened' in Ireland (Foster et al., 2009).

The Leptocerid caddis species *Leptocerus tineiformis* was recorded in low numbers from sites 1 and 2 (**Appendix A**). Whilst not legally protected or of high conservation status, the species appears to occupy a limited distribution in Ireland (O'Connor, 2020).

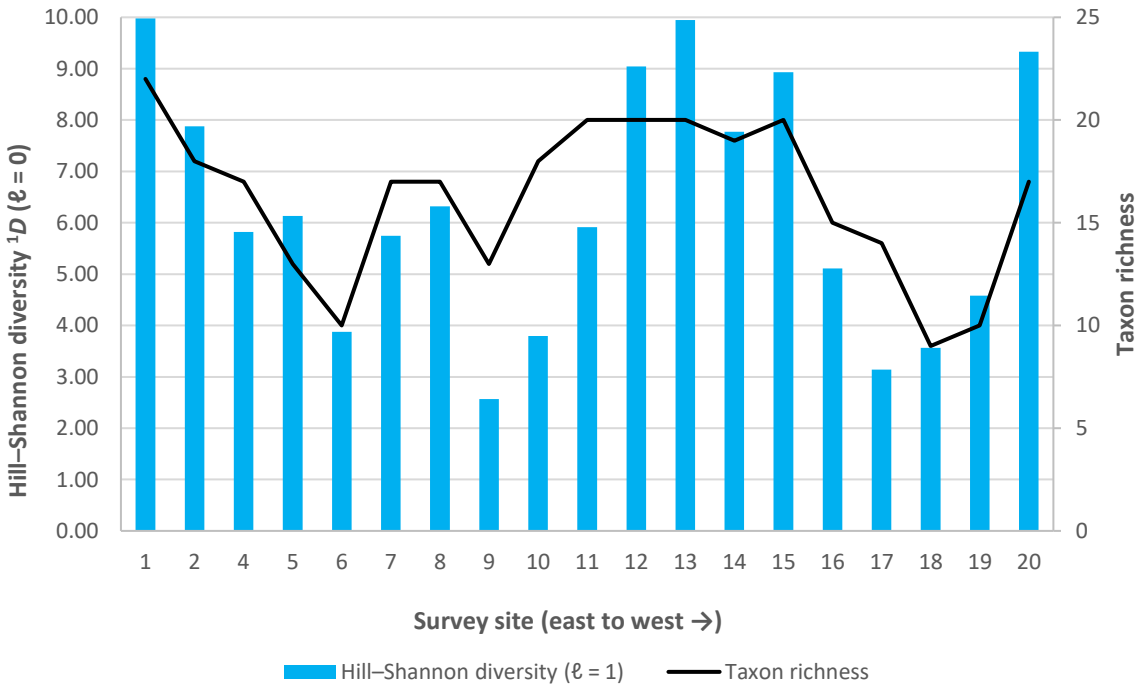


Figure 4.1 Longitudinal macro-invertebrate species diversity (Hill-Shannon diversity) and taxon richness (no. species) per survey site[4], April-May 2023

[4] site 3 located between the 3rd and 4th locks was not accessible for survey in April-May 2023 due to construction works

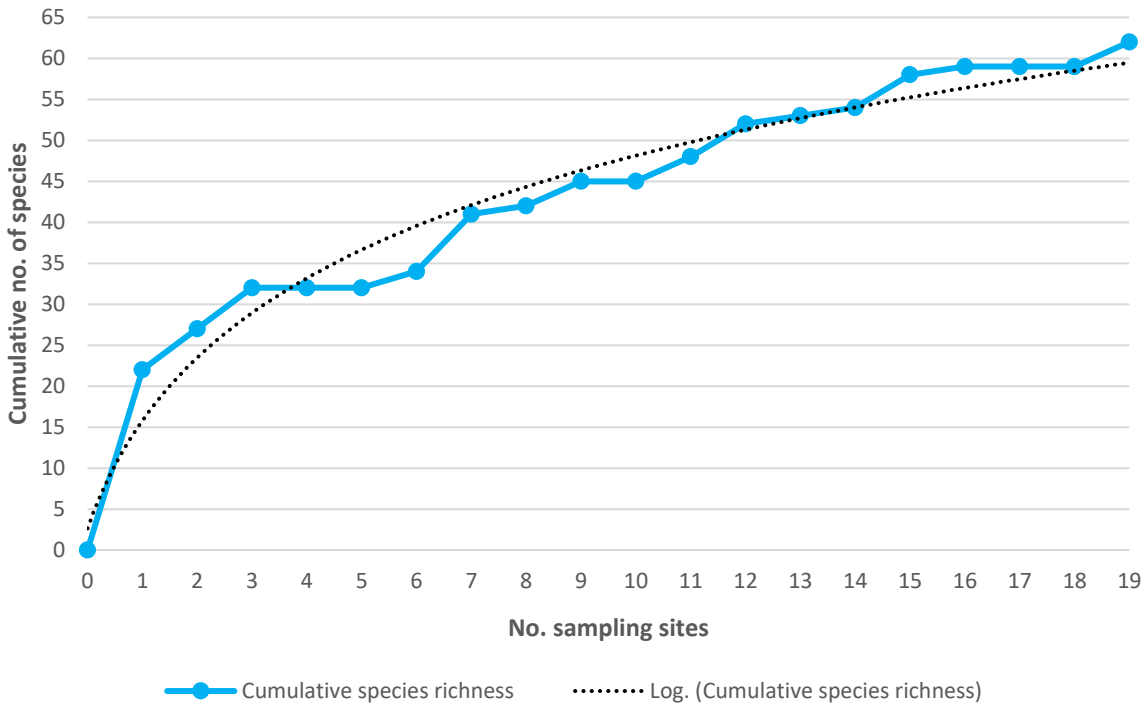


Figure 4.2 Cumulative macro-invertebrate taxon/species richness curve (east to west) for the 2023 survey sites



Plate 4.1 *Myxas glutinosa* recorded and released at site 13 near Collin's Bridge, May 2023



Plate 4.2 *Myxas glutinosa* alongside *Physa fontinalis* (left) and a pea mussel (Sphaeriidae) for scale (bottom right)



Plate 4.3 High quality, macrophyte-rich *Myxas glutinosa* habitat at site 13, Collin's Bridge



Plate 4.4 Dragonfly larvae (*Aeshna* sp.) consuming damselfly larvae (Coenagrionidae) at site 14, May 2023



Plate 4.5 Nationally scarce cased caddis (*Leptocerus tineiformis*)[5]

[5] Source http://urmaskruus.planet.ee/pohjaloomad/T_failid/Leptocerus%20tineiformis.html

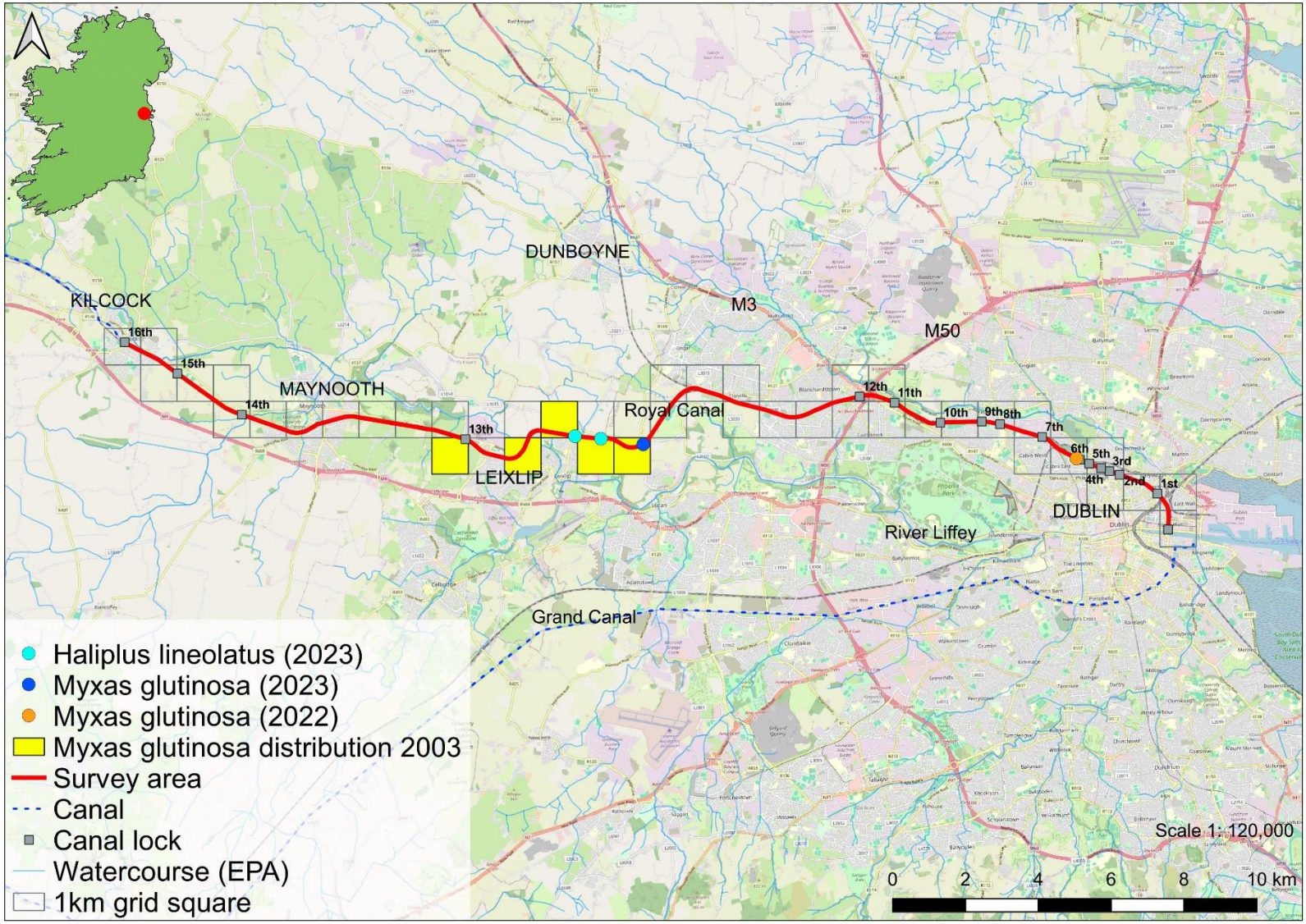


Figure 4.1 Rare/protected macro-invertebrates recorded in the Royal Canal survey area, April-May 2023

5. Discussion

The current survey of macro-invertebrate communities along 33km of the Royal Canal has provided a robust, contemporary baseline with which future data can be compared with, helping to identify potential trends in populations and assemblages as well as the occurrence of rare and or protected species.

The Royal Canal, with its variety of habitats, has long been known to support a diverse range of aquatic macro-invertebrate species (Monahan & Caffrey, 1996). A total of *n*=62 species across 37 no. families were recorded during the current survey. Species richness was typically highest in the Pakenham Bridge to Leixlip area (*n*=19-20, sites 12-15 inclusive). Site 1 (Croke Park) was also relatively diverse in terms of the number of species (*n*=18). These areas were also the most diverse when considering Hill-Shannon diversity index also that calculates geometric mean rarity (**Figure 4.1**). The canal from Pakenham Bridge to Leixlip was typically more macrophyte-rich and less urbanised than the sections either side, thus providing a more varied range of micro-habitats. The positive link between macrophyte diversity/cover and higher invertebrate diversity/richness is expected given the greater frequency of available refugia, shelter, oviposition sites and food resources (Law et al., 2019; Walker et al., 2013; Monahan & Caffrey, 1996).

The cumulative species richness curve (**Figure 4.2**) indicates the true number of species in the survey area is being slightly underestimated, i.e. the curve has not yet reached (but is approaching) its asymptote. This would suggest that a slight increase in the number of sampling sites for subsequent annual monitoring would better detect the full range of macro-invertebrate taxa within the Royal Canal, including rare species.

5.1 Rare and or protected species

The current survey identified a low number of protected species previously known from the canal, namely *Haliplus lineolatus* and *Myxas glutinosa* (see below) (**Table 4.1**). The endangered gastropod snail *Myxas glutinosa* was recorded from site 13 near Collin's Bridge (**Plate 4.1, 4.2**) where suitable habitat comprising abundant macrophytes (including yellow lily), soft sediment and localised hard substrata (Holyoak, 2004; Carlsson, 2001; Whitfield et al., 1998) were present. Two live individuals were identified in the field and released, with a suspected dead *Myxas glutinosa* shell also recorded from site 15 near Leixlip Confey station although live specimens are required for identification confirmation (Moorkens, pers. comm.). The recorded distribution falls within the range identified by Moorkens & Killeen (2005) (i.e. Dewey Bridge to Collin's Bridge). A suspected *Myxas glutinosa* shell was also recorded in 2022 by Triturus at Phibsborough, west of the 6th lock (Triturus, 2022; **Figure 4.1**) although no live specimens were recorded at this location during the current survey. In light of local suitability, further annual monitoring will be required to ascertain whether the range of this molluscan species has contracted or expanded in more recent years (e.g. since 2003; **Figure 4.1**), following historical declines throughout the canal (Moorkens & Killeen, 2003). As a species, *Myxas glutinosa* known for periodic population declines and sudden recoveries (Carlsson, 2001).

The hydravore crawler water beetle (*Haliplus lineolatus*) was recorded in low numbers at sites 14 and 15 near Leixlip (**Appendix A**). This species is listed as 'near threatened' in Ireland (Foster et al., 2009). This species had previously only been recorded from the western extent of the Royal Canal near

Mullingar in 1986 (NBDC data, not shown). As adults, this species browses on hydrozoans and sponges in lakes and canals with larvae feeding on algae and duckweeds (Foster et al., 2009). The species prefers well-oxygenated water, higher conductivity waters (Pakulnicka et al., 2015) with areas of both macrophytes and bare clay (Eyre et al., 1986). Considering these preferences, the Royal Canal survey area is of high suitability for the species and further investigations are required regarding its current, apparently restricted distribution.

5.2 Potentially invasive species

The non-native shrimp (Gammarid) species *Crangonyx* sp. showed a widespread distribution, being recorded from a total of 15 of 20 no. sampling sites throughout the survey area (i.e. sites 1, 2, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19 & 20) (**Appendix A**). Whilst *Crangonyx pseudogracilis* has been known in Ireland since 1969 (Phoenix Park, Dublin; Holmes, 1975) its Irish range has expanded in recent years (Minchin et al., 2013) and it is now well established (Baars et al., 2021). This includes the Royal (and Grand) Canal (Invas, 2021; Triturus data) where it has been present since at least 2006 (EcoServe, 2011). Another *Crangonyx* species, *C. floridanus* has recently been recorded in the River Liffey and Barrow catchments (Baars et al., 2021). Given the accepted difficulties in differentiating *Crangonyx* species without molecular techniques (Mauvisseau et al., 2018), it was not possible to speciate the *Crangonyx* species recorded in the Royal Canal during this survey. The ecological impacts of either *Crangonyx* species in Ireland remains uncertain (Baars et al., 2021).

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7. Appendix A – macro-invertebrate species list

Table 6.1a Macro-invertebrate species recorded at survey sites 1-10 on the Royal Canal, April-May 2023 (non-native species in **bold**)

Group	Family	Species	1	2	3[6]	4	5	6	7	8	9	10
Ephemeroptera	Baetidae	*Cloeon* sp.	2	1	n/a							
Ephemeroptera	Baetidae	*Cloeon simile*			n/a							
Trichoptera	Leptoceridae	*Adicella reducta*		3	n/a							
Trichoptera	Leptoceridae	*Athripsodes aterrimus*	5		n/a	3	6	4	3	4	2	
Trichoptera	Leptoceridae	*Leptocerus tineiformis*	6	4	n/a							
Trichoptera	Leptoceridae	*Mystacides longicornis*	5	10	n/a		3		1			
Trichoptera	Leptoceridae	*Triaenodes bicolor*			n/a	1						
Trichoptera	Limnephilidae	*Anabolia nervosa*			n/a							
Trichoptera	Limnephilidae	*Halesus radiatus*			n/a							1
Trichoptera	Limnephilidae	*Limnephilus lunatus*			n/a				1		1	3
Trichoptera	Limnephilidae	*Limnephilus marmoratus*	2	1	n/a	1		5	2		1	10
Odonata	Aeshnidae	*Aeshna* sp.	2	1	n/a							1
Odonata	Aeshnidae	*Anax imperator*			n/a							
Odonata	Aeshnidae	*Brachytron pratense*			n/a							
Odonata	Coenagrionidae	sp. indet.	12	6	n/a	3	3		4	3		3
Odonata	Libellulidae	*Sympetrum* sp.		1	n/a							
Ephemeroptera	Caenidae	*Caenis horaria*			n/a							
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*			n/a					1		
Trichoptera	Polycentropodidae	*Plectrocnemia geniculata*			n/a							
Crustacea	Gammaridae	*Gammarus duebeni*			n/a			1				
Coleoptera	Curculionidae	sp. indet.	3		n/a							
Coleoptera	Gyrinidae	Gyrinidae larva			n/a							
Coleoptera	Gyrinidae	*Gyrinus substriatus*			n/a							
Coleoptera	Haliplidae	*Haliplus immaculatus*			n/a					3	4	

[6] site 3 located between the 3rd and 4th locks was not accessible for survey in April-May 2023 due to construction works

Group	Family	Species	1	2	3[6]	4	5	6	7	8	9	10
Coleoptera	Halipliidae	*Haliplus lineolatus*			n/a							
Coleoptera	Halipliidae	*Haliplus ruficollis group*			n/a							1
Coleoptera	Halipliidae	*Haliplus* sp.	2		n/a	1			1			
Coleoptera	Hydrophilidae	*Anacaena limbata*			n/a							
Coleoptera	Hydrophilidae	*Laccobius sp.*			n/a							
Diptera	Chironomidae	Non-*Chironomus* spp.	3		n/a			1				
Diptera	Culicidae	sp. indet.			n/a							
Hemiptera	Corixidae	*Cymatia bonsdorffii*			n/a						1	
Hemiptera	Corixidae	*Hesperocorixa linnaei*			n/a							1
Hemiptera	Corixidae	*Hesperocorixa* sp.	1		n/a							
Hemiptera	Corixidae	*Siagara* sp.		1	n/a							
Hemiptera	Corixidae	sp. indet.			n/a							
Hemiptera	Notonectidae	Notonectidae nymph			n/a				1	6	3	1
Hemiptera	Notonectidae	*Notonecta marmorea viridis*			n/a							2
Hemiptera	Gerridae	*Gerris* sp.			n/a							
Hirudinidae	Piscicolidae	*Piscicola* sp.			n/a					1		
Gastropoda	Bithnyiidae	*Bithynia tentaculata*	16	8	n/a	12	6	9	8	18	13	12
Gastropoda	Lymnaeidae	*Lymnaea stagnalis*			n/a			1				
Gastropoda	Neritidae	*Theodoxus fluviatilis*	1		n/a							
Gastropoda	Planorbidae	*Hippeutis complanatus*			n/a							
Gastropoda	Planorbidae	*Planorbis planorbis*	9	13	n/a	1	1	2	5	3	2	
Gastropoda	Valvatidae	*Valvata piscinalis*	1		n/a							
Arachnida	Hydrachnidiae	sp. indet.	1		n/a	1						
Crustacea	**Crangonyctidae**	***Crangonyx* sp.**	**1**	**10**	n/a				**3**	**3**	**6**	**2**
Crustacea	Asellidae	*Asellus aquaticus*	3	6	n/a	5			2	4	4	17
Gastropoda	Sphaeriidae	sp. indet.	12	1	n/a			6	3	14	14	17
Gastropoda	Lymnaeidae	*Ampullacaena balthica*	1	1	n/a		1					

Group	Family	Species	1	2	3[6]	4	5	6	7	8	9	10
Gastropoda	Physidae	*Physa fontinalis*		4	n/a	3				2	1	
Hirudinidae	Erpobdellidae	sp. indet.	2		n/a							
Hirudinidae	Glossiphoniidae	sp. indet.		1	n/a		1					
Megaloptera	Sialidae	*Sialis lutaria*			n/a							
Diptera	Chironomidae	*Chironomus* spp.			n/a					1		
Annelidae	Oligochaeta	sp. indet.			n/a	1						
Lepidoptera	Pyralidae	sp. indet.		2	n/a						1	
Abundance			**90**	**74**	n/a	**32**	**21**	**29**	**34**	**63**	**53**	**71**
Taxon richness			21	18	n/a	11	7	8	12	13	13	13

Table 7.1b Macro-invertebrate species recorded at survey sites 11-20 on the Royal Canal, April-May 2023 (non-native species in **bold**)

Group	Family	Species	11	12	13	14	15	16	17	18	19	20
Ephemeroptera	Baetidae	*Cloeon simile*						1				
Trichoptera	Leptoceridae	*Athripsodes aterrimus*	1	16	2	1		2	6		3	6
Trichoptera	Leptoceridae	*Mystacides longicornis*		1						1		2
Trichoptera	Leptoceridae	*Triaenodes bicolor*	3	5	4				2			3
Trichoptera	Limnephilidae	*Anabolia nervosa*						1			8	4
Trichoptera	Limnephilidae	*Limnephilus lunatus*			1		5		1			
Trichoptera	Limnephilidae	*Limnephilus marmoratus*		4	5	3	2	2	4		5	1
Odonata	Aeshnidae	*Aeshna* sp.		1								
Odonata	Aeshnidae	*Anax imperator*						1				
Odonata	Aeshnidae	*Brachytron pratense*		1								
Odonata	Coenagrionidae	sp. indet.		11	9	2	3	12	5			
Ephemeroptera	Caenidae	*Caenis horaria*							1			
Trichoptera	Polycentropodidae	*Plectrocnemia geniculata*						1				
Coleoptera	Gyrinidae	Gyrinidae larva		1								

Group	Family	Species	11	12	13	14	15	16	17	18	19	20
Coleoptera	Gyrinidae	*Gyrinus substriatus*					1					
Coleoptera	Halipliidae	*Haliplus lineolatus*				1	1					
Coleoptera	Halipliidae	*Haliplus* sp.		1								
Coleoptera	Hydrophilidae	*Laccobius sp.*										1
Diptera	Chironomidae	Non-*Chironomus* spp.	1	5	1		1	4	1			3
Diptera	Culicidae	sp. indet.			1							
Hemiptera	Corixidae	*Hesperocorixa linnaei*					1			3	1	
Hemiptera	Corixidae	sp. indet.			1							
Hemiptera	Notonectidae	Notonectidae nymph	2	2	2	2	1	2		2	2	2
Hemiptera	Notonectidae	*Notonecta marmorea viridis*				1				1		
Hemiptera	Gerridae	*Gerris* sp.										1
Gastropoda	Bithnyiidae	*Bithynia tentaculata*	11	13	8	2	4	9	1	10	1	8
Gastropoda	Planorbidae	*Hippeutis complanatus*	2									
Gastropoda	Planorbidae	*Planorbis planorbis*	1	1		1		1				3
Arachnida	Hydrachnidiae	sp. indet.	2	1			1					
Crustacea	**Crangonyctidae**	***Crangonyx* sp.**	**6**		**1**	**1**	**1**	**3**	**7**	**8**	**1**	**1**
Crustacea	Asellidae	*Asellus aquaticus*	1		1	2	3	8	2	4	3	12
Gastropoda	Sphaeriidae	sp. indet.	1	5	10		7	1	6	6		1
Gastropoda	Lymnaeidae	*Ampullacaena balthica*	1								1	
Gastropoda	Physidae	*Physa fontinalis*			2			3	1			
Hirudinidae	Glossiphoniidae	sp. indet.					5					11
Megaloptera	Sialidae	*Sialis lutaria*		2	2				1			
Diptera	Chironomidae	*Chironomus* spp.		1		1			2	2	3	1
Lepidoptera	Pyralidae	sp. indet.	2									
Abundance			**34**	**71**	**50**	**17**	**36**	**51**	**40**	**37**	**28**	**61**
Taxon richness			13	17	15	11	14	15	14	9	10	17



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Survey of the Royal Canal east of Kilcock for freshwater molluscs with particular reference to the glutinous snail, *Myxas glutinosa*

Spring 2024

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1. Introduction

The Glutinous snail *Myxas glutinosa* is a Northern European species whose range extends from Scandinavia to Switzerland, east to the Urals and Siberia, and west to Ireland, which has the most westerly populations in the world.

Myxas glutinosa is present towards the Dublin city end of the Grand Canal (Moorkens & Killeen, 2005). Having one of the rarest freshwater molluscs in Europe in a capital city canal is of great international biodiversity interest.

The snail requires very clean calcareous water and has suffered extreme decline throughout its range due to losses in water and habitat quality. It has become extinct from half of its range and is known from single or very few sites in the remainder of its range (Vinarski *et al*., 2013). As a result, the Glutinous snail is currently protected in most European states. It is listed as "Endangered" in the Irish Red Data List (Byrne *et al.,* 2009). However, despite the species drastic decline throughout Europe, and its presence in Red Lists of many countries, *Myxas* was assessed as being of Least Concern (LC) in the European Red List of Non-marine molluscs (Cuttelod *et al.*, 2011). However, this Red List is currently under review and the species' status may well be revised in the very near future.

Ireland has long been an international stronghold of this species, and it has been recorded from 31 ten km squares in Ireland, of which only 14 are post-1965, indicating a significant decline (Kerney 1999). The majority of the Irish records have been from the Grand and Royal Canals. Populations have also been confirmed in western lakes (Holyoak 2004, 2005), although there has been no more recent records.

A wide-ranging survey of the Grand and Royal Canals in 2003 (Moorkens & Killeen 2005) showed that *Myxas* was still present in both canals, but had become more restricted in range than in previous years. A study for Dublin City Council highlighted the decline and conservation importance of this species (Tubridy & Moorkens, 2009).

Since 2010 several surveys for *Myxas* have been undertaken for Waterways Ireland. This work was initiated as Waterways Ireland proposed the dredging of levels 1 to 7 of the Circular line of the Grand Canal in Dublin City. A monitoring programme was initiated and surveys for *Myxas* were undertaken in March/April 2010 (Moorkens, 2010), March 2011 (Moorkens, 2011), in 2012 (Moorkens 2012). Follow-up surveys were carried out in 2013 and 2014. The most recent survey of the Grand Canal for *Myxas* was carried out in 2021 and comprised Resurvey of all 71 previously sampled sites, plus other locations from Lock 1 Main Line (Lock at Suir road Davitt Road Junction) out through Lock 3 Inchicore out as far as the M50 Bridge at Park West to the level there beside the filter beds (Moorkens 2021). The 2021 results showed that *Myxas glutinosa* was still living in the Grand Canal from Level 1 near Grand Canal Dock to the M50 motorway at Park West. However, the species distribution was becoming more fragmented, the abundance was much lower, and much of the habitat was in poorer condition than was recorded in 2009 prior to the dredging operations.

There have been no targeted surveys for *Myxas* on the Royal Canal since the original 2003 survey. In 2022 Triturus Environmental Ltd. were contracted by the Shandon Residents Association to conduct an aquatic biodiversity audit and management plan for the Royal Canal at Shandon Gardens, Phibsborough, Dublin (Trituris 2022). Two (unconfirmed) individuals of *Myxas* were found in their survey section. In 2023 Trituris undertook annual baseline aquatic macro-invertebrate surveys of the Royal Canal between the 1st lock (Spencer Dock, Dublin City) and the 16th lock (Kilcock, Co. Kildare). The survey included the 12 sites in the survey area which had been sampled by Moorkens & Killeen in 2003. The Glutinous snail was recorded alive at site 13 near Collin's Bridge, and a shell was recorded from site 15 near Leixlip Confey station (Trituris 2024).

2. Methodology

The Royal Canal was sampled using an extendable robust, aluminium-framed pond net (handle and frame 2.4m in length, equipped with a 0.5mm nylon mesh bag). Both the bivalves (which mainly live in the sediment) and the gastropods (which mainly live on the weeds) were collected. At each survey site a set of samples was taken, each set consisting of sub-samples from a range of diverse sub-habitat locations, of which the net contents were amalgamated into a bucket. The sample was agitated in water to release snails from the weed, allowed to settle, and then snail-free vegetation was removed.

The samples were examined in the field by tipping the molluscs into a plastic tray, and a species list was recorded. A sample of the sediment at each site was retained to allow all of the pea mussels (and other molluscs not seen in the field) to be extracted and identified.

In addition to sampling general aquatic vegetation and soft substrate, specific searches for *Myxas glutinosa* were made by targeting the species' preferred habitat i.e. marginal rocks amongst clean silty substrate, hard substrates such as walls, and the waterlily *Nuphar lutea*.

3. Sample sites

A total of 20 sites were sampled from Allen Bridge, just west of Kilcock to Mountjoy in Dublin city centre. Twelve of the sites sampled in 2024 coincided with the 2003 sites (and with Trituris 2024). Eight further sites were added: one west of the M50 at Clonsilla Station, and 7 east of the M50, including a section at Shandon Gardens, Phibsborough surveyed by Trituris in 2022 (Table 1,Figures 1 and 2). It was not possible to sample any of the Canal east of the Third Lock as all the towpaths were closed for construction works. The work was carried out between and 18th and 23rd April 2024, the season when *Myxas* matures.

Table 1: Location of sample sites (Further details in Appendix 1)

2024 Site No	2003 Site No.	Site	Grid Ref
24/1	28	W of Kilcock	N87841 40238
24/2	29	Opp Carton House	N96234 37362
24/3	30	Dewey Bridge	N97971 36945
24/4	31	Louisa Bridge	N99409 36554
24/5	32	Leixlip Stn, Confey	N99352 36502
24/6	33	At RCAG slipway	O01790 36996
24/7	34	Collins Bridge	O02807 36835
24/8	35	Westmanstown	O03880 38250
24/9	Not surveyed	Clonsilla Station	O04936 38149
24/10	36	Castleknock Station	O08517 38073
24/11	Not surveyed	NW of 11th lock	O09540 38015
24/12	37	E of Ashtown Bridge/10th Lock	O11171 37437
24/13	38	W of Reilly Bridge/8th Lock	O12489 37400
24/14	Not surveyed	NW of Broom Bridge	O13106 37224
24/15	Not surveyed	NW of 7th Lock	O13664 37059
24/16	Not surveyed	SE of 7th Lock	O14055 36828
24/17	Not surveyed	Shandon gardens NW end	O14309 36620
24/18	Not surveyed	Shandon Gardens NW of 6th Lock	O14678 36434
24/19	39	Royal Canal Bank, SE of 5th Lock and Cross Gun's Bridge	O15161 36230
24/20	Not surveyed	By Mountjoy Prison, between 4th and 3rd Locks	O15493 36116

Figure 1: Location of sites west of the M50 (Sites 24/1 to 24/10)

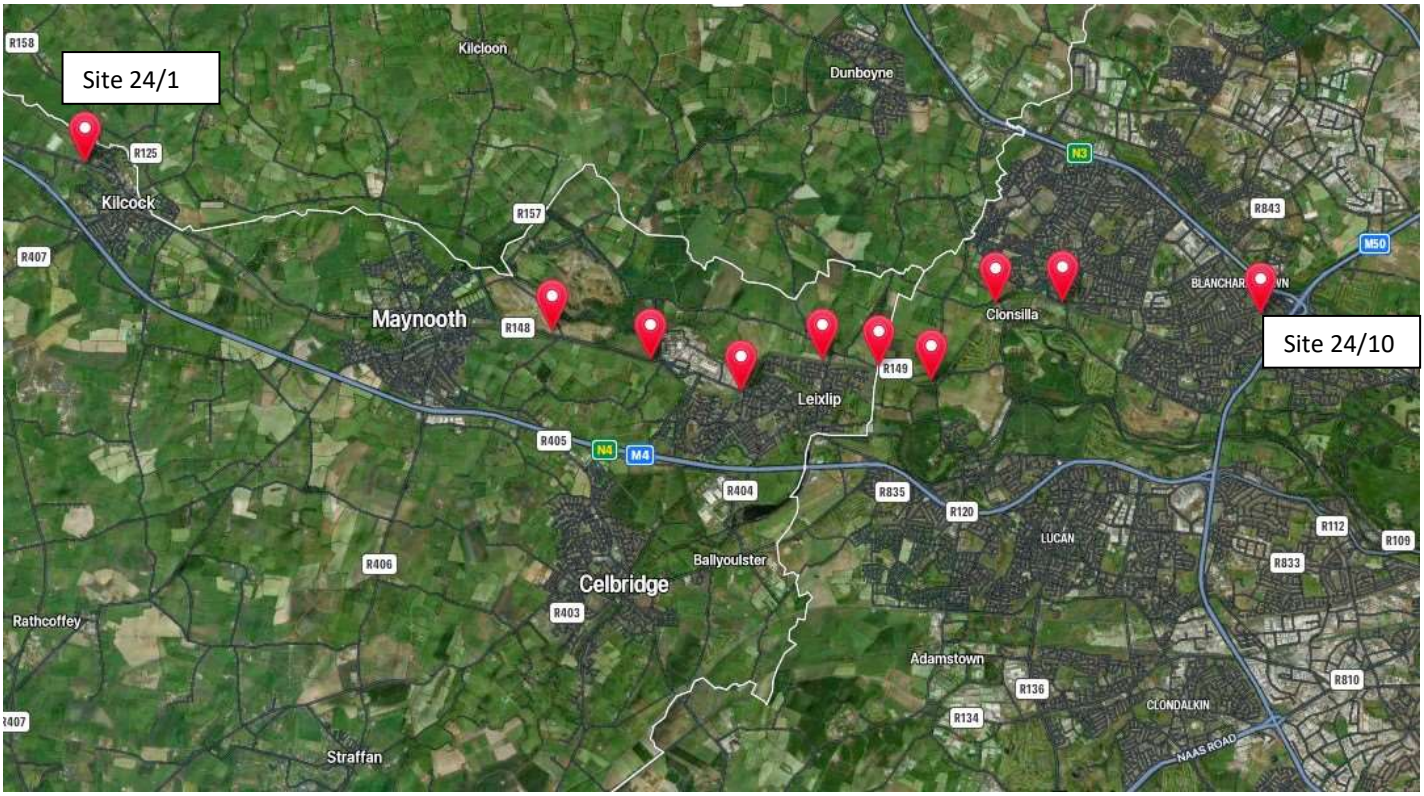
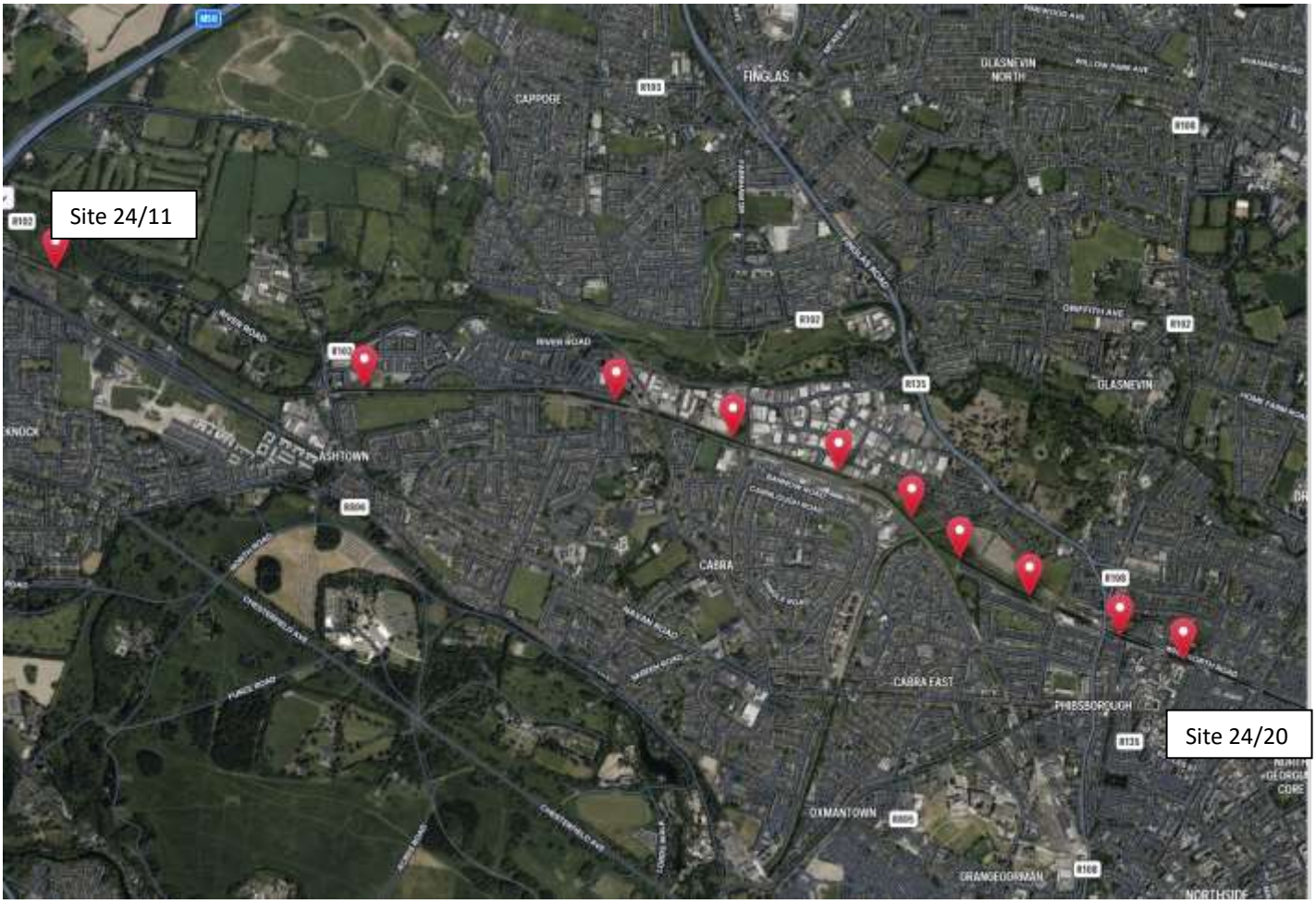


Figure 2: Location of sites east of the M50 (Sites 24/11 to 24/20)



Results 2024

The results of the aquatic molluscs recorded are shown in Tables 2 and 3.

A total of 25 species were recorded comprising 15 gastropods and 10 bivalves. The number of species per site ranged from 8 to 15, with a mean of 12.3. The list includes the Lake limpet *Acroloxus lacustris* which was not found in the 2003 surveys. Three species found in 2003: *Valvata cristata, Anodonta cygnea* and *A. anatina* were not recorded in 2024. For comparison, the results from 2003 are shown in Appendix 2.

The Glutinous snail *Myxas glutinosa* was recorded at 3 sites: 24/7 Collin's Bridge (Figure 3) where it was common (also found at this site in a 2023 survey by Triturus (2024), 24/8 Westmanstown (2 live), west of the M50, and at Shandon Gardens, Phibsborough 24/18 (one live individual). However, it was not found at the four locations west of Collin's Bridge from where the species had been recorded in 2003 (Appendix 2).

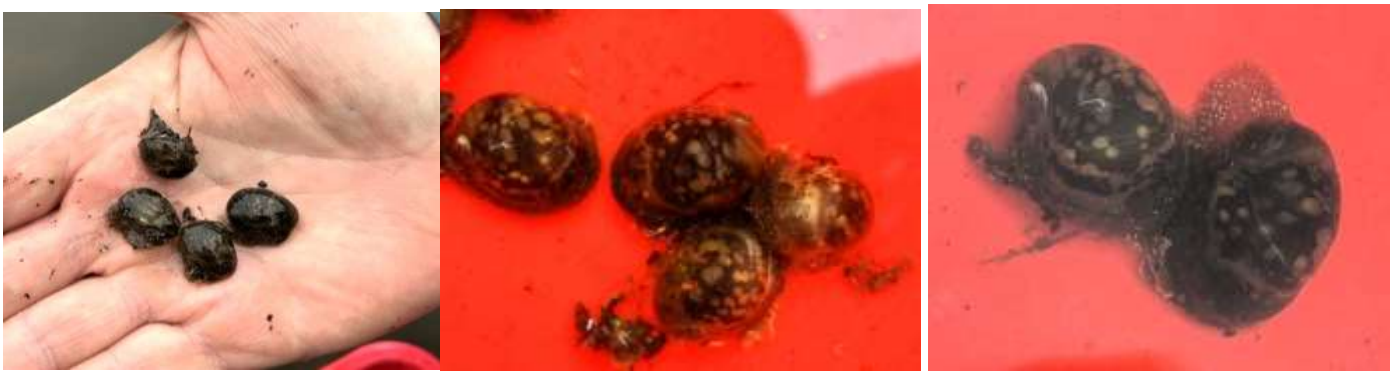
Table 2: 2024 Molluscan composition of samples at sites west of the M50 (Sites 24/1 to 24/10)
NS=not sampled

2024 Site No.	24/1	24/2	24/3	24/4	24/5	24/6	24/7	24/8	24/9	24/10
(2003 Site No.)	28	29	30	31	32	33	34	35	NS	36
Mollusc Species										
Valvata piscinalis	X									
Bithynia tentaculata	X	X	X	X	X	X	X	X	X	X
Bithynia leachii	X	X	X	X	X	X	X	X	X	X
Physa fontinalis	X	X	X	X	X	X	X	X	X	X
Stagnicola fuscus	X	X	X							
Lymnaea stagnalis		X			X		X			X
Ampullaceana balthica	X	X	X							X
Myxas glutinosa							**X**	**X**		
Planorbis carinatus	X	X	X	X	X	X	X	X	X	X
Bathyomphalus contortus	X	X		X			X			X
Gyraulus albus	X	X		X		X			X	
Gyraulus crista	X									
Hippeutis complanatus			X					X	X	X
Planorbarius corneus							X		X	
Acroloxus lacustris			X		X		X			
Sphaerium corneum	X	X	X	X	X	X	X	X	X	X
Musculium lacustre				X		X				X
Pisidium amnicum	X									
Euglesa henslowana	X		X		X		X	X	X	
E. hibernicum	X	X	X		X	X	X	X		
E. milium	X	X	X	X	X	X	X	X		X
E nitida	X	X	X		X	X	X	X	X	
E. obtusalis			X	X		X			X	X
E. pseudosphaerium				**X**						**X**
E. subtruncata	X	X	X	X	X	X	X	X	X	X
No. of Species	17	14	15	12	12	12	15	12	12	14

Table 3: 2024 Molluscan composition of samples at sites east of the M50 (Sites 24/11 to 24/20)
NS=not sampled

2024 Site No.	24/11	24/12	24/13	24/14	24/15	24/16	24/17	24/18	24/19	24/20
(2003 Site No.)	NS	37	38	NS	NS	NS	NS	NS	39	NS
Mollusc Species										
Valvata piscinalis										
Bithynia tentaculata	X	X	X	X	X	X	X	X	X	X
Bithynia leachii	X	X	X	X	X	X	X	X	X	X
Physa fontinalis	X	X	X	X	X	X	X	X	X	X
Stagnicola fuscus										
Lymnaea stagnalis	X	X	X	X				X		X
Ampullaceana balthica		X	X	X				X		
Myxas glutinosa								**X**		
Planorbis carinatus	X	X	X	X	X	X	X	X	X	X
Bathyomphalus contortus		X		X				X		X
Gyraulus albus	X	X								
Gyraulus crista										
Hippeutis complanatus	X			X				X		X
Planorbarius corneus										
Acroloxus lacustris										
Sphaerium corneum	X	X	X	X	X	X	X	X	X	X
Musculium lacustre										
Pisidium amnicum										
Euglesa henslowana										
E. hibernicum						X	X		X	X
E. milium	X	X		X	X	X	X	X	X	
E nitida	X	X	X	X	X	X	X	X	X	X
E. obtusalis			X	X		X	X	X		X
E. pseudosphaerium						**X**	**X**		**X**	
E. subtruncata	X	X	X	X	X	X	X	X		X
No. of Species	11	12	10	13	8	11	11	14	9	12

Figure 3: Myxas glutinosa from just west of Collin's Bridge (Site 24/7)



The False-orb pea mussel *Euglesa psudosphaerium* was found at 5 sites: Louisa Bridge 24/4 and Castleknock Station 24/10, west of the M50, and at sites 24/16, 24/17 and 24/19 from SE of the 7th Lock to Royal Canal Bank, SE of 5th Lock and Cross Gun's Bridge.

Five species: *Bithynia tentaculata, B. leachii, Physa fontinalis, Planorbis carinatus, Sphaerium corneum and Euglesa substruncata* were found at every site. *Valvata piscinalis* was found only at the westernmost site 24/1 at Kilcock, and *Euglesa henslowana* was found only at sites west of M50.

Discussion

The results from the 2024 and 2003 surveys for the two endangered species and the total species counts are summarised in Tables 4 and 5.

In reviewing the status of aquatic molluscs in the Royal Canal 19 years following the equivalent survey, the decline in the number of sites with *Myxas glutinosa* west of the M50 stands out. Changes in the riparian habitat since 2003 are very evident at the sites where *Myxas* is no longer found, particularly in both the bank profiles, which have become steeper, and the width of the riparian zone, which has narrowed. *Myxas* needs a gradually sloped bank with a variety of substrate, including hard surfaces for it to crawl and graze on, as well as the indicator species *Nuphar lutea*, which is considered to support it through food and physical structure. The remaining two sites West of the M50 both have gradual slopes and wide riparian zones. The towpath was un-metalled with a grassy bank with a ditch on the landward side. Shallow sloping banks had a wide fringe of *Glyceria* and abundant *Nuphar* (Figures 4 and 5). It is important to protect these sites from negative impacts both in the riparian area and the aquatic zone.

East of the M50 *Myxas* was found at the Shandon Gardens site (24/18), and was recorded in this area also by Triturus (2022). This has also a wide riparan zone and shallow canal banks and lots of *Nuphar.* (Figure 6). It remains absent from the sites sampled in 2003, where it was not found at all east of the M50.



Figure 4. Site 24 – 7 Collin's Bridge with good numbers of *Myxas* in ideal habitat.



Figure 5. Abundant *Nuphar* in the vicinity of *Myxas* location at Collin's Bridge.



Figure 6. Wide riparian area and shallow banks at Shandon Gardens (24/18).

Ongoing works at the Cross Guns Bridge area (Site 24/19) demonstrates the loss of opportunity for *Myxas* in this area (Figures 7 and 8), and how biodiversity is lost through lack of space. The riparian zone is narrow on the south side from the road encroaching to almost the edge of the canal, and on the north side the bank is being regraded in a very steep manner.



Figure 7. Regrading of the north bank of the canal at Phibsborough (24/19).



Figure 8. Encroachment at both sides of the canal at Phibsborough (24/19).

Table 4: 2024 and 2003 results for endangered species and total species west of the M50

2003 Site Number	2024 Site Number	Location	*Myxas* records 2003	*Myxas* records 2024	*E.pseud.* records 2003	*E.pseud.* records 2024	Total mollusc species 2003	Total mollusc species 2024
28	24/1	W of Kilcock					15	17
29	24/2	Opp Carton House					12	14
30	24/3	Dewey Bridge	X				14	15
31	24/4	Louisa Bridge	X			X	18	12
32	24/5	Leixlip Stn, Confey	X		X		15	12
33	24/6	At RCAG slipway	X				17	12
34	24/7	Collins Bridge	X	X			18	15
35	24/8	Westmanstown		X			11	12
NS	24/9	Clonsilla Station						12
36	24/10	Castleknock Station				X	9	14

Table 5: 2024 and 2003 results for endangered species and total species east of the M50

2003 Site Number	2024 Site Number	Location	*Myxas* records 2003	*Myxas* records 2024	*E.pseud.* records 2003	*E.pseud.* records 2024	Total mollusc species 2003	Total mollusc species 2024
NS	24/11	NW of 11th lock						11
37	24/12	E of Ashtown Bridge/10th Lock					7	12
38	24/13	W of Reilly Bridge/8th Lock					12	10
NS	24/14	NW of Broom Bridge						13
NS	24/15	NW of 7th Lock						8
NS	24/16	SE of 7th Lock				X		11
NS	24/17	Shandon gardens NW end				X		11
NS	24/18	Shandon Gardens NW of 6th Lock		X				14
39	24/19	Royal Canal Bank, SE of 5th Lock and Cross Gun's Bridge				X	7	9
NS	24/20	By Mountjoy Prison, between 4th and 3rd Locks						12

The other species listed as Endangered in the Irish red list (Byrne et al., 2009) is *Euglesa psudosphaerium.* There have only ever been 19 records of the species in Ireland, and all 5 from this century are from the 2003 canal survey. West of the M50 there were 2 2024 sites , but it was not found at the 2003 site at Leixlip Station, where both endangered species are now missing.

East of the M50 *Euglesa psudosphaerium* was found in 2 previously unsurveyed locations, as well as at Site 24/19. The disturbance at this latter site places this rare species at risk.

West of the M50 the average number of mollusc species per site was 13.5. This compares with an average of 14.3 in 2003. The largest declines were at Louisa Bridge, which was a very important site of excellent quality in 2003, but is now considerably degraded. The sites east of the M50 are not comparable, as only 3 were surveyed in 2003 compared with 10 in 2024. In 2024 there were an average of 11.1 species per site, somewhat lower than west of the M50.

The presence of two endangered species so close to the centre of a capital city is to be celebrated and it should provide a great emphasis on the protection of their habitat. The canal should be maintained in as natural a state as possible, and any steepening of the canal banks should be avoided.

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Appendix 1: Descriptions of sample sites

Plants: Stonewort *Chara* sp.; Broad-leaved pondweed *Potamogeton natans*; Yellow water lily *Nuphar lutea;* Common reed *Phragmites australis;* Unbranched bur-reed *Sparganium emersum*; Whorl-leaf milfoil *Myriophyllum verticillatum*; Arrowhead *Sagittaria sagittifolia*; Common clubrush *Schoenoplectus lacustris;* Lesser-pond sedge *Carex acutiformis;* Yellow flag *Iris pseudacorus*; Reed sweet-grass *Glyceria maxima*

2024 Site No	Site	Grid Ref	Description	
24/1	E and W of Allen Bridge, W of Kilcock	N87841 40238	Canal appears as though it has been dredged. Generally steep banks, sampled from towpath on north side. Only sparse fringing vegetation, mostly *Glyceria,* substrate compacted	
24/2	Opposite Carton House	N96234 37362	Sampled from towpath on north bank. Shallower slope to banks and much wider strip of fringing vegetation with *Phragmites*, *Glyceria* and *Nuphar*. Dense patches of *Chara* sp. Marginal rocks near bridge	
24/3	Dewey Bridge	N97971 36945	Steeply sloping banks on north side. Patchy fringing and emergent vegetation including *Glyceria, Nuphar, Saggitaria, Schoenoplectus*. Banks are mown and clippings go into the canal	

24/4	Louisa Bridge	N99409 36554	Disturbed and poor quality habitat on the north side of the roadbridge, with sparse marginal vegetation on muddy rubble. Some better habitat south of the bridge with *Glyceria* and *Nuphar*	
24/5	Leixlip Stn, Confey	N99352 36502	Good habitat along section on north bank west of bridge. Relatively broad fringe with *Glyceria, Sparganium*, lots of *Nuphar*, *Carex*. Deep water beyond the riparian margin. Likely impact from Greenway construction	
24/6	At RCAG slipway	O01790 36996	Houseboats moored on a long section, thus relatively little riparian habitat	
24/7	Collins Bridge	O02807 36835	The section on the north bank was the un-metalled original towpath on a grassy bank with a ditch on the landward side. Shallow sloping banks with wide fringe of *Glyceria* and abundant *Nuphar* [*Myxas* found and Smooth Newts]	
24/8	Westmanstown	O03880 38250	Similar to above with grassy path and ditch. Slightly steeper banks than at Collin's Bridge, but good fringe of riparian and emergent vegetation, *Glyceria, Nuphar, Schoenoplectus*	
24/9	Clonsilla Station	O04936 38149	Accessed from north bank. Rather shaded. Relatively steep-sided bank with patchy fringing vegetation – mostly *Glyceria*, and only sparse *Nuphar* away from the bank. Water turbid	

24/10	Castleknock Station	O08517 38073	Towpath along south bank adjacent to railway. Houseboats moored on western and eastern side of the roadbridge. Moderately sloping bank with *Glyceria, Nuphar*, *Myriophyllum.* Denser fringing vegetation along north bank (not sampled)	
24/11	NW of 11th lock	O09540 38015	Sampled from towpath along south bank. Banks have been sculpted as part of new greenway works. Clay substrate exposed and very little marginal or submerged macrophytes. Sparse *Phragmites* & *Glyceria*	
24/12	E of Ashtown Bridge/10th Lock	O11171 37437	Sampled from towpath on north bank and east of the bridge. Fringing and emergent vegetation fragmented but some places with wider strips with *Glyceria, Nuphar*, and dense *Myriophyllum*. Canal full of grass clippings	
24/13	W of Reilly Bridge/8th Lock	O12489 37400	Very similar to above. Sampled from towpath on north bank and east of the bridge. Fringing and emergent vegetation fragmented but some places with wider strips with *Glyceria, Nuphar*, and dense *Myriophyllum*. Canal full of grass clippings, traffic cones and other rubbish	
24/14	NW of Broom Bridge	O13106 37224	Very similar to above , riparian zone shelves off quickly into deeper water	
24/15	NW of 7th Lock	O13664 37059	North side of canal. Relatively shallow slope and narrow riparian zone with *Glyceria* and sparse, emergent *Nuphar, Potamogeton* and *Myriophyllum*	

24/16	SE of 7th Lock	O14055 36828	Generally similar to above but with blanket weed. Narrow mown grassy strip between greenway and canal, clippings in the canal.	
24/17	Shandon gardens NW end	O14309 36620	South side of canal near Coke Oven Cottages (within Trituris 2023 survey area). Fragmented riparian zone with *Glyceria* and *Iris*, and sparse *Nuphar*. Major bank reshaping and steep slope with metalled greenway on opposite bank	
24/18	Shandon Gardens NW of 6th Lock	O14678 36434	South side of canal near 6th Lock (within Trituris 2023 survey area). Habitat similar to above but with more *Phragmites* and *Nuphar* and marginal rocks. A single live *Myxas* found.	
24/19	Royal Canal Bank, SE of 5th Lock and Cross Gun's Bridge	O15161 36230	Small patch of riparian habitat (*Iris, Glyceria*) on south side, east of bridge. Most of the riparian zone had a steep slope and had been subject to reshaping	
24/20	By Mountjoy Prison, between 4th and 3rd Locks	O15493 36116	Sampled from south bank. Broad, gently shelving bank down to canal edge, but then banks steepen. Patchy *Glyceria* fringe, bare in places. No access possible east of the 3rd lock due to construction works	

Appendix 2: 2003 Sample locations and mollusc results (Moorkens & Killeen, 2005)

Plants: Gl = *Glyceria maxima;* Nu = *Nuphar lutea;* Mv = *Myriophyllum verticillatum;* Ph = *Phragmites australis;* Ju = *Juncus sp.;* Ec = *Elodea canadensis;* Ch = *Chara sp.;* Myr = *other Myriophyllum sp.;* Pot = *Potamogeton sp.*

Site No	Site	Grid Ref	Date	(m)	Clarity	Plants
28	W of Kilcock	N8779 4035	4/22/2003	0.3-1	Sl turbid	Gl, Nu, Mv
29	Opp Carton House	N9623437362	4/6/2003	0.3-1	Sl turbid	Ph, Ju, Nu, Mv, Ec
30	Dewey Bridge	N9797136945	4/6/2003	0.3-.5	Sl turbid	Gl, Ph, Ec
31	Louisa Bridge	N9940936554	4/6/2003	0.3-.7	Sl turbid	Gl, Ph, Nu, Mv, Ec
32	Leixlip Stn, Confey	O0079 3705	5/6/2003	0.3-1	Sl turbid	Gl, Nu, Mv, Ch
33	At RCAG slipway	O0179036996	4/6/2003	0.3-.9	Sl turbid	Gl, Ec, Nu, Ch
34	Collins Bridge	O0280736835	4/6/2003	0.6	Turbid	Ju, Ph, Nu
35	Westmanstown	O0388038250	4/6/2003	0.5	Turbid	Nu
36	Castleknock Station	O0851738073	10/5/2003	0.5	Sl turbid	Gl, Myr, Pot, fil algae
37	Ashtown Bridge	O10995 37418	10/5/2003	0.8	Turbid	Gl, blanket weed
38	Cabra	O1271 3732	10/5/2003	0.8	Turbid	Gl, fil algae
39	Dalymount	O1514936231	10/5/2003	0.8	Turbid	Sparse Gl

Site No.	28	29	30	31	32	33	34	35	36	37	38	39
Mollusc Species												
Valvata cristata					X		X		X			X
Valvata piscinalis	X											X
Bithynia tentaculata	X	X	X	X	X	X	X		X	X	X	X
Bithynia leachii	X	X	X	X	X	X	X		X		X	X
Physa fontinalis	X		X	X		X	X		X		X	
Stagnicola palustris = S. fuscus						X	X				X	
Lymnaea stagnalis	X	X		X	X	X	X	X	X		X	
Radix ovata = Ampullanceana balthica	X	X	X	X		X	X	X		X		
Myxas glutinosa			X	X	X	X	X					
Planorbis carinatus	X	X	X	X	X	X	X	X		X	X	X
Bathyomphalus contortus	X	X	X	X	X		X	X			X	
Gyraulus albus	X	X		X				X				
Armiger crista = Gyraulus crista			X				X	X				
Hippeutis complanatus				X			X					X
Planorbarius corneus					X			X				
Anodonta anatina				X		X						
Anodonta cygnea						X						
Sphaerium corneum	X	X	X	X	X	X	X	X	X	X	X	
Musculium lacustre		X	X	X		X	X	X				
Pisidium amnicum			X	X								
P. henslowanum = Euglesa henslowana	X					X						
P. hibernicum = E. hibernica	X			X	X	X	X					
P. milium = E. milium	X	X	X	X	X	X	X	X	X	X	X	X
P. nitidum = E. nitida	X	X	X	X	X	X	X		X	X	X	
P. obtusale = E. obtusalis					X						X	
P. pseudosphaerium = E. pseudosphaerium					X							
P. subtruncatum = E.subtruncata	X	X	X	X	X	X	X	X	X	X	X	
No. of Species	15	12	14	18	15	17	18	11	9	7	12	7

Royal Canal Urban Greenway glutinous snail (*Myxas glutinosa*) survey 2025



Prepared by Triturus Environmental Ltd. for DBFL

June 2025

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Table of contents

1. Introduction **3**

1.1 Background 3

1.2 *Myxas glutinosa* conservation status & legislative protection 3

2. Methodology **4**

2.1 *Myxas* survey 4

2.2 Macro-invertebrate survey 4

2.3 Biosecurity 4

3. Desktop review **7**

4. Results **8**

4.1 Occurrence of *Myxas glutinosa* 8

4.2 Other macro-invertebrates 8

5. Discussion & recommendations **23**

5.1 *Myxas glutinosa* plant & habitat associations 23

5.2 Threats, pressures & recommendations 24

6. References **27**

7. Appendix A – macro-invertebrate communities **29**

1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by DBFL Consulting Engineers Ltd. on behalf of Fingal County Council and the National Transport Authority (NTA), to undertake a survey for the endangered glutinous snail (*Myxas glutinosa*) (Byrne et al., 2009). The survey was undertaken to inform the detailed design of the Royal Canal Urban Greenway Scheme to minimise impacts to the freshwater molluscan species. The survey was undertaken along the Royal Canal between Confey slipway and Packenham Bridge (chainages 0-2850), a linear distance of c.3km. The survey also included an adjoining drainage channel in the footprint of proposed works (north/west bank of canal) and 300m of canal in the vicinity of Callaghan's Bridge, Clonsilla (chainages 3950 to 4250). The survey was completed on the 29th and 30th May 2025 by Bill Brazier and Ross Macklin.

This baseline survey mapped distribution of *Myxas glutinosa* within the survey area to determine habitat associations and minimise impacts to core areas of habitat. The survey was required in light of previous records for the species near Collin's Bridge (Moorkens & Killeen, 2024; Triturus, 2024; refer also to section 3). The data collated would inform species-specific mitigation measures for the proposed Royal Canal Urban Greenway Scheme.

1.2 *Myxas glutinosa* conservation status & legislative protection

The glutinous snail (*Myxas glutinosa*) is a small air breathing (pulmonate) gastropod mollusc listed as Endangered on the Irish Red list for non-marine molluscs (Anderson, 2025; Bryne et al., 2009) due to declines from habitat degradation, primarily from eutrophication[1]. The species has declined drastically in many European countries, with local extinctions in some (Vinarski et al., 2013). The Irish population is considered internationally significant, supporting potentially 50% of global populations (Byrne et al., 2009). In spite of this, the species has no legal protection in Ireland nor is it listed as an Annex species under the Habitats Directive (92/43/EEC).

The species is globally vulnerable although, counterintuitively, it is currently classed as being of Least Concern in Europe despite a current known population according to the IUCN Red List (von Proschwitz & Seddon, 2011). On a global scale, the snail is listed as Data Deficient (Mollusc Specialist Group, 1996), a category which recognizes that the species is probably threatened, but with data insufficient to evaluate it properly (Bouchet et al., 1999).

[1] It is one of the most sensitive of freshwater gastropods to eutrophication and pollution (Mouthon & Charvet, 1999; Whitfield et al., 1998)

2. Methodology

2.1 *Myxas* survey

Targeted surveys for the glutinous snail (*Myxas glutinosa*) were undertaken on the 29th and 30th May 2025. The c.3km survey area between Confey slipway and Pakenham Bridge was delineated into 29 no. contiguous 100m sections (**Figure 2.1**), with a further 3 no. 100m sections in the vicinity of Callaghan's Bridge, Clonsilla also surveyed (chainages 3950 to 4250). This total coverage approach facilitated a more accurate assessment of *Myxas glutinosa* distribution and habitat suitability within the wider survey area. The late-May survey fell within the accepted period for targeted *Myxas glutinosa* surveys. Water clarity was high at the time of survey, maximising visibility and increasing chances of snail detection.

A combination of sweep sampling (hand net 250mm width, 300mm deep with 500µm mesh size), hand searching of boulder refugia (Willing & Hughes, 2017) and snorkelling techniques were employed in each 100m survey section, with all meso-habitats investigated. Particular focus was placed on areas of habitat characteristically utilised by the species according to the literature (e.g. areas of boulders/rocks, stands of yellow lily etc.). All *Myxas glutinosa* were identified in the field[2] and returned to the site of capture. Handling was undertaken very carefully given the known delicate shell and mantle of the species. Habitat suitability for *Myxas glutinosa* was assessed according to the available species-specific literature (e.g. Hughes, 2017; Willing & Hughes, 2017; Willing et al., 2014; Pond Action, 1993). The location of *Myxas* individuals or groups was recorded via handheld GPS with notes of macrophyte and riparian plant associations made for both supporting and non-supporting habitat areas. This informed species specific habitat associations to target preservation of core areas of habitat utilised by the snail.

2.2 Macro-invertebrate survey

To establish the symbiotic macro-invertebrate communities within the Royal Canal, 4 no. composite sweep samples were collected throughout the *Myxas* survey area to determine the community composition and detect any other rare/protected species.

A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the canal bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). Samples were identified in the field but where unusual specimens were encountered, they were fixed in 70% ethanol for subsequent laboratory identification. No *Myxas glutinosa* were retained and all specimens were released to their site of origin. All rare invertebrate species were cross-references against NPWS Red List publications for beetles (Foster et al., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley et al., 2020) and other relevant taxa (i.e. Byrne et al., 2009; Nelson et al., 2011).

2.3 Biosecurity

[2] Live *Myxas glutinosa* can easily be identified in the field because the mantle of this very fragile species extends almost entirely over the exterior of the globous shell when the molluscs are active, in addition to the very reduced spire (Vinarski et al., 2020; Anderson, 2016; Willing et al. 2014).

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.



Figure 2.1 Overview of the Royal Canal Urban Greenway *Myxas glutinosa* survey area, June 2025

3. Desktop review

The endangered glutinous snail (*Myxas glutinosa*) occupies a limited distribution in Ireland, with most contemporary records available from the Grand and Royal Canals (Moorkens & Killeen, 2024; Triturus, 2024; Moorkens & Killeen, 2005; Moorkens & Killeen, 2003). The species is also known from a number of large western alkaline lakes (Holyoak, 2005, 2004), including Lough Ree where it has recently been re-recorded by Triturus staff in June 2025 (Triturus, unpublished data).

In contrast to the neighbouring Grand Canal, few targeted surveys for *Myxas glutinosa* have been undertaken on the Royal Canal. While historical records exist for the species throughout the canal's length, contemporary records are confined to eastern sections in Kildare and Dublin (Blackshade Bridge is the most westerly location, from 2003). The current distribution supports the evident decline of populations from historical levels (Moorkens & Killeen, 2005).

In more recent years, macro-invertebrate surveys completed by Triturus in May 2022 recorded two empty *Myxas* shells from the Royal Canal at Phibsborough (6th level) (Triturus, 2022). In 2023, annual aquatic macro-invertebrate surveys of the Royal Canal between the 1st and 16th locks identified two *Myxas glutinosa* adults immediately west of Collin's Bridge (within the current survey area) and a dead shell near Leixlip Confey station (Triturus, 2024). The 2024 annual survey of the Royal Canal, undertaken by Evelyn Moorkens and Ian Killeen on behalf of Triturus, also identified *Myxas glutinosa* at a total of 3 out of 20 sites at Collin's Bridge and Westmanstown (within the current survey area) in addition to Shandon Gardens, Phibsborough (outside current survey area) (Moorkens & Killeen, 2024).



Plate 3.1 *Myxas glutinosa* adult recorded and released by Triturus at Collin's Bridge on the Royal Canal in May 2023

4. Results

4.1 Occurrence of *Myxas glutinosa*

A total of ≥158 live *Myxas glutinosa* specimens (mostly adults) were recorded in the current survey along 3km of the Royal Canal between Confey slipway near Leixlip and Pakenham Bridge (**Table 4.1; Figures 4.1-4.4).** A low number of empty shells (3 no.) and egg masses (3 no.) were also recorded between Confey slipway and Collin's Bridge (**Figure 4.1**). No live *Myxas*, empty shells or egg masses were recorded in the vicinity of Callaghan's Bridge (300m of canal between chainages 3950 & 4250) with higher rates of disturbance and low habitat suitability for the species.

Two areas of higher *Myxas glutinosa* density were recorded in the survey area. The highest density of snails was located along the canal littorals (north bank) between Confey slipway and Collin's Bridge (chainage c. 540-565) where *Myxas* adults were abundant (>100 specimens) on a linear area of shallow sloping clay substrate adjoining *Nuphar lutea*, *Chara hispida* and *Schoenoplectus lacustris* (**Plate 4.5**). An area of lower snail density was present adjoining and underneath Pakenham Bridge (west bank only) where c.25 adult snails were recorded grazing on limestone flagstone and adjoining loose boulders at its base (**Plate 4.12, 4.13**).

Myxas glutinosa showed a clear affinity for the submerged leaves of *Nuphar lutea* throughout the survey area, with low numbers recorded grazing on boulders/hard substrata and exposed areas of calcareous clays. A single specimen was identified on the stem of branched bur-reed (*Sparganium erectum*).

4.2 Other macro-invertebrates

Excluding *Myxas glutinosa*, a total of 28 macro-invertebrate species across 22 families were recorded via sweep sampling in May 2025 (**Appendix A**). A low number of Red listed swan mussel (*Anodonta cygnea*) were recorded during the survey. This species is classed as vulnerable in Ireland (Byrne et al., 2009). Currently elevated threat to the species exists from the expansion of invasive bivalves including zebra mussel (*Dresseina polymorpha*), quagga mussel (*Dresseina bugensis*) and Asian clam (*Corbicula fluminea*).

No other rare or protected macro-invertebrate species were recorded in the composite sweep samples taken throughout the survey area. The macro-invertebrate community was dominated by common species such as freshwater hoglouse (*Asellus aquaticus*), bluet damselflies (Coenagrionidae), pea mussels (Sphaeriidae) and gastropod snails including *Bithynia tentaculata*.

Table 4.1 Summary of *Myxas glutinosa* recorded in the Royal Canal survey area, June 2025

Date	Location	Record	Abundance	Notes	ITM x	ITM y
29/05/2025	220m east of Confey slipway	Dead shell	n/a	Single dead/empty shell recorded from shallow sloping clay margin	701903	736987
29/05/2025	240m east of Confey slipway	*Myxas* eggs	n/a	*Myxas* egg mass recorded on small boulder in shallow sloping clay margin near moored boat with scattered hard substrata.	701924	736981
29/05/2025	Angling peg 45	Adult	1	Single *Myxas* adult attached to *Sparganium erectum* stem amongst *Nuphar lutea*	701943	736974
29/05/2025	Angling peg 50	Adult	3	3 x *Myxas* individuals on *Nuphar lutea* leaves among Chara, <75cm depth. Shallow, gently sloping with silt.	702030	736931
29/05/2025	425m east of Confey slipway	Adult	1	1 x *Myxas* on largest boulder in patch adjoining large stand of lily in 1-1.2m depth. Small area of exposed gravelly rocky slope with *Glyceria maxima* and *Nuphar lutea* with scattered small boulder. Only some localised *Chara* sp. Dead shell also recorded	702080	736900
29/05/2025	425m east of Confey slipway	Dead shell		Dead/empty shell recorded within above patch	702078	736899
29/05/2025	445m east of Confey slipway	Adult	1	1 x smaller adult *Myxas* recorded via snorkelling on tall *Nuphar lutea* stem along south bank lily fringe in 1.6m depth adjoining deep navigation channel. Atypical habitat	702096	736878
29/05/2025	490m west of Collin's bridge	Adult	100	Abundant *Myxas* adults (>100) along shallow sloping clay shelf between *Schoenoplectus lacustris* stands opposite old boat. Abundant *Chara hispida* below clay fringe, with frequent *Alisma-plantago aquatica* and *Nuphar lutea*. Snails grazing on shallow exposed soft bed (not plants) which was noticeably warmer than adjoining deeper areas. No snails in deep water	Start: 702180 Stop: 702196	Start: 736847 Stop: 736827
29/05/2025	460m west of Collin's bridge	Adult	10	Scattered low density of *Myxas* in small linear patch of exposed clay in upper littorals. More silt than clay with bedded substrata. Scattered *Chara hispida* with occasional *Nuphar lutea* and *Sparganium erectum*	702220	736814
29/05/2025	390m west of Collin's bridge	Adult	12	Low density of *Myxas* in short silty section dominated by *Chara hispida* with frequent *Nuphar lutea* (and decaying tree leaves)	702290	736782
30/05/2025	640m NE of Collin's Bridge	Adult	1	1 x *Myxas* adult on small calcified boulder at base of steep clay bank. Area of *Alisma-plantago aquatica*, *Nuphar lutea* and *Chara hispida* with some clay slopes in upper littorals between 50cm and 80cm deep.	703087	737323
30/05/2025	850m NE of Collin's Bridge	Adult	1	1 x *Myxas* grazing on small low gradient patch of exposed gravelly clay adjoining silt with *Elodea canadensis*, *Glyceria maxima*, *Chara hispida* and *Nuphar lutea*, <1m deep. Good quality habitat but only single adult present.	703204	737496
30/05/2025	South of Packenham Bridge	Adult	3	3 x *Myxas* adults grazing on angular limestone cobble in rocky clay area at base of bank adjoining *Nuphar lutea* and abundant *Sagittaria sagittifolia* and *Elodea canadensis*. Very few other snails present.	703711	738171
30/05/2025	Packenham Bridge	Adult	25	c.25 x adult *Myxas* grazing on sloping calcified retaining wall under & adjoining Packenham Bridge (west bank only), with some on adjacent *Nuphar lutea* at base. Adjoining deeper *Sagittaria sagittifolia* and *Nuphar lutea* with some *Chara* sp. in upper littorals near wall and scattered boulder/cobble at its base	Start: 703757 Stop: 703794	Start: 738216 Stop: 738251



Figure 4.1 Overview of the Royal Canal Urban Greenway *Myxas glutinosa* records, June 2025



Figure 4.2 Location of the *Myxas glutinosa* records between Confey slipway and Collin's Bridge, June 2025



Figure 4.3 Location of the *Myxas glutinosa* records between Collin's Bridge and Pakenham Bridge, June 2025



Figure 4.4 Location of the *Myxas glutinosa* records in the vicinity of Pakenham Bridge, June 2025



Plate 4.1 *Myxas glutinosa* egg mass (centre) on boulder from the margins of the Royal Canal near Confey slipway with cased caddis (left) and other Lymnaeid snail species egg mass (right), May 2025



Plate 4.2 Adult *Myxas glutinosa* (right) alongside the very common *Bithynia tentaculata* recorded from the Royal Canal, May 2025



Plate 4.3 Using a dry suit and face (snorkel) mask to detect *Myxas glutinosa* was very effective given high water clarity in the survey area



Plate 4.4 Sweep netting of marginal *Nuphar lutea* stands and other macrophytes on the Royal Canal, May 2025



Plate 4.5 Part of the highest *Myxas* density area in the survey area (>100 individuals) – a sparse linear *Nuphar lutea* bed with a clay bed between *Schoenoplectus lacustris* stands



Plate 4.6 Underwater image of *Myxas glutinosa* (left) and *Bithynia tentaculata* (right) in the Royal Canal grazing on a submerged *Nuphar lutea* leaf growing amongst *Chara hispida*



Plate 4.7 *Myxas glutinosa* adult recorded on the underside of a small boulder along the littorals of the Royal Canal, May 2025



Plate 4.8 Representative image of the Royal Canal between Confey slipway and Collin's Bridge showing abundant macrophyte growth with good localised suitability for *Myxas glutinosa*



Plate 4.9 Representative image of the Royal Canal east of Collin's Bridge – superficially suitable for *Myxas* but with higher disturbance, greater silt deposition rates and steeper shelving margins



Plate 4.10 Underwater image of a heavily silted bed with poor suitability for *Myxas glutinosa* grazing east of Collin's Bridge (none recorded)



Plate 4.11 Representative image of the heavily silted adjoining drainage channel along the north bank of the Royal Canal west of Confey slipway with no suitability for *Myxas glutinosa*



Plate 4.12 Underwater image of *Myxas glutinosa* grazing on angular limestone flag at the base of the Pakenham Bridge (north bank) scour protection wall, May 2025. Grikes (fissures) in the flag likely serve as valuable *Myxas* refugia.

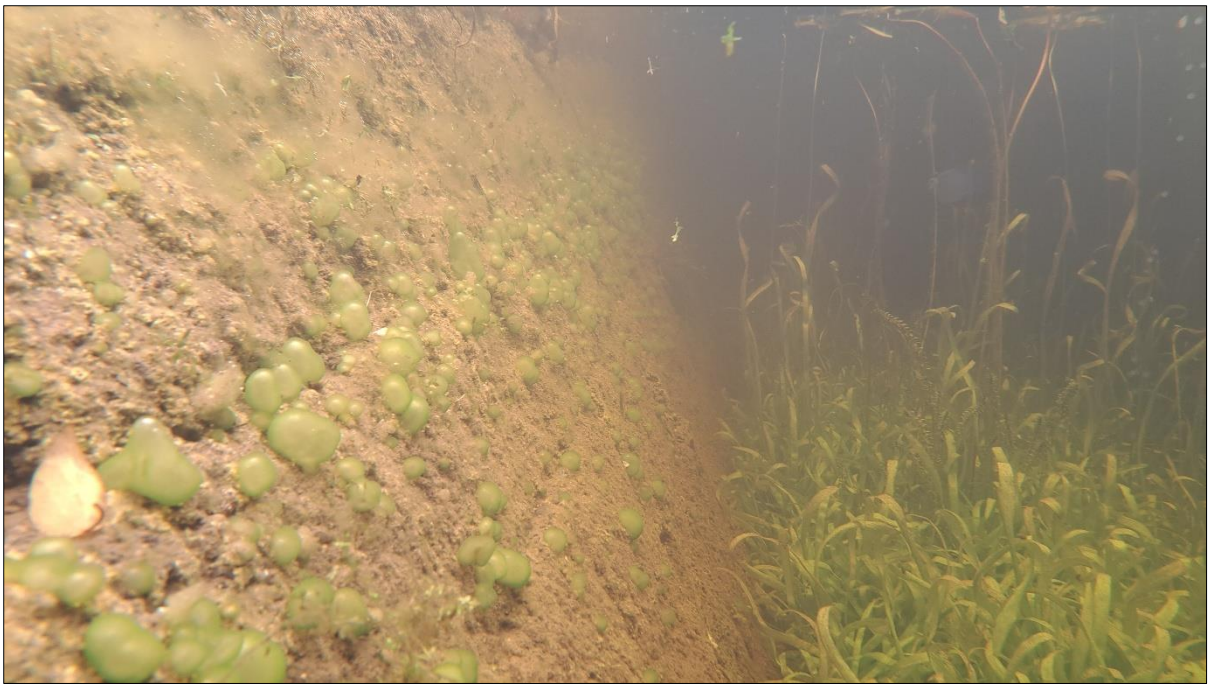


Plate 4.13 The steeply sloping (c.45-60°) Pakenham Bridge western bank scour protection wall supported c.25 adult *Myxas glutinosa*, with none recorded on the near vertical east bank wall



Plate 4.14 Submerged leaves of *Nuphar lutea* in a less vegetated area near Pakenham Bridge – classic *Myxas glutinosa* grazing habitat



Plate 4.15 Loose angular boulder and cobble at the base of an old retaining wall/bank strengthening area near Pakenham Bridge. Such areas are suitable for *Myxas glutinosa* but were rare in the survey area



Plate 4.16 Red-listed swan mussel (*Anodonta cygnea*) recorded from the Royal Canal via sweep sampling in May 2025

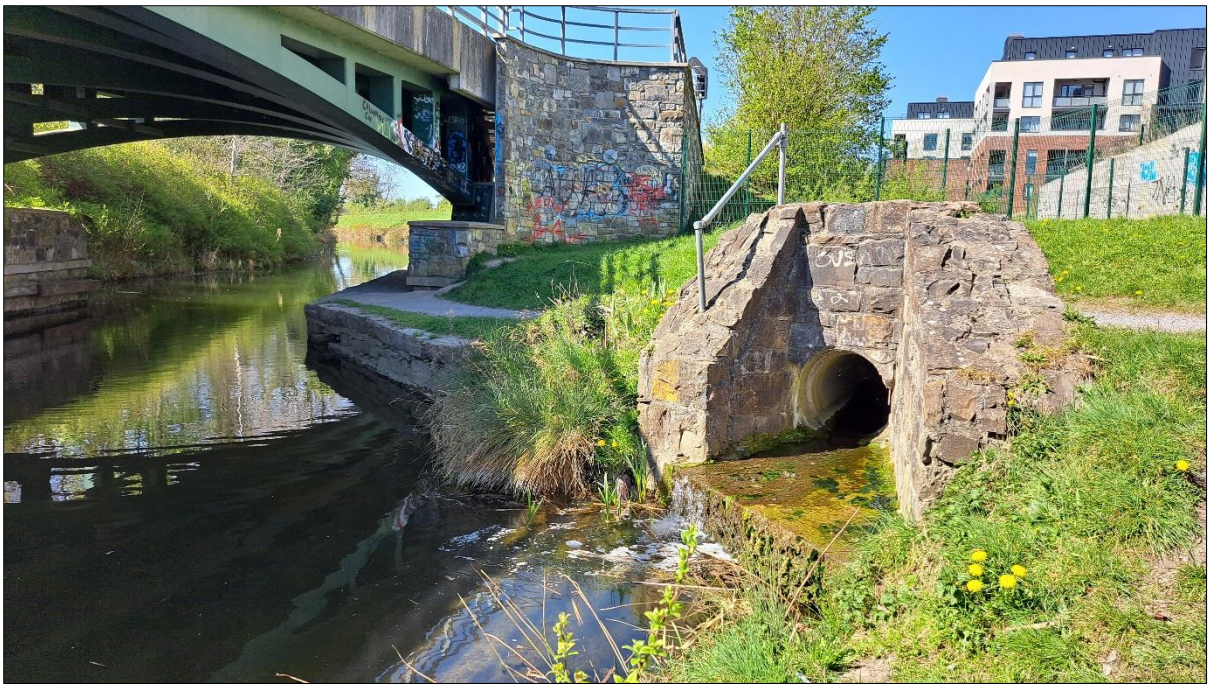


Plate 4.17 Representative image of the Royal Canal at Callaghan's Bridge showing eutrophication (storm drain) source. No *Myxas glutinosa* were recorded in a 300m vicinity of the bridge in May 2025

5. Discussion & recommendations

The current survey, utilising a comprehensive total coverage approach of sweep netting, hand searching and snorkelling techniques, recorded over 150 live (adult) specimens of the endangered *Myxas glutinosa* in a 3km section of the Royal Canal between Confey slipway and Pakenham Bridge. Whilst the species had been recorded in this area previously (e.g. Collin's Bridge), the data collated has significantly expanded the knowledge of *Myxas glutinosa* within the waterway. This will inform mitigation measures to protect the species and their habitat in light of the proposed completion of the Royal Canal Urban Greenway, as well as other future developments.

Almost all *Myxas glutinosa* recorded in the current May 2025 survey were adults, with only a very low number of juveniles (1%). In Ireland adults have typically been found throughout the May to August period, with maturing juveniles usually more detectable by the autumn (Holyoak, 2004, 2005; Triturus pers. obs. 2025). This implies a staggered breeding strategy that is in contrast to the one remaining UK population (Llyn Tegid). Non-synchronous breeding of metapopulations may allow the species to persist despite its limited range and high habitat specificity.

5.1 *Myxas glutinosa* plant & habitat associations

Suitability for *Myxas glutinosa* was high within the survey area although this was localised and typically confined to short/small sections of shallow canal littorals along the north (towpath) bank. There was a clear affinity towards the submerged leaves of yellow lily (*Nuphar lutea*) throughout the survey area, with most recorded specimens present (grazing) on this macrophyte. The association between *Myxas* and *Nuphar lutea* has long been known throughout their range (Bichain & Ryelandt, 2023; Müller, 1774), including in Ireland (Holyoak, 2004; Moorkens & Killeen, 2003). Although *Nuphar lutea* was abundant (sometimes dominant) throughout the survey area, *Myxas* clearly preferred shallower and warmer littoral/marginal areas with lower lily density and reduced cover of other macrophyte species such as *Schoenoplectus lacustris*, *Potamogeton* spp. and *Chara hispida*. This correlation is likely linked to water temperatures and levels of light penetration which influence the epiphytic microalgal communities on which *Myxas* predominantly grazes. It was observed in the current survey that *Myxas glutinosa* was often the only snail species grazing on submerged living or decaying *Nuphar* leaves.

The highest density of *Myxas glutinosa* was present in a shallow littoral section of canal between Confey slipway and Collin's Bridge (chainage c. 540-565). Over 100 adults were recorded grazing on both submerged *Nuphar lutea* leaves (often amongst *Chara hispida*) and exposed argillaceous (clay-dominated) sediment in 0.1-0.75m of water (**Plate 5.1**). Invariably areas of softer organic-rich and flocculent silt (e.g. north of Collin's Bridge), often at the base of steeper marginal slopes, did not support grazing *Myxas glutinosa*. This corroborates the observations of other studies regarding their aversion to high siltation.

Despite extensive hand searching, only a very low number of *Myxas glutinosa* were recorded on or under boulder refugia (e.g. **Plate 4.7**). It is suggested that *Myxas* typically seek boulder refugia and graze on epilithic algae in the autumn and winter period[3] when cover and growth of macrophytes

[3] *Myxas glutinosa* in Llyn Tegid (Lake Bala), the only remaining mainland UK population, show a strong year-round affinity to the underside of boulders in contrast to elsewhere where macrophytes are preferred (e.g. Irish lakes and canals) (Willing et al., 2014).

decreases (Carlsson, 2001a, 2001b). Given the typical U-shaped canal profile and a soft sediment bed, areas with hard substrata were rare in the survey area with many often bedded in silt and thus poorly accessible (as refugia) to *Myxas*.

However, of note is the identification of a hitherto unidentified habitat for *Myxas glutinosa* in the Royal Canal by way of a sloping scour protection wall adjoining and underneath Pakenham Bridge (west bank). The 60° angled wall composed of calcified limestone flag and nearby rocks supported c.25 grazing *Myxas* adults (**Plate 4.12**). In contrast, the eastern wall of the bridge was near vertical (80-90°), heavily shaded and did not support any grazing *Myxas*, presumably due to lower water temperatures and less well developed epilithic algal communities. The Pakenham Bridge structure, with its extensive grazing habitat and abundant refugia (grikes) was not too dissimilar in nature to *Myxas* habitats found along the seasonally inundated limestone shores of several Irish lakes such as Loughs Mask and Cullin (Holyoak, 2005, 2004), albeit artificial and sloping.



Plate 5.1 Areas of argillaceous (clay) sediment in the upper littorals were rare in the survey area but typically supported grazing *Myxas glutinosa*, even when the areas were very small. The shallow nature of these areas make them especially sensitive to any bank grading or dewatering works

5.2 Threats, pressures & recommendations

Although considered as one of the most sensitive of freshwater gastropods to eutrophication and pollution (Mouthon & Charvet, 1999; Whitfield et al., 1998), populations of *Myxas glutinosa* have been found in eutrophic (Bichain & Ryelandt, 2023; Carlsson, 2000) and even polluted habitats (Vinarksi et al., 2013). Isolated populations aside (e.g. Llyn Tegid, Wales), the snail would appear to be relatively plastic in its habitat requirements across its range (Vinarski & Aksenova, 2023; Coucherat, 2023; Glöer, 2019; Whitfield et al., 1998).

Nonetheless, in light of the current report findings (i.e. widespread *Myxas glutinosa* along the north bank of the Royal Canal), the design and construction of the proposed Royal Canal Urban Greenway

must remain cognisant of the species and its specific habitat requirements. Given high sensitivity to changes in habitat, light levels and (likely) water temperatures, the avoidance of increased riparian shading in areas of high quality *Myxas* habitat along the canal littorals would be a vital consideration. Furthermore, increased bank erosion (siltation and increased turbidity) and changes in riparian and littoral vegetation adjacent to the proposed Greenway route must be avoided to prevent changes in *Myxas* habitat quality, feeding zones and breeding areas. Given the negative association with siltation (Willing & Hughes, 2017; Whitfield et al., 1998) specific mitigation must be applied to prevent increased rates of littoral silt deposition during the construction phase or operational phases of the Greenway (e.g. sediment run-off, increased bank erosion). In this regard, any surface water drainage during the construction and operational phase should be directed towards the adjacent drainage channel (that does not support *Myxas*) rather than the canal itself.

This reliance of *Myxas glutinosa* on shallow margins make it particularly vulnerable to sudden or extreme water level changes (Moorkens, 2021, 2012; Willing & Hughes, 2017; Moorkens & Killeen, 2003). Given this and the species' preference of very shallow grazing habitat in the upper canal littorals along the towpath bank (often <10cm depth), even temporary reduction of water levels in suitable *Myxas* habitat must be avoided during Greenway works. Widening and extending the existing towpath on the drainage channel side should be considered wherever possible in preference to encroaching the already narrow canal riparian zone and littoral zones. As a mature and contiguous riparian corridor along the canal has wide ranging ecological benefits and also buffers potential impacts, existing buffers should be preserved with minimal incursion on the canal littorals.

Myxas glutinosa appears particularly susceptible to competition from other gastropods (Hughes, 2017). Many areas of the Royal Canal survey area were heavily vegetated with abundant competing Planorbid and Lymnaeid snail species that where present in excessive abundance often were associated with the absence of *Myxas glutinosa.* Thus strict mitigation measures must be applied during works to mitigate and avoid eutrophication and associated increases in filamentous green algae. Increased nutrients may proliferate populations of other more pollution-tolerant (competing) snail species and extirpate *Myxas* populations. Siltation can also transport nutrients into areas and thus is often associated with eutrophication.

Given the paucity of suitable rocky refugia for *Myxas glutinosa* within the survey area (i.e. a soft sediment bed), artificial refugia (after Hughes, 2017) inclusive of other viable alternative (e.g. reef balls; **Plate 5.2**) could be installed to create long-term refugia for the species. These structures would protect *Myxas* from predation while also providing a substrate for periphyton proliferation. The chosen locations for such artificial refugia would be subject to careful consideration and must be completed in consultation with an aquatic ecology expert. Artificial refugia could be installed in conjunction with localised thinning of noxious macrophytes (discussed further below).

The option of removing locally excessive macrophytic vegetation in gently sloping canal littorals would improve conditions for grazing *Myxas*, allowing for meta-population expansion. Dense reed lines of common club-rush or an equivalent high density of submerged macrophytes that can became invasive of the canal inclusive of whorled water-mifoil (*Myriophyllum verticillatum*), mares tail (*Hippurus vulgaris*), Elodea species and arrowhead (*Sagittaria sagittifolia*), can also restrict light niche space for *Myxas* grazing habitat. Nationally scarce charophytes inclusive of *Tolypella* species also occupy the same gently sloping niche space as *Myxas glutinosa* and therefore the thinning of reeds with root zone

removal (to restrict regrowth) could significantly benefit both rare *Myxas glutinosa* and *Tolypella* species.

Although the current survey is considered comprehensive in mapping the distribution of *Myxas glutinosa* throughout the study area, the species is known for periodic population declines, sudden recoveries and range fluctuations (Bichain & Ryelandt, 2023; Carlsson, 2001b). This exemplifies the importance of regular monitoring to inform targeted species management measures, inclusive of conservation evidence where habitat enhancement has been undertaken or following significant construction works that may impact local glutinous snail populations.



Plate 5.2 Example of a refugia used in marine environments known as 'reef balls'. Such structures could act as viable *Myxas glutinosa* refugia in Irish Canal environments where marginal boulders can be scarce. It can provide both refuge from predators and act an ideal grazing substrate once periphyton establishes

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7. Appendix A – macro-invertebrate communities

Table 7.1 Macro-invertebrate community recorded in the Royal Canal, May 2025 (composite samples, excluding *Myxas glutinosa*)

Group	Family	Species	1	2	3	4
Trichoptera	Leptoceridae	*Athripsodes aterrimus*	2	2	2	6
Trichoptera	Leptoceridae	*Mystacides longicornis*				5
Trichoptera	Leptoceridae	*Triaenodes bicolor*	2		1	1
Trichoptera	Limnephilidae	*Anabolia nervosa*	3			
Trichoptera	Limnephilidae	*Limnephilus marmoratus*	3	3	1	
Trichoptera	Phryganeidae	*Agrypnia obsoleta*	1	2		1
Odonata	Aeshnidae	sp. indet.	1			
Odonata	Aeshnidae	*Anax imperator*				1
Odonata	Coenagrionidae	sp. indet.	5	6	1	8
Ephemeroptera	Caenidae	*Caenis horaria*	1			
Trichoptera	Polycentropodidae	*Plectrocnemia geniculata*			1	
Coleoptera	Dytiscidae	*Hyphydrus ovatus*			1	1
Coleoptera	Halipliidae	*Haliplus* sp.	2	1	2	3
Diptera	Chironomidae	Non-*Chironomus* spp.			2	
Gastropoda	Bithnyiidae	*Bithynia tentaculata*	8	17	6	11
Gastropoda	Planorbidae	*Gyraulus albus*	1			
Gastropoda	Planorbidae	*Planorbis planorbis*			1	1
Hemiptera	Corixidae	Corixidae nymph	2			
Hemiptera	Gerridae	*Gerris* sp.			1	
Hemiptera	Hydrometridae	*Hydrometra stagnorum*			1	
Hemiptera	Notonectidae	Notonectidae nymph	1	1	2	9
Crustacea	Asellidae	*Asellus aquaticus*	7	33	12	3
Crustacea	Crangonyctidae	*Crangonyx* sp.	1	3	2	1
Gastropoda	Physidae	*Physa fontinalis*	4	5		
Megaloptera	Sialidae	*Sialis lutaria*			2	
Mollusca	Sphaeriidae	sp. indet.	9	11	11	7
Mollusca	Unionidae	*Anodonta cygnea*		1		1
Diptera	Chironomidae	*Chironomus* spp.	1			
Abundance			**54**	**85**	**49**	**59**
Taxon richness			**18**	**12**	**17**	**15**



Triturus Environmental Ltd.,

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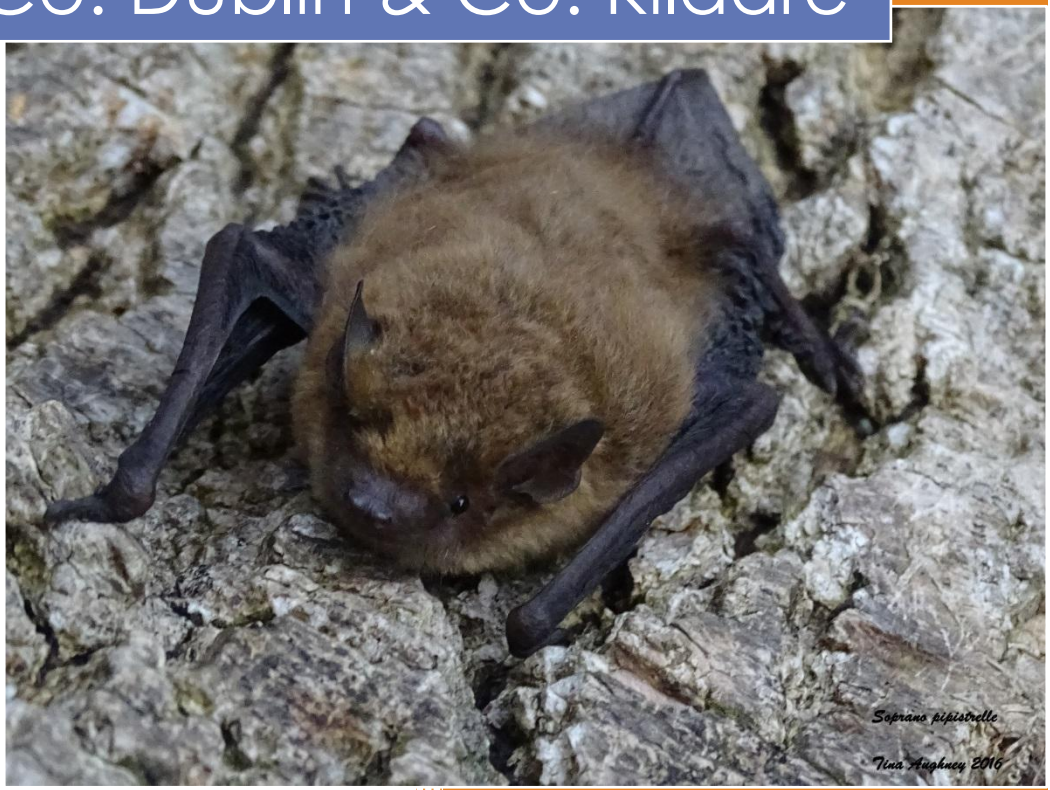
Little Island,

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2026

Royal Canal Bat Assessment – 8km Section, Co. Dublin & Co. Kildare



Tina Aughney

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NPWS licence C047/2026 (Licence to handle bats, expires 31st December 2026);
NPWS licence 014/2026 (Licence to photograph/film bats, expires 31st December 2026);
NPWS licence DER/BAT 2026-119 (Survey licence, expires 31st December 2026).

Statement of Authority: Dr Aughney has worked as a Bat Specialist since 2000 and has undertaken extensive survey work for all Irish bat species including large scale development projects, road schemes, residential developments, wind farm developments and smaller projects in relation to building renovation or habitat enhancement. She was a monitoring co-ordinator and trainer for Bat Conservation Ireland for 20 years. She is a co-author of the 2014 publication *Irish Bats in the 21st Century.* This book received the 2015 CIEEM award for Information Sharing. Dr Aughney is a contributing author for the Atlas of Mammals in Ireland 2010-2015. She is a trained bat handler, bat ringer and radio-telemetry project manager. She is a member of the Nathusius' Pipistrelle Working Group and the Cavan Bat Group.

All analysis and reporting are completed by Dr Tina Aughney. Data collected and surveying is completed with the assistance of trained field assistants. Mr. Shaun Boyle and Ms. Eva Boyle (Field Assistants) under NPWS licence DER/BAT 2026-119 (Survey licence, expires 31st December 2026). Both field assistants have received in-house training to undertake all elements of bat surveying according to Collins (2023).

Client: DBFL Consulting Engineers on behalf of Fingal County Council

Project Name & Location: 8km section from County Kildare to County Dublin.

Report Revision History

Date of Issue	Draft Number	Issued To (process of issuing)
18th February 2026	Draft 1	DBFL (by email)
2nd March 2026	Draft 2	DBFL (by email)
24th April 2026	Draft 3	DBFL (by email)

Purpose

This document has been prepared as a Report for Client. Only the most up to-date report should be consulted. All previous drafts/reports are deemed redundant in relation to the named site. Bat Eco Services Ltd. accepts no responsibility or liability for any use that is made of this document other than by the client for the purposes for which it was originally commissioned and prepared.

Carbon Footprint Policy

It is the policy of Bat Eco Services Ltd. to provide documentation digitally to reduce carbon footprint. Printing of reports etc. is avoided, where possible.

Record Submission Policy

It is the policy of Bat Eco Services Ltd. to submit all bat records to the NBDC database one-year post-surveying. This is to ensure that a high-level bat and mammal databases are available for future desktop reviews. This action will be automatically undertaken unless otherwise requested, where there is genuine justification.

Executive Summary

Project Name & Location: Royal Canal Greenway

Proposed work: Upgrade of canal towpath.

Bat Survey Results - Summary

Bat Species	Roosts	Foraging	Commuting
Common pipistrelle *Pipistrellus pipistrellus*		√	√
Soprano pipistrelle *Pipistrellus pygmaeus*		√	√
Nathusius' pipistrelle *Pipistrellus nathusii*		√	√
Leisler's bat *Nyctalus leisleri*		√	√
Brown long-eared bat *Plecotus auritus*		√	√
Daubenton's bat *Myotis daubentonii*		√	√
Natterer's bat *Myotis nattereri*		√	√
Whiskered bat *Myotis mystacinus*			
Lesser horseshoe bat *Rhinolophus hipposideros*			

Bat Survey Duties Completed (Indicated by red shading)

Tree PBR Survey	◯	Daytime Building Inspection	◯
Static Detector Survey	◯	Daytime Bridge Inspection	◯
Dusk Bat Survey	◯	Dawn Bat Survey	◯
Walking Transect	◯	Driving Transect	◯
Trapping / Mist Netting	◯	IR Camcorder filming	◯
Endoscope Inspection	◯	Other	◯

_____

Citation: Bat Eco Services (2026) Royal Canal Bat Assessment – 8km Section, Co. Dublin & Co. Kildare. Unpublished report prepared for DBFL Consulting Engineers.

Contents

1. Introduction 5

1.1 Relevant Legislation & Bat Species Status 5
1.1.1 NPWS Article 17 Reporting 6
1.1.2 Irish Bat Monitoring Programme – Population Trends 7
1.1.3 Assessment Parameters 8
1.1.4 Bat Mitigation Measures 9

2. Proposed Development Description 18

2.1 Site Location 18
2.2 Proposed Project 18
2.2.1 Proposed Works 20

3. Bat Survey Methodology 22

3.1 Guidance Document 22
3.2 Desktop Review 22
3.2.1 Bat Conservation Ireland Database 22
3.2.2 Bat Conservation Landscape Favourability 22
3.2.3 Historical Bat Surveys 23
3.3 Daytime Inspections 23
3.3.1 Bridge Inspection 23
3.4 Night-time Bat Detector Surveys 24
3.4.1 Dusk & Dawn Bat Surveys 24
3.4.2 Passive Static Bat Detector Survey 2022 & 2025 24

4. Bat Survey Results 26

4.1 2025 & 2026 Survey Results 26
4.1.1 Static Surveillance 26
4.1.2 Walking Transect 1 32
4.1.3 Walking Transect 2 33
4.2 2022 Survey Results 35
4.2.1 Daytime Inspections 35
4.2.2 Bat Habitat & Commuting Routes Mapping 37
4.3 Night-time Bat Detector Surveys 38
4.3.1 Dusk & Dawn Bat Survey - Bridges 38
4.3.2 Passive Static Bat Detector Survey 39
4.3.3 Walking Transect Survey Results 45
4.4 Location of Light Sensitive Bat Species 51
4.5 Potential Bat Roosts in Trees 56
4.6 Survey Effort, Constraints & Survey Assessment 58

5. Bat Ecological Evaluation 59

5.1 Bat Species Recorded & Sensitivity 59
5.2 Bat Foraging Habitat & Commuting Routes 63
5.3 Zone of Influence – Bat Landscape Connectivity 63

6. Assessment of Potential Impact 64

6.1 Bat Mitigation Measures 64
6.1.1 Lighting Plan 64
6.1.2 Tree Assessment 67
6.1.3 Landscaping 67

6.1.4 Bat Conservation Measures 67
7. Survey Conclusions 68
8. Bibliography 69
9. Appendices 73
9.1 Appendix 1 Bat Habitat & Commuting Route Classifications 73
9.2 Appendix 2 Static Surveillance - 2022 75
9.3 Appendix 3 Static Surveillance 2022 & 2025 77
9.4 Appendix 4 2022 Walking Transect Survey Results 78
9.5 Appendix 5 2025 Static Surveillance Results (Total number of bat passes recorded for each bat species noted). 103
9.6 Appendix 6 Tree PBRs (Wildlife Surveys Ireland Ltd. data) 103
9.7 Appendix 6 Bat Assessment Tables 105
10. Bat Species Profile 108
10.1 Bat Conservation Ireland Bat Species Maps 108
Bat records for County Dublin (Source: www.batconservationireland.org) 108

1. Introduction

Bat Eco Services Ltd. was commissioned by DBFL Consulting Engineers on behalf of Fingal County Council to undertake a bat survey of 8km section of the Royal Canal from the County Kildare to County Dublin. Surveys were undertaken in 2022, 2025 and 2026.

1.1 Relevant Legislation & Bat Species Status

All Irish bat species are protected under the Wildlife Act (1976) and Wildlife Amendment Acts (2000 and 2010). 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 Irish bats are listed in Annex IV of the Habitats Directive and the lesser horseshoe bat *Rhinolophus hipposideros* is further listed under Annex II. 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, under existing legislation, the destruction, alteration or evacuation of a known bat roost is an offence. The most recent guidance document is "Guidance document on the strict protection of animal species of Community interest un the Habitats Directive (Brussels, 12.10.2021 C(2021) 7391 final".

Regulation 51(2) of the 2011 Regulations provides –

("(2) Notwithstanding any consent, statutory or otherwise, given to a person by a public authority or held by a person, except in accordance with a licence granted by the Minister under *Regulation 54,* a person who in respect of the species referred to in *Part 1* of the *First Schedule*—
(*a*) deliberately captures or kills any specimen of these species in the wild, (*b*) deliberately disturbs these species particularly during the period of breeding, rearing, hibernation and migration,
(*c*) deliberately takes or destroys eggs of those species from the wild,
(*d*) damages or destroys a breeding site or resting place of such an animal, or
(*e*) keeps, transports, sells, exchanges, offers for sale or offers for exchange any specimen of these species taken in the wild, other than those taken legally as referred to in Article 12(2) of the Habitats Directive, shall be guilty of an offence."

The grant of planning permission does not permit the commission of any of the above acts or render the requirement for a derogation licence unnecessary in respect of any of those acts.

Any works interfering with bats and especially their roosts, may only be carried out under a derogation licence granted by National Parks and Wildlife Service (NPWS) pursuant to Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011 (which transposed the EU Habitats Directive into Irish law).

There are eleven recorded bat species in Ireland, nine of which are considered resident on the island. 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 island. Nathusius' pipistrelle *Pipistrellus nathusii* 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, 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. A total of 41 SACs have been designated for the Annex II species lesser horseshoe bat (1303), of which nine have also been selected for the Annex I habitat 'Caves not open to the public' (8310).

The following species list (Table 1) identifies the range of bat species (resident and vagrant) whose presence has been confirmed in Ireland along with their current status. According to the Bat Conservation Ireland databases, eight of the nine resident bat species have been recorded in Co. Dublin.

Table 1a: Status of the Irish bat fauna (Marnell *et al.,* 2019 & NPWS, 2022).

Species: Common Name	Irish Status	European Status	Global Status
Resident Bat Species ^			
Daubenton's bat *Myotis daubentonii*	Least Concern	Least Concern	Least Concern
Whiskered bat *Myotis mystacinus*	Least Concern	Least Concern	Least Concern
Natterer's bat *Myotis nattereri*	Least Concern	Least Concern	Least Concern
Leisler's bat *Nyctalus leisleri*	Least Concern	Least Concern	Least Concern
Nathusius' pipistrelle *Pipistrellus nathusii*	Least Concern	Least Concern	Least Concern
Common pipistrelle *Pipistrellus pipistrellus*	Least Concern	Least Concern	Least Concern
Soprano pipistrelle *Pipistrellus pygmaeus*	Least Concern	Least Concern	Least Concern
Brown long-eared bat *Plecotus auritus*	Least Concern	Least Concern	Least Concern
Lesser horseshoe bat *Rhinolophus hipposideros*	Inadequate	Least Concern	Least Concern
Possible Vagrants ^			
Brandt's bat Myotis brandtii	Data deficient	Least Concern	Least Concern
Greater horseshoe bat *Rhinolophus ferrumequinum*	Data deficient	Near threatened	Near threatened

^ Roche *et al.,* 2014

1.1.1 NPWS Article 17 Reporting

NPWS (2019) provides details on the conservation status for each of Ireland's bat species along with distribution maps (See appendices for such maps). The following table summarises the conclusions of Article 17 assessment of conservation status at the end of the most recent reporting period. Additional information for each of the bat species provides some clarifying notes in relation to the conservation status conclusions. Such information, where appropriate to the current project, will be drawn on in the project assessment section.

Table 1b: NPWS Article 17 Conservation Status of Irish Bat Species (Adapted from NPWS, 2022).

	Range	Population	Habitat	Future Prospects	Conservation Status Assessment	Conservation Status Trend
Lesser horseshoe bat	Inadequate	Favourable	Inadequate	Inadequate	Inadequate	Deteriorating
Common pipistrelle	Favourable	Favourable	Favourable	Favourable	Favourable	Improving
Soprano pipistrelle	Favourable	Favourable	Favourable	Favourable	Favourable	Improving
Nathusius' pipistrelle	Unknown	Unknown	Favourable	Unknown	Unknown	Not applicable
Natterer's bat	Favourable	Favourable	Favourable	Favourable	Favourable	Stable
Daubenton's bat	Favourable	Favourable	Favourable	Favourable	Favourable	Improving
Whiskered bat	Favourable	Favourable	Favourable	Favourable	Favourable	Improving
Brown long-eared bat	Favourable	Favourable	Favourable	Favourable	Favourable	Improving
Leisler's bat	Favourable	Favourable	Favourable	Favourable	Favourable	Improving

1.1.2 Irish Bat Monitoring Programme – Population Trends

The Irish Bat Monitoring Programme provides information on monitoring schemes managed by Bat Conservation Ireland:

- Car-Based Bat Monitoring (All Ireland) – monitors common pipistrelle, soprano pipistrelle, Leisler's bats with limited information for Nathusius' pipistrelle and *Myotis* species.
- All Ireland Daubenton's Bat Waterway Monitoring
- Brown Long-eared Bat Roost Monitoring
- Lesser Horseshoe Bat Monitoring

This provides population trend data for seven bat species: common pipistrelle, soprano pipistrelle, Leisler's bat, Nathusius' pipistrelle, Daubenton'bat, brown long-eared bat and lesser horseshoe bat (some limited data for *Myotis* species). There is currently a new monitoring surveys for Natterer's bat and whiskered bat (Woodland Surveys). Annual reporting is undertaken and the most recent report (Aughney *et al.,* 2023) is referenced for this report. In summary, the population trends for each bat species are as follows:

- Trends of the three common bat species (common pipistrelle, soprano pipistrelle and Leisler's bat) continued to increase in 2022, although the yearly estimates of common pipistrelle levelled out a little. Confidence intervals of these three bat species were all above their baseline indices indicating they each show a significantly increasing trend.

- Nathusius' pipistrelle trends are still unclear due to low encounter rates but decreased a little in 2022 compared to previous years.
- The yearly estimate for the *Myotis* spp. group steadied out a little but overall the smoothed trend for this group is still well below the baseline.
- Daubenton's bat numbers trend line appears to be fairly steady from year to year with error bars consistently encompassing the baseline.
- Brown long-eared bat shows a fluctuating trend around the baseline and is considered to be currently stable.
- Lesser horseshoe bat continue to increase in 2022 for the summer counts while low winter counts caused a slight downward trend in 2022. But overall, this species has increased over the last 20 years of monitoring.

1.1.3 Assessment Parameters

Different parameters are considered for the overall assessment of the potential impact(s) of a proposed development on local bat populations. The overall impacts of the proposed project on local bat populations is assessed using the following criteria:

- Impact Quality using the parameters Positive, Neutral or Negative Impact (based on EPA, 2017)

Table 1c: Criteria for assessing impact quality based on EPA, 2017,

Quality of Effect	Criteria
Positive	A change which improves the quality of the environment (for example, by increasing species diversity; or the improving reproductive capacity of an ecosystem, or by removing nuisances or improving amenities).
Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
Negative	A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem; or damaging health or property or by causing nuisance).

- Impact Significance of potential impact parameters on specific bat species in relation to particular elements (e.g. roosting sites, foraging area and commuting routes) are assessed with reference to the following:
    - Table 4 of Marnell *et al.* (2022) (Figure 1a);
    - the known ecology and distribution of the bat species in Ireland;
    - bat survey results including type of roosts (if any recorded), pattern of bat usage of the survey area, level of bat activity recorded etc.
    - and bat specialist experience.

- Impact Significance of the proposed development on local bat populations maybe determine, where applicable, using the parameters listed in Table 2c (based on EPA, 2017).

Table 1d: Criteria for assessing significance of effects based on EPA, 2017,

Significance of Effects	Definition
Imperceptible	An effect capable of measurement but without significant consequences.
Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Significant	An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Very Significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
Profound	An effect which obliterates sensitive characteristics

The following terms will be used, where possible and applicable, when quantifying the duration of the potential effects (selected from EPA, 2017):

- Temporary – effects lasting less than a year
- Short-term – effects lasting 1 to 7 years
- Medium term – effects lasting 7 to 15 years
- Long term – effects lasting 15 to 60 years
- Permanent – effects lasting over 60 years
- Reversible – effects that can be undone, for example through remediation or restoration.

1.1.4 Bat Mitigation Measures

1.1.4.1 Bats & Lighting

All European bat species, including Irish bat species, are nocturnal. Light levels as low as typical full moon levels, i.e. around 0.1 LUX, can alter the flight activity of bats (Voigt *et al.* 2018). Any level of artificial light above that of moonlight can mask the natural rhythms of lunar sky brightness and, thus, can disrupt patterns of foraging and mating and might, for instance, interfere with entrainment of the circadian system.

Artificial light pollution is an increasing global problem (Rich and Longcore, 2006) and Artificial light at night (ALAN) is considered a major threat to biodiversity, especially to nocturnal species. As urbanisation expands into the landscape, the degree of street lighting also expands. Its ecological impacts can have a profound affect the behaviour of nocturnal animals including impacts on reproductive behaviours, orientation, predator-prey interaction and competition among others, depending on the taxon and ecosystem in question (Longcore and Rich 2004). It is considered by Hölker *et al.* (2010) to be a key biodiversity threat to biodiversity conservation. In relation to bats, the potential impacts of artificial night lighting can result in habitat fragmentation (Hanski, 1998), delay in roost emergence (Downs *et al.,* 2003) and a reduction in prey items.

In the context of behavioural ecology, lights can work to attract or repel certain animals. Many groups of insects, including moths, lacewings, beetles, bugs, caddisflies, crane flies, midges, hoverflies and wasps, can be attracted to artificial light (Eisenbeis and Hassel 2000; Frank 1988; Kolligs 2000). Attraction depends on the spectrum of light. In the context of streetlights, white (mercury vapour) lamps emit a white light that includes ultraviolet. High pressure sodium lights (yellow) emit some ultraviolet, while low pressure sodium lamps (orange) emit no ultraviolet light (e.g. Rydell 2006). As a result of the attractiveness of lights to aerial invertebrates, swarms of insects often occur in and around streetlights and, particular bat species such as aerial insect predators, can exploit the swarming insects to their advantage. Such attraction can also take prey items away from dark zones where light sensitive species are foraging, thus reducing their likelihood of feeding effectively.

Rydell (2006) divides bats into four categories in terms of their characteristic behaviours at streetlamps. The four categories are based on bat size, wing morphology and echolocation call characteristics which were highlighted by Norberg and Rayner (1987) to determine flight speed, manoeuvrability, and prey detection capabilities of bats. Rydell (2006) stated that the large, fast flying bats, which are confined to open airspace, fly high over lit areas and are rarely observed near ground level. None of these, typically large free-tailed bats (e.g. large species of the family Molossidae), are found in Ireland. The second category are the medium-sized fast flying species, including the *Nyctalus* species, which patrol the street well above the lights and can be seen occasionally as they dive for prey into the light cone. This group includes the Leisler's bat, which is found in Ireland. Rydell's third category describes the small but fast flying bats that are manoeuvrable enough to forage around light posts or under the lights and includes the small *Pipistrellus* species of the old world, three of which are found in Ireland. The fourth category includes broad-winged slow flyers, most of which are seldom or never observed at lights. Slow flying bat species may be more vulnerable to predation by diurnal birds of prey, and this may restrict their exploitation of insects around artificially illuminated areas (e.g. Speakman 1991). There are also the concerns that some bat species are more light sensitive and therefore actively avoid lit up areas. This is particularly relevant for lesser horseshoe bats. Therefore, from this, we can categorise the suite of Irish bats species as follows (please note that the sensitivity category is the author's description):

Table 1e: Potential light sensitivity of the Irish bat fauna using categories described by Rydell, 2006.

Species: Common Name	Rydell Category	Sensitivity
Daubenton's bat *Myotis daubentonii*	Category 4	Light sensitive
Whiskered bat *Myotis mystacinus*	Category 4	Light sensitive
Natterer's bat *Myotis nattereri*	Category 4	Light sensitive
Leisler's bat *Nyctalus leisleri*	Category 2	Light tolerant
Nathusius' pipistrelle *Pipistrellus nathusii*	Category 3	Semi-tolerant
Common pipistrelle *Pipistrellus pipistrellus*	Category 3	Semi-tolerant
Soprano pipistrelle *Pipistrellus pygmaeus*	Category 3	Semi-tolerant
Brown long-eared bat *Plecotus auritus*	Category 4	Light sensitive
Lesser horseshoe bat *Rhinolophus hipposideros*	Category 4	Light sensitive

The ability of different bat species to exploit insects gathered around streetlights varies greatly. Gleaning species such as *Myotis* bats rarely forage around streetlights (Rydell and Racey, 1995). The ecological effects of illuminating aquatic habitats are also poorly known. Moore *et al.* (2006) found that light levels in an urban lake, subject simply to sky glow and not direct illumination from lights, reached the same order of magnitude as full moonlight.

All European bat species, including Irish bat species, are nocturnal. As a consequence, the scientific literature provides evidence that artificial lighting does impacts on bats. The degree of impact depends on the light sensitivity of the bat species and the type of luminaire. Lesser horseshoe bats are light sensitive and therefore adversely effected by the presence of lighting in all aspects of their life strategies (e.g. foraging, commuting, drinking and roosting).

The potential impacts of street lighting can be summarised as follows:

- Attracting Prey Items

Lights can work to attract or repel certain animals. Many groups of insects can be attracted to artificial light and this attraction depends on the spectrum of light. As a result of the attractiveness of lights to aerial invertebrates, swarms of insects often occur in and around streetlights. Such attraction can also take prey items away from dark zones where light sensitive species, such as lesser horseshoe bats, are foraging, thus reducing their likelihood of feeding effectively.

- Reducing Foraging Habitat

The research documents that there is less bat species diversity foraging in habitats lit up by artificial lighting. Only bat species considered to be light tolerant are generally able to exploit habitats with lighting present, but overall, all bat species activity tends to be less in lit up habitats compared to non-lit up habitats.

- Fragmenting The Landscape

Scientific evidence shows that lighting is a barrier to the movement of light sensitive bat species, such as lesser horseshoe bats. Light sensitive bat species will actively seek dark corridors to commute along and therefore the presence of lighting in commuting habitats will restrict their movement of such species in the landscape.

- Reducing Drinking Sites

There is increasing evidence that drinking sites for bats is an essential component for local bat population survival and that the presence of artificial lighting at waterbodies prevents bats from availing of this resource.

Lighting, including streetlights come in an array of different types but for streetlights they typically include High Pressure Sodium, Low Pressure Sodium, Mercury Vapour and the more modern Light Emitting Diodes (LED). An array of field-based research has been undertaken to document the potential impact of lighting on bat flight activity. LED lighting is predicted to constitute 70% of the outdoor and residential lighting markets by 2020. While the use of LEDs promotes energy and cost savings relative to traditional lighting technologies, little is known about the effects these broad-spectrum “white” lights will have on wildlife, human health, animal welfare, and disease transmission. Consequently, a large array of research has been undertaken recently on the potential impact of LED on bats.

Stone *et al.* (2012) undertook research in relation to "Cool" LED streetlights on an array of local bat species in England. Overall the presence of LED street lights had a significant negative impact on lesser horseshoe bats and *Myotis* spp. for all light treatments investigated while there was no sign impact of light treatment type on *Pipistrellus pygmaeus* (soprano pipistrelle – a common Irish bat species) or *Nyctalus* (Leisler's bats is part of this bat family and is a common Irish bat species)/*Eptesicus* species. This research paper also documented behavioural changes for the different bat species. Lesser horseshoe bats and *Myotis* spp. did not avoid lights by flying along the other side of the hedge but altered their commuting behaviour altogether. It was concluded that LEDs can fragment commuting routes causing bats to alter their behaviour with potentially negative conservation consequences. Lesser horseshoe bat activity was significantly lower during high intensity treatment than medium, but at all treatment levels (even as low as 3.6 LUX), activity was significantly lower than unlit control (LUX level measurements were taken at 1.7m at the hedge below the light).

Russo *et al.* (2017) investigated the impact of LED lighting on drinking areas for bats in Italy. Drinking sites are considered to be important components for the survival of local bat populations. Drinking sites were illuminated with a portable LED outdoor light emitting (48 high-power LEDs generated a light intensity of 6480 lm (4000–4500 K) at 25°C, two peaks of relative luminous flux at 450 and 590 nm). *Plecotus auritus* (brown long-eared bat – resident in Ireland), *Pipistrellus pygmaeus* (soprano pipistrelle – resident in Ireland) and *Rhinolophus hipposideros* (lesser horseshoe bat – resident in Ireland) did not drink when troughs were illuminated.

Rowse *et al.* (2018) researched the impacts of LED lights (portable lights, 97W 4250K LED on 10m high poles) in England on local bat populations. Treatments were either 100% light intensity; dimmed (using pulse width modulation) at 50% or 25% light intensity; and unlit. Sites were in suburban areas along busy roads but with vegetation and tree lines adjacent. High light levels (50% & 100% light treatments) increased activity of opportunistic *Pipistrellus pipistrellus* (common pipistrelle – resident in Ireland) but reduced activity of *Myotis* species group. Conversely 25% and unlit sites had no difference from each other. The research paper conclude that dimming could be an effective strategy to mitigate ecological impacts of streetlights.

Wakefield *et al.* (2017) stated that an important factor to be aware of in relation to LED is the direction of the light projected. Therefore, it is recommended that highly focused/shielded LEDS designed to filter out short wavelengths of light may should be used as they attract relatively fewer insects. Less insects attracted to street lights means less insects leaving dark zones where light sensitive bat species primarily feed.

Martin *et al.* (2021) showed that LED streetlights lead to a reduction in the total number of insects captured with light traps in a wide range of families. Coleoptera and Lepidoptera orders were the most sensitive groups to ecological light pollution in the study area. The paper suggested that LED was the least attractive light system for most of the affected groups both because of its very little emitted short-wavelength light and because of its lower light intensity. They also concluded that reduction in insect attraction to LED could be even larger with current LED technologies emitting warmer lights, since other research showed that LED emitting "warmer white" colour light (3000 K) involves significantly lower attraction for insects than "colder white" LED (6000 K).

Wilson *et al.* (2021) investigate the impact of LED on biting insects and concluded because LED is highly malleable regarding spectral composition, they can be tailored to decrease or increase insect catches, depending on situation. Therefore, this design control of LED could greatly assist in reducing impact of street lighting on local bat populations.

Stone *et al*. (2015) reviewed the impacts of ALAN on bat roosts and flight paths in order to provide recommendations in relation to street lighting. The principal recommendations were to avoid lighting places where bats are present and to ensure that there are interconnected light exclusion zones and variable light regimes with reduced intensity of light in specific areas (e.g. important foraging and commuting habitats) as responses to street lighting may vary between species. It recommends that there should be a 'light threshold'.

1.1.4.1.1 Lighting Guidelines – Effective Mitigation Measures

Because of this extensive amount of research there are two principal guideline documents available for best practice for effective mitigation relating to outdoor lighting.

EUROBATS (Voigt *et al.,* 2018) guidelines recommends the following:

- ALAN should be strictly avoided, and artificial lighting should be installed only where and when necessary, coupled with the following:
    - Dynamic lighting schemes, where possible.
    - Use a minimal number of lighting points and luminaires on low positions in relation to the ground for minimising light trespass to adjacent bat habitats or into the sky.
    - Use focused light, e.g. by using LED or shielded luminaires which limit the light flux only to the required areas and prevent light trespass into adjacent bat habitats.
    - Create screens, either by erecting walls or by planting hedgerows or trees, to prevent light trespass, e.g. from illuminated roads, to surrounding bat habitats.
    - Exits of bat roosts and a buffer zone around them should be protected from direct or indirect lighting to preserve the natural circadian rhythm of bats.

This BCT (2018) guidelines provides a list of recommendations in relation to luminaire design, which is based on the extensive research completed to-date on the potential impact of lighting on bats, and therefore provides best practice mitigation measures. These recommendations are the basis of mitigation measures pertaining to bats listed in this report and are summarised as follows:

- All luminaires used should lack UV/IR elements to reduce impact.
- A warm white spectrum (<2700 Kelvins should be used to reduce the blue light component of the LED spectrum).
- Luminaires should have a peak wavelength higher than 550nm to avoid the component of light most disturbing to bats.
- Only luminaires with an upward light ratio of 0% and with good optical control should be used.
- Luminaires should be mounted on the horizontal, i.e. no upward tilt.
- Column heights should be carefully considered to minimise light spill. The shortest column height allowed should be used where possible.
- Bollard lighting should be considered for pedestrian, parks and greenway areas, if deemed necessary.

1.1.4.2 Bat Box Schemes

Bat Boxes are frequently used as part of bat mitigation to retain local bat populations within an area proposed to be development. The NPWS Bat Mitigation Guidelines (Marnell *et al.* 2022) considers that where roosts of low conservation significance (Figure 20, Marnell *et al.* (2022)) are to be lost due to a development, bat boxes may provide an appropriate form of mitigation and the effectiveness depends on the type of bat box provided, which should be appropriate to the bat species (Figure 1f).

Table 7 The types of bat box used by different species.

Species	Summer/ maternity	Summer/non breeding	Hibernation*	Notes
Rhinolophus hipposideros	N/A	N/A	N/A	Horseshoe bats cannot use bat boxes
Myotis daubentonii	H	H		
Myotis mystacinus	H	H		
Myotis nattereri	H	?		
Pipistrellus nathusii	H	H		
Pipistrellus pipistrellus	C	C/H	C	H are rarely used as maternity roosts.
Pipistrellus pygmaeus	C	C/H	C	
Nyctalus leisleri	H	H	H?	
Plecotus auritus	H	H		Maternity roosts

Key

* Large well-insulated hibernation boxes may be more successful

N/A -not applicable; bat boxes should not be considered as replacement roosts

H – tree hollow-type box, providing a void in which bats can cluster

C – tree crevice-type box, with 25-35mm crevices

? – few data on which to base an assessment

Figure 1a: Table 7 (p 58) Reproduced from Marnell *et al.* (2022).

1.1.4.2.1 Effectiveness of Bat Boxes as a Mitigation Measure

Two publications that provide good scientific advise in relation to the effectiveness of bat boxes are presented below. McAney & Hanniffy (2015) reviewed the use of bat boxes in Ireland in relation to the bat usage of the following bat box schemes: 62 Schwegler boxes of three models erected in Portumna Forest Park (Bat box scheme consisted of 30x 1FF design, 30x 2FN design and 2x 1FW design); 50 2FN boxes erected in Coole-Garryland Nature Reserve and 50 2FN boxes erected in Knockma Nature Reserve of which 40 were later transferred to Glengarriff Nature Reserve County Cork. The bat box schemes were set up in March 1999 and data was collected up to 2015. Eight of the nine resident bat species were recorded roosting in bat boxes (lesser horseshoe bats cannot use bat boxes due to their need to fly, rather than crawl, into roosts). The main summary points are as follows:

- Leisler's, brown long-eared and *Pipistrellus* spp. were recorded in boxes at all three Galway woods, Daubenton's bat was only recorded in Garryland, Natterer's bat was only recorded in Glengarriff and whiskered/Brandt's was recorded just twice.
- There was a 31% chance of encountering a bat at Portumna Forest Park compared to 11.5% and 10% at Coole-Garryland Nature Reserve and Knockma Nature Reserve respectively.
- Pipistrellus spp. preferred 1FF boxes as this bat box design offer crevice-like roosting conditions. This species group also showed a seasonal preference with more bats present later in the season (visual observations confirmed the bats were using the boxes as mating roosts) and their numbers increased from the time that the bat box scheme was originally established.
- Brown long-eared bats preferred 2FN boxes that mimic holes in trees, the natural roosting sites for this species. This species also showed no seasonal pattern to their occurrence in the boxes. However one aspect of 2FN boxes that this report mentions is the high occupancy

by birds which can be an issue in relation to nesting material reducing the availability of bat boxes for roosting bats.
- Leisler's bat showed no preference for box model but showed a seasonal preference with more bats present later in the season.
- Aspect was not a significant factor for occupancy but most boxes received dappled sunshine for part of the day.
- The other factor that proved significant was the length of time the boxes were in place, with occupancy rates increasing for all three species, although in the case of pipistrelles this increase appears to have stabilised. So, although the boxes were occupied very quickly, it took several years before they were regularly occupied and before clusters of bats were formed and breeding was confirmed.

Collins *et al.* (2020) investigated the implementation and effectiveness of bat roost mitigation, which included bat boxes, in building developments completed between 2006 and 2014 in England and Wales. The bat species studied were: common and soprano pipistrelle, brown long-eared bat and *Myotis* species, all of which are present in Ireland. A summary of the main points relating to bat boxes are as follows:

- Bat boxes were the most frequently deployed roosting provision (i.e. alternative roosts), being installed at 64% (n = 71) of sites surveyed as a compensation or enhancement measure.
- Box frequencies ranged from 1 to 41 at sites where they were installed, with an average of 6.6 boxes per site.
- Bats, or evidence of bats, were recorded in 20% of these bat boxes.
- Bat boxes mounted externally on buildings showed the highest occupation rate regardless of species while Common pipistrelle showed a preference for these over tree mounted boxes; the opposite was true for soprano pipistrelle.
- The four most popular bat box models used by consultants in the study were all Schwegler woodcrete bat boxes. Bat presence was highest in the 1FF bat box design (32%, n = 53) and lowest for birds (8%). The tree-mounted 2F and wall-integrated 1FR/2FR models both demonstrated similar bat presence rates of 23% (n = 43) and 25% (n = 32) respectively. The 2FN tree-mounted model showed the lowest presence rate for bats (11%, n = 19) and the highest for birds (58%). There were also 26 timber bat boxes, none of which were used by bats.

The author has also erected several bat box schemes and, where possible, has completed occasional monitoring visits. One such example is a bat box scheme erected in Kileshandra, Co. Cavan which consists of 8 Schwegler woodcrete bat boxes of various designs. The bat boxes were erected on mature trees located in a linear woodland adjacent to a river. This bat box scheme was erected in 2012 as part of mitigation for the demolishment of a large derelict building where small satellite roosts were recorded for *Pipistrellus* spp. and Daubenton's bat. Two site visits have been completed since 2012 and during these visits the bat boxes were checked for evidence of bat usage. The first site visit was on 25/8/2015 and one bat box was occupied by a single Leisler's bat while the additional seven bat doxes had evidence of bat droppings (*Pipistrellus* spp. and *Myotis* spp.). During the second site visit (27/7/2019) four bat boxes were occupied by bats (Soprano pipistrelle x1 individual (adult male), Leisler's bat x1 individual (adult male) and two bat boxes with x16 Daubenton's bats and x10 Daubenton's bats respectively). Biometrics was recorded for the 12 of the bats (which included 10 of the Daubenton's bats recorded in the bat box with 16 individuals) and five of these Daubenton's bats were lactating females with the remaining five Daubenton's bats recorded as juveniles, thereby indicating that this bat box was used as a maternity roost. The remaining four bat boxes all had droppings within for *Pipistrellus* spp and Leisler's bats. This bat box scheme, while

just one example, demonstrates that when bat boxes are erected in an area with good bat habitat (bat survey documented a high level of bat activity for the named bat species), a high level of occupancy of bat boxes will occur.

In relation to bat boxes, Marnell *et al.* (2022), a document that provides guidelines that are considered to be practical and effective based on past experience, recommends that the design life of potential bat boxes, including essential maintenance, should be about 10 years, as this would be comparable with the lifespan of the tree roosts that bat boxes are designed to mimic. The guidelines continue by stating that the "This lifespan can be achieved with good quality wooden boxes and exceeded by woodcrete bat boxes or other types of construction that ensure any softwoods are protected from the weather and attack by squirrels" (note – this includes woodstone bat boxes).

In relation to the number of bat boxes recommended to be erected, Lintott & Mathews (2018) found that the greater the number of bat boxes deployed, the greater the probability of at least one of the boxes becoming occupied and that the odds of bats occupying at least one box increased by approximately 7% with each additional bat box that was deployed. Bat boxes are erected, as part of this proposed development, to mitigate for the loss of potential roosts in trees. Therefore, the number of bat boxes are calculated according to the number of trees with additional boxes added for greater bat conservation value.

Therefore, Schwegeler woodcrete bat boxes are recommended as a bat mitigation measure and the authors preference to use 1FF designs as this box is open at the bottom which reduces build-up of droppings (i.e. it is a self-cleaning bat box). Both McAney & Hannify (2015) and Collins *et al.* (2020) demonstrated that usage of this bat box design by bat species recorded in this survey report. This bat box is also less likely to be used by birds and therefore retaining it for bat usage between monitoring visits. To increase occupancy of bat boxes by bats it is important to erect bat boxes 4m or higher (to ensure that bat boxes are out of reach from disturbance by humans and predation by other mammals) and that they should be located where bats have been documented foraging and commuting. The aspect of the bat box is not an influencing factor in relation to occupancy. These recommendations have all been included in this report.

1.1.4.3 Landscaping For Bats

Bats depend on the landscape for foraging, roosting and commuting. Different bat species will travel different distances, to and from their principal roosting sites, depending on their morphology, life stage and preferred foraging areas. Bats in Ireland are insect eating mammals and feed on an array of insects, whose populations are ultimately supported by vegetation. Areas of rich vegetation habitat tend to support higher abundances of insect populations and therefore a higher abundance of bats. In addition, many bat species rely on continuous linear habitats (e.g. treelines and hedgerows) to commute along. As a consequence, landscaping as part of a proposed development project is an important element to the goal of retaining local bat populations.

The Bat Conservation Trust publication "Landscape and Urban Design for bats and biodiversity" (Gunnell *et al.,* 2012) is a resource for planning landscape design in our urban areas. This resource encourages measures to enhance existing bat foraging habitat, create water features such as ponds (drinking sites for bats and as a source of emerging insects), manage species rich grassland and planting of tall vegetation to ensure that exiting treelines and hedgerows are linked. It also recommends that use of landscaping as a means to creating dark zones or dark corridors for this mammal group to fly along in our lit urban areas. This is also support by the BCT Lighting Guidelines (BCT, 2018) where landscape design can be utilised to buffer potential light spillage from developments.

1.1.4.4 Seasonality of Bat Mitigation Measures

The NPWS Bat Mitigation Guidelines (Marnell *et al.* 2022) provides best practice guidance in relation to the timing of bat mitigation measures. It states that the most common and effective method of avoiding potential harm to a bat is to carry out the work at an appropriate time of the year. The following table provides a summary of timings.

Table 5 Optimum season for works in different types of roosts.

Bat usage of site	Optimum period for carrying out works (some variation between species)
Maternity	1st October – 1st May
Summer (not a proven maternity site)	1st September – 1st May
Hibernation	1st May – 1st October
Mating/swarming	1st November – 1st August

Figure 1b: Table 5 (p 50) Reproduced from Marnell *et al.* (2022).

Timing of bat mitigation measures is relevant to the proposed tree felling of Potential Bat Roosts (PBRs). Felling is recommended outside the principal maternity season and during mild weather conditions (to avoid cold weather that would encourage bats to hibernate). This coupled with dusk/dawn surveys and additional daytime inspections is best practice to ensure that tree felling is completed without causing harm to potentially roosting bats. The preferred tree felling months also avoids the bird nesting season.

2. Proposed Development Description

2.1 Site Location

The stretch of the Royal Canal was surveyed, and this is shown on the figure below (Figure 2a). The area survey is located along the length of the red line.

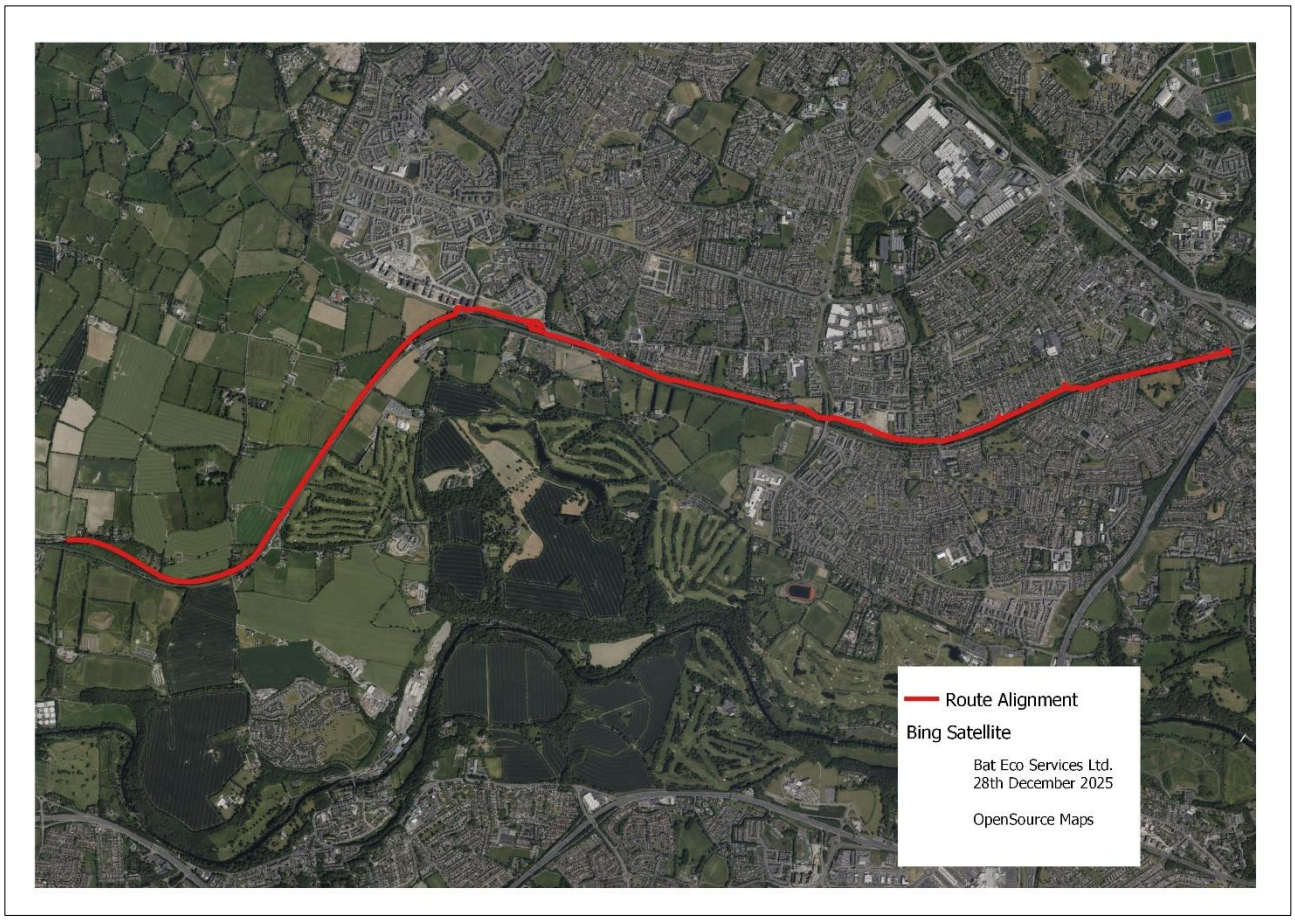


Figure 2a: Red line boundary and extent of survey area of Royal Canal, Co. Dublin & Co. Kildare.

2.2 Proposed Project

The Royal Canal Urban Greenway (hereafter referred to as the 'Proposed Scheme') is a pedestrian and cycle route (approx. 8.1km in length) which is to be constructed along / adjacent to the Royal Canal as it heads eastwards from the Kildare County Boundary to the Old Navan Road (near 12th Lock) to connect with a previously constructed section of the Greenway (Ashtown Greenway). The proposed development is a joint scheme, Fingal County Council (the Client) is the scheme promoter in conjunction with the National Transport Authority (NTA) as the funding body and Waterways Ireland (WI) who are the principle property owner.

The Royal Canal Links the River Shannon in County Longford to the River Liffey in Dublin City's Docklands. On its way, it passes close to a number of towns, including Mullingar, Kilcock, Maynooth and Leixlip before entering Fingal where it passes through the built-up areas of Clonsilla, Coolmine, Castleknock and Blanchardstown on its way towards the north city.
It will provide a high quality, safe, attractive and environmentally sympathetic walking and cycling corridor serving Castleknock, Blanchardstown, Clonsilla, Coolmine and the wider Dublin 15 area. The greenway will encourage recreation while offering an attractive sustainable transport choice for

school children and commuters, bringing significant environmental, economic and health benefits to the wider community.

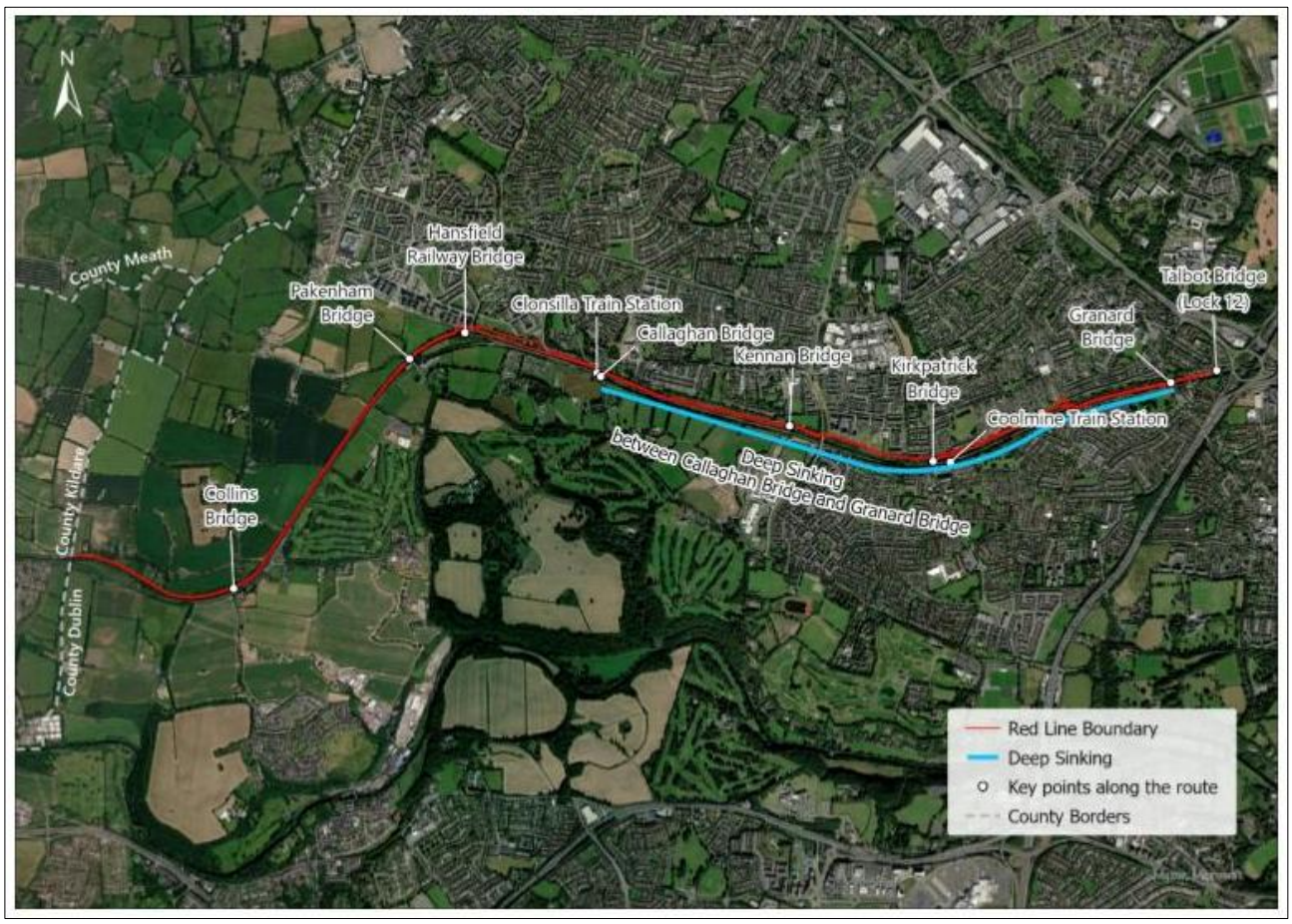


Figure 2b: The Royal Canal Urban Greenway, Co. Dublin & Co. Kildare.

The scheme has been divided into three distinct sections based on their different geographical and physical characteristics to simplify the assessment process as follows:

- Section 1 – Kildare County Border to Hansfield Railway Bridge (Ch. 0000m – 3200m)
- Section 2 – Hansfield Railway Bridge to Kennan Bridge (Ch. 3200m – 5300m)
- Section 3 – Kennan Bridge to Talbot Bridge (Ch 5300m – 8100m)

Section 1 extends from Kildare/Dublin County boundary line to Hansfield Railway Bridge. This section is rural/peri-urban in nature, predominately farmlands, however, it also adjoins local amenities such Westmanstown Golf Club and Westmanstown Sports Centre.

Section 2 extends from Hansfield Railway Bridge, through Clonsilla under Callaghan Bridge to Kennan Bridge at Porterstown Road. In Section 2, the character of the area changes from rural to predominantly suburban in nature. This section is predominately residential on the northern side of the canal with farmlands on the southern side.

Section 3 runs from Kennan Bridge (Porterstown Road) to Talbot Bridge (Old Navan Road). This section is predominately urban with extensive residential catchments on both sides of the Canal.

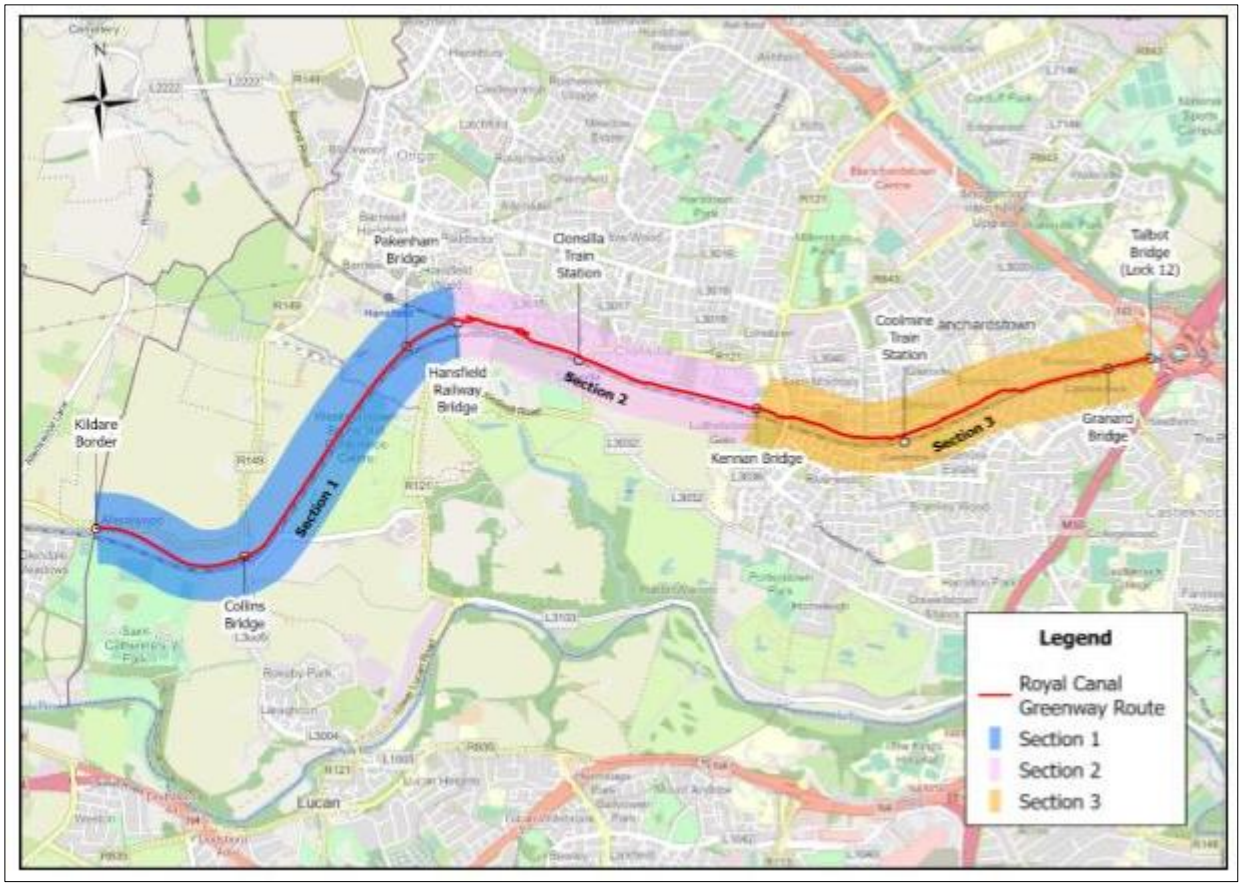


Figure 2c: Study Area sections along Royal Canal Urban Greenway, Co. Dublin & Co. Kildare.

2.2.1 Proposed Works

The proposed greenway route is approximately 8.1km in length, approx. 5km of the route will be along the canal towpath, while 3.1km of the greenway will be away from the towpath to minimise impacts on trees and habitats along the canal. The greenway route will also tie into the recently constructed pedestrian/cycle routes at St. Joseph's and Windmill Court residential developments (combined length of approx. 800m).

The proposed works include:

· Construction of the greenway route which contains the following pavements/surfacing:
o Section 1 – unbound surface (width 2-3m) from Kildare County Border to Hansfield Railway Bridge (Ch. 0 – 3200m).
o Section 2 – bituminous surface (3-4m width) for the majority of the section, with the exception of pre-cast concrete cantilevered boardwalk from approx. Ch. 4140 - 4540.
o Section 3 - bituminous surface (4m width) for the majority of the section, in-situ concrete surfacing and portions of raised boardwalk due to local topography.
· Construction of embankments and retaining structures along certain sections of the route where the topography requires stabilisation.
· Toucan Signalised Crossings (no. 4) and zebra crossings (no. 1) are proposed at road crossing along the scheme.
· Lighting will not be provided on the western section of the scheme. Lighting will be provided from Hansfield to 12th Lock (Ch. 3200m – 8100m). The lighting design will be designed in line with best practice and will be sensitive to ecology such as bats, birds and other mammals. To prevent the greenway overlooking the back gardens of the residents of Delwood Park and for security reasons, the ground level of the greenway is proposed to be lowered to match,

or be lower than, the existing ground level of the adjacent back gardens and a 2m high timber palisade fence provided, with an anti-climb wire mesh fence (Ch. 6200 – 6800).

· Installation of the Quarry Bridge (30m single span composite steel beam and concrete deck bridge) which spans a steep section of historic quarry on the northern bank of the Royal Canal (Ch. +6500m).

· Site investigations to be carried out within the red line boundary, additional to what has been carried out to date, where necessary to inform detailed design, potentially including (but not limited to) confirmation of geotechnical characteristics in relation to foundation design through boreholes, and locating of existing utilities in relation to drainage and utility designs through GPR surveys and/or slit trenches.

· The 2m high fence line to be maintained along the southern side of the greenway along the Brompton green area. To provide further privacy to the Brompton residents, planting and railings will be provided on the Brompton side of the greenway through the Brompton green area.

· Construction of the Landmark Bridge (Steal bridge) which will traverse the canal (at Ch. 7100-7200). The steel bridge will be approximately 185m in length and will have a maximum single span of 30m.

· Construction of an underpass is proposed in Section 3 beneath Castleknock Road on the southern side of Granard Bridge (Ch. +7770).

· A Pocket Park is proposed at Hansfield, south of the St. Joseph's residential development. The park will have a wildflower meadow, native hedgerow, embankment slide, informal play area and picnic area with tables and benches etc.

· Demolition of two houses and ancillary structures on approach to Hansfield Road (Ch. 3650 to 3800) facilitate the routing of the proposed scheme and Pocket Park.

· To compensate for the removal of trees, hedgerows and vegetation along the proposed route, a variety of native/naturalized species have been selected to enhance and increase woodland cover as part of the proposed schemes Landscape Plan.

3. Bat Survey Methodology

3.1 Guidance Document

This report will draw on guidelines already available in Europe and will use the following documents:

- Collins, J. (Editor) (2023) Bat Surveys for Professional Ecologists: Good Practice Guidelines (4th edition). Bat Conservation Trust, London
- Marnell, F., Kelleher, C. & Mullen, E. (2022) Bat mitigation guidelines for Ireland v2. Irish Wildlife Manuals, No. 134. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland (Version 1: Kelleher & Marnell, 2006).

Collins (2016 & 2023) was the principal document used to provide guidance in relation to bat survey effort required. Marnell *et al.* (2022) is referred to for guidance in relation to survey guidance (timing and survey design), derogation licences and mitigation measures.

This report provides details of Bat Eco Services Ltd. survey results (2022 & 2025) and pertinent results from Wildlife Surveys Ireland Ltd. (please see Section 3.2.3 for more details).

3.2 Desktop Review

3.2.1 Bat Conservation Ireland Database

Bat Conservation Ireland acts as the central depository for bat records for the Republic of Ireland. Its' bat database is comprised of >100,000 bat records. The database primarily contains bat records from the following datasets:

- Irish Bat Monitoring Programme
- BATLAS 2020 & 2010
- Ad Hoc Bat Records submitted by ecologist bat groups etc.

The Bat Conservation Ireland database was accessed on 4th September 2025 to collated bat records for a 1km radius of the proposed development site (O2117462614). An important caveat to note is that the BCIreland dataset is dependent on bat records being regularly submitted to BCIreland and/or NBDC. Therefore, the absence of information does not necessarily imply that there are no bats or bat roosts present in the search area.

3.2.2 Bat Conservation Landscape Favourability

Bat Conservation Ireland (BCIreland) 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). This model was queried on 4th September 2025. 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 for the consideration of bat conservation. The island is divided into 5km squares and the landscape favourability (expressed as a percentage, the higher the value, the greater the favourability) of each 5km square for each species of bat was modelled. A caveat is attached to the model: the model is based on records held on the Bat Conservation Ireland 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. This model was used as part of the desktop study for this report.

3.2.3 Historical Bat Surveys

A bat survey was commissioned in 2024 and this was undertaken by Wildlife Surveys Ireland. The surveys completed in 2024 were as follows: daytime assessment of bridges and trees; dusk and dawn surveys and static surveillance. Some of findings of this survey (data that could be extracted with mapping co-ordinates) are incorporated into the findings of the surveys completed by Bat Eco Services Ltd. This includes the daytime assessment of bridges and trees, bat records collated (by static surveillance and dusk surveys) of light sensitive bat species (i.e. brown long-eared bat and Daubenton's bat).

Citation: Wildlife Surveys Ireland Ltd. (2024) A bat assessment of the Royal Canal, an 8km section from Leixlip, Kildare to Castleknock, Dublin 15. Unpublished report for Fingal County Council, Draft 2 (Date: October 2024).

3.3 Daytime Inspections

3.3.1 Bridge Inspection

Structures such as bridges are likely places that may provide a roosting space for bats and these were inspected during the daytime for evidence of bat usage. Evidence of bat usage is in the form of actual bats (visible or audible), bat droppings, urine staining, grease marks (oily secretions from glands present on stonework) and claw marks. In addition, the presence of bat fly pupae (bat parasite) also indicated that bat usage of a crevice, for example, has occurred in the past. Inspections are undertaken visually with the aid of a strong torch beam (LED Lenser P14.2) and endoscope (General DC5660A Wet / Dry Scope).

Bridge structures and similar stone structures were assessed using a 4-point classification system designed for bridges by Billington & Norman (1997) as presented below.

Survey Dates: 2nd May 2022

Table 2a: Bridge and Stone Structure Bat Roost Classification System (Adapted from Billington & Norman, 1997).

Bridge Category	Description
0	No potential (i.e. no suitable crevices for roosting bats).
1	Low potential (i.e. crevices present that may be of use to bats).
2	High potential (i.e. crevices ideal for roosting bats but no evidence of usage during inspections).
3	Roost (evidence of bats roosting either because bats are present or other evidence is recorded during inspection (e.g. bat droppings).

3.4 Night-time Bat Detector Surveys

3.4.1 Dusk & Dawn Bat Surveys

Dusk Emergence Surveys were completed from 10 minutes before sunset to at least 110 minutes post sunset and the surveyors position themselves adjacent to the bridge to be surveyed to determine if bats are roosting within, location of roost(s), number of bats, bat species etc.

Survey Dates: 2nd, 3rd, 5th, 10th May 2022

Dawn surveys were completed from 110 minutes before sunrise to 10 minutes after sunrise. Surveys are completed during mild and dry weather conditions with air temperature 8°C or greater. All bat encounters are noted during surveys.

Survey Dates: 6th and 11th May 2022

The following equipment was used:

Surveyor 1 (Principal surveyor): Anabat Walkabout Full Spectrum Bat Detector and Petersson D200 Heterodyne Bat Detector.

Surveyor 2: Bat Logger M2 Spectrum Bat Detector and Petersson D200 Heterodyne Bat Detector.

Walking transects were completed post Dusk Emergence Surveys or 40 minutes after sunset and involved the surveyor(s) walking the survey area. The full spectrum bat detectors record all bat echolocation calls which are time stamped and geo-referenced. Calls were analysed using Kaeidoscope Pro and validation of bat species was completed by the principal bat surveyor prior to mapping. Mapping of bat encounters was undertaken using QGIS and an excel file produced for mapping purposes (ITM Irish grid reference co-ordinates). Due to the length of the survey area, the 8km stretch was divided into two halves with Clonsilla Bridge as the dividing point. Transect 1 walking transect was completed over two nights with the section of the canal east of the bridge walked on the first survey night. The remaining section west of the bridge was completed on a second survey night. This process was repeated for Transect 2.

Survey Dates: 2nd, 3rd, 5th, 10th May 2022 & 15th and 24th April 2026

3.4.2 Passive Static Bat Detector Survey 2022 & 2025

Passive Static Bat Surveys were completed from 2nd May to 7th May 2022 (5 nights recording, 22:00hrs to 06:00hrs). Additional static surveys were completed from 22nd September to 3rd October 2025 (10 nights recording).

A Passive Static Bat Surveys involves leaving a static bat detector unit (with ultrasonic microphone) in a specific location and set to record for a specified period of time (i.e. a bat detector is left in the field, there is no observer present and bats which pass near enough to the monitoring unit are recorded and their calls are stored for analysis post surveying). The bat detector is effectively used as a bat activity data logger and the habitat type of where the bat detector is location is noted to allow interpretation of the results (e.g. Open verses Edge verses Closed habitat types – see table below). Static surveillance results in a far greater sampling effort over a shorter period. Bat detectors with ultrasonic microphones are used as the ultrasonic calls produced by bats cannot be heard by human hearing.

The microphone of the unit was positioned horizontally to reduce potential damage from rain. Passive recording units use Real Time recording as a technique to record bat echolocation calls and

using specific software, the recorded calls are identified. It is these sonograms (2-d sound pictures) that are digitally stored on the SD card (or micro SD cards depending on the model) and downloaded for analysis.

The recordings are analysed using Wildlife Acoustics Kaleidoscope Pro. The Auto-Id function is used for all sound files but manual verification is used to ensure the auto-id function is accurate. This is particularly important for less common bat species and cryptic bat species such as *Myotis* species. In addition, "Noise" and "Unidentified" sound files are also checked. Each sequence of bat pulses are noted as a bat pass to indicate level of bat activity for each species recorded. This is either expressed as the number of bat passes per hour or per survey night.

AudioMoths were used for this static surveillance due to the open nature of the canal bank. This unit is small and therefore less visible. However, it is a simple recording unit that is not triggered by noise but is set to record for time periods. The recording units were set to recorded for 10 secs with 20 sec sleep from 22:00hrs to 06:00hrs. A total of 960 audio files were recorded per night per unit. The following static units were deployed during this static bat detector survey:

Table 2b: Static Bat Detectors deployed during Static Bat Detector Surveys.

Static Unit Code	Bat Detector Type	Recording Function	Microphone
AM Units 1 - 12	Silicon Labs AudioMoth	Passive Full Spectrum	MEMS microphone which is surface mounted
Mini Bat 1 & 2	Wildlife Acoustics	Passive Full Spectrum	SMM-U2

Surveillance Dates: 2nd May to 7th May 2022 & 22nd September to 2nd October 2025

4. Bat Survey Results

A bat survey is comprised of several different elements. The results of these different types of surveys are presented below in a stepwise fashion and summarised at the end of the section. It is important that the whole section is read to gain a full impression of the potential bat value of the survey area.

4.1 2025 & 2026 Survey Results

4.1.1 Static Surveillance

Due to the late request for bat surveys in 2025, it is determined that a repeat of the static surveillance undertaken in 2022 would be appropriate during the month of September. Twelve locations (like the 12 locations surveyed in 2022) were re-surveyed to compared activity levels between the two surveillance years. The 2025 static surveys were completed for 10 nights, compared to 5 nights during 2022. The reason for this is that the 2025 surveys were undertaken outside the preferred bat activity season of May to August. Undertaking static surveillance in September is likely to record less bat activity compared to month of June, when the 2022 static surveillance was undertaken. Therefore, to err on the side of caution, a longer static surveillance period was completed in 2025 to compensate for this. This was required to ensure that enough surveillance was completed to record the full suite of bat species in the area. This was the case for the site in general and with one additional bat species (i.e. Natterer's bat). A table is provided in the appendices and the total number of bat passes for each static location is listed for both 2022 and 2025.



Figure 3a: Location of static units deployed in 2025 by Bat Eco Services Ltd.

The species composition recorded on static locations in 2025 compared to 2022 remained the same for the following static locations:

- Statics 1, 7, 8, 10, 11 & 12

The main difference between the 2022 and 2025 static surveillance in relation to species composition is as follows:

- One new species was recorded: Natterer's bat. This species was recorded on Static 5 and Static 6.
- New record for Daubenton's bat was recorded on Static 2.
- New records for Brown long-eared bat were recorded on Static 4 and Static 6.
- Brown log-eared bat was not recorded on Static 3.
- Nathusius' pipistrelle was not recorded on Static 3.
- New record for Leisler's bat was recorded on Static 4.
- Static 9 recorded successfully in 2025 and therefore provided records for four bats species at this location.

Table 3a: Results of Static Bat Detectors deployed during Static Bat Detector Surveys.

Static Code (AM code)	Location Description / Bat Habitat Type	Grid Reference (ITM)	Survey Period	Bat Species
2025 Static 1	Royal Canal bank Tall vegetation on both sides of the canal.	708751, 738159	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat
2025 Static 2	Royal Canal bank Tall vegetation on both sides of the canal.	707674, 737859	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat
2025 Static 3	Royal Canal bank Tall vegetation on both sides of the canal.	707133, 737632	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat
2025 Static 4	Royal Canal bank Tall vegetation on both sides of the canal.	706185, 737755	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Brown long-eared bat
2025 Static 5	Royal Canal bank Tall vegetation on both sides of the canal.	705645, 737897	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat Natterer's bat
2025 Static 6	Royal Canal bank Tall vegetation on both sides of the canal.	705016, 738112	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Brown long-eared bat

				Natterer's bat
2025 Static 7	Royal Canal bank Tall vegetation on both sides of the canal.	704394, 738323	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
2025 Static 8	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation.	703452, 737866	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
2025 Static 9	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation. Conifer treeline on far bank and flood lights from sports pitch.	703233, 737556	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Nathusius' pipistrelle
2025 Static 10	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation. Vegetation cleared on far side.	703054, 737269	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
2025 Static 11	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation. Vegetation cleared on far side.	702095, 736899	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Brown long-eared bat
2025 Static 12	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation.	701394, 737014	22nd September 2025 (10 nights)	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Brown long-eared bat

The total number of bat encounters for each bat species at the static locations varied. The following graphs provides an illustration of this (Please see Appendices for 2025 static surveillance results). The static surveillance results in 2025 indicate that soprano pipistrelle was the most frequently recorded bat species. The higher levels of bat activity for this species were record on Static 6 and Static 8. Common pipistrelles were the 2nd most frequently recorded bat species and there was a peak of activity at Static 7. Leisler's bat activity was highest at Static 3. Daubenton's bats were recorded in variable numbers, but the peak is at Static 6. Brown long-eared bats were recorded away

from lit up areas along the canal and recorded in a low level of activity. Nathusius' pipistrelle was infrequently recorded.

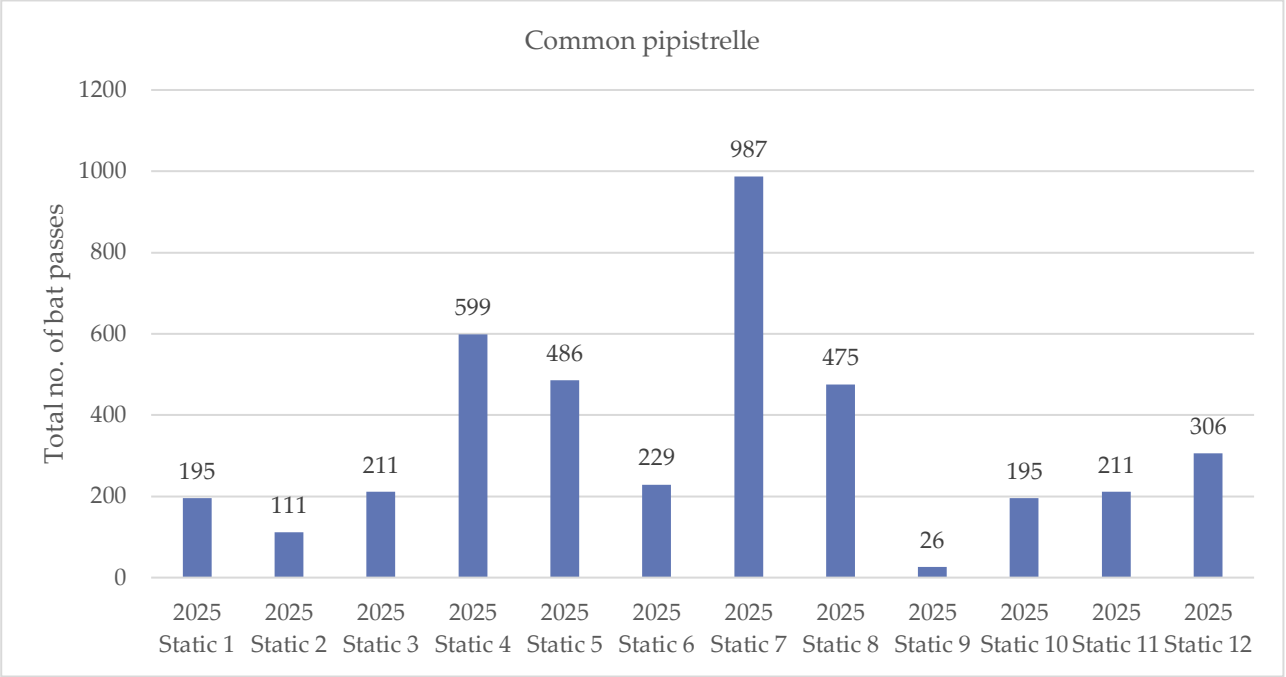


Figure 3a: Total number of Common pipistrelle bat passes recorded during 2025 static surveillance for each static unit location.

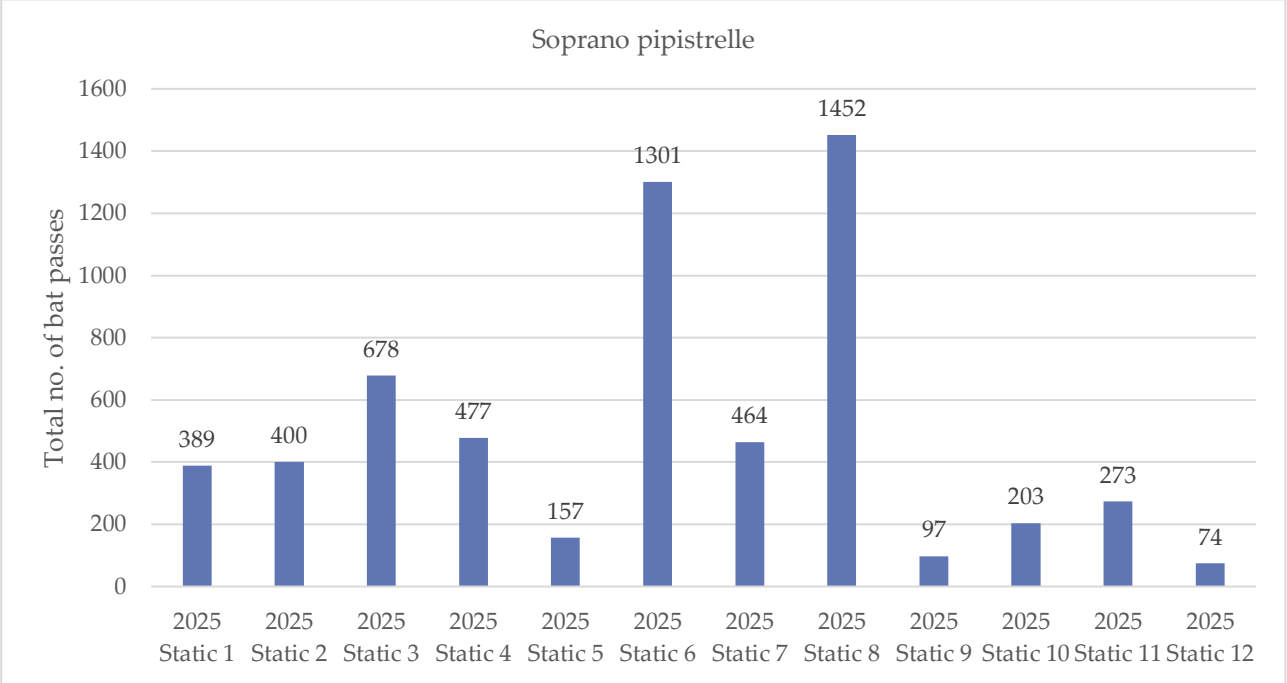


Figure 3b: Total number of Soprano pipistrelle bat passes recorded during 2025 static surveillance for each static unit location.

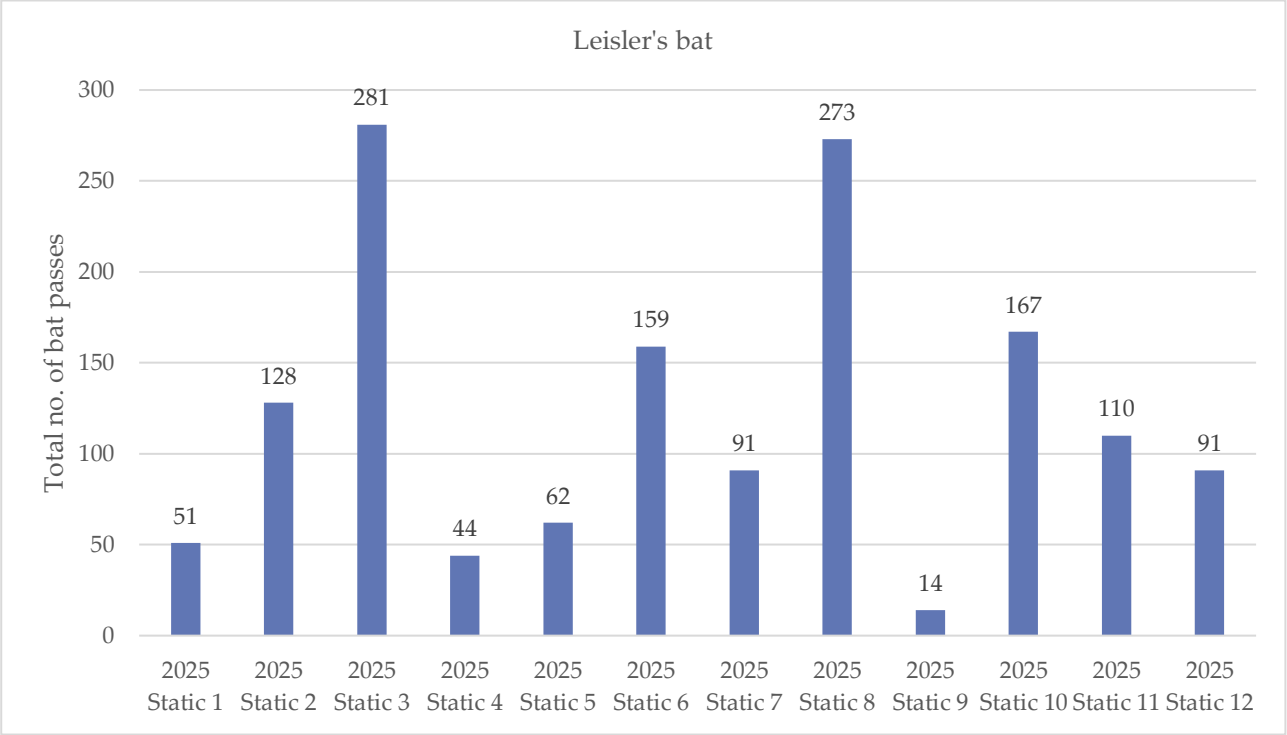


Figure 3c: Total number of Leisler's bat passes recorded during 2025 static surveillance for each static unit location.

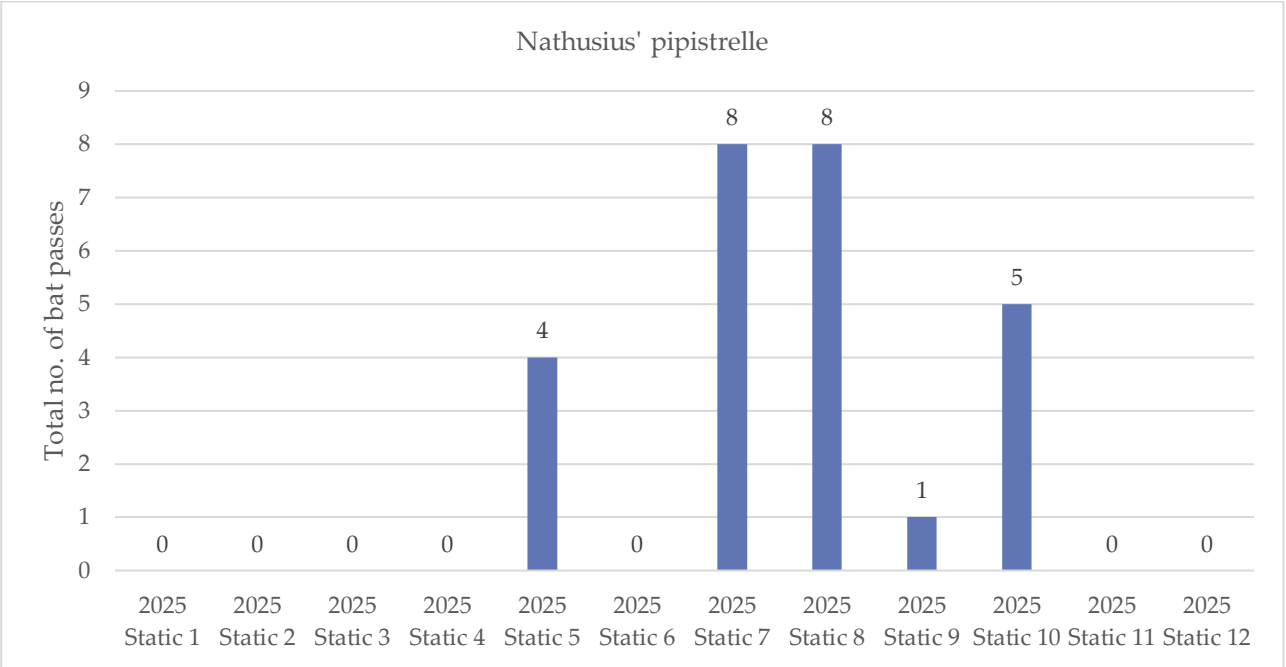


Figure 3d: Total number of Nathusius' bat passes recorded during 2025 static surveillance for each static unit location.

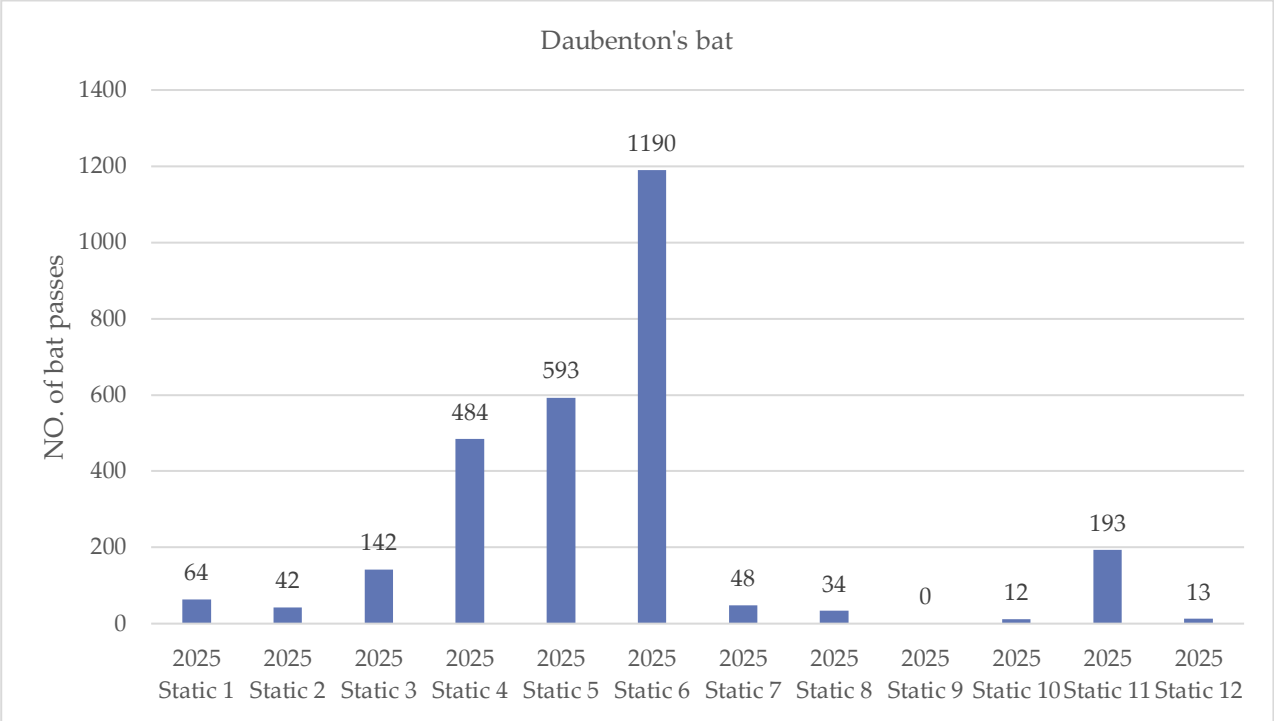


Figure 3e: Total number of Daubenton's bat passes recorded during 2025 static surveillance for each static unit location.

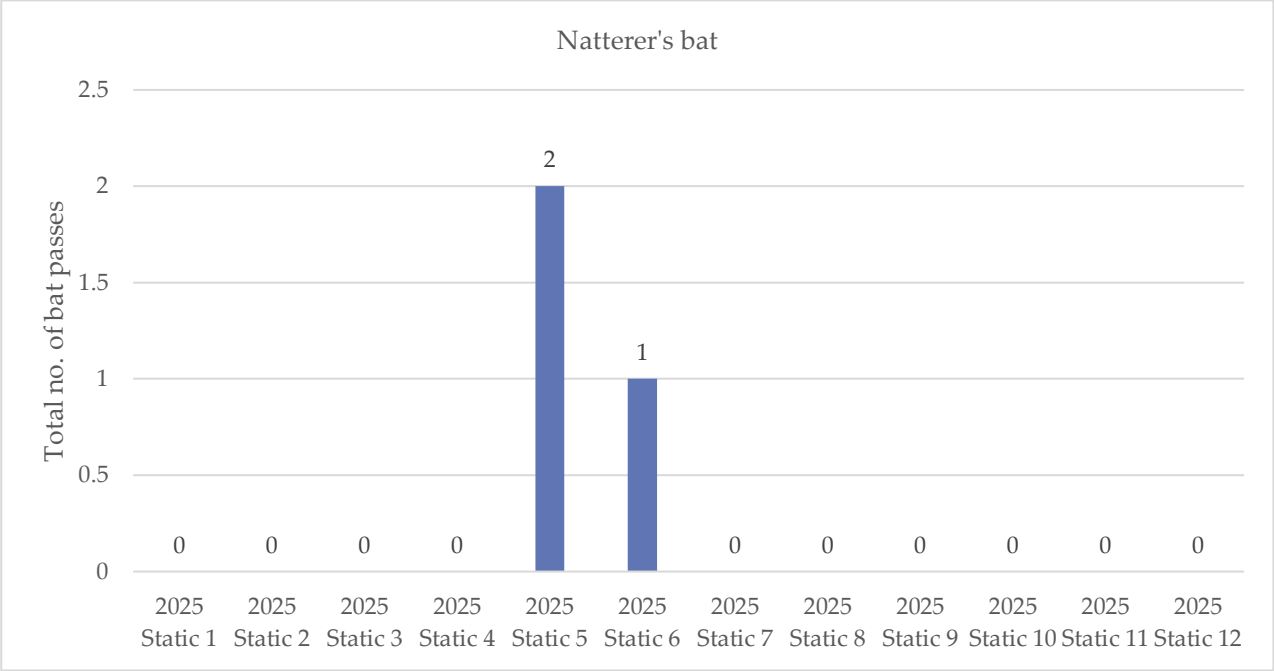


Figure 3f: Total number of Natterer's bat passes recorded during 2025 static surveillance for each static unit location.

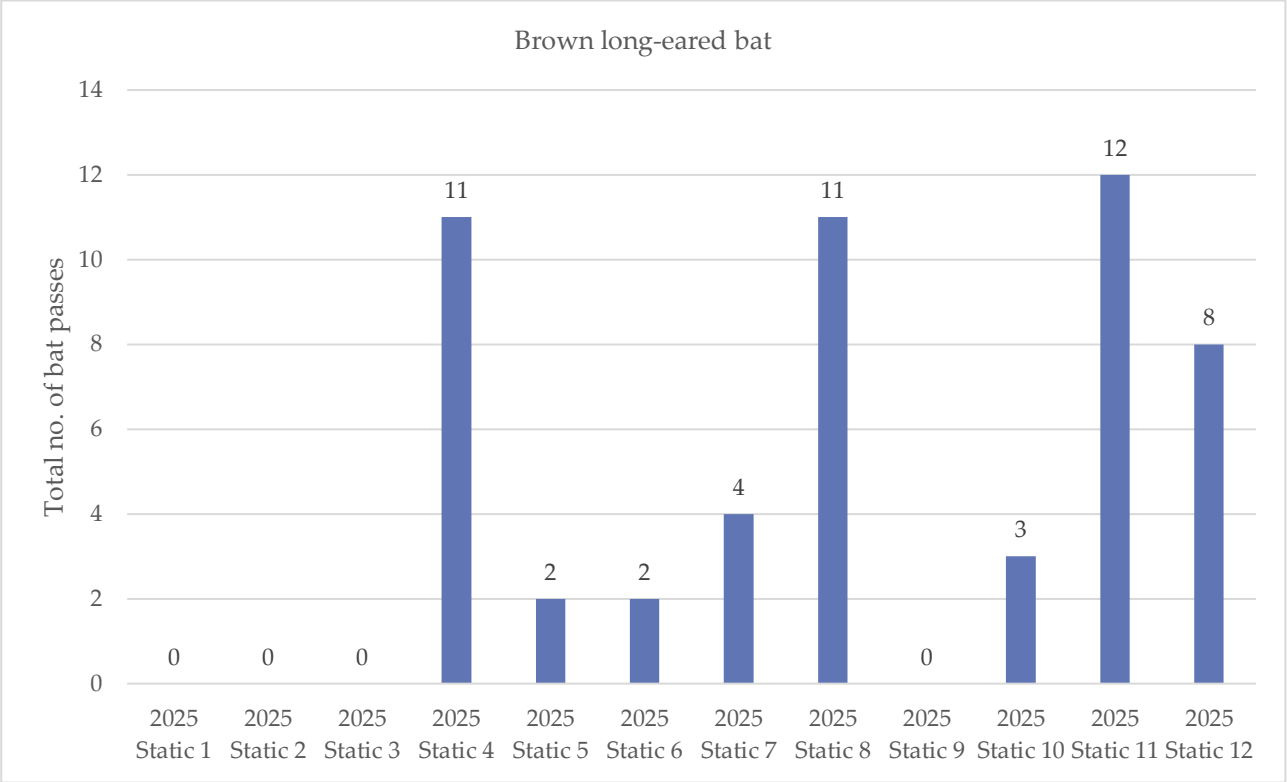


Figure 3g: Total number of brown long-eared bat passes recorded during 2025 static surveillance for each static unit location.

4.1.2 Walking Transect 1

The entire 8km route was walk on the 15th April 2026 (Weather conditions: full cloud cover, light wind, dry and 9-10oC) from 21:30 hours to 02:00 hrs (4.5 hrs) starting at the 12th Lock and heading towards Leixlip. The first bat was detected at 21:34 hrs (soprano pipistrelle) with few bats detected after midnight. The weather conditions were suitable for survey for the entire duration of the survey but the lower level of bat activity recorded after midnight may reflect the season of the survey (i.e. April, shoulder month for bat activity).

During the waking transect three species of bat was detected: soprano pipistrelle, common pipistrelle and Daubenton's bat.

- Soprano pipistrelle: 57 passes
- Common pipistrelle: 27 passes
- Daubenton's bat: 6 passes.

Most of the activity was recorded along the Dublin stretch of the canal with little bat activity recorded along the Kildare section, apart from the Daubenton's bat activity. This species was only recorded along the Kildare section of the canal. This may reflect that this section of the canal was surveyed in the later half of the survey period and bat activity may have reduced at that time, due to seasonal conditions. As consequence, the 2nd walking transect will start in Kildare and finish in Dublin.

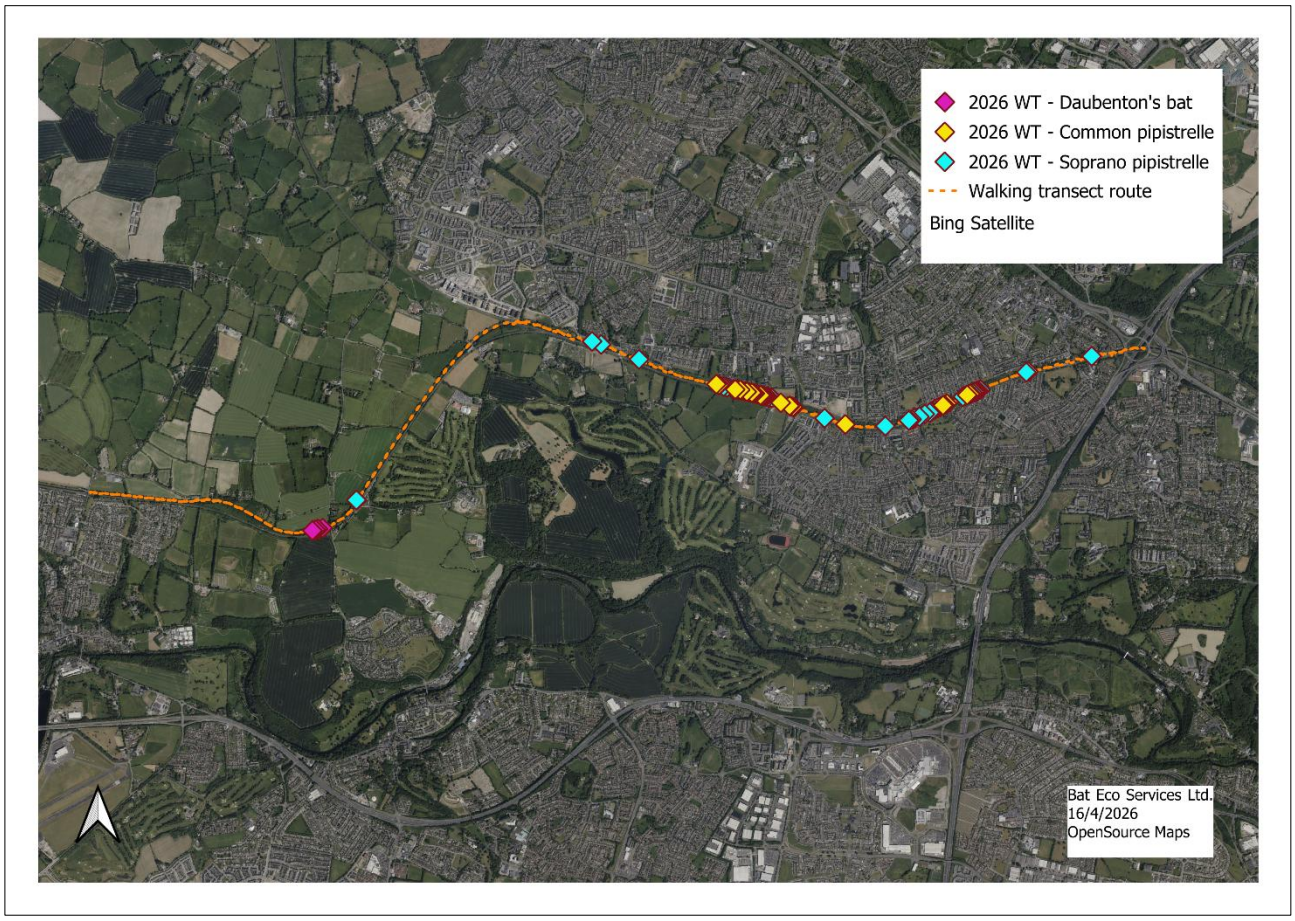


Figure 3h: Survey results of walking transect 1 completed in 2026 by Bat Eco Services Ltd.

4.1.3 Walking Transect 2

The entire 8km route was walk on the 24th April 2026 (Weather conditions: clear sky, calm, dry and 8-10oC) from 21:30 hours to 02:00 hrs (4.5 hrs) starting at the at Leixlip and walking towards the 12th Lock. The first bat was detected at 21:34 hrs (soprano pipistrelle) with few bats detected after midnight. The weather conditions were suitable for survey for the entire duration of the survey but the lower level of bat activity recorded after midnight may reflect the season of the survey (i.e. April, shoulder month for bat activity).

During the waking transect five species of bat was detected: Leisler's bat, soprano pipistrelle, common pipistrelle, brown long-eared bat and Daubenton's bat.

- Leisler's bat: 5 passes
- Soprano pipistrelle: 158 passes
- Common pipistrelle: 79 passes
- Brown long-eared bat: 2 passes
- Daubenton's bat: 5 passes.

The level activity was higher during this walking transect and was recorded along the entire length of the canal route. This reflects a week later walking transects with improving weather conditions.

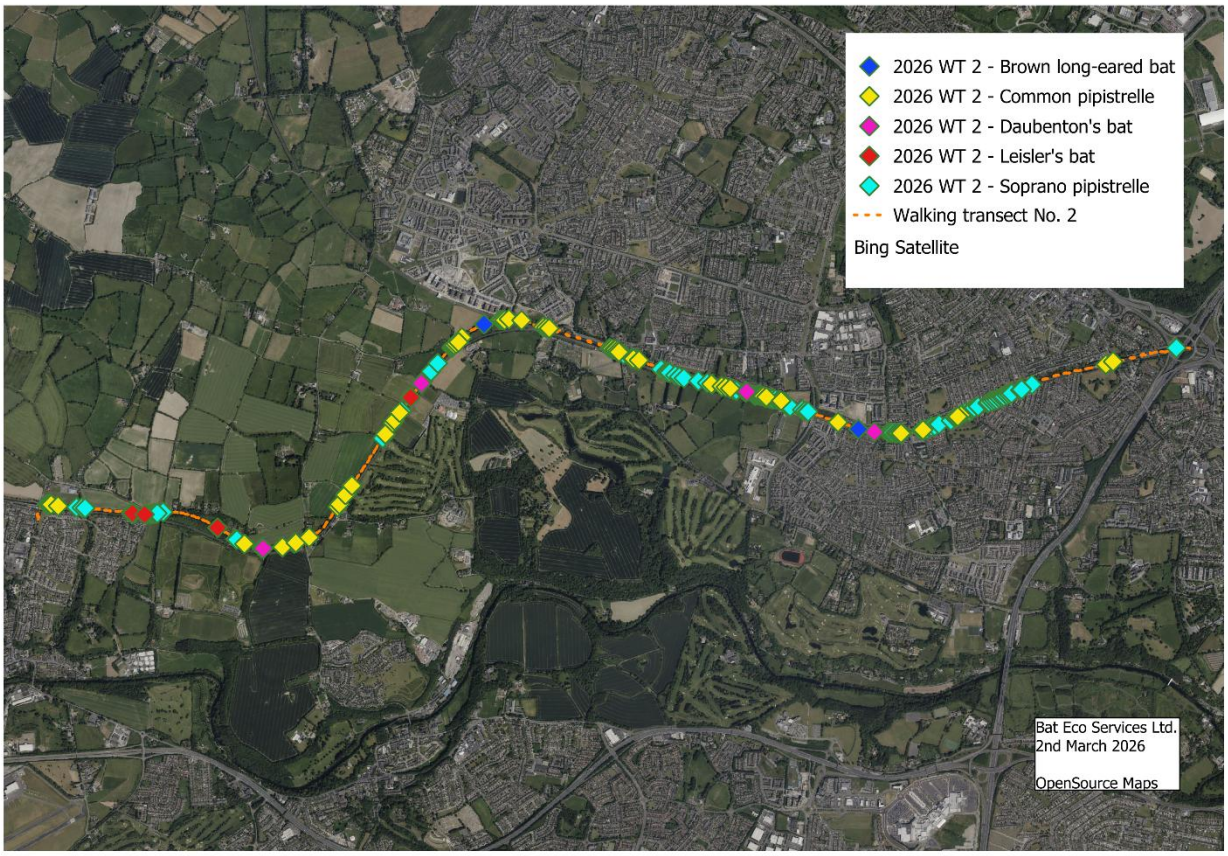


Figure 3i: Survey results of walking transect 2 completed in 2026 by Bat Eco Services Ltd.

4.2 2022 Survey Results

4.2.1 Daytime Inspections

4.2.1.1 Bridge Inspection

The following bridges were inspected on 2nd May 2022 and the bridges are numbered in order from the M50 to the County Kildare border. Two bridges were not accessible while all other bridges within the survey area were inspected. No bats were recorded during the daytime inspection.

A repeat inspection of bridges by Wildlife Surveys Ireland Ltd. is also presented in the table below, as this is a more up to-date survey.

Table 3b: Buildings / Structures inspection results.

Bridge Code	Description	Grid Reference (ITM)	Roost Type / Suitability	Bat Species	Wildlife Surveys Irl.
Bridge 1	Stone bridge, single arch (pedestrian), crevices suitable.	709035, 738184	Category 2	None present	Not inspected
Bridge 2 Talbot Bridge	Natural stone bridge, single arch, difficult to access (canal gates).	708707, 738166	Not fully assessed	Not applicable	Not accessible
Bridge 3 R806 Road Bridge	Stone arch bridge, old pointing of crevices noted, small crevices.	708423, 738096	Category 1	None present	High for roosting bats, no bats present
Bridge 4 Kilpatrick Bridge	Stone arch bridge with metal bridge extension – not accessible. Steep banks either side of canal.	706964, 738590	Not fully assessed	Not applicable	Not accessible
Bridge 5 Dr Troy Bridge	Modern bridge, no crevices suitable for roosting bats. High concrete bridge.	706282, 737706	Category 0	None present	Low for roosting bats, no bats present
Bridge 6 Porterstown Bridge	Natural stone, single arch (road bridge) – number of crevices. Recently pointed.	706081, 737773	Category 1	None present	Not accessible
Bridge 7 Callaghan Bridge	Natural stone, single arch (road bridge) – number of crevices.	704924, 738144	Category 2	None present	Moderate to High potential for roosting bats, no bats present

Bridge 8 **Deep Sink**	Modern bridge (Deep Sink area). No suitable roosts spaces.	704102, 738389	Category 0	None present	Low for roosting bats, no bats present
Bridge 9 **Pakenham Bridge**	Natural stone, single arch (road bridge) – small number of crevices.	703763, 738225	Category 1	None present	Moderate potential for roosting bats, no bats present
Bridge 10 **Collins Bridge**	Natural stone, single arch (road bridge L3005) – small number of crevices.	702679, 736809	Category 1	None present	Moderate potential for roosting bats, no bats present



Figure 4: Bridges surveyed along the survey route in 2022 by Bat Eco Services Ltd.

4.2.2 Bat Habitat & Commuting Routes Mapping

The habitat types, with reference to Fossit (2000) were recorded both within the survey area and adjacent to the survey area on 2nd May 2022. The survey area was primarily linear watercourse of the Royal Canal and typical habitats associated with this narrow watercourse. A tow path runs the length of the canal surveyed. The base material of the tow path ranges from a sealed tarmac surface to dirt track on the grassland verge.

The degree of tall vegetation (i.e. hedgerows and treelines) along the canal within the survey area varied greatly. Tall vegetation was generally recorded on one canal bank for the length of the survey area and this was generally on the tow path side of the canal. Tall vegetation was present on the far-side of the canal bank along sections of the survey area but due to the presence of the railway line on the far-side side of the canal (i.e. on the side where there was no tow path), there was greater areas where vegetation was cleared or the presence of train stations increased the degree of lighting and buildings/structures adjacent to the canal. However, sections along the canal located within the great urban development tended to have tall vegetation on both sides of the canal and this buffered the canal from potential human noise and lighting (except where lighting was present along the canal tow path – eastern section in vicinity of the M50).

Table 4a: Habitat types present within survey area.

Habitat	Yes	Habitat	Yes	Habitat	Yes	Habitat	Yes
Cultivated land		Salt marshes		Exposed rock		Fens/flushes	
Built land	√	Brackish waters		Caves		Grasslands	√
Coastal structures		Springs		Freshwater marsh		Scrub	√
Shingle/gravel		Swamps		Lakes/ponds		Hedges/treelines	√
Sea cliffs/islets		Disturbed ground	√	Heath		Conifer plantation	
Sand dunes		Watercourse	√	Bog		Woodland	√

Table 4b: Habitat types present adjacent to survey area.

Habitat	Yes	Habitat	Yes	Habitat	Yes	Habitat	Yes
Cultivated land	√	Salt marshes		Exposed rock		Fens/flushes	
Built land	√	Brackish waters		Caves		Grasslands	√
Coastal structures		Springs		Freshwater marsh		Scrub	√
Shingle/gravel		Swamps		Lakes/ponds		Hedges/treelines	√
Sea cliffs/islets		Disturbed ground	√	Heath		Conifer plantation	√
Sand dunes		Watercourse	√	Bog		Woodland	√

4.3 Night-time Bat Detector Surveys

4.3.1 Dusk & Dawn Bat Survey - Bridges

The following table summarises the results of the bat detector surveys completed on for bridges located within the survey area. These bridges were surveyed as they had features that were considered the most likely to provide bat roosting crevices. No bat roosts were recorded.

Table 5: Bridge survey results.

Bridge Code	Location & Grid Reference	Bat Species (No. of bats)	Access Points	Vegetation / Lighting arrangement
Bridge 1	In middle of M50 road complex 709035, 738184	2/5/2022: Dusk Survey Start Time: 20:44 hrs Weather: 110C, calm, full cloud cover and dry. No bats emerged	Not applicable Bats recorded during survey (not roosting): soprano pipistrelle, common pipistrelle, Daubenton's bat	Lighting along canal present on either side of the M50 road complex in this area. Lighting associated with buildings. LUX levels: 17 on canal, 72 from motorway lights. Vegetation on both sides of canal.
Bridge 7	Clonsilla 704924, 738144	5/5/22: Dusk Survey Start Time: 20:51 hrs Weather: 140C, calm, full cloud cover and dry. No bats emerged	Not applicable Bats recorded during survey (not roosting): soprano pipistrelle, common pipistrelle, Daubenton's bat	Lighting present at railway station and car parking area. LUX levels: 4-5 on canal, Vegetation on both sides of canal.
Bridge 9	703763, 738225	6/5/22: Dawn Survey Start Time: 03:54 hrs Weather: 140C, calm, full cloud cover and dry. No bats returned to roost	Not applicable Bats recorded during survey (not roosting): soprano pipistrelle, common pipistrelle,	No lighting along canal. Lighting associated with railway maintenance depot. Vegetation on tow path side of canal.
Bridge 10	702679, 736809	11/5/22: Dawn Survey Start Time: 03:51 hrs Weather: 140C, calm, full cloud cover and dry. No bats returned to roost	Not applicable Bats recorded during survey (not roosting): soprano pipistrelle, common pipistrelle,	No lighting along canal. Lighting associated with railway maintenance depot and private buildings. Vegetation on tow path side of canal.

4.3.2 Passive Static Bat Detector Survey

The following table summarises the results recorded on the static units deployed (Please see Table 11 & Figure 2b for locations within the survey area). A total of six species of bat was recorded during the static surveillance: soprano pipistrelle, common pipistrelle, Leisler's bat, Daubenton's bat, Nathusius' pipistrelle and brown long-eared bat. Four static locations recorded all six species of bat: Static Code 3, 5, 7 and 10. Two of the species of bat recorded are considered to be light sensitive bat species (Daubenton's bat and brown long-eared bat) and these were recorded at ten of the static locations.

Table 6: Results of Static Bat Detectors deployed during Static Bat Detector Surveys.

Static Code (AM code)	Location Description / Bat Habitat Type	Grid Reference (ITM)	Survey Period	Bat Species
1 (AM 17)	Royal Canal bank Tall vegetation on both sides of the canal.	708750, 738190	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat
2 (AM 19)	Royal Canal bank Tall vegetation on both sides of the canal.	707673, 737858	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Nathusius' pipistrelle
3 (AM 20)	Royal Canal bank Tall vegetation on both sides of the canal.	707129, 737632	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
4 (AM 6)	Royal Canal bank Tall vegetation on both sides of the canal.	706185, 737758	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Daubenton's bat
5 (AM T5)	Royal Canal bank Tall vegetation on both sides of the canal.	705543, 737936	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
6 (AM 18)	Royal Canal bank Tall vegetation on both sides of the canal.	705017, 738113	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat
7 (AM T4)	Royal Canal bank Tall vegetation on both sides of the canal.	704410, 738320	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat

8 (AM 3)	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation.	703539, 737969	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
9 (AM 4)	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation. Conifer treeline on far bank and flood lights from sports pitch.	703262, 737582	2nd to 6th June 2022	Failed to record- No data
10 (AM T1)	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation. Vegetation cleared on far side.	703039, 737252	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Nathusius' pipistrelle Brown long-eared bat
11 (AM T2)	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation. Vegetation cleared on far side.	702269, 736793	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Brown long-eared bat
12 (AM T3)	Royal Canal bank Hedgerow with individual trees along tow path. Small amount of canal side vegetation.	701449, 737010	2nd to 6th June 2022	Soprano pipistrelle Common pipistrelle Leisler's bat Daubenton's bat Brown long-eared bat



Figure 5: Location of static units deployed during 2022 static surveillance.

The total number of bat encounters for each bat species at the static locations varied. The following graphs provides an illustration of this (Please see Appendices for a full break down of the nightly static surveillance results). The static surveillance results indicate that common pipistrelle was the most frequently recorded bat species and was more consistently recorded along the canal within the survey area. The higher levels of bat activity for this species were along the eastern section of the canal and may reflect the roosting resource in buildings located adjacent to the canal.

Soprano pipistrelles were the 2nd most frequently recorded bat species and there was a peak of activity at Static Location 2. There is likely to be a roost adjacent to the canal in this area. Leisler's bat activity was highest at Static Location 8 and during the walking transects, this species was recorded foraging over the canal and mature trees in this area. Daubenton's bats were recorded in low numbers, but the peak is at Static Location 1, near to Bridge 1 and an area of canal lighting. However, during the dusk survey of Bridge 1 and walking transects, Daubenton's bat were noted commuting through this area but no foraging. Therefore, it is likely that there is a roost near this area and individuals from the roost use the can to disperse into the landscape. Brown long-eared bats were recorded away from lit up areas along the canal. Nathusius' pipistrelle was infrequently recorded.

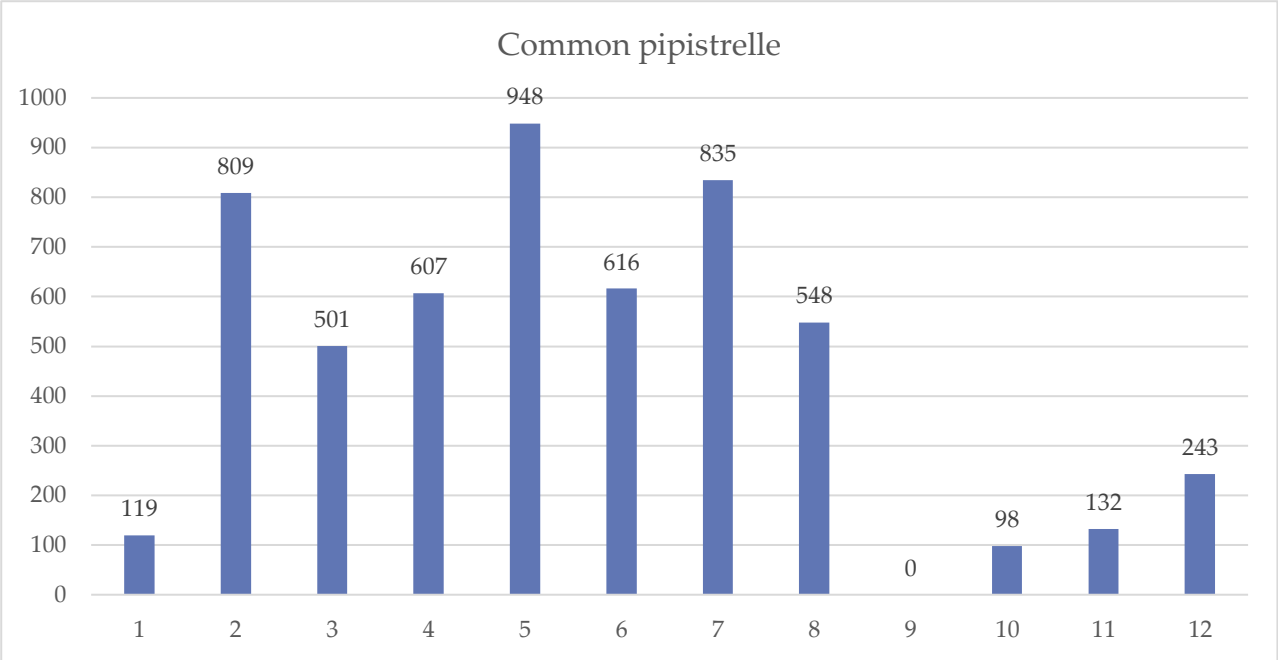


Figure 6a: Total number of Common pipistrelle bat passes recorded during static surveillance for each static unit location.

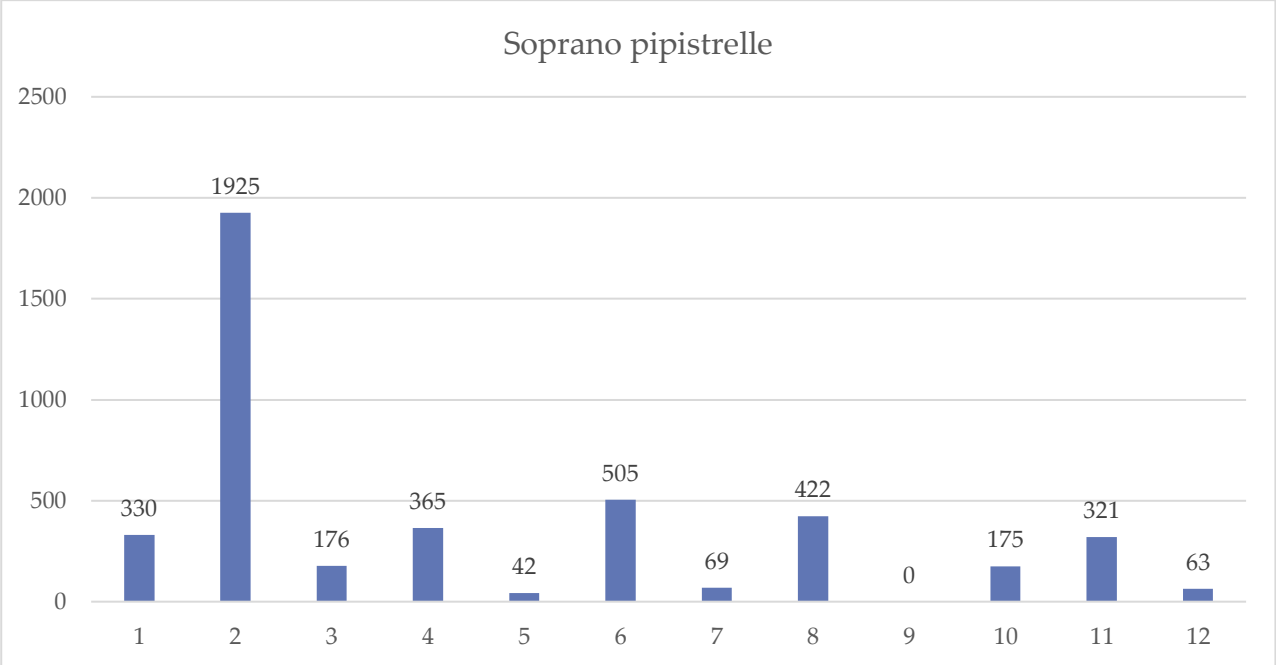


Figure 6b: Total number of Soprano pipistrelle bat passes recorded during static surveillance for each static unit location.

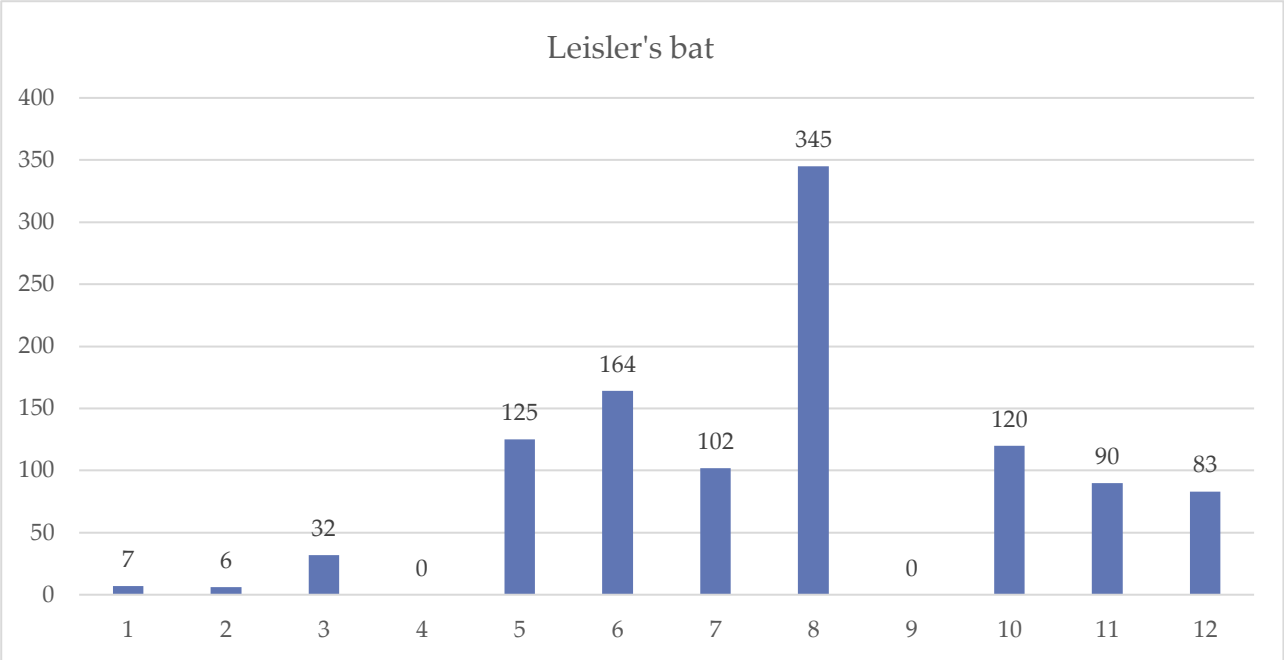


Figure 6c: Total number of Leisler's bat passes recorded during static surveillance for each static unit location.

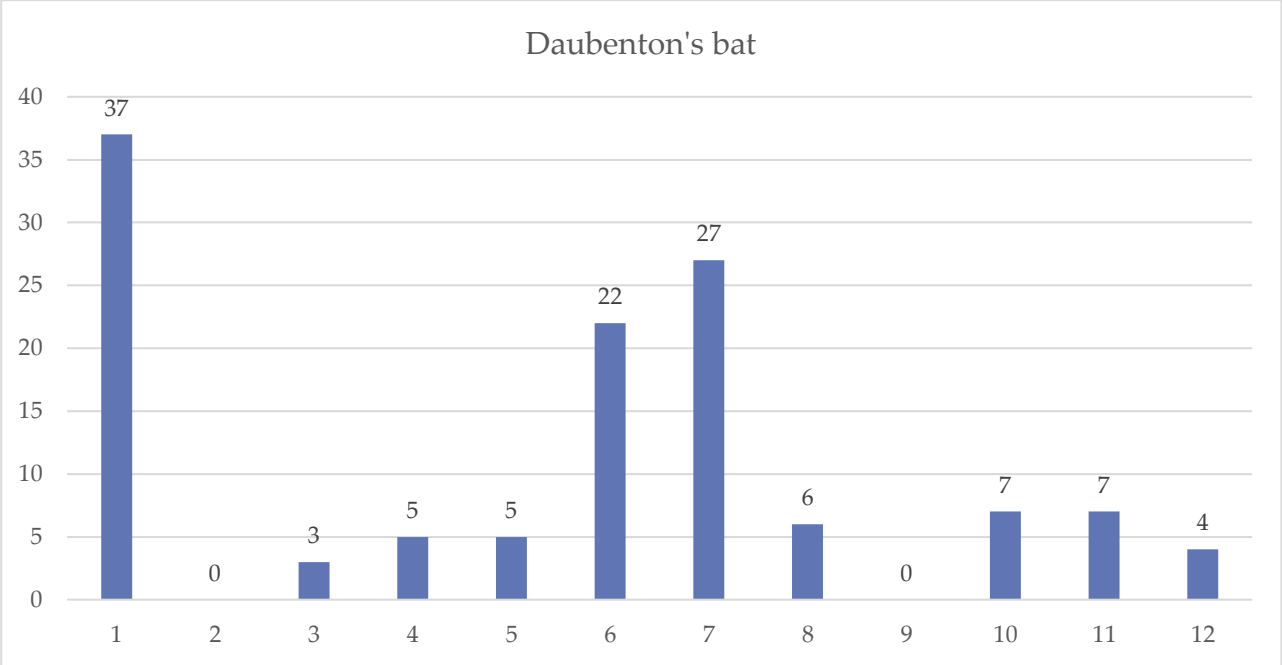


Figure 6d: Total number of Leisler's bat passes recorded during static surveillance for each static unit location.

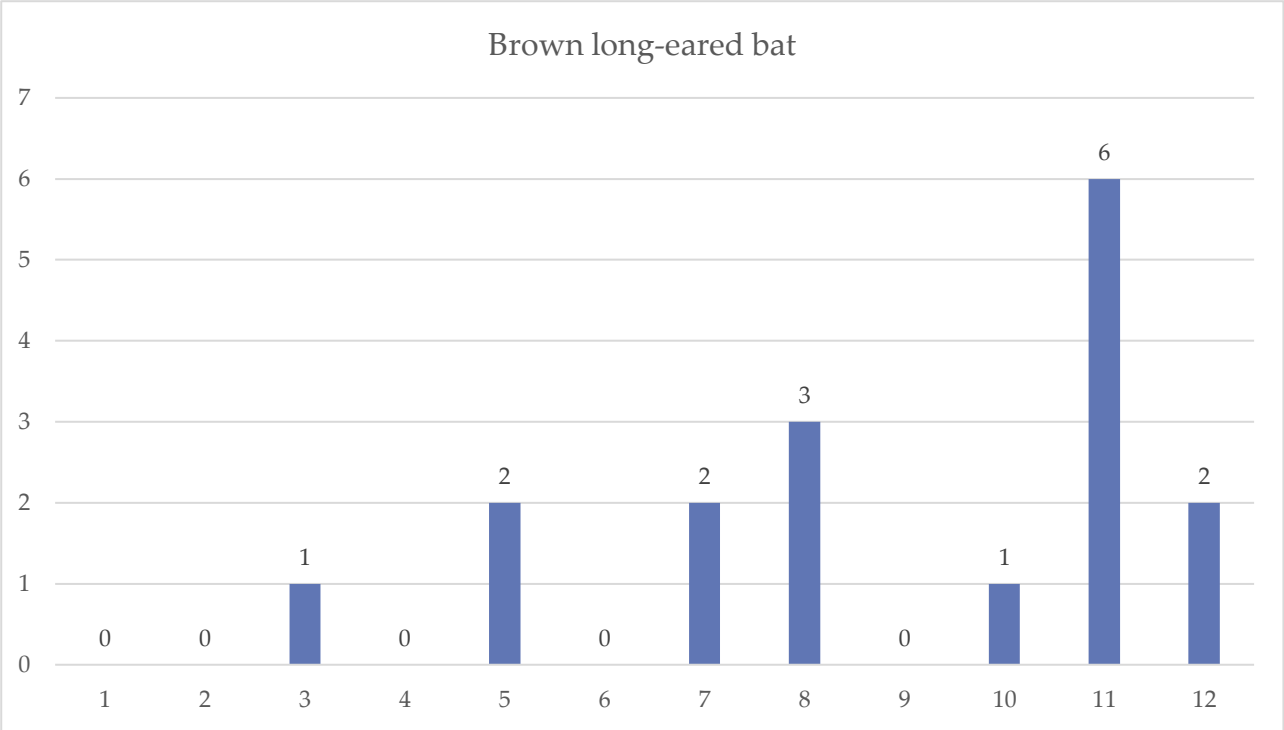


Figure 6e: Total number of Brown long-eared bat passes recorded during static surveillance for each static unit location.

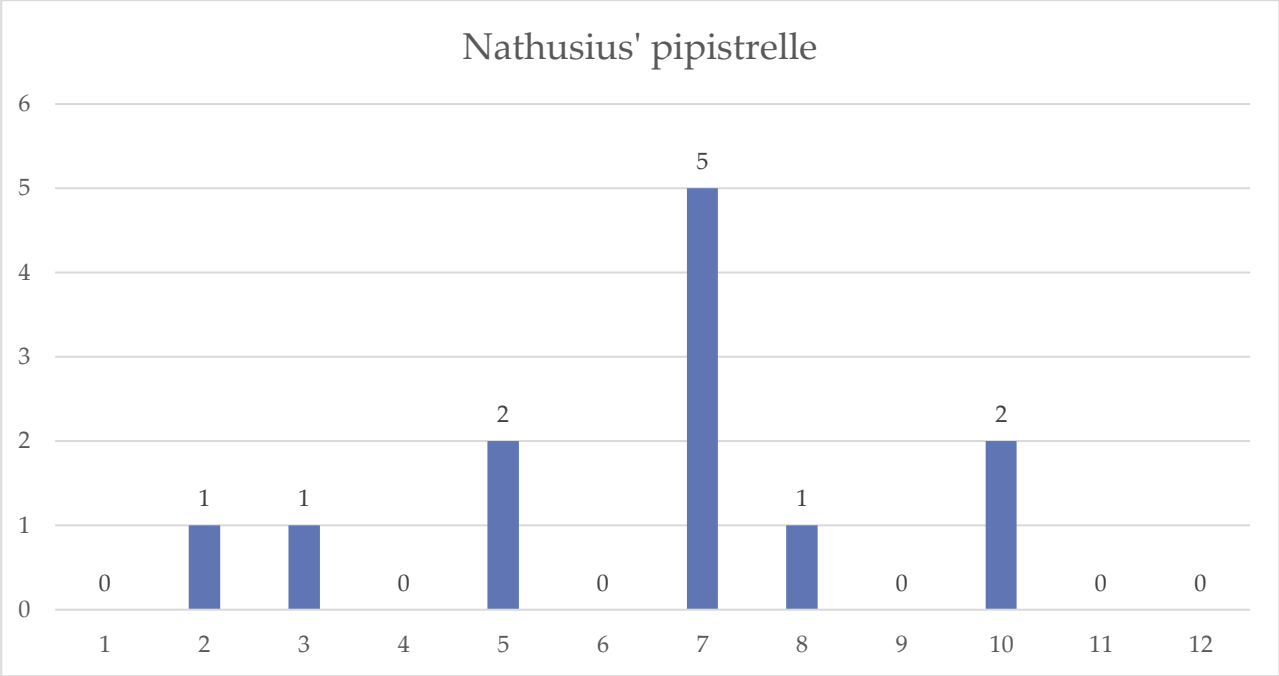


Figure 6f: Total number of Nathusius' pipistrelle bat passes recorded during static surveillance for each static unit location.

4.3.3 Walking Transect Survey Results

All the bat encounters recorded during the four survey dates for the two walking transects were mapped and presented for each bat species on the figures below.

Transect 1 was completed on the 2nd and 3rd May 2022 and four species of bat was recorded during these surveys: common pipistrelle (296 bat encounters), soprano pipistrelle (616 bat encounters), Leisler's bat (48 bat encounters) and Daubenton's bat (12 bat encounters). Soprano pipistrelle was the most frequently encountered bat species. There tended to be a greater level of bat activity on the section of the canal located in the western half of the survey area. This coincided with less urbanisation and therefore less lighting levels.



Figure 7a: Common pipistrelle bat encounters recorded during Transect 1 (2nd and 3rd May 2022).



Figure 7b: Soprano pipistrelle bat encounters recorded during Transect 1 (2nd and 3rd May 2022).



Figure 7c: Leisler's bat encounters recorded during Transect 1 (2nd and 3rd May 2022).



Figure 7d: Daubenton's bat encounters recorded during Transect 1 (2nd and 3rd May 2022).

Transect 2 was completed on the 5th and 10th May 2022 and six species of bat was recorded during these surveys: common pipistrelle (274 bat encounters), soprano pipistrelle (210 bat encounters), Leisler's bat (57 bat encounters), Nathusius' pipistrelle (1 bat encounter), brown long-eared bat (2 bat encounters) and Daubenton's bat (1 bat encounter). Soprano pipistrelle was the most frequently encountered bat species. There tended to be a greater level of bat activity on the section of the canal located in the western half of the survey area. This coincided with less urbanisation and therefore less lighting levels.



Figure 8a: Common pipistrelle bat encounters recorded during Transect 2 (5th and 10th May 2022).



Figure 8b: Soprano pipistrelle bat encounters recorded during Transect 2 (5th and 10th May 2022).

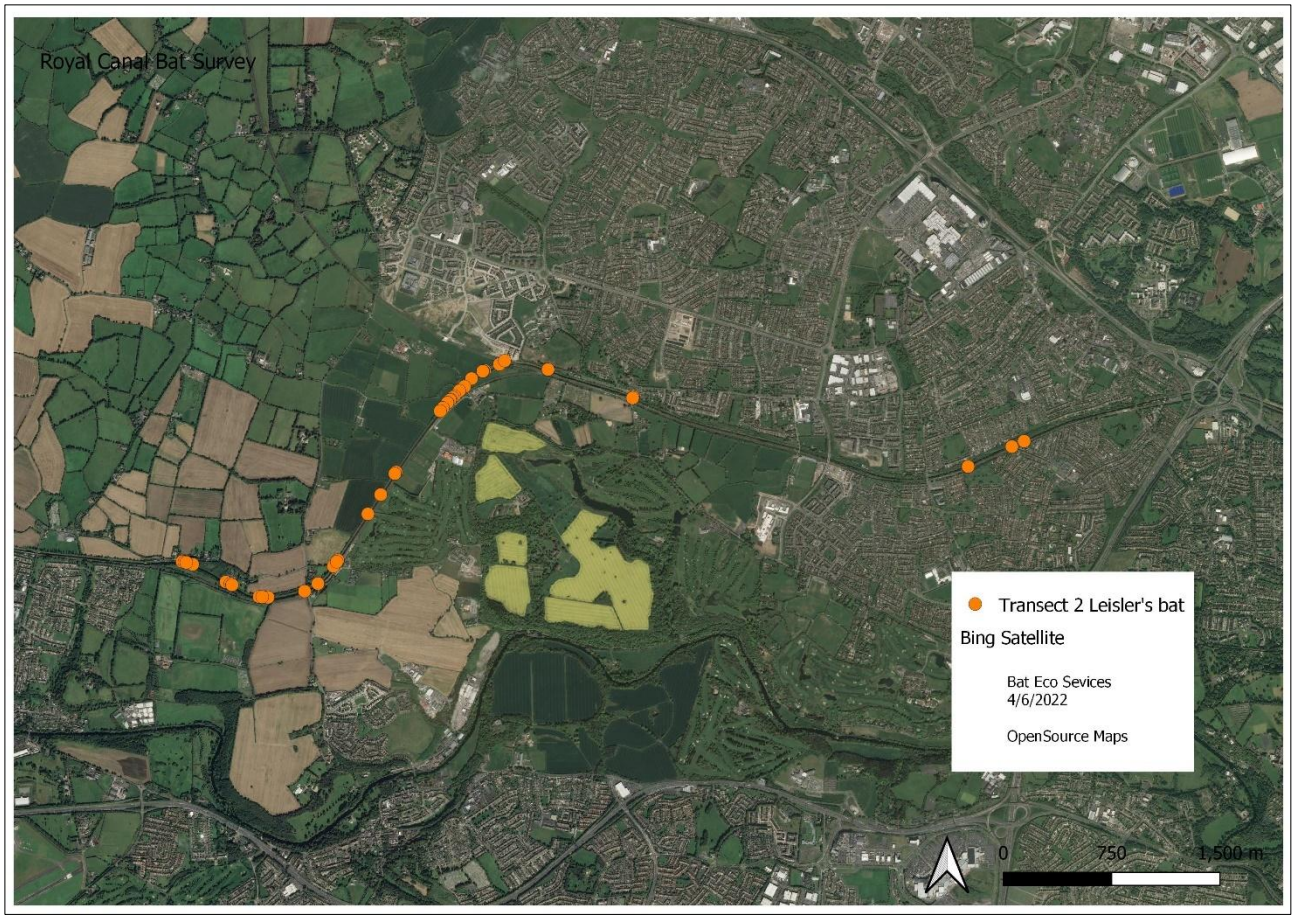


Figure 8c: Leisler's bat encounters recorded during Transect 2 (5th and 10th May 2022).



Figure 8d: Daubenton's bat encounters recorded during Transect 2 (5th and 10th May 2022).



Figure 8e: Brown long-eared bat encounters recorded during Transect 2 (5th and 10th May 2022).



Figure 8f: Nathusius' pipistrelle bat encounters recorded during Transect 2 (5th and 10th May 2022).

4.4 Location of Light Sensitive Bat Species

This bat survey is to provide a baseline to determine potential impact of development of the tow path upgrades along the section of the Royal Canal surveyed, if such upgrades include the installation of lighting like that located along the Ashtown section of the canal. The bat species that could be used for this future comparison is the two light sensitive bat species recorded during the 2022 surveys: Daubenton's bat and brown long-eared bat while three light sensitive bat species were recorded in 2025: Daubenton's bat, Natterer's bat and brown long-eared bat.

The Daubenton's bat is associated with waterbodies as it has a preference to feed on aquatic insects while both the Natterer's bat and brown long-eared bat are woodland specialists. While all three bat species are considered widespread in their distribution across the island, they are not as common as the three most common bat species in Ireland: common pipistrelle, soprano pipistrelle and Leisler's bat. Therefore, it is not expected to encounter these bat species in the same activity levels as the three more Irish common bat species.

Urbanisation (negative influence) and the degree of tall vegetation (positive influence) is two important factors that influence the presence of these three bats species (i.e. Daubenton's bat, Natterer's bat and brown long-eared bat). As the principal habitat within the survey area is the Royal Canal, it is therefore expected to have a greater number of Daubenton's bat encounters, as demonstrated by the maps below. In addition, Natterer's bats and brown long-eared bat tends to avoid urbanisation and this is also reflected by the bat encounters for these two species of bat. There is currently some lighting along the section of the canal around the M50 interchange and, consequently, these bat species were not recorded in this area. The areas this species was encountered coincided with areas currently with no lighting.

- Daubenton's bat: a total of 23 bat encounters from 2022, 11 of the 2025 static locations and 10 bat encounters from 2026.
- Brown long-eared bat: a total of 10 bat encounters from 2022, on eight of the 2025 static locations and 2 bat encounters in 2026.
- Natterer's bat: only recorded on two statics during the 2025 static surveillance.

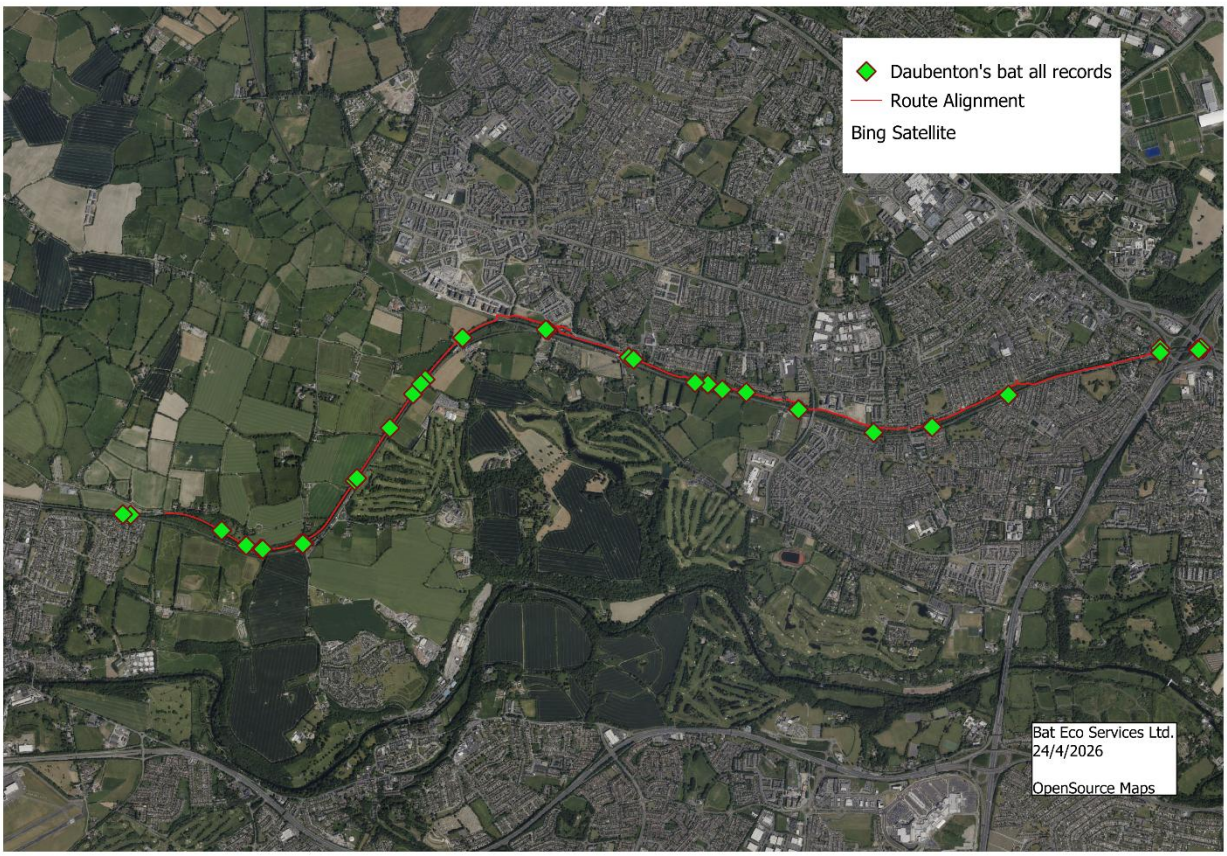


Figure 9a: Daubenton's bat encounters recorded during all bat surveys.

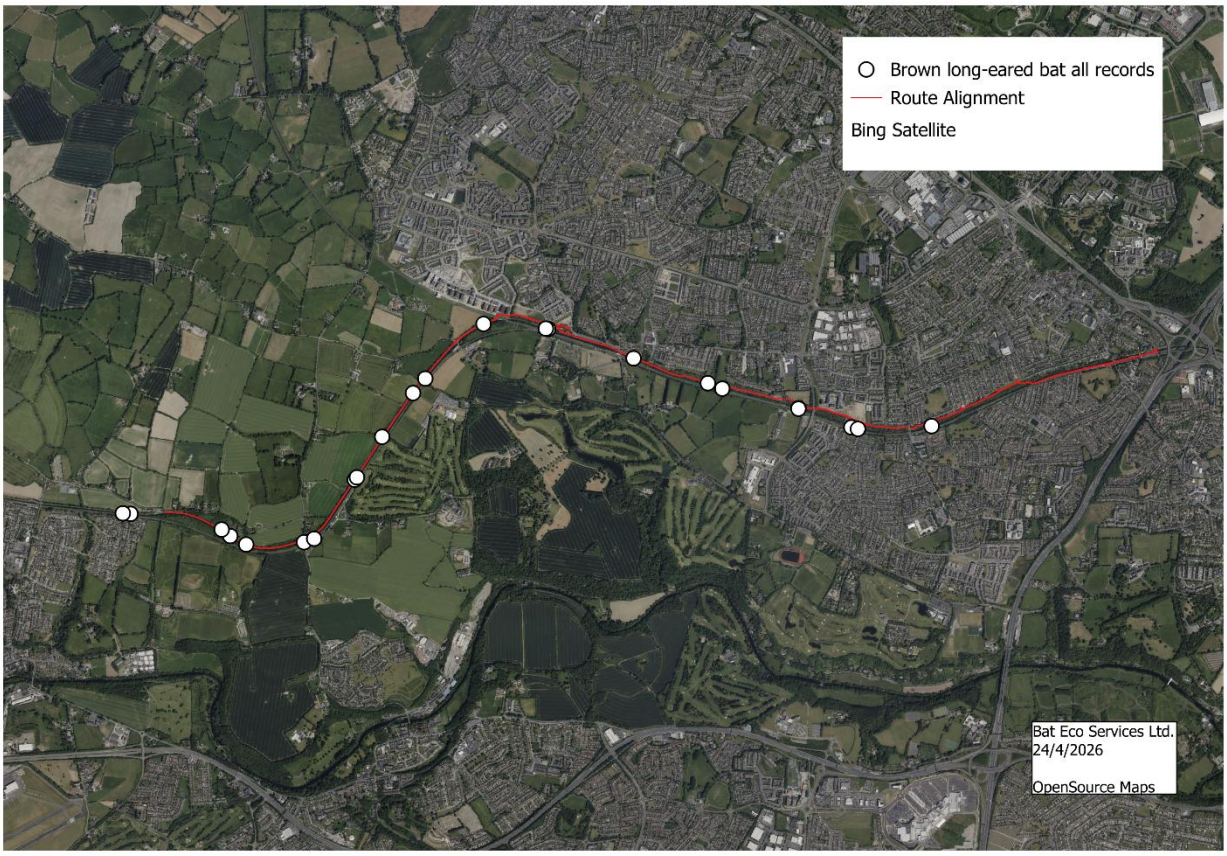


Figure 9b: Brown long-eared bat encounters recorded during all bat surveys.



Figure 9c: Natterer's bat encounters recorded during 2025 static surveillance.

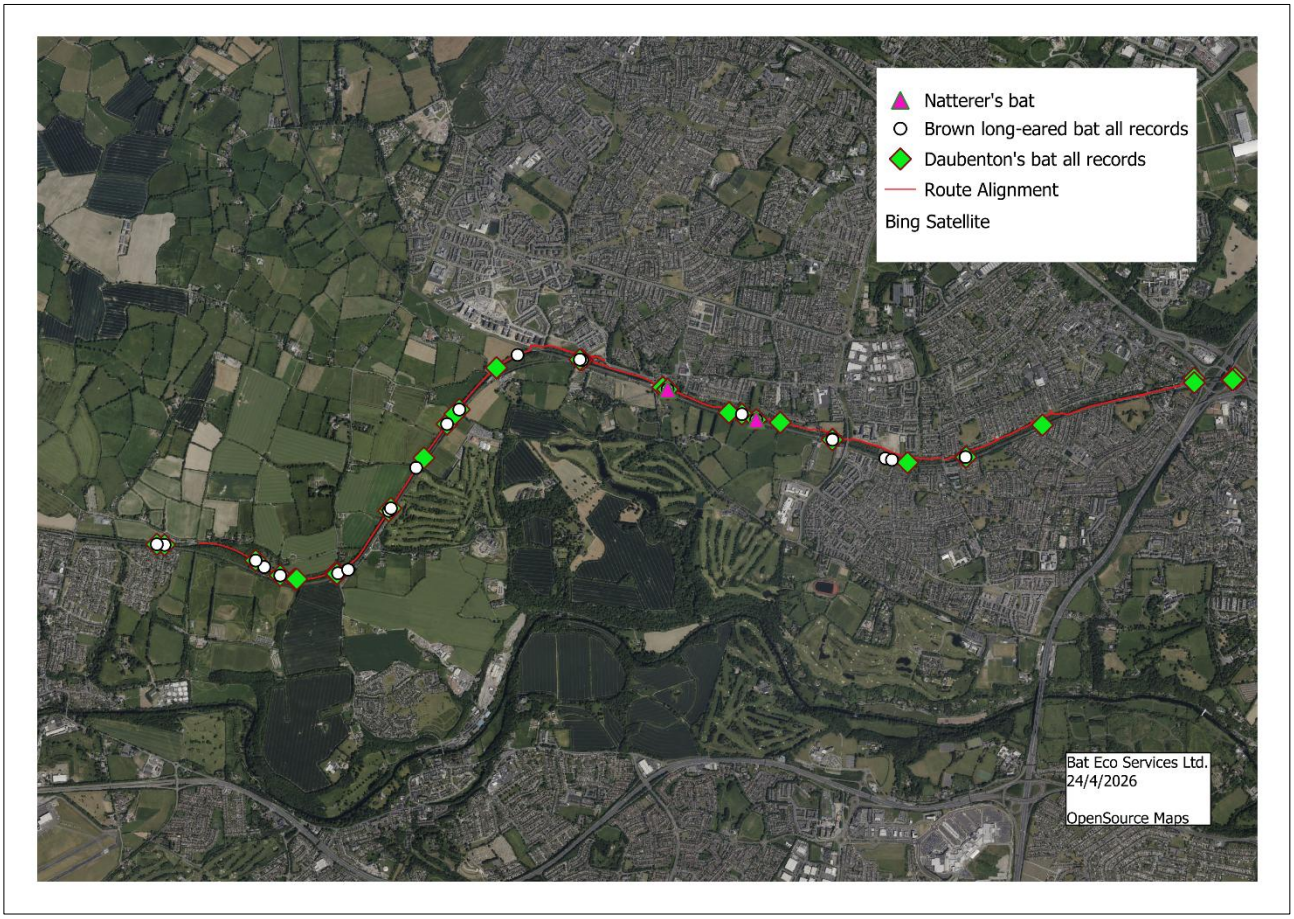


Figure 9d: Light sensitive bat species bat encounters in survey area.

To assess the potential impact of the proposed public lighting, a shapefile of the location of luminaires and the model illuminance (i.e. horizontal light spill) was provided. This was mapped against the recorded locations of lighting sensitive bat species. Lighting is not proposed for the entire length of the canal surveyed. A closer examination of this map undertaken and the following areas are of concern in relation to the potential impact of lighting on the movement of light-sensitive bat species post works:

- Length of lanterns proposed along the Hansfield Road (L3015) to Callaghan Bridge continuing east (a total of 13 lanterns west of Callaghan Bridge and 14 lanterns to the east of Callaghan Bridge): Figure 93
- South of Roselawn Rd to R806 Road Bridge and continuing east (20 lanterns west of R806 Road Bridge and 9 lanterns east of R806 Road Bridge): Figure 9g.

The modelled horizontal illuminance of the lanterns listed above may cause light spill on to the surface of the Grand Canal. Therefore, the lighting design has incorporated front shields to reduce light spill towards the water surface.



Figure 9e: Lanterns that may cause lighting spill onto the surface of Grand Canal (Between arrows).

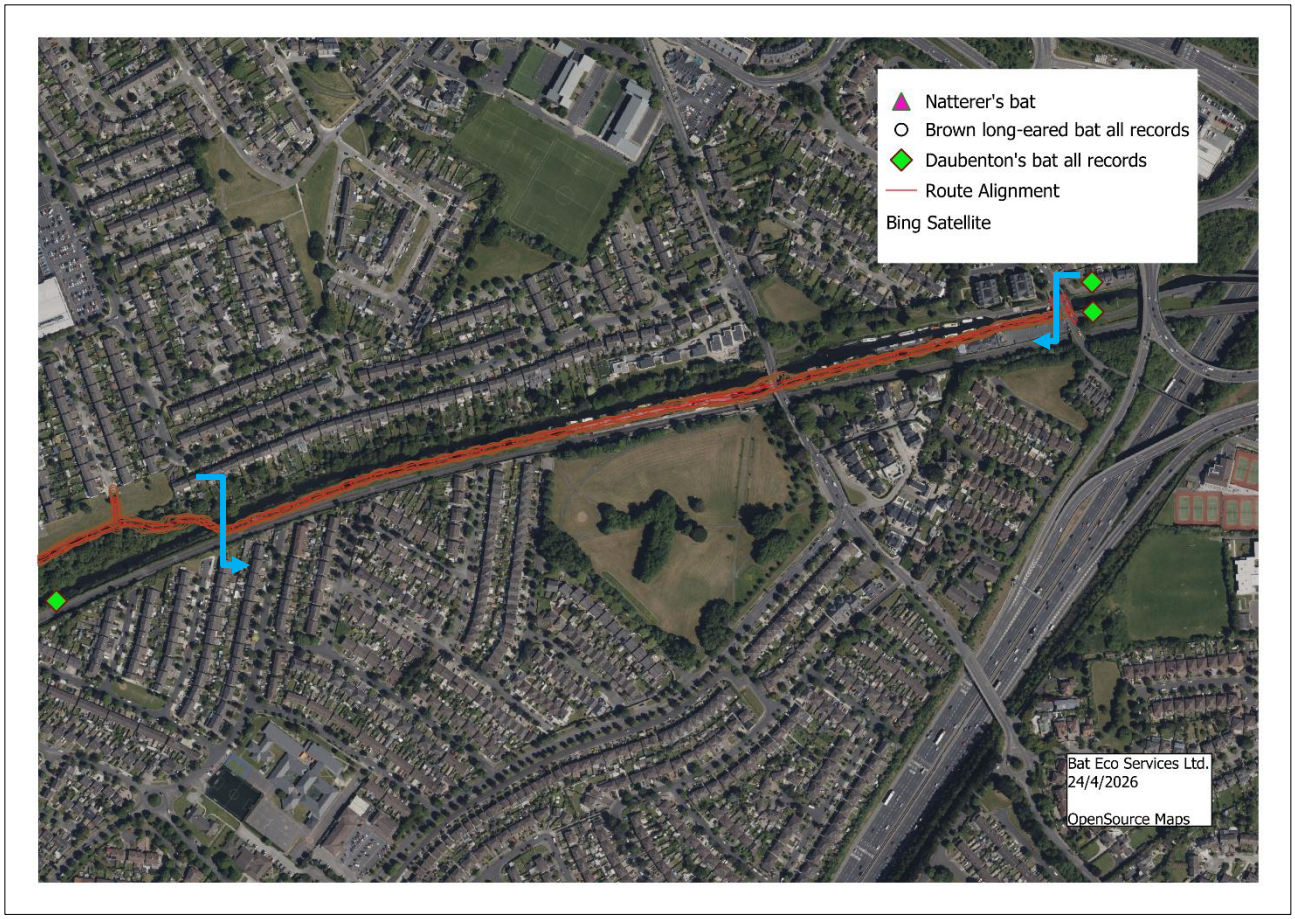


Figure 9f: Lanterns that may cause lighting spill onto the surface of Grand Canal (Between arrows).

4.5 Potential Bat Roosts in Trees

Wildlife Surveys Ireland Ltd. undertook a daytime assessment of trees along the survey route. Bat Eco Services Ltd. extracted this data and presented it on a map below. This comprises of 19 locations where Potential Bat Roosts (PBR) Value of 2 & 3 are present. PBR Value 3 trees were mapped as these are two locations (PBR 6 and PBR 17) where bat boxes could be erected, as part of bat mitigation measures recommended by Wildlife Surveys Ireland Ltd.

In relation to PBR Value 2 trees (17 locations, multiple trees at specific locations), Wildlife Surveys Ireland Ltd. recommended further surveys if such trees required felling. The trees in this group is primarily mature trees with potential roost features and/or heavy ivy growth. The full list of trees is presented in Appendices (Appendix 6).

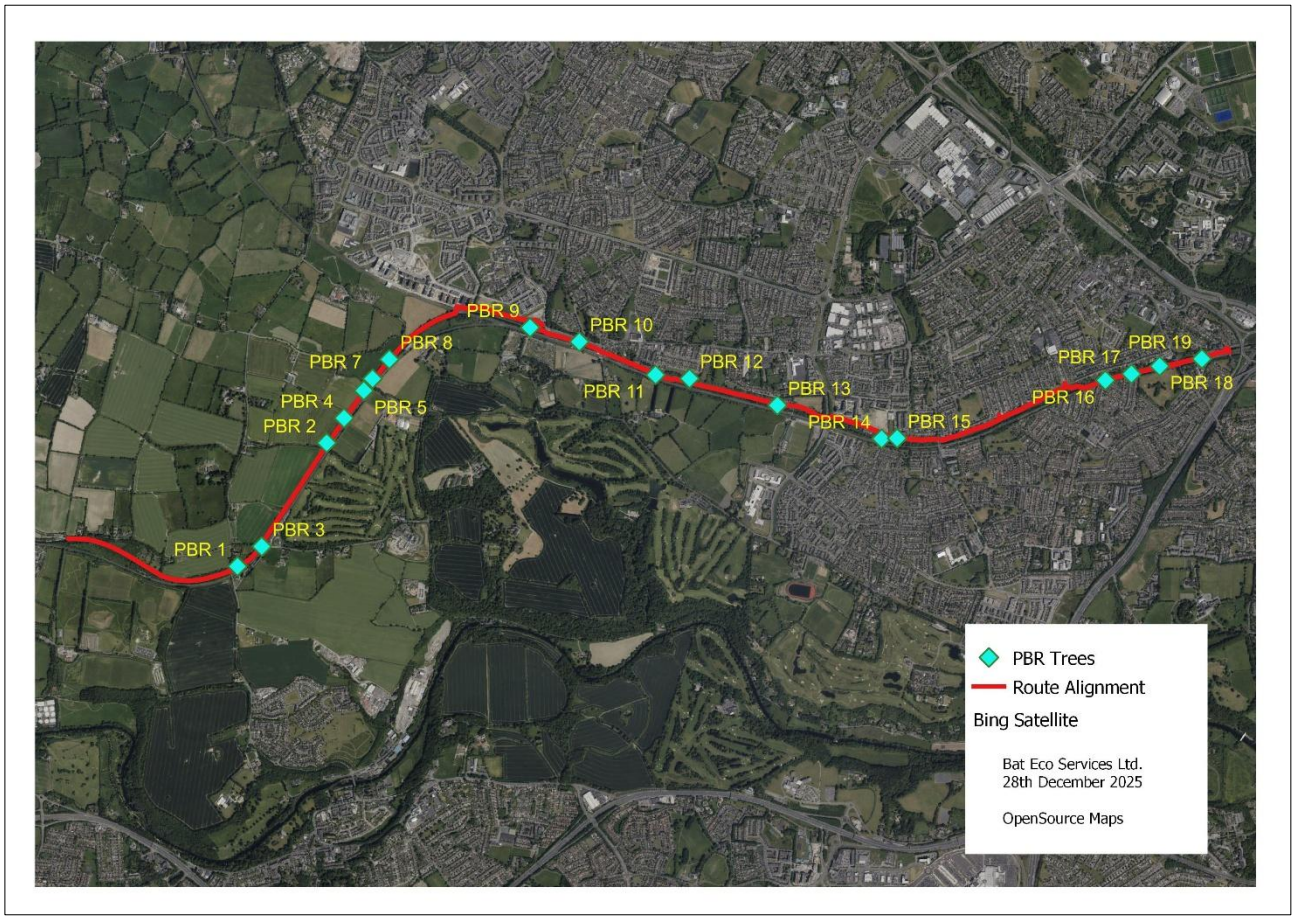


Figure 7: PBR trees recorded by Wildlife Surveys Ireland Ltd. in 2024.

Please consult original survey report for greater detail about this data.

4.5.1.1 Tree Removal Plan

The tree removal plan (Arborcultural Report – Charles McCorkell Arboricultural Consultancy) was consulted to determine what trees are proposed to be felled. The following tables provides a summary of this, and it includes 23 trees. These trees will require a ground assessment to determine the Potential Bat Roost (PBR) value.

Table 7: Survey Effort, Constraints & Survey Assessment Results (Bat Eco Services Ltd. only).

Tree Tag No.	Tree Species	Age	Condition (Arborist)
T604	Wild cherry	Mature	Ivy growth, structurally poor, decay
T454	Common beech	Early mature	Ivy growth, structurally poor
T383	Charry laurel	Early mature	Fair structural condition
T381	Ash	Mature	Ivy growth, structurally poor
T380	Sycamore	Mature	Ivy growth, structurally fair
T379	Sycamore	Mature	Ivy growth, structurally fair
T378	Ash	Mature	Ivy growth, structurally fair
T329	Sycamore	Mature	Ivy growth, structurally fair
T648	Sycamore	Mature	Fair structural condition
T647	Ash	Mature	Fair structural condition
T298	Ash	Early mature	Fair structural condition
T287	Common alder	Early mature	In good structural condition
T283	Ash	Mature	Fair structural condition
T271	Common alder	Early mature	In good structural condition
T273	Sycamore	Semi-mature	Ivy growth, structurally poor
T270	Holly	Early mature	Structurally poor
T262	Common alder	Early mature	In good structural condition
T258	Common alder	Early mature	In good structural condition
T257	Common alder	Early mature	In good structural condition
T255	Ash	Early mature	Ivy growth, structurally poor
T253	Ash	Early mature	Ivy growth, structurally poor
T252	Ash	Early mature	Ivy growth, structurally poor
T251	Ash	Early mature	Ivy growth, structurally poor

The tree survey report also outlines sections / groups of trees that may be partially removed. However, these trees were not individually assessed due to limited access.

4.6 Survey Effort, Constraints & Survey Assessment

The following table details any Survey Constraints encountered by Bat Eco Services Ltd. only, and a summary of Scientific Assessment completed.

Table 7: Survey Effort, Constraints & Survey Assessment Results (Bat Eco Services Ltd. only).

Category	Discussion
Timing of surveys	May 2022 – during the appropriate survey season for bats. September 2025 – appropriate for static surveillance
Survey Type	Bat Survey Duties Completed (Indicated by red shading) Tree PBR Survey ○ Daytime Building Inspection ○ Static Detector Survey ■ Daytime Bridge Inspection ■ Dusk Bat Survey ■ Dawn Bat Survey ■ Walking Transect ■ Driving Transect ○ Trapping/Mist Netting ○ IR Camcorder filming ○ Endoscope Inspection ■ Other ○
Weather conditions	Suitable weather conditions for bat surveys.
Survey Constraints	2 bridges not accessible for daytime inspection.
Survey effort **TOTAL = 1,741 hrs**	2022 Daytime inspection (2 surveyors) = 12 hrs 2022 Static surveillance: 12 units, 5 nights = 480 hrs 2022 Dusk & Dawn Surveys (x4, 2 surveyors) = 16 hrs 2022 Walking Transects (x2, 2 surveyors) = 24 hrs 2025 Static Surveillance (12 units, 10 nights) = 1,200 hrs 2026 Walking transect = 9 hrs
Extent of survey area	Approx. 8km stretch of Royal Canal from M50 interchange to County Kildare border.
Equipment	One static unit failed to record in 2022. However, additional statics were deployed to address this scenario to ensure that there was good coverage along the length of the canal to be surveyed. Therefore, failure of one static unit is not an issue.

The extent of the surveys undertaken has achieved to determine:

- Presence / absence of bat within the survey area;
- A bat species list for the survey area;
- Extent and pattern of usage by bats within the survey area.

Surveying was completed according to Collins (2016 & 2023) and the timing and survey level meets this guidance document.

It is therefore deemed that the Scientific Assessment completed is appropriate to meet the aims of the bat survey.

5. Bat Ecological Evaluation

5.1 Bat Species Recorded & Sensitivity

A total of seven bat species were recorded during the array of bat surveys completed: common pipistrelle, soprano pipistrelle, Leisler's bat, Daubenton's bat, Natterer's bat, brown long-eared bat and Nathusius' pipistrelle. As expected, the three most common Irish bat species (common pipistrelle, soprano pipistrelle and Leisler's bat) were the most frequently recorded bat species. Three light sensitive bat species (Daubenton's bat, Natterer's bat and brown long-eared bat) were occasionally recorded and tended to be in areas where there was no outdoor lighting and/or tall vegetation on at least one of the canal banks.

Leisler's bat

- Leisler's bat is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern. The national Leisler's bat population is considered to be significantly increasing trend (Aughney *et al.,* 2022).
- The modelled Core Area for Leisler's bats is a relatively large area that covers much of the island of Ireland (52,820km^2). The Bat Conservation Ireland 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 species but that it is a landscape species and has a habitat preference at a scale of 20.5km.
- The population estimates (2023 figures) indicates that population is between 112,800 and 202,300 individuals and this this represents a 49.92% increase compared to 2012 population estimates (Roche & Langton, 2024).

The overall trend for the national population of Leisler's bat in Article 17 reporting (NPWS, 2019) is as follows:

- Range = Favourable
- Population = Favourable
- Habitat for species = Favourable
- Overall Assessment of Conservation Status = Favourable
- Overall trend in Conservation Status = Stable

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; and
- Increasing urbanisation.

Common pipistrelle

- Common pipistrelle is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern. The national common pipistrelle population is considered to be significantly increasing trend (Aughney *et al.,* 2022).
- The modelled Core Area for common pipistrelle is a relatively large area that covers much of the island of Ireland (56,485km^2). The Bat Conservation Ireland Irish

Landscape Model indicated that the Common pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanization (<30%) (Roche *et al.,* 2014).

- The population estimates (2023 figures) indicates that population is between 1,074,000 and 2,416,500 individuals and this this represents a 75.4% increase compared to 2012 population estimates (Roche & Langton, 2024).

The overall trend for the national population of common pipistrelle in Article 17 reporting (NPWS, 2019) is as follows:

- Range = Favourable
- Population = Favourable
- Habitat for species = Favourable
- Overall Assessment of Conservation Status = Favourable
- Overall trend in Conservation Status = Stable

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)

Soprano pipistrelle

- Soprano pipistrelle is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern. The national soprano pipistrelle population is considered to be significantly increasing trend (Aughney *et al.,* 2022).
- The modelled Core Area for soprano pipistrelle is a relatively large area that covers much of the island of Ireland (62,020km^2). The Bat Conservation Ireland Irish Landscape Model indicated that the soprano pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.,* 2014).
- The population estimates (2023 figures) indicates that population is between 1,204,800 and 2,709,600 individuals and this this represents a 140.2% increase compared to 2012 population estimates (Roche & Langton, 2024).

The overall trend for the national population of soprano pipistrelle in Article 17 reporting (NPWS, 2019) is as follows:

- Range = Favourable
- Population = Favourable
- Habitat for species = Favourable
- Overall Assessment of Conservation Status = Favourable
- Overall trend in Conservation Status = Stable

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; and

- Increasing urbanisation (e.g. increase in lighting).

Daubenton's Bat

- Daubenton's bat is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern. The national Daubenton's bat population is considered to be stable (Aughney *et al.,* 2021).
- The modelled Core Area for Daubenton's bat is (41,285 km^2) reflecting the distribution of sizeable river catchments. 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).
- The population estimates (2023 figures) indicates that population is between 56,500 and 76,500 individuals and this this represents a 1.24% decrease compared to 2012 population estimates (Roche & Langton, 2024).

The overall trend for the national population of Daubenton's bat in Article 17 reporting (NPWS, 2019) is as follows:

- Range = Favourable
- Population = Favourable
- Habitat for species = Favourable
- Overall Assessment of Conservation Status = Favourable
- Overall trend in Conservation Status = Stable

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; and
- Light pollution.

Brown long-eared bat

- Brown long-eared bat is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern. The national brown long-eared bat population is considered to be stable (Aughney *et al.,* 2021).
- The modelled Core Area for brown long-eared bat is a relatively large area that covers much of the island of Ireland (49,929 km^2). The Bat Conservation Ireland 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 0.5km emphasising the importance of local landscape features for this species (Roche *et al.,* 2014).
- The population estimates (2023 figures) indicates that population is between 65,200 and 102,000 individuals and this this represents a 5.18% increase compared to 2012 population estimates (Roche & Langton, 2024).

The overall trend for the national population of brown long-eared bat in Article 17 reporting (NPWS, 2019) is as follows:

- Range = Favourable

- Population = Favourable
- Habitat for species = Favourable
- Overall Assessment of Conservation Status = Favourable
- Overall trend in Conservation Status = Stable

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; and
- Light pollution.

Natterer's bat

- Natterer's bat is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern. The national Natterer's bat population is currently unknown.
- The modelled Core Area for Natterer's bat is a relatively large area that covers much of the island of Ireland (52,864km^2).The Bat Conservation Ireland 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). Therefore, it is likely that this species is more widespread within the survey area.

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; and
- Increasing urbanisation (e.g. increase in lighting).

Nathusius' pipistrelle

- Nathusius' pipistrelle is an Annex IV bat species under the EU Habitats Directive. The status of this bat species is listed as Least Concern.
- The modelled Core Area for Nathusius' pipistrelle is a relatively restricted area (13,543km^2) and these areas are primarily associated with large water bodies such as Lough Neagh and the Lough Erne complex. The Bat Conservation Ireland 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, any records recorded for this species is important.

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; and

- Water pollution may be a threat to this species because it is particularly associated with lakes.

No Annex II bat species are known to occur in County Dublin or County Kildare (i.e. lesser horseshoe bat) and were not recorded within the survey.

There is no recorded bat roosts recorded within the bridges surveyed but it was noted that six of the bridges inspected contained small crevices that may provide roosting for individual bats.

5.2 Bat Foraging Habitat & Commuting Routes

The Royal Canal provides an important linear waterway for commuting and foraging bats in the local area of the canal. This is especially important in an urban setting, as often, such linear waterways are the remaining dark conduit in a urban area where there is a large degree of street lighting.

5.3 Zone of Influence – Bat Landscape Connectivity

The Royal Canal provides an important linear waterway for commuting and foraging bats in the local area of the canal. This is especially important in an urban area, as often, such linear waterways are the remaining dark conduit in a location where there is a large degree of street lighting. It provides landscape connectivity within the general environs of the canal to green areas located north and south of the Royal Canal.

It is considered that the proposed development will increase lighting because of the operation of the greenway, with a public lighting design, as a cycle commute route. As bats are nocturnal mammals and the three of the bat species recorded are lighting sensitive bat species, it is considered that the proposed lighting of the canal towpath will have a long-term Significant negative impact on local bat populations. Therefore, bat mitigation measures in relation to the proposed public lighting is required.

In addition, vegetation and tree removal will decrease potential foraging and commuting habitat for local bat populations. However, the extent of vegetation and tree removal is minimal considering the length of the proposed greenway. Therefore, it's likely impact on local bat populations is Negative but a Slight impact.

6. Assessment of Potential Impact

A total of seven bat species were recorded during the array of bat surveys completed: common pipistrelle, soprano pipistrelle, Leisler's bat, Daubenton's bat, Natterer's bat, brown long-eared bat and Nathusius' pipistrelle. As expected, the three most common Irish bat species (common pipistrelle, soprano pipistrelle and Leisler's bat) were the most frequently recorded bat species. Three light sensitive bat species (Daubenton's bat, Natterer's bat and brown long-eared bat) were occasionally recorded and tended to be in areas where there was no outdoor lighting and/or tall vegetation on at least one of the canal banks.

The potential impact of the proposed upgrades include:

- Removal of vegetation (scrub etc.)
- Felling of 23 trees and partial removal of individual trees in groups not fully assessed
- Installation of public lighting.

Bat mitigation measures are described below and these take into consideration Marnell *et al.* (2022) as well as best practice guidelines from Collins (2016) and BCT (2023). The measures described are those considered to be practical and effective based on experience of the principal bat specialist, for the proposed development site. Measures are also reflective to published scientific research, where available and applicable to Irish bat populations. As stated by Marnell *et. Al.* (2022) "Any mitigation intended to ensure that there is no impact or minimal impact on the bats must be clearly described in detail, giving examples of how it worked in other places". Please see Section 1.2.3 for more information.

6.1 Bat Mitigation Measures

6.1.1 Lighting Plan

This element of the proposed planning application is important aspect in relation to local bat populations. All European bat species, including Irish bat species, are nocturnal. They usually hide in roosts during the daytime, while fly to feeding areas or drinking sites using commuting routes during the night. Annually bats will hibernate in the winter, swarm in the autumn and give birth in the summer months. In all aspects of the bat lifestyle, Artificial Light at Night (ALAN) may significantly change their natural behaviour in relation to roosting, commuting and feeding. While bats are naturally exposed only to very low lighting levels produced by moonlight, starlight and low intensity twilight, light levels greater than natural light levels can impact on the lifestyle of bats.

Bats are light sensitive bats species, hence their nocturnal activities. The three bat species recorded commuting and foraging within the survey area are Light Tolerant or Semi-tolerant bat species (i.e. Leisler's bat and Nathusius' pipistrelle, common pipistrelle and soprano pipistrelle respectively). Two light sensitive bat species were recorded, and these two bat species should influence the design of any outdoor lighting programme along the canal. It is important that strict lighting guidelines are required to reduce the potential impact of the proposed development on local bat populations as standard best practice. It is recommended the no lighting is installed along the canal. However, it this is a requirement then the following needs to be strictly followed to minimise the potential negative impact on light sensitive bat species.

Luminaire design is extremely important to achieve an appropriate lighting regime. Luminaires come in a myriad of different styles, applications and specifications which a lighting professional can help to select. The following should be considered when choosing luminaires. This is taken from the most recent BCT Lighting Guidelines (BCT, 2023).

Where lighting is deemed necessary, the following are required:

- All luminaires should lack UV elements when manufactured. Metal halide, compact fluorescent sources should not be used.
- LED luminaires should be used where possible due to their sharp-cut-off, lower intensity, good colour rendition and dimming capability,
- A warm white light source (2700 Kelvin or lower) should be adopted to reduce blue light component of luminaires. A 2700 Kelvin luminaire appears as a warm yellow due to the reduction in the stark blue light associated with higher Kelvin values (e.g. 4000 Kelvins). The "warmer" the light, the less of an impact on nocturnal wildlife. The progression of LED technology means that most luminaires are available at 2700 Kelvins and lower. Therefore, it is recommended that such luminaires are standard for "biodiversity areas" and as LED technology develops, 2200 Kelvins may become more commonly available in future years.
- Light sources should feature peak wavelengths higher than 550nm to avoid the component of light most disturbing to bats.
- Waymarking inground markers (low output with cowls or similar to minimised upward light spill) to delineate path edges, if required, for pedestrian zones within the proposed development area should be used.
- Column heights should be carefully considered to minimise light spill and glare visibility. This should be balanced with the potential for increased numbers of columns and upward light reflectance as with bollards.
- Only luminaires with a negligible or zero Upward Light Ration, and with good optical control, should be considered.
- Luminaires should always be mounted horizontally, with no light output above 90° and/or no upward tilt.
- Where appropriate, external security light should be set on motion sensors and set to as short a possible a timer as the risk assessment will allow (e.g. 1-2 minute timer).
- Only if all other options have been explored, accessories such as baffles, hoods or louvres can be used to reduce light spill and direct it only to where it is needed.

Any external lighting for the proposed development should strictly follow the above guidelines and these should be strictly implemented during construction and operation phase of the proposed development.

Extensive consultation was undertaken with the lighting engineers. Consequently, the proposed public lighting has taken into consideration the BCT (2023) guidelines and the bat survey results. The lighting design report states the following:

"The Greenway was designated as being ecologically sensitive largely due to the presence of bats using the canal as a feeding ground or a commuting route. From an ecological point the preferred option was for no lighting however this conflicted with the requirement for the provision of a safer environment and the encouragement of use of the greenway. A compromise between all interested parties was reached; this was a warm white colour temperature selected, the addition of louvres fitted to the luminaires to minimise light spill onto the canal and the addition of an intelligent motion detection and control system ensuring only occupied sections of the greenway to be achieving full designed to lux levels.

Due to the potential low foot fall and the more rural nature of the Hansfield Railway Bridge to Kildare/Fingal County Boundary section of the greenway public lighting was not justified and as such not proposed.

The lighting class was selected as pre the methodology of EN13201-1:2014 and in conjunction with Fingal County Councils' Public lighting specification.

EN13201-2:2015 Category P4 was selected for the greenway."

The report continues to state:

"2700K LEDs were selected as these are the warmest colour temperature LEDs acceptable to Fingal County Council at time of design. Cooler LEDs were considered, however it was determined the increased energy eAiciency benefit did not outweigh the potential additional negative ecological impact. It is accepted that warmer colour temperature LEDs have less negative ecological impact due to lower amounts of light in the blue spectrum emitted by them.

All proposed luminaires were selected on their optical and energy performance as well at their robustness.

To achieve the required lux levels on the greenway the lighting configuration was carefully designed to achieve recommended illuminance levels whilst minimising light spill. This was achieved by a combination of optimised column height, luminaire Wattage, optical setting and column location. All luminaires proposed have high performance optics designed to get the light onto the target area thus minimising spill light.

The Upward Light Ratio (ULR) is 0%.

The colour temperature of the LEDs are 2700K.

Additionally louvres are fitted as required to further minimise the amount spill light. The lighting calculation takes into account the effect of any louvres proposed."

In relation to the proposed canal pedestrian bridge, the following was implemented into the design:

"At CH7200 the greenway crosses the canal, to achieve compliant lux levels on the bridge without light spill onto the canal the bridge was lit via a LED module that fits into the handrail of the bridge. Due to the low mounting height and the bridge acting as a barrier minimal light spill expected onto the canal. The LED modules are to be electrical class III (Extra low voltage)."

The Lighting system proposed is as follows:

"Lighting Layout: Proposed Luminaire:

- Greenway section – Urbis Axia 2.1 fitted with 2700K colour temperature LEDs. Front, rear or front & rear louvres available as retrofittable option. Impact resistance rating of IK10 and Ingress Protection rating of IP66.
- Canal bridge crossing Urbis Alinea lighting module to be mounted in to the bridge handrail. Impact resistance rating of IK10 and Ingress Protection rating of IP66.
- All luminaires have a design life of 25 years (100,000h LED & driver burn life)."

Therefore the following conditions, to meet BCT (2023), have been included in the public lighting design:

- LED luminaires, no UV elements

- 2700 Kelvin luminaires
- Minimum height of lamp poles: these have been set to 5m to reduce light spill (standard pole height is 6m)
- Luminaires will feature peak wavelengths higher than 550nm
- Luminaires will be mounted horizontally
- Shields have been factored into each luminaire to reduce lighting spill
- Existing luminaires will be changed to match the new design (as above)
- PIR sensors will be erected along the length of the public lighting scheme

These mitigation measures will reduce the potential impact of the proposed lighting on local bat populations. A pedestrian bridge is proposed, and lighting is designed into the handrails of the bridge. The lighting design will also meet the BCT (2023) guidelines.

6.1.2 Tree Assessment

Twenty-trees are proposed to be felled and the PBR value of these trees are required to determine the mitigation measures required. If trees, recorded as PBRs are proposed to be felled, further surveying is required to determine if they are bats roosts. Felling should be felled outside the bird nesting season and under the supervision of a bat specialist.

In relation to partial removal of individual trees in groups not fully assessed, it is recommended that these are assess once access is permitted.

Bat boxes are required to be erected to provide alternative roosting and the number of bat boxes is determined by the number of PBR trees felled.

6.1.3 Landscaping

It is recommended that native tree, shrub and plant species are included in the landscaping plan. It is recommended that night-scented planting is also undertaken to encourage foraging areas for local bat populations.

Any trees proposed to be felled requires planting of standard trees as a compensatory measure. Section 4.5 provided details of trees suitable for bat boxes. Bat boxes should be erected under supervision of a bat specialist to ensure that they are erected correctly. Schwegler woodcrete bat boxes are recommended.

6.1.4 Bat Conservation Measures

It is recommended that additional bat boxes are erected within the landscaping plan for the proposed upgrades as a bat conservation measures. Section 4.5 provided details of trees suitable for bat boxes. Bat boxes should be erected under supervision of a bat specialist to ensure that they are erected correctly. Schwegler woodcrete bat boxes (x4 units – 1FF design) are recommended.

The strict implementation of the bat mitigation measures described above will reduce the potential impact of the development on local bat populations.

7. Survey Conclusions

A total of seven bat species were recorded during the array of bat surveys completed: common pipistrelle, soprano pipistrelle, Leisler's bat, Daubenton's bat, Natterer's bat, brown long-eared bat and Nathusius' pipistrelle. As expected, the three most common Irish bat species (common pipistrelle, soprano pipistrelle and Leisler's bat) were the most frequently recorded bat species. Three light sensitive bat species (Daubenton's bat, Natterer's bat and brown long-eared bat) were occasionally recorded and tended to be in areas where there was no outdoor lighting and/or tall vegetation on at least one of the canal banks.

Extensive consultation was undertaken in relation to the proposed public lighting and this has been designed with consideration of the local bat populations. Additional bat mitigation measures have been recommended in relation to tree felling, vegetation removal, landscaping and bat box schemes.

The strict implementation of the bat mitigation measures described above will reduce the potential impact of the development on local bat populations.

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9. Appendices

9.1 Appendix 1 Bat Habitat & Commuting Route Classifications

Table 1.A: Hedgerow Category (Bat Conservation Ireland, 2015)

Type of Hedgerow / Treeline	Code	Description / Bat Potential
Small Hedgerow	**SH**	Hedgerow is less than approximately 1.5 m high, there are no, or very few, protruding bushes or trees. This type of hedgerow would provide little shelter to bats. 
Medium Hedgerow	**MH**	Hedgerow is approximately 1.5 to 3 m high. This type of hedgerow will provide foraging and commuting potential for bats. 
Sparse Treeline Hedgerow	**ST**	Hedgerow, low or medium in height, with individuals trees (where tree canopies, for the most part, do not touch).

		
Dense Treeline Hedgerow	**DT**	Large uncut hedgerows or treelines, dominated by mainly large tree or very tall scrub species (e.g. tall hawthorn, blackthorn or hazel), where the canopies are mostly touching. 

Table 1.B: Habitat Classification (Bat Conservation Ireland, 2015, based on Fossit, 2000)

Cultivated land		Salt marshes		Exposed rock		Fens/flushes	
Built land		Brackish waters		Caves		Grasslands	
Coastal structures		Springs		Freshwater marsh		Scrub	
Shingle/gravel		Swamps		Lakes/ponds		Hedges/treelines	
Sea cliffs/islets		Disturbed ground		Heath		Conifer plantation	
Sand dunes		Watercourse		Bog		Woodland	

9.2 Appendix 2 Static Surveillance - 2022

Key: SP = soprano pipistrelle; CP = common pipistrelle; Leis = Leisler's bat; Daub = Daubenton's bat; BLE = brown long-eared bat; Nath P = Nathusius' pipistrelle.

AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 19	02/05/2022	583	67	0	0	0	0
	03/05/2022	344	160	1	0	0	0
Static 1	04/05/2022	340	159	1	0	0	0
	05/05/2022	179	322	4	0	0	1
	06/05/2022	479	101	0	0	0	0
	TOTAL	**1925**	**809**	**6**	**0**	**0**	**1**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 17	02/05/2022	48	9	0	28	0	0
	03/05/2022	43	17	0	0	0	0
Static 2	04/05/2022	65	41	2	5	0	0
	05/05/2022	110	37	5	1	0	0
	06/05/2022	64	15	0	3	0	0
	TOTAL	**330**	**119**	**7**	**37**	**0**	**0**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 20	02/05/2022	47	100	0	0	0	0
	03/05/2022	38	169	0	1	1	1
Static 3	04/05/2022	33	76	30	1	0	0
	05/05/2022	26	113	2	0	0	0
	06/05/2022	32	43	0	1	0	0
	TOTAL	**176**	**501**	**32**	**3**	**1**	**1**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 6	02/05/2022	47	121	0	2	0	0
	03/05/2022	66	127	0	1	0	0
Static 4	04/05/2022	101	165	0	0	0	0
	05/05/2022	74	124	0	0	0	0
	06/05/2022	77	70	0	2	0	0
	TOTAL	**365**	**607**	**0**	**5**	**0**	**0**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box T5	02/05/2022	2	265	21	2	2	0
	03/05/2022	12	113	25	0	0	0
Static 5	04/05/2022	16	129	25	1	0	0
	05/05/2022	11	279	41	1	0	2
	06/05/2022	1	162	13	1	0	0
	TOTAL	**42**	**948**	**125**	**5**	**2**	**2**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 18	02/05/2022	80	214	25	12	0	0
	03/05/2022	132	115	38	3	0	0
Static 6	04/05/2022	102	120	39	2	0	0
	05/05/2022	102	95	39	1	0	0
	06/05/2022	89	72	23	4	0	0
	TOTAL	**505**	**616**	**164**	**22**	**0**	**0**

AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box T4	02/05/2022	12	296	9	24	0	0
	03/05/2022	24	129	6	2	1	3
Static 7	04/05/2022	12	151	39	1	0	1
	05/05/2022	11	159	46	0	1	1
	06/05/2022	10	100	2	0	0	0
	TOTAL	**69**	**835**	**102**	**27**	**2**	**5**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 3	02/05/2022	75	240	38	2	0	0
	03/05/2022	126	73	40	2	0	0
Static 8	04/05/2022	123	70	93	1	0	0
	05/05/2022	55	52	156	0	3	0
	06/05/2022	43	113	18	1	0	1
	TOTAL	**422**	**548**	**345**	**6**	**3**	**1**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box 4	02/05/2022	No recordings					
	03/05/2022						
Static 9	04/05/2022						
	05/05/2022						
	06/05/2022						
	TOTAL	**0**	**0**	**0**	**0**	**0**	**0**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box T1	02/05/2022	44	21	26	6	0	0
	03/05/2022	52	15	12	0	0	1
Static 10	04/05/2022	48	23	19	0	1	1
	05/05/2022	21	15	55	1	0	0
	06/05/2022	10	24	8	0	0	0
	TOTAL	**175**	**98**	**120**	**7**	**1**	**2**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box T2	02/05/2022	174	58	40	1	2	0
	03/05/2022	61	41	12	5	1	0
Static 11	04/05/2022	75	25	17	1	3	0
	05/05/2022	5	8	19	0	0	0
	06/05/2022	6	0	2	0	0	0
	TOTAL	**321**	**132**	**90**	**7**	**6**	**0**
AM No.	Date	SP	CP	Leis	Daub	BLE	Nath P
Box T3	02/05/2022	20	88	7	2	0	0
	03/05/2022	8	47	24	1	0	0
Static 12	04/05/2022	19	33	25	1	2	0
	05/05/2022	13	60	26	0	0	0
	06/05/2022	3	15	1	0	0	0
	TOTAL	**63**	**243**	**83**	**4**	**2**	**0**

9.3 Appendix 3 Static Surveillance 2022 & 2025

Total number of bat passes recorded for each static locationed:

- 2022: RED
- 2025: BLUE

Static No.	No. of Nights	Common pipistrelle	Soprano pipistrelle	Nathusius' pipistrelle	Leisler's bat	Daubenton's bat	Natterer's bat	Brown long-eared bat
2022 Static 1	5	119	330	0	7	37	0	0
2025 Static 1	10	195	389	0	51	64	0	0
2022 Static 2	5	809	1925	1	6	0	0	0
2025 Static 2	10	111	400	0	128	42	0	0
2022 Static 3	5	501	176	1	32	3	0	1
2025 Static 3	10	211	678	0	281	142	0	0
2022 Static 4	5	607	365	0	0	5	0	0
2025 Static 4	10	599	477	0	44	484	0	11
2022 Static 5	5	948	42	2	125	5	0	2
2025 Static 5	10	486	157	4	62	593	2	2
2022 Static 6	5	616	505	0	164	22	0	0
2025 Static 6	10	229	1301	0	159	1190	1	2
2022 Static 7	5	835	69	5	102	27	0	2
2025 Static 7	10	987	464	8	91	48	0	4
2022 Static 8	5	548	422	1	345	6	0	3
2025 Static 8	10	475	1452	8	273	34	0	11
2022 Static 9	5	0	0	0	0	0	0	0
2025 Static 9	10	26	97	1	14	0	0	0
2022 Static 10	5	98	175	2	120	7	0	1
2025 Static 10	10	195	203	5	167	12	0	3
2022 Static 11	5	132	321	0	90	7	0	6
2025 Static 11	10	211	273	0	110	193	0	12
2022 Static 12	5	243	63	0	83	4	0	2
2025 Static 12	10	306	74	0	91	13	0	8

9.4 Appendix 4 2022 Walking Transect Survey Results

MYODAU = Daubenton's bat; NYCLEI = Leisler's bat; PIPPIP = common pipistrelle, PIPPYP – soprano pipistrelle, PLEAUR = brown long-eared bat, PIPNAT = Nathusius' pipistrelle

Transect 1

DATE	TIME	HOUR	AUTO ID*	MANUAL ID	MODEL	ITM Easting	ITM Northing
02/05/2022	22:38:37	22	NoID	MYODAU	M2	709019	738178
02/05/2022	23:52:40	23	NoID	MYODAU	M2	704982	738127
02/05/2022	21:32:45	21	MYODAU	MYODAU	M2	709045	738187
02/05/2022	21:34:40	21	MYODAU	MYODAU	M2	709022	738183
02/05/2022	21:34:44	21	MYODAU	MYODAU	M2	709021	738182
02/05/2022	21:35:20	21	MYODAU	MYODAU	M2	709018	738183
02/05/2022	21:41:30	21	MYODAU	MYODAU	M2	709034	738187
02/05/2022	21:58:45	21	MYODAU	MYODAU	M2	709039	738195
02/05/2022	22:38:33	22	MYODAU	MYODAU	M2	709023	738178
02/05/2022	23:52:46	23	MYODAU	MYODAU	M2	704982	738126
03/05/2022	50:19.9	22	MYODAU	MYODAU	Scout	703803	738265
03/05/2022	02:01.4	23	MYODAU	MYODAU	Scout	703288	737626
02/05/2022	23:13:40	23	NYCLEI	NYCLEI	M2	707073	737619
02/05/2022	23:13:43	23	NYCLEI	NYCLEI	M2	707070	737619
02/05/2022	23:14:00	23	NYCLEI	NYCLEI	M2	707064	737622
02/05/2022	23:14:01	23	NYCLEI	NYCLEI	M2	707064	737622
02/05/2022	23:14:06	23	NYCLEI	NYCLEI	M2	707065	737622
02/05/2022	23:54:49	23	NYCLEI	NYCLEI	M2	704967	738137
02/05/2022	23:54:52	23	NYCLEI	NYCLEI	M2	704963	738138
03/05/2022	49:05.9	21	NoID	NYCLEI	Scout	703330	737694
03/05/2022	52:35.7	21	NoID	NYCLEI	Scout	703373	737756
03/05/2022	53:53.2	21	NoID	NYCLEI	Scout	703430	737836
03/05/2022	48:45.1	21	NoID	NYCLEI	Scout	703326	737689
03/05/2022	03:44.9	23	NoID	NYCLEI	Scout	703216	737516
03/05/2022	12:05.5	21	Noise	NYCLEI	Scout	701666	737019
03/05/2022	17:13.8	21	NoID	NYCLEI	Scout	701923	736982
03/05/2022	29:02.0	21	Noise	NYCLEI	Scout	702406	736767
03/05/2022	29:08.9	21	Noise	NYCLEI	Scout	702416	736766
03/05/2022	42:34.4	21	NoID	NYCLEI	Scout	703077	737313
03/05/2022	47:57.7	21	NoID	NYCLEI	Scout	703290	737636
03/05/2022	09:50.9	23	NoID	NYCLEI	Scout	702982	737159
03/05/2022	07:27.1	21	NYCLEI	NYCLEI	Scout	701451	737020
03/05/2022	07:31.1	21	NYCLEI	NYCLEI	Scout	701451	737020
03/05/2022	12:22.9	21	NYCLEI	NYCLEI	Scout	701685	737020
03/05/2022	16:46.8	21	NYCLEI	NYCLEI	Scout	701919	736984
03/05/2022	17:21.8	21	NYCLEI	NYCLEI	Scout	701930	736980
03/05/2022	17:29.8	21	NYCLEI	NYCLEI	Scout	701930	736980
03/05/2022	19:31.8	21	NYCLEI	NYCLEI	Scout	702038	736926
03/05/2022	25:06.4	21	NYCLEI	NYCLEI	Scout	702204	736824
03/05/2022	28:22.8	21	NYCLEI	NYCLEI	Scout	702372	736769
03/05/2022	28:52.0	21	NYCLEI	NYCLEI	Scout	702395	736767
03/05/2022	28:56.0	21	NYCLEI	NYCLEI	Scout	702402	736767
03/05/2022	47:19.8	21	NYCLEI	NYCLEI	Scout	703265	737600
03/05/2022	49:17.2	21	NYCLEI	NYCLEI	Scout	703330	737694
03/05/2022	49:27.8	21	NYCLEI	NYCLEI	Scout	703330	737694
03/05/2022	49:38.0	21	NYCLEI	NYCLEI	Scout	703330	737694
03/05/2022	50:15.4	21	NYCLEI	NYCLEI	Scout	703336	737702
03/05/2022	50:26.8	21	NYCLEI	NYCLEI	Scout	703336	737702
03/05/2022	50:37.8	21	NYCLEI	NYCLEI	Scout	703335	737702
03/05/2022	50:49.1	21	NYCLEI	NYCLEI	Scout	703335	737702
03/05/2022	50:57.1	21	NYCLEI	NYCLEI	Scout	703335	737702
03/05/2022	53:07.9	21	NYCLEI	NYCLEI	Scout	703392	737784

03/05/2022	53:21.8	21	NYCLEI	NYCLEI	Scout	703404	737799
03/05/2022	46:27.6	22	NYCLEI	NYCLEI	Scout	704055	738386
03/05/2022	55:27.4	22	NYCLEI	NYCLEI	Scout	703568	738012
03/05/2022	58:13.7	22	NYCLEI	NYCLEI	Scout	703452	737861
03/05/2022	00:23.6	23	NYCLEI	NYCLEI	Scout	703361	737731
03/05/2022	01:03.9	23	NYCLEI	NYCLEI	Scout	703330	737685
03/05/2022	03:56.4	23	NYCLEI	NYCLEI	Scout	703214	737513
03/05/2022	05:27.3	23	NYCLEI	NYCLEI	Scout	703150	737415
02/05/2022	21:31:32	21	NoID	PIPPIP	M2	709045	738187
02/05/2022	21:37:49	21	NoID	PIPPIP	M2	709034	738184
02/05/2022	21:41:49	21	NoID	PIPPIP	M2	709032	738187
02/05/2022	21:42:41	21	NoID	PIPPIP	M2	709042	738185
02/05/2022	21:48:24	21	NoID	PIPPIP	M2	709030	738192
02/05/2022	21:49:40	21	NoID	PIPPIP	M2	709027	738195
02/05/2022	21:53:04	21	NoID	PIPPIP	M2	709031	738190
02/05/2022	21:54:03	21	NoID	PIPPIP	M2	709031	738188
02/05/2022	21:55:29	21	NoID	PIPPIP	M2	709032	738196
02/05/2022	21:55:49	21	NoID	PIPPIP	M2	709031	738197
02/05/2022	21:58:10	21	NoID	PIPPIP	M2	709035	738194
02/05/2022	21:58:17	21	NoID	PIPPIP	M2	709036	738193
02/05/2022	21:58:27	21	NoID	PIPPIP	M2	709038	738193
02/05/2022	22:04:45	22	NoID	PIPPIP	M2	709035	738190
02/05/2022	22:05:46	22	NoID	PIPPIP	M2	709039	738186
02/05/2022	22:06:15	22	NoID	PIPPIP	M2	709037	738188
02/05/2022	22:06:20	22	NoID	PIPPIP	M2	709035	738189
02/05/2022	22:07:03	22	NoID	PIPPIP	M2	709033	738193
02/05/2022	22:07:28	22	NoID	PIPPIP	M2	709033	738193
02/05/2022	22:07:47	22	NoID	PIPPIP	M2	709033	738191
02/05/2022	22:07:55	22	NoID	PIPPIP	M2	709034	738192
02/05/2022	22:08:35	22	NoID	PIPPIP	M2	709032	738190
02/05/2022	22:08:50	22	NoID	PIPPIP	M2	709034	738188
02/05/2022	22:09:28	22	NoID	PIPPIP	M2	709032	738187
02/05/2022	22:12:19	22	NoID	PIPPIP	M2	709036	738186
02/05/2022	22:12:27	22	NoID	PIPPIP	M2	709035	738187
02/05/2022	22:12:42	22	NoID	PIPPIP	M2	709036	738186
02/05/2022	22:13:52	22	NoID	PIPPIP	M2	709035	738187
02/05/2022	22:14:42	22	NoID	PIPPIP	M2	709034	738190
02/05/2022	22:14:56	22	NoID	PIPPIP	M2	709031	738192
02/05/2022	22:15:10	22	NoID	PIPPIP	M2	709033	738190
02/05/2022	22:15:21	22	NoID	PIPPIP	M2	709034	738189
02/05/2022	22:16:25	22	NoID	PIPPIP	M2	709033	738188
02/05/2022	22:16:33	22	NoID	PIPPIP	M2	709032	738186
02/05/2022	22:18:14	22	NoID	PIPPIP	M2	709033	738192
02/05/2022	22:18:34	22	NoID	PIPPIP	M2	709031	738191
02/05/2022	22:19:01	22	NoID	PIPPIP	M2	709034	738190
02/05/2022	22:23:20	22	NoID	PIPPIP	M2	709037	738192
02/05/2022	22:24:01	22	NoID	PIPPIP	M2	709034	738192
02/05/2022	22:29:08	22	NoID	PIPPIP	M2	709035	738189
02/05/2022	22:32:41	22	NoID	PIPPIP	M2	709035	738192
02/05/2022	22:48:25	22	NoID	PIPPIP	M2	708295	738059
02/05/2022	23:21:25	23	NoID	PIPPIP	M2	706784	737580
02/05/2022	23:25:50	23	Noise	PIPPIP	M2	706457	737665
02/05/2022	23:43:57	23	NoID	PIPPIP	M2	705301	738000
02/05/2022	21:19:34	21	PIPPIP	PIPPIP	M2	709033	738188
02/05/2022	21:19:51	21	PIPPIP	PIPPIP	M2	709036	738186
02/05/2022	21:20:52	21	PIPPIP	PIPPIP	M2	709024	738184
02/05/2022	21:22:15	21	PIPPIP	PIPPIP	M2	709037	738185
02/05/2022	21:22:19	21	PIPPIP	PIPPIP	M2	709039	738182
02/05/2022	21:24:56	21	PIPPIP	PIPPIP	M2	709040	738184
02/05/2022	21:30:24	21	PIPPIP	PIPPIP	M2	709041	738184
02/05/2022	21:31:10	21	PIPPIP	PIPPIP	M2	709045	738186

02/05/2022	21:31:29	21	PIPPIP	PIPPIP	M2	709044	738187
02/05/2022	21:43:06	21	PIPPIP	PIPPIP	M2	709026	738183
02/05/2022	21:43:49	21	PIPPIP	PIPPIP	M2	709027	738184
02/05/2022	21:44:29	21	PIPPIP	PIPPIP	M2	709030	738187
02/05/2022	21:44:56	21	PIPPIP	PIPPIP	M2	709021	738192
02/05/2022	21:45:03	21	PIPPIP	PIPPIP	M2	709022	738192
02/05/2022	21:45:35	21	PIPPIP	PIPPIP	M2	709022	738189
02/05/2022	21:45:43	21	PIPPIP	PIPPIP	M2	709023	738189
02/05/2022	21:45:51	21	PIPPIP	PIPPIP	M2	709023	738189
02/05/2022	21:46:13	21	PIPPIP	PIPPIP	M2	709022	738187
02/05/2022	21:46:27	21	PIPPIP	PIPPIP	M2	709022	738187
02/05/2022	21:46:45	21	PIPPIP	PIPPIP	M2	709019	738187
02/05/2022	21:50:19	21	PIPPIP	PIPPIP	M2	709035	738188
02/05/2022	21:52:27	21	PIPPIP	PIPPIP	M2	709031	738190
02/05/2022	21:55:12	21	PIPPIP	PIPPIP	M2	709029	738192
02/05/2022	21:58:13	21	PIPPIP	PIPPIP	M2	709035	738194
02/05/2022	22:03:42	22	PIPPIP	PIPPIP	M2	709035	738189
02/05/2022	22:03:56	22	PIPPIP	PIPPIP	M2	709035	738189
02/05/2022	22:04:12	22	PIPPIP	PIPPIP	M2	709037	738192
02/05/2022	22:05:15	22	PIPPIP	PIPPIP	M2	709035	738189
02/05/2022	22:05:52	22	PIPPIP	PIPPIP	M2	709038	738187
02/05/2022	22:06:00	22	PIPPIP	PIPPIP	M2	709038	738187
02/05/2022	22:06:07	22	PIPPIP	PIPPIP	M2	709038	738187
02/05/2022	22:06:28	22	PIPPIP	PIPPIP	M2	709033	738191
02/05/2022	22:06:42	22	PIPPIP	PIPPIP	M2	709032	738193
02/05/2022	22:07:41	22	PIPPIP	PIPPIP	M2	709034	738192
02/05/2022	22:08:07	22	PIPPIP	PIPPIP	M2	709034	738190
02/05/2022	22:08:18	22	PIPPIP	PIPPIP	M2	709034	738190
02/05/2022	22:08:25	22	PIPPIP	PIPPIP	M2	709033	738190
02/05/2022	22:08:37	22	PIPPIP	PIPPIP	M2	709033	738190
02/05/2022	22:09:14	22	PIPPIP	PIPPIP	M2	709034	738188
02/05/2022	22:09:20	22	PIPPIP	PIPPIP	M2	709033	738188
02/05/2022	22:09:34	22	PIPPIP	PIPPIP	M2	709029	738187
02/05/2022	22:09:41	22	PIPPIP	PIPPIP	M2	709028	738188
02/05/2022	22:09:49	22	PIPPIP	PIPPIP	M2	709029	738187
02/05/2022	22:11:26	22	PIPPIP	PIPPIP	M2	709028	738186
02/05/2022	22:11:47	22	PIPPIP	PIPPIP	M2	709035	738186
02/05/2022	22:11:56	22	PIPPIP	PIPPIP	M2	709034	738187
02/05/2022	22:12:12	22	PIPPIP	PIPPIP	M2	709035	738188
02/05/2022	22:12:47	22	PIPPIP	PIPPIP	M2	709036	738185
02/05/2022	22:13:09	22	PIPPIP	PIPPIP	M2	709033	738185
02/05/2022	22:13:16	22	PIPPIP	PIPPIP	M2	709034	738187
02/05/2022	22:13:31	22	PIPPIP	PIPPIP	M2	709034	738188
02/05/2022	22:13:39	22	PIPPIP	PIPPIP	M2	709034	738187
02/05/2022	22:14:01	22	PIPPIP	PIPPIP	M2	709036	738187
02/05/2022	22:14:10	22	PIPPIP	PIPPIP	M2	709036	738186
02/05/2022	22:14:17	22	PIPPIP	PIPPIP	M2	709036	738186
02/05/2022	22:14:29	22	PIPPIP	PIPPIP	M2	709036	738188
02/05/2022	22:15:07	22	PIPPIP	PIPPIP	M2	709032	738191
02/05/2022	22:15:35	22	PIPPIP	PIPPIP	M2	709035	738188
02/05/2022	22:15:42	22	PIPPIP	PIPPIP	M2	709035	738189
02/05/2022	22:15:53	22	PIPPIP	PIPPIP	M2	709035	738190
02/05/2022	22:16:09	22	PIPPIP	PIPPIP	M2	709033	738190
02/05/2022	22:16:17	22	PIPPIP	PIPPIP	M2	709033	738190
02/05/2022	22:18:22	22	PIPPIP	PIPPIP	M2	709032	738191
02/05/2022	22:22:41	22	PIPPIP	PIPPIP	M2	709039	738192
02/05/2022	22:23:43	22	PIPPIP	PIPPIP	M2	709036	738192
02/05/2022	22:28:14	22	PIPPIP	PIPPIP	M2	709035	738190
02/05/2022	22:28:24	22	PIPPIP	PIPPIP	M2	709035	738187
02/05/2022	22:31:42	22	PIPPIP	PIPPIP	M2	709036	738187
02/05/2022	22:32:02	22	PIPPIP	PIPPIP	M2	709034	738188

02/05/2022	22:33:14	22	PIPPIP	PIPPIP	M2	709033	738189
02/05/2022	22:33:31	22	PIPPIP	PIPPIP	M2	709034	738188
02/05/2022	22:33:45	22	PIPPIP	PIPPIP	M2	709033	738187
02/05/2022	22:34:06	22	PIPPIP	PIPPIP	M2	709032	738187
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02/05/2022	22:35:42	22	PIPPIP	PIPPIP	M2	709033	738189
02/05/2022	22:43:53	22	PIPPIP	PIPPIP	M2	708643	738145
02/05/2022	22:44:00	22	PIPPIP	PIPPIP	M2	708634	738144
02/05/2022	22:46:21	22	PIPPIP	PIPPIP	M2	708448	738099
02/05/2022	22:46:38	22	PIPPIP	PIPPIP	M2	708430	738100
02/05/2022	22:46:45	22	PIPPIP	PIPPIP	M2	708424	738102
02/05/2022	22:47:00	22	PIPPIP	PIPPIP	M2	708403	738094
02/05/2022	22:47:57	22	PIPPIP	PIPPIP	M2	708331	738071
02/05/2022	22:48:20	22	PIPPIP	PIPPIP	M2	708301	738061
02/05/2022	22:48:28	22	PIPPIP	PIPPIP	M2	708292	738058
02/05/2022	22:48:32	22	PIPPIP	PIPPIP	M2	708286	738057
02/05/2022	22:48:48	22	PIPPIP	PIPPIP	M2	708265	738053
02/05/2022	22:50:59	22	PIPPIP	PIPPIP	M2	708091	738013
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02/05/2022	22:59:34	22	PIPPIP	PIPPIP	M2	707664	737861
02/05/2022	22:59:50	22	PIPPIP	PIPPIP	M2	707645	737855
02/05/2022	23:00:18	23	PIPPIP	PIPPIP	M2	707612	737841
02/05/2022	23:00:28	23	PIPPIP	PIPPIP	M2	707599	737836
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02/05/2022	23:05:42	23	PIPPIP	PIPPIP	M2	707356	737729
02/05/2022	23:07:41	23	PIPPIP	PIPPIP	M2	707359	737728
02/05/2022	23:15:17	23	PIPPIP	PIPPIP	M2	707060	737625
02/05/2022	23:20:48	23	PIPPIP	PIPPIP	M2	706835	737592
02/05/2022	23:21:44	23	PIPPIP	PIPPIP	M2	706761	737582
02/05/2022	23:23:07	23	PIPPIP	PIPPIP	M2	706666	737602
02/05/2022	23:24:31	23	PIPPIP	PIPPIP	M2	706557	737641
02/05/2022	23:25:05	23	PIPPIP	PIPPIP	M2	706515	737648
02/05/2022	23:25:27	23	PIPPIP	PIPPIP	M2	706486	737660
02/05/2022	23:25:52	23	PIPPIP	PIPPIP	M2	706456	737666
02/05/2022	23:25:55	23	PIPPIP	PIPPIP	M2	706449	737667
02/05/2022	23:27:52	23	PIPPIP	PIPPIP	M2	706291	737722
02/05/2022	23:33:42	23	PIPPIP	PIPPIP	M2	706073	737812
02/05/2022	23:34:06	23	PIPPIP	PIPPIP	M2	706041	737817
02/05/2022	23:34:16	23	PIPPIP	PIPPIP	M2	706028	737819
02/05/2022	23:34:33	23	PIPPIP	PIPPIP	M2	706003	737824
02/05/2022	23:35:01	23	PIPPIP	PIPPIP	M2	705971	737833
02/05/2022	23:43:07	23	PIPPIP	PIPPIP	M2	705369	737985
02/05/2022	23:44:05	23	PIPPIP	PIPPIP	M2	705291	738004
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02/05/2022	23:46:39	23	PIPPIP	PIPPIP	M2	705106	738083
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02/05/2022	21:21:54	21	NoID	PIPPIP	M2	709038	738187
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02/05/2022	21:29:42	21	NoID	PIPPIP	M2	709037	738184
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02/05/2022	21:31:48	21	NoID	PIPPIP	M2	709050	738189
02/05/2022	21:42:55	21	Noise	PIPPIP	M2	709029	738184
02/05/2022	23:44:13	23	NoID	PIPPIP	M2	705278	738009
03/05/2022	49:05.9	21	NoID	PIPPIP	Scout	703330	737694
03/05/2022	52:35.7	21	NoID	PIPPIP	Scout	703373	737756
03/05/2022	53:53.2	21	NoID	PIPPIP	Scout	703430	737836

03/05/2022	48:45.1	21	NoID	PIPPIP	Scout	703326	737689
03/05/2022	03:44.9	23	NoID	PIPPIP	Scout	703216	737516
03/05/2022	33:54.1	21	Noise	PIPPIP	Scout	702688	736829
03/05/2022	42:46.3	21	Noise	PIPPIP	Scout	703081	737319
03/05/2022	43:08.1	21	NoID	PIPPIP	Scout	703101	737348
03/05/2022	43:59.7	21	Noise	PIPPIP	Scout	703132	737396
03/05/2022	44:13.6	21	Noise	PIPPIP	Scout	703142	737411
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03/05/2022	46:05.1	21	NoID	PIPPIP	Scout	703217	737527
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03/05/2022	24:31.3	22	Noise	PIPPIP	Scout	704544	738282
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03/05/2022	30:23.4	22	NoID	PIPPIP	Scout	704916	738159
03/05/2022	31:20.6	22	NoID	PIPPIP	Scout	704893	738166
03/05/2022	33:07.4	22	NoID	PIPPIP	Scout	704837	738192
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03/05/2022	36:16.5	22	NoID	PIPPIP	Scout	704726	738231
03/05/2022	36:30.6	22	NoID	PIPPIP	Scout	704713	738235
03/05/2022	37:29.1	22	Noise	PIPPIP	Scout	704657	738251
03/05/2022	47:11.9	22	Noise	PIPPIP	Scout	704021	738380
03/05/2022	52:17.2	22	Noise	PIPPIP	Scout	703711	738169
03/05/2022	52:47.5	22	Noise	PIPPIP	Scout	703687	738145
03/05/2022	56:13.5	22	NoID	PIPPIP	Scout	703536	737973
03/05/2022	56:49.8	22	Noise	PIPPIP	Scout	703515	737946
03/05/2022	57:15.3	22	Noise	PIPPIP	Scout	703496	737922
03/05/2022	07:03.9	23	Noise	PIPPIP	Scout	703096	737335
03/05/2022	30:27.0	23	Noise	PIPPIP	Scout	701806	737019
03/05/2022	15:55.8	21	PIPPIP	PIPPIP	Scout	701906	736989
03/05/2022	16:16.7	21	PIPPIP	PIPPIP	Scout	701915	736986
03/05/2022	22:31.1	21	PIPPIP	PIPPIP	Scout	702139	736864
03/05/2022	29:25.0	21	PIPPIP	PIPPIP	Scout	702433	736767
03/05/2022	29:42.8	21	PIPPIP	PIPPIP	Scout	702433	736767
03/05/2022	29:51.3	21	PIPPIP	PIPPIP	Scout	702439	736768
03/05/2022	31:27.6	21	PIPPIP	PIPPIP	Scout	702556	736788
03/05/2022	33:20.2	21	PIPPIP	PIPPIP	Scout	702675	736821
03/05/2022	34:33.1	21	PIPPIP	PIPPIP	Scout	702732	736858
03/05/2022	36:39.0	21	PIPPIP	PIPPIP	Scout	702846	736965
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03/05/2022	39:03.4	21	PIPPIP	PIPPIP	Scout	702929	737089
03/05/2022	39:14.7	21	PIPPIP	PIPPIP	Scout	702938	737103
03/05/2022	39:57.5	21	PIPPIP	PIPPIP	Scout	702968	737147
03/05/2022	42:57.6	21	PIPPIP	PIPPIP	Scout	703090	737331
03/05/2022	43:18.9	21	PIPPIP	PIPPIP	Scout	703104	737353
03/05/2022	43:26.9	21	PIPPIP	PIPPIP	Scout	703113	737368
03/05/2022	43:48.9	21	PIPPIP	PIPPIP	Scout	703128	737391
03/05/2022	44:19.1	21	PIPPIP	PIPPIP	Scout	703147	737420
03/05/2022	44:38.0	21	PIPPIP	PIPPIP	Scout	703162	737443
03/05/2022	45:44.5	21	PIPPIP	PIPPIP	Scout	703207	737512
03/05/2022	45:54.9	21	PIPPIP	PIPPIP	Scout	703214	737522
03/05/2022	46:25.1	21	PIPPIP	PIPPIP	Scout	703235	737552
03/05/2022	46:37.2	21	PIPPIP	PIPPIP	Scout	703242	737565
03/05/2022	48:23.9	21	PIPPIP	PIPPIP	Scout	703312	737669
03/05/2022	48:34.6	21	PIPPIP	PIPPIP	Scout	703319	737679
03/05/2022	51:53.3	21	PIPPIP	PIPPIP	Scout	703343	737713
03/05/2022	52:25.6	21	PIPPIP	PIPPIP	Scout	703366	737745
03/05/2022	52:56.6	21	PIPPIP	PIPPIP	Scout	703388	737777
03/05/2022	53:31.9	21	PIPPIP	PIPPIP	Scout	703415	737814
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03/05/2022	55:28.6	21	PIPPIP	PIPPIP	Scout	703496	737928
03/05/2022	56:51.9	21	PIPPIP	PIPPIP	Scout	703562	738015

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03/05/2022	18:46.6	22	PIPPIP	PIPPIP	Scout	704171	738395
03/05/2022	20:24.1	22	PIPPIP	PIPPIP	Scout	704287	738369
03/05/2022	23:07.3	22	PIPPIP	PIPPIP	Scout	704477	738302
03/05/2022	23:58.2	22	PIPPIP	PIPPIP	Scout	704524	738286
03/05/2022	24:43.3	22	PIPPIP	PIPPIP	Scout	704550	738275
03/05/2022	25:04.5	22	PIPPIP	PIPPIP	Scout	704570	738273
03/05/2022	25:30.2	22	PIPPIP	PIPPIP	Scout	704592	738271
03/05/2022	32:17.4	22	PIPPIP	PIPPIP	Scout	704855	738186
03/05/2022	32:24.2	22	PIPPIP	PIPPIP	Scout	704844	738192
03/05/2022	32:35.7	22	PIPPIP	PIPPIP	Scout	704838	738191
03/05/2022	32:46.3	22	PIPPIP	PIPPIP	Scout	704837	738192
03/05/2022	32:56.9	22	PIPPIP	PIPPIP	Scout	704837	738192
03/05/2022	33:17.4	22	PIPPIP	PIPPIP	Scout	704834	738192
03/05/2022	33:29.2	22	PIPPIP	PIPPIP	Scout	704833	738192
03/05/2022	33:39.9	22	PIPPIP	PIPPIP	Scout	704833	738192
03/05/2022	33:50.4	22	PIPPIP	PIPPIP	Scout	704833	738193
03/05/2022	34:01.6	22	PIPPIP	PIPPIP	Scout	704832	738194
03/05/2022	34:14.2	22	PIPPIP	PIPPIP	Scout	704832	738195
03/05/2022	34:18.2	22	PIPPIP	PIPPIP	Scout	704832	738195
03/05/2022	34:36.9	22	PIPPIP	PIPPIP	Scout	704822	738198
03/05/2022	35:09.2	22	PIPPIP	PIPPIP	Scout	704797	738205
03/05/2022	38:46.2	22	PIPPIP	PIPPIP	Scout	704580	738269
03/05/2022	39:03.6	22	PIPPIP	PIPPIP	Scout	704560	738273
03/05/2022	39:20.7	22	PIPPIP	PIPPIP	Scout	704537	738279
03/05/2022	44:30.4	22	PIPPIP	PIPPIP	Scout	704195	738389
03/05/2022	47:19.7	22	PIPPIP	PIPPIP	Scout	704008	738375
03/05/2022	47:51.0	22	PIPPIP	PIPPIP	Scout	703968	738361
03/05/2022	51:30.9	22	PIPPIP	PIPPIP	Scout	703746	738208
03/05/2022	51:57.1	22	PIPPIP	PIPPIP	Scout	703729	738191
03/05/2022	52:25.4	22	PIPPIP	PIPPIP	Scout	703699	738158
03/05/2022	52:35.7	22	PIPPIP	PIPPIP	Scout	703691	738149
03/05/2022	54:11.0	22	PIPPIP	PIPPIP	Scout	703617	738070
03/05/2022	55:36.8	22	PIPPIP	PIPPIP	Scout	703558	738001
03/05/2022	56:03.4	22	PIPPIP	PIPPIP	Scout	703542	737977
03/05/2022	56:24.3	22	PIPPIP	PIPPIP	Scout	703527	737963
03/05/2022	56:34.9	22	PIPPIP	PIPPIP	Scout	703521	737954
03/05/2022	00:47.7	23	PIPPIP	PIPPIP	Scout	703344	737704
03/05/2022	02:43.2	23	PIPPIP	PIPPIP	Scout	703258	737580
03/05/2022	02:56.6	23	PIPPIP	PIPPIP	Scout	703250	737566
03/05/2022	03:07.7	23	PIPPIP	PIPPIP	Scout	703244	737558
03/05/2022	06:29.6	23	PIPPIP	PIPPIP	Scout	703109	737353
03/05/2022	06:53.2	23	PIPPIP	PIPPIP	Scout	703098	737338
03/05/2022	07:10.0	23	PIPPIP	PIPPIP	Scout	703086	737322
03/05/2022	19:33.9	23	PIPPIP	PIPPIP	Scout	702470	736767
03/05/2022	19:44.2	23	PIPPIP	PIPPIP	Scout	702464	736766
03/05/2022	20:01.3	23	PIPPIP	PIPPIP	Scout	702440	736765
03/05/2022	20:08.7	23	PIPPIP	PIPPIP	Scout	702426	736765
03/05/2022	23:07.7	23	PIPPIP	PIPPIP	Scout	702237	736805
03/05/2022	24:20.8	23	PIPPIP	PIPPIP	Scout	702180	736840
03/05/2022	24:31.4	23	PIPPIP	PIPPIP	Scout	702176	736843
03/05/2022	25:27.7	23	PIPPIP	PIPPIP	Scout	702115	736878
03/05/2022	25:33.7	23	PIPPIP	PIPPIP	Scout	702103	736886
03/05/2022	23:30:33	23	PIPPIP	PIPPIP	Scout	701789	737019
03/05/2022	30:44.7	23	PIPPIP	PIPPIP	Scout	701776	737020
03/05/2022	30:59.6	23	PIPPIP	PIPPIP	Scout	701759	737021
03/05/2022	54:57.5	21	NoID	PIPPIP	Scout	703477	737902
03/05/2022	54:20.1	22	NoID	PIPPIP	Scout	703618	738069
03/05/2022	55:21.4	22	Noise	PIPPIP	Scout	703577	738022
03/05/2022	55:59.4	22	Noise	PIPPIP	Scout	703548	737986
02/05/2022	22:38:37	22	NoID	PIPPYG	M2	709019	738178

02/05/2022	21:09:51	21	NoID	PIPPYG	M2	709030	738182
02/05/2022	21:21:54	21	NoID	PIPPYG	M2	709038	738187
02/05/2022	21:22:35	21	NoID	PIPPYG	M2	709038	738181
02/05/2022	21:29:42	21	NoID	PIPPYG	M2	709037	738184
02/05/2022	21:31:41	21	NoID	PIPPYG	M2	709047	738188
02/05/2022	21:31:48	21	NoID	PIPPYG	M2	709050	738189
02/05/2022	21:42:55	21	Noise	PIPPYG	M2	709029	738184
02/05/2022	23:44:13	23	NoID	PIPPYG	M2	705278	738009
02/05/2022	21:25:51	21	Noise	PIPPYG	M2	709038	738187
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02/05/2022	21:40:30	21	Noise	PIPPYG	M2	709039	738186
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02/05/2022	23:39:30	23	PIPPYG	PIPPYG	M2	705639	737918
02/05/2022	23:51:33	23	PIPPYG	PIPPYG	M2	704979	738130
02/05/2022	23:51:38	23	PIPPYG	PIPPYG	M2	704979	738126
02/05/2022	23:53:24	23	PIPPYG	PIPPYG	M2	704981	738128
03/05/2022	54:57.5	21	NoID	PIPPYG	Scout	703477	737902
03/05/2022	54:20.1	22	NoID	PIPPYG	Scout	703618	738069
03/05/2022	55:21.4	22	Noise	PIPPYG	Scout	703577	738022
03/05/2022	55:59.4	22	Noise	PIPPYG	Scout	703548	737986
03/05/2022	30:35.5	21	Noise	PIPPYG	Scout	702488	736773
03/05/2022	41:44.0	21	Noise	PIPPYG	Scout	703042	737260
03/05/2022	17:23.4	22	NoID	PIPPYG	Scout	704083	738385
03/05/2022	37:14.3	22	Noise	PIPPYG	Scout	704672	738247
03/05/2022	51:19.9	22	NoID	PIPPYG	Scout	703761	738218
03/05/2022	54:48.6	22	Noise	PIPPYG	Scout	703603	738054
03/05/2022	04:50.2	23	Noise	PIPPYG	Scout	703178	737458
03/05/2022	18:55.7	23	NoID	PIPPYG	Scout	702518	736775
03/05/2022	21:18.3	23	Noise	PIPPYG	Scout	702352	736770
03/05/2022	22:23.1	21	PIPPYG	PIPPYG	Scout	702136	736867
03/05/2022	23:41.4	21	PIPPYG	PIPPYG	Scout	702171	736845
03/05/2022	30:00.5	21	PIPPYG	PIPPYG	Scout	702455	736769
03/05/2022	30:10.8	21	PIPPYG	PIPPYG	Scout	702467	736770
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03/05/2022	32:44.6	21	PIPPYG	PIPPYG	Scout	702650	736817
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03/05/2022	36:49.1	21	PIPPYG	PIPPYG	Scout	702851	736971
03/05/2022	37:28.8	21	PIPPYG	PIPPYG	Scout	702879	737014
03/05/2022	37:39.7	21	PIPPYG	PIPPYG	Scout	702887	737026
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03/05/2022	40:25.6	21	PIPPYG	PIPPYG	Scout	702989	737179
03/05/2022	40:40.1	21	PIPPYG	PIPPYG	Scout	703000	737197
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03/05/2022	41:11.7	21	PIPPYG	PIPPYG	Scout	703022	737229
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03/05/2022	41:32.7	21	PIPPYG	PIPPYG	Scout	703037	737251
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03/05/2022	42:23.1	21	PIPPYG	PIPPYG	Scout	703070	737303
03/05/2022	43:38.3	21	PIPPYG	PIPPYG	Scout	703120	737380
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03/05/2022	46:58.5	21	PIPPYG	PIPPYG	Scout	703256	737587
03/05/2022	47:09.0	21	PIPPYG	PIPPYG	Scout	703263	737597
03/05/2022	47:25.6	21	PIPPYG	PIPPYG	Scout	703273	737610
03/05/2022	47:36.3	21	PIPPYG	PIPPYG	Scout	703277	737615
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03/05/2022	48:03.3	21	PIPPYG	PIPPYG	Scout	703298	737648
03/05/2022	48:13.4	21	PIPPYG	PIPPYG	Scout	703305	737657
03/05/2022	48:55.5	21	PIPPYG	PIPPYG	Scout	703328	737691
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03/05/2022	50:04.7	21	PIPPYG	PIPPYG	Scout	703335	737701
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03/05/2022	52:03.7	21	PIPPYG	PIPPYG	Scout	703350	737723
03/05/2022	52:15.0	21	PIPPYG	PIPPYG	Scout	703357	737732
03/05/2022	52:46.0	21	PIPPYG	PIPPYG	Scout	703381	737767
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03/05/2022	54:14.4	21	PIPPYG	PIPPYG	Scout	703445	737859
03/05/2022	54:25.9	21	PIPPYG	PIPPYG	Scout	703454	737872
03/05/2022	54:36.6	21	PIPPYG	PIPPYG	Scout	703461	737881
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03/05/2022	55:36.7	21	PIPPYG	PIPPYG	Scout	703508	737942
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03/05/2022	55:57.6	21	PIPPYG	PIPPYG	Scout	703524	737963
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03/05/2022	56:18.9	21	PIPPYG	PIPPYG	Scout	703538	737982
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03/05/2022	56:59.4	21	PIPPYG	PIPPYG	Scout	703571	738025
03/05/2022	57:09.6	21	PIPPYG	PIPPYG	Scout	703576	738031
03/05/2022	57:19.1	21	PIPPYG	PIPPYG	Scout	703588	738047
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03/05/2022	58:03.5	21	PIPPYG	PIPPYG	Scout	703625	738090
03/05/2022	58:13.8	21	PIPPYG	PIPPYG	Scout	703634	738100

03/05/2022	58:24.0	21	PIPPYG	PIPPYG	Scout	703643	738110
03/05/2022	58:35.2	21	PIPPYG	PIPPYG	Scout	703653	738121
03/05/2022	58:45.4	21	PIPPYG	PIPPYG	Scout	703662	738130
03/05/2022	58:55.9	21	PIPPYG	PIPPYG	Scout	703672	738143
03/05/2022	59:11.2	21	PIPPYG	PIPPYG	Scout	703688	738158
03/05/2022	00:21.6	22	PIPPYG	PIPPYG	Scout	703745	738214
03/05/2022	00:31.2	22	PIPPYG	PIPPYG	Scout	703761	738221
03/05/2022	16:55.6	22	PIPPYG	PIPPYG	Scout	704074	738387
03/05/2022	23:31.6	22	PIPPYG	PIPPYG	Scout	704509	738294
03/05/2022	25:57.3	22	PIPPYG	PIPPYG	Scout	704625	738260
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03/05/2022	26:40.2	22	PIPPYG	PIPPYG	Scout	704675	738248
03/05/2022	27:06.6	22	PIPPYG	PIPPYG	Scout	704700	738241
03/05/2022	35:49.1	22	PIPPYG	PIPPYG	Scout	704755	738222
03/05/2022	36:46.5	22	PIPPYG	PIPPYG	Scout	704698	738240
03/05/2022	36:56.1	22	PIPPYG	PIPPYG	Scout	704689	738243
03/05/2022	37:03.5	22	PIPPYG	PIPPYG	Scout	704675	738246
03/05/2022	37:17.3	22	PIPPYG	PIPPYG	Scout	704660	738250
03/05/2022	37:35.2	22	PIPPYG	PIPPYG	Scout	704650	738251
03/05/2022	37:46.0	22	PIPPYG	PIPPYG	Scout	704642	738251
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03/05/2022	38:24.6	22	PIPPYG	PIPPYG	Scout	704603	738262
03/05/2022	48:16.2	22	PIPPYG	PIPPYG	Scout	703939	738349
03/05/2022	51:49.8	22	PIPPYG	PIPPYG	Scout	703734	738197
03/05/2022	53:03.6	22	PIPPYG	PIPPYG	Scout	703670	738125
03/05/2022	53:19.6	22	PIPPYG	PIPPYG	Scout	703658	738113
03/05/2022	53:26.9	22	PIPPYG	PIPPYG	Scout	703650	738105
03/05/2022	53:39.1	22	PIPPYG	PIPPYG	Scout	703637	738091
03/05/2022	53:50.0	22	PIPPYG	PIPPYG	Scout	703627	738081
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03/05/2022	54:29.3	22	PIPPYG	PIPPYG	Scout	703616	738067
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03/05/2022	54:53.9	22	PIPPYG	PIPPYG	Scout	703592	738040
03/05/2022	55:09.5	22	PIPPYG	PIPPYG	Scout	703581	738026
03/05/2022	55:48.2	22	PIPPYG	PIPPYG	Scout	703550	737989
03/05/2022	57:32.8	22	PIPPYG	PIPPYG	Scout	703478	737897
03/05/2022	57:43.6	22	PIPPYG	PIPPYG	Scout	703475	737892
03/05/2022	59:42.7	22	PIPPYG	PIPPYG	Scout	703386	737765
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03/05/2022	00:15.7	23	PIPPYG	PIPPYG	Scout	703366	737736
03/05/2022	00:31.7	23	PIPPYG	PIPPYG	Scout	703352	737716
03/05/2022	01:21.8	23	PIPPYG	PIPPYG	Scout	703318	737667
03/05/2022	02:10.0	23	PIPPYG	PIPPYG	Scout	703280	737615
03/05/2022	02:20.4	23	PIPPYG	PIPPYG	Scout	703274	737605
03/05/2022	02:32.3	23	PIPPYG	PIPPYG	Scout	703266	737593
03/05/2022	06:40.6	23	PIPPYG	PIPPYG	Scout	703108	737352
03/05/2022	07:21.5	23	PIPPYG	PIPPYG	Scout	703081	737314
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03/05/2022	10:08.2	23	PIPPYG	PIPPYG	Scout	702975	737148
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03/05/2022	11:04.9	23	PIPPYG	PIPPYG	Scout	702937	737090
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03/05/2022	12:51.2	23	PIPPYG	PIPPYG	Scout	702862	736976
03/05/2022	13:01.8	23	PIPPYG	PIPPYG	Scout	702855	736965
03/05/2022	13:57.4	23	PIPPYG	PIPPYG	Scout	702816	736909
03/05/2022	14:11.1	23	PIPPYG	PIPPYG	Scout	702803	736896
03/05/2022	14:21.6	23	PIPPYG	PIPPYG	Scout	702799	736893
03/05/2022	16:50.3	23	PIPPYG	PIPPYG	Scout	702645	736810
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03/05/2022	17:11.5	23	PIPPYG	PIPPYG	Scout	702632	736806
03/05/2022	17:21.1	23	PIPPYG	PIPPYG	Scout	702624	736804

03/05/2022	17:33.6	23	PIPPYG	PIPPYG	Scout	702619	736802
03/05/2022	17:52.3	23	PIPPYG	PIPPYG	Scout	702604	736797
03/05/2022	25:02.6	23	PIPPYG	PIPPYG	Scout	702135	736867
03/05/2022	26:10.2	23	PIPPYG	PIPPYG	Scout	702069	736906
03/05/2022	28:13.2	23	PIPPYG	PIPPYG	Scout	701934	736979

Transect 2

DATE	TIME	HOUR	AUTO ID*	MANUAL ID	MODEL	ITM Easting	ITM Northing
10/05/2022	25:50.3	22	NoID	MYODAU	Scout	702659	736809
05/05/2022	21:10:42	21	NYCLEI	NYCLEI	M2	704932	738145
05/05/2022	21:35:07	21	NYCLEI	NYCLEI	M2	704935	738154
05/05/2022	22:30:50	22	NYCLEI	NYCLEI	M2	704932	738147
05/05/2022	23:14:45	23	NYCLEI	NYCLEI	M2	707254	737671
05/05/2022	23:14:47	23	NYCLEI	NYCLEI	M2	707256	737672
05/05/2022	23:18:58	23	NYCLEI	NYCLEI	M2	707559	737810
05/05/2022	23:20:08	23	NYCLEI	NYCLEI	M2	707644	737848
10/05/2022	33:37.8	21	NoID	NYCLEI	Scout	704009	738380
10/05/2022	33:04.8	22	NoID	NYCLEI	Scout	702399	736766
10/05/2022	44:26.4	22	NoID	NYCLEI	Scout	702115	736873
10/05/2022	48:54.7	21	Noise	NYCLEI	Scout	703735	738199
10/05/2022	21:05.1	22	Noise	NYCLEI	Scout	702890	737024
10/05/2022	34:21.4	22	Noise	NYCLEI	Scout	702345	736771
10/05/2022	50:56.6	22	Noise	NYCLEI	Scout	701811	737015
10/05/2022	51:12.6	22	NoID	NYCLEI	Scout	701827	737011
10/05/2022	57:10.5	22	Noise	NYCLEI	Scout	702145	736861
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10/05/2022	22:30.6	21	NYCLEI	NYCLEI	Scout	704346	738343
10/05/2022	22:40.0	21	NYCLEI	NYCLEI	Scout	704346	738344
10/05/2022	22:58.1	21	NYCLEI	NYCLEI	Scout	704346	738344
10/05/2022	35:47.3	21	NYCLEI	NYCLEI	Scout	703906	738337
10/05/2022	35:53.4	21	NYCLEI	NYCLEI	Scout	703898	738332
10/05/2022	36:33.1	21	NYCLEI	NYCLEI	Scout	703895	738332
10/05/2022	37:47.4	21	NYCLEI	NYCLEI	Scout	703894	738332
10/05/2022	38:03.5	21	NYCLEI	NYCLEI	Scout	703894	738332
10/05/2022	38:15.7	21	NYCLEI	NYCLEI	Scout	703894	738332
10/05/2022	39:29.7	21	NYCLEI	NYCLEI	Scout	703816	738281
10/05/2022	41:42.0	21	NYCLEI	NYCLEI	Scout	703767	738226
10/05/2022	48:58.8	21	NYCLEI	NYCLEI	Scout	703732	738197
10/05/2022	49:48.2	21	NYCLEI	NYCLEI	Scout	703698	738160
10/05/2022	50:21.7	21	NYCLEI	NYCLEI	Scout	703686	738150
10/05/2022	51:36.8	21	NYCLEI	NYCLEI	Scout	703672	738137
10/05/2022	53:12.8	21	NYCLEI	NYCLEI	Scout	703667	738133
10/05/2022	54:45.0	21	NYCLEI	NYCLEI	Scout	703651	738114
10/05/2022	54:49.0	21	NYCLEI	NYCLEI	Scout	703649	738113
10/05/2022	54:59.3	21	NYCLEI	NYCLEI	Scout	703649	738113
10/05/2022	56:05.6	21	NYCLEI	NYCLEI	Scout	703649	738114
10/05/2022	56:11.6	21	NYCLEI	NYCLEI	Scout	703649	738114
10/05/2022	57:40.6	21	NYCLEI	NYCLEI	Scout	703618	738078
10/05/2022	58:07.7	21	NYCLEI	NYCLEI	Scout	703599	738057
10/05/2022	07:21.5	22	NYCLEI	NYCLEI	Scout	703293	737634
10/05/2022	07:33.1	22	NYCLEI	NYCLEI	Scout	703285	737623
10/05/2022	07:56.7	22	NYCLEI	NYCLEI	Scout	703285	737623
10/05/2022	08:28.8	22	NYCLEI	NYCLEI	Scout	703285	737623
10/05/2022	11:59.8	22	NYCLEI	NYCLEI	Scout	703187	737478
10/05/2022	15:20.4	22	NYCLEI	NYCLEI	Scout	703098	737344
10/05/2022	21:11.1	22	NYCLEI	NYCLEI	Scout	702882	737013
10/05/2022	26:01.3	22	NYCLEI	NYCLEI	Scout	702659	736809
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10/05/2022	32:43.5	22	NYCLEI	NYCLEI	Scout	702406	736767
10/05/2022	34:01.0	22	NYCLEI	NYCLEI	Scout	702366	736769
10/05/2022	48:53.7	22	NYCLEI	NYCLEI	Scout	701884	736995
10/05/2022	51:16.7	22	NYCLEI	NYCLEI	Scout	701840	737008
10/05/2022	57:26.0	22	NYCLEI	NYCLEI	Scout	702157	736853
10/05/2022	57:36.5	22	NYCLEI	NYCLEI	Scout	702157	736853
10/05/2022	06:58.8	23	NYCLEI	NYCLEI	Scout	702752	736862
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05/05/2022	21:41:21	21	NoID	PIPNAT	M2	704939	738141
06/05/2022	00:36:30	0	NoID	PIPPIP	M2	705480	737954
06/05/2022	00:40:07	0	Noise	PIPPIP	M2	705215	738040
06/05/2022	00:44:12	0	NoID	PIPPIP	M2	704918	738154
05/05/2022	21:31:36	21	PIPPIP	PIPPIP	M2	704933	738144
05/05/2022	21:31:47	21	PIPPIP	PIPPIP	M2	704934	738143
05/05/2022	21:33:09	21	PIPPIP	PIPPIP	M2	704937	738143
05/05/2022	22:16:38	22	PIPPIP	PIPPIP	M2	704938	738139
05/05/2022	22:18:29	22	PIPPIP	PIPPIP	M2	704941	738139
05/05/2022	22:21:14	22	NoID	PIPPIP	M2	704936	738144
05/05/2022	22:21:35	22	NoID	PIPPIP	M2	704932	738147
05/05/2022	22:23:17	22	PIPPIP	PIPPIP	M2	704933	738152
05/05/2022	22:23:44	22	PIPPIP	PIPPIP	M2	704936	738148
05/05/2022	22:40:59	22	NoID	PIPPIP	M2	704877	738183
05/05/2022	22:42:49	22	NoID	PIPPIP	M2	705014	738118
05/05/2022	22:53:59	22	Noise	PIPPIP	M2	705939	737835
05/05/2022	23:08:01	23	Noise	PIPPIP	M2	706812	737577
05/05/2022	23:50:19	23	NoID	PIPPIP	M2	708384	738081
06/05/2022	00:07:09	0	PIPPIP	PIPPIP	M2	707377	737737
06/05/2022	00:19:21	0	PIPPIP	PIPPIP	M2	706470	737662
06/05/2022	00:19:46	0	PIPPIP	PIPPIP	M2	706438	737673
06/05/2022	00:20:00	0	PIPPIP	PIPPIP	M2	706420	737684
06/05/2022	00:21:33	0	PIPPIP	PIPPIP	M2	706298	737720
06/05/2022	00:21:43	0	PIPPIP	PIPPIP	M2	706286	737724
06/05/2022	00:26:25	0	PIPPIP	PIPPIP	M2	706146	737775
06/05/2022	00:26:34	0	PIPPIP	PIPPIP	M2	706135	737778
06/05/2022	00:26:48	0	PIPPIP	PIPPIP	M2	706119	737781
06/05/2022	00:27:23	0	PIPPIP	PIPPIP	M2	706094	737799
06/05/2022	00:28:52	0	PIPPIP	PIPPIP	M2	705986	737833
06/05/2022	00:29:04	0	PIPPIP	PIPPIP	M2	705971	737835
06/05/2022	00:29:08	0	PIPPIP	PIPPIP	M2	705964	737837
06/05/2022	00:29:15	0	PIPPIP	PIPPIP	M2	705955	737843
06/05/2022	00:29:53	0	PIPPIP	PIPPIP	M2	705931	737848
06/05/2022	00:30:11	0	PIPPIP	PIPPIP	M2	705930	737846
06/05/2022	00:31:33	0	PIPPIP	PIPPIP	M2	705846	737863
06/05/2022	00:33:42	0	PIPPIP	PIPPIP	M2	705684	737906
06/05/2022	00:37:23	0	PIPPIP	PIPPIP	M2	705414	737973
06/05/2022	00:37:32	0	PIPPIP	PIPPIP	M2	705398	737975
06/05/2022	00:37:48	0	PIPPIP	PIPPIP	M2	705377	737976
06/05/2022	00:38:34	0	PIPPIP	PIPPIP	M2	705319	737998
06/05/2022	00:38:51	0	PIPPIP	PIPPIP	M2	705297	738002
06/05/2022	00:39:33	0	PIPPIP	PIPPIP	M2	705246	738027
06/05/2022	00:41:06	0	PIPPIP	PIPPIP	M2	705147	738072
06/05/2022	00:42:03	0	PIPPIP	PIPPIP	M2	705089	738100
06/05/2022	00:42:17	0	PIPPIP	PIPPIP	M2	705071	738105
06/05/2022	00:44:51	0	PIPPIP	PIPPIP	M2	704871	738182
05/05/2022	21:17:03	21	PIPPIP	PIPPIP	M2	704943	738138
05/05/2022	21:18:02	21	PIPPIP	PIPPIP	M2	704942	738140
05/05/2022	21:18:56	21	PIPPIP	PIPPIP	M2	704940	738141
05/05/2022	21:19:37	21	PIPPIP	PIPPIP	M2	704942	738140
05/05/2022	21:20:34	21	PIPPIP	PIPPIP	M2	704939	738144
05/05/2022	21:21:14	21	PIPPIP	PIPPIP	M2	704944	738137
05/05/2022	21:21:28	21	PIPPIP	PIPPIP	M2	704944	738138

05/05/2022	21:21:51	21	PIPPIP	PIPPIP	M2	704943	738139
05/05/2022	21:23:13	21	PIPPIP	PIPPIP	M2	704945	738134
05/05/2022	21:23:43	21	PIPPIP	PIPPIP	M2	704945	738135
05/05/2022	21:24:04	21	PIPPIP	PIPPIP	M2	704941	738136
05/05/2022	21:24:28	21	PIPPIP	PIPPIP	M2	704934	738143
05/05/2022	21:27:37	21	PIPPIP	PIPPIP	M2	704945	738138
05/05/2022	21:30:03	21	PIPPIP	PIPPIP	M2	704928	738146
05/05/2022	21:30:51	21	PIPPIP	PIPPIP	M2	704931	738146
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05/05/2022	21:32:14	21	PIPPIP	PIPPIP	M2	704938	738142
05/05/2022	21:32:21	21	PIPPIP	PIPPIP	M2	704939	738141
05/05/2022	21:32:37	21	PIPPIP	PIPPIP	M2	704938	738142
05/05/2022	21:32:44	21	PIPPIP	PIPPIP	M2	704938	738143
05/05/2022	21:32:50	21	PIPPIP	PIPPIP	M2	704936	738143
05/05/2022	21:33:22	21	PIPPIP	PIPPIP	M2	704937	738142
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05/05/2022	21:37:26	21	PIPPIP	PIPPIP	M2	704937	738145
05/05/2022	21:37:56	21	PIPPIP	PIPPIP	M2	704937	738144
05/05/2022	21:38:08	21	PIPPIP	PIPPIP	M2	704937	738143
05/05/2022	21:38:35	21	PIPPIP	PIPPIP	M2	704938	738141
05/05/2022	21:38:51	21	PIPPIP	PIPPIP	M2	704939	738140
05/05/2022	21:39:34	21	PIPPIP	PIPPIP	M2	704939	738143
05/05/2022	21:44:41	21	PIPPIP	PIPPIP	M2	704936	738143
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05/05/2022	21:56:00	21	PIPPIP	PIPPIP	M2	704934	738139
05/05/2022	22:05:02	22	PIPPIP	PIPPIP	M2	704936	738140
05/05/2022	22:05:27	22	PIPPIP	PIPPIP	M2	704933	738142
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05/05/2022	22:06:24	22	PIPPIP	PIPPIP	M2	704930	738142
05/05/2022	22:06:35	22	PIPPIP	PIPPIP	M2	704928	738146
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05/05/2022	22:12:28	22	PIPPIP	PIPPIP	M2	704936	738149
05/05/2022	22:12:33	22	PIPPIP	PIPPIP	M2	704937	738145
05/05/2022	22:12:45	22	PIPPIP	PIPPIP	M2	704938	738142
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05/05/2022	22:14:30	22	PIPPIP	PIPPIP	M2	704937	738145
05/05/2022	22:14:42	22	PIPPIP	PIPPIP	M2	704938	738143
05/05/2022	22:15:27	22	PIPPIP	PIPPIP	M2	704937	738142
05/05/2022	22:15:40	22	PIPPIP	PIPPIP	M2	704937	738143
05/05/2022	22:16:16	22	PIPPIP	PIPPIP	M2	704935	738142
05/05/2022	22:16:27	22	PIPPIP	PIPPIP	M2	704936	738140

05/05/2022	22:16:56	22	PIPPIP	PIPPIP	M2	704940	738140
05/05/2022	22:17:07	22	PIPPIP	PIPPIP	M2	704938	738141
05/05/2022	22:17:21	22	PIPPIP	PIPPIP	M2	704940	738141
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05/05/2022	22:18:18	22	PIPPIP	PIPPIP	M2	704945	738137
05/05/2022	22:18:50	22	PIPPIP	PIPPIP	M2	704935	738144
05/05/2022	22:19:02	22	PIPPIP	PIPPIP	M2	704934	738148
05/05/2022	22:19:10	22	PIPPIP	PIPPIP	M2	704935	738146
05/05/2022	22:19:19	22	PIPPIP	PIPPIP	M2	704935	738143
05/05/2022	22:19:31	22	PIPPIP	PIPPIP	M2	704940	738141
05/05/2022	22:19:42	22	PIPPIP	PIPPIP	M2	704938	738142
05/05/2022	22:19:53	22	PIPPIP	PIPPIP	M2	704935	738143
05/05/2022	22:20:07	22	PIPPIP	PIPPIP	M2	704940	738139
05/05/2022	22:20:19	22	PIPPIP	PIPPIP	M2	704942	738140
05/05/2022	22:20:30	22	PIPPIP	PIPPIP	M2	704942	738138
05/05/2022	22:20:41	22	PIPPIP	PIPPIP	M2	704938	738143
05/05/2022	22:20:51	22	PIPPIP	PIPPIP	M2	704938	738143
05/05/2022	22:22:30	22	PIPPIP	PIPPIP	M2	704923	738162
05/05/2022	22:22:54	22	PIPPIP	PIPPIP	M2	704925	738156
05/05/2022	22:23:04	22	PIPPIP	PIPPIP	M2	704927	738154
05/05/2022	22:23:57	22	PIPPIP	PIPPIP	M2	704932	738152
05/05/2022	22:24:03	22	PIPPIP	PIPPIP	M2	704930	738154
05/05/2022	22:24:12	22	PIPPIP	PIPPIP	M2	704930	738153
05/05/2022	22:24:24	22	PIPPIP	PIPPIP	M2	704932	738152
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05/05/2022	22:29:51	22	PIPPIP	PIPPIP	M2	704936	738150
05/05/2022	22:30:07	22	PIPPIP	PIPPIP	M2	704932	738153
05/05/2022	22:30:37	22	PIPPIP	PIPPIP	M2	704930	738148
05/05/2022	22:30:58	22	PIPPIP	PIPPIP	M2	704932	738150
05/05/2022	22:31:12	22	PIPPIP	PIPPIP	M2	704926	738153
05/05/2022	22:37:32	22	PIPPIP	PIPPIP	M2	704871	738184
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05/05/2022	22:41:46	22	PIPPIP	PIPPIP	M2	704926	738154
05/05/2022	22:42:09	22	PIPPIP	PIPPIP	M2	704962	738137
05/05/2022	22:44:04	22	PIPPIP	PIPPIP	M2	705107	738076
05/05/2022	22:49:12	22	PIPPIP	PIPPIP	M2	705552	737928
05/05/2022	22:50:59	22	PIPPIP	PIPPIP	M2	705693	737894
05/05/2022	22:51:17	22	PIPPIP	PIPPIP	M2	705714	737887
05/05/2022	22:51:27	22	PIPPIP	PIPPIP	M2	705729	737884
05/05/2022	22:51:40	22	PIPPIP	PIPPIP	M2	705747	737880
05/05/2022	22:51:42	22	PIPPIP	PIPPIP	M2	705749	737879
05/05/2022	22:53:51	22	PIPPIP	PIPPIP	M2	705927	737839
05/05/2022	22:54:01	22	PIPPIP	PIPPIP	M2	705941	737834
05/05/2022	22:54:06	22	PIPPIP	PIPPIP	M2	705949	737831
05/05/2022	22:55:44	22	PIPPIP	PIPPIP	M2	706079	737804
05/05/2022	22:59:50	22	PIPPIP	PIPPIP	M2	706225	737744
05/05/2022	22:59:55	22	PIPPIP	PIPPIP	M2	706233	737741
05/05/2022	22:59:57	22	PIPPIP	PIPPIP	M2	706236	737741
05/05/2022	23:00:06	23	PIPPIP	PIPPIP	M2	706246	737736
05/05/2022	23:00:10	23	PIPPIP	PIPPIP	M2	706251	737735
05/05/2022	23:01:10	23	PIPPIP	PIPPIP	M2	706330	737705
05/05/2022	23:08:05	23	PIPPIP	PIPPIP	M2	706818	737578
05/05/2022	23:08:08	23	PIPPIP	PIPPIP	M2	706822	737578
05/05/2022	23:08:45	23	PIPPIP	PIPPIP	M2	706871	737582
05/05/2022	23:10:58	23	PIPPIP	PIPPIP	M2	707040	737596

05/05/2022	23:11:36	23	PIPPIP	PIPPIP	M2	707093	737609
05/05/2022	23:14:33	23	PIPPIP	PIPPIP	M2	707241	737665
05/05/2022	23:19:26	23	PIPPIP	PIPPIP	M2	707591	737825
05/05/2022	23:32:23	23	PIPPIP	PIPPIP	M2	708388	738078
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05/05/2022	23:59:23	23	PIPPIP	PIPPIP	M2	707666	737863
05/05/2022	23:59:29	23	PIPPIP	PIPPIP	M2	707658	737859
06/05/2022	00:34:04	0	NoID	PIPPIP	M2	705655	737911
05/05/2022	22:15:46	22	PIPPIP	PIPPIP	M2	704936	738143
10/05/2022	33:25.8	21	Noise	PIPPIP	Scout	704010	738380
10/05/2022	35:27.2	21	Noise	PIPPIP	Scout	703925	738347
10/05/2022	34:11.4	22	Noise	PIPPIP	Scout	702359	736770
10/05/2022	56:10.2	22	NoID	PIPPIP	Scout	702085	736898
10/05/2022	57:50.5	22	PIPNAT	PIPPIP	Scout	702164	736849
10/05/2022	40:34.7	23	PIPNAT	PIPPIP	Scout	704573	738271
10/05/2022	26:42.7	21	PIPPIP	PIPPIP	Scout	704152	738394
10/05/2022	28:08.2	21	PIPPIP	PIPPIP	Scout	704096	738394
10/05/2022	28:16.3	21	PIPPIP	PIPPIP	Scout	704087	738390
10/05/2022	28:20.3	21	PIPPIP	PIPPIP	Scout	704082	738385
10/05/2022	28:30.5	21	PIPPIP	PIPPIP	Scout	704082	738383
10/05/2022	28:40.7	21	PIPPIP	PIPPIP	Scout	704082	738382
10/05/2022	28:54.8	21	PIPPIP	PIPPIP	Scout	704082	738382
10/05/2022	28:58.8	21	PIPPIP	PIPPIP	Scout	704082	738382
10/05/2022	29:22.6	21	PIPPIP	PIPPIP	Scout	704082	738383
10/05/2022	29:27.6	21	PIPPIP	PIPPIP	Scout	704082	738383
10/05/2022	29:39.7	21	PIPPIP	PIPPIP	Scout	704083	738383
10/05/2022	29:43.7	21	PIPPIP	PIPPIP	Scout	704083	738383
10/05/2022	29:51.6	21	PIPPIP	PIPPIP	Scout	704083	738383
10/05/2022	30:02.2	21	PIPPIP	PIPPIP	Scout	704082	738383
10/05/2022	30:10.2	21	PIPPIP	PIPPIP	Scout	704082	738383
10/05/2022	30:17.9	21	PIPPIP	PIPPIP	Scout	704081	738383
10/05/2022	30:33.2	21	PIPPIP	PIPPIP	Scout	704081	738383
10/05/2022	30:43.2	21	PIPPIP	PIPPIP	Scout	704080	738384
10/05/2022	31:09.8	21	PIPPIP	PIPPIP	Scout	704081	738384
10/05/2022	31:21.5	21	PIPPIP	PIPPIP	Scout	704081	738384
10/05/2022	31:32.8	21	PIPPIP	PIPPIP	Scout	704082	738384
10/05/2022	31:40.8	21	PIPPIP	PIPPIP	Scout	704082	738384
10/05/2022	31:49.3	21	PIPPIP	PIPPIP	Scout	704082	738384
10/05/2022	31:58.5	21	PIPPIP	PIPPIP	Scout	704076	738384
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10/05/2022	32:20.1	21	PIPPIP	PIPPIP	Scout	704059	738386
10/05/2022	32:30.6	21	PIPPIP	PIPPIP	Scout	704048	738385
10/05/2022	32:40.9	21	PIPPIP	PIPPIP	Scout	704037	738383
10/05/2022	32:52.6	21	PIPPIP	PIPPIP	Scout	704026	738381
10/05/2022	33:15.1	21	PIPPIP	PIPPIP	Scout	704010	738380
10/05/2022	33:48.3	21	PIPPIP	PIPPIP	Scout	704009	738380
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10/05/2022	33:36.3	22	PIPPIP	PIPPIP	Scout	702388	736767
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10/05/2022	43:58.5	22	PIPPIP	PIPPIP	Scout	702115	736874
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10/05/2022	44:47.7	22	PIPPIP	PIPPIP	Scout	702115	736873
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10/05/2022	46:04.0	22	PIPPIP	PIPPIP	Scout	702077	736901
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10/05/2022	55:04.4	22	PIPPIP	PIPPIP	Scout	702078	736903
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10/05/2022	01:43.3	23	PIPPIP	PIPPIP	Scout	702413	736765
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10/05/2022	40:55.0	22	PIPNAT	PIPPYG	Scout	702120	736878
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10/05/2022	48:26.2	21	PIPPYG	PIPPYG	Scout	703755	738213
10/05/2022	50:50.6	21	PIPPYG	PIPPYG	Scout	703681	738145
10/05/2022	51:00.8	21	PIPPYG	PIPPYG	Scout	703681	738145
10/05/2022	58:15.0	21	PIPPYG	PIPPYG	Scout	703598	738056
10/05/2022	58:23.0	21	PIPPYG	PIPPYG	Scout	703598	738056
10/05/2022	58:55.8	21	PIPPYG	PIPPYG	Scout	703584	738040
10/05/2022	59:17.2	21	PIPPYG	PIPPYG	Scout	703571	738024
10/05/2022	59:24.0	21	PIPPYG	PIPPYG	Scout	703564	738014
10/05/2022	59:34.4	21	PIPPYG	PIPPYG	Scout	703563	738014
10/05/2022	59:45.6	21	PIPPYG	PIPPYG	Scout	703563	738014
10/05/2022	30:12.3	22	PIPPYG	PIPPYG	Scout	702597	736797
10/05/2022	33:14.9	22	PIPPYG	PIPPYG	Scout	702394	736767
10/05/2022	40:01.1	22	PIPPYG	PIPPYG	Scout	702119	736877
10/05/2022	40:09.2	22	PIPPYG	PIPPYG	Scout	702119	736877
10/05/2022	40:14.4	22	PIPPYG	PIPPYG	Scout	702119	736877
10/05/2022	40:25.5	22	PIPPYG	PIPPYG	Scout	702119	736878
10/05/2022	40:37.0	22	PIPPYG	PIPPYG	Scout	702119	736878
10/05/2022	40:45.1	22	PIPPYG	PIPPYG	Scout	702119	736878
10/05/2022	41:05.3	22	PIPPYG	PIPPYG	Scout	702119	736877
10/05/2022	41:27.0	22	PIPPYG	PIPPYG	Scout	702113	736875
10/05/2022	41:38.9	22	PIPPYG	PIPPYG	Scout	702113	736874
10/05/2022	41:50.0	22	PIPPYG	PIPPYG	Scout	702113	736874
10/05/2022	42:31.1	22	PIPPYG	PIPPYG	Scout	702114	736873
10/05/2022	42:50.8	22	PIPPYG	PIPPYG	Scout	702114	736873
10/05/2022	43:35.9	22	PIPPYG	PIPPYG	Scout	702114	736873
10/05/2022	43:46.8	22	PIPPYG	PIPPYG	Scout	702115	736873
10/05/2022	44:04.4	22	PIPPYG	PIPPYG	Scout	702115	736874
10/05/2022	44:15.9	22	PIPPYG	PIPPYG	Scout	702115	736873
10/05/2022	45:11.2	22	PIPPYG	PIPPYG	Scout	702115	736873
10/05/2022	45:32.6	22	PIPPYG	PIPPYG	Scout	702099	736887
10/05/2022	01:10.8	23	PIPPYG	PIPPYG	Scout	702391	736764
10/05/2022	01:22.2	23	PIPPYG	PIPPYG	Scout	702391	736764
10/05/2022	04:23.0	23	PIPPYG	PIPPYG	Scout	702597	736794
10/05/2022	08:09.4	23	PIPPYG	PIPPYG	Scout	702814	736916

10/05/2022	24:24.3	23	PIPPYG	PIPPYG	Scout	703545	737990
10/05/2022	34:40.6	23	PIPPYG	PIPPYG	Scout	704148	738395
10/05/2022	36:31.2	23	PIPPYG	PIPPYG	Scout	704278	738364
10/05/2022	40:45.8	23	PIPPYG	PIPPYG	Scout	704584	738269
10/05/2022	41:01.1	23	PIPPYG	PIPPYG	Scout	704589	738268
05/05/2022	23:04:33	23	PLEAUR	PLEAUR	M2	706560	737623
10/05/2022	57:14.1	22	NoID	PLEAUR	Scout	702156	736853

9.5 Appendix 5 2025 Static Surveillance Results (Total number of bat passes recorded for each bat species noted).

Static No.	Common pipistrelle	Soprano pipistrelle	Nathusius' pipistrelle	Leisler's bat	Daubenton's bat	Natterer's bat	Brown long-eared bat
2025 Static 1	195	389	0	51	64	0	0
2025 Static 2	111	400	0	128	42	0	0
2025 Static 3	211	678	0	281	142	0	0
2025 Static 4	599	477	0	44	484	0	11
2025 Static 5	486	157	4	62	593	2	2
2025 Static 6	229	1301	0	159	1190	1	2
2025 Static 7	987	464	8	91	48	0	4
2025 Static 8	475	1452	8	273	34	0	11
2025 Static 9	26	97	1	14	0	0	0
2025 Static 10	195	203	5	167	12	0	3
2025 Static 11	211	273	0	110	193	0	12
2025 Static 12	306	74	0	91	13	0	8

9.6 Appendix 6 Tree PBRs (Wildlife Surveys Ireland Ltd. data)

Tree PRF Survey	Location	Details	PRF Value	ITM Easting	ITM Northing	Notes	PBR No.
25/09/2024	Between Collins Bridge & Pakenham Bridge	Sycamore, Lime	Value 2	702717	736853	Mature Sycamore & Lime trees	PBR 1
25/09/2024	Between Collins Bridge & Pakenham Bridge	x2 Oak	Value 2	703258	737601	Oaks with multiple crevices	PBR 2
25/09/2024	Between Collins Bridge & Pakenham Bridge	Ash, dead Ash	Value 2	702864	736973	Large ash, dying ash with peeling bark	PBR 3
25/09/2024	Between Collins Bridge & Pakenham Bridge	Ash, dead Ash	Value 2	703363	737751	Dead Ash with hollow, daying ash adjacent	PBR 4
25/09/2024	Between Collins Bridge & Pakenham Bridge	x2 dead Ash	Value 2	703483	737918	2 dead trees with hollows	PBR 5
25/09/2024	Between Collins Bridge & Pakenham Bridge	Row semi-mature trees	Value 3	703483	737918	Suitable for bat boxes	PBR 6
25/09/2024	Between Collins Bridge & Pakenham Bridge	Row of mature trees	Value 2	703536	737990	Oak, Ash and Beech trees with heavy ivy growth	PBR 7
25/09/2024	Between Collins Bridge & Pakenham Bridge	Dead tree	Value 2	703638	738107	Large dead tree with numerous cracks	PBR 8
25/09/2024	Deep Sink to Callaghan Bridge	Deciduous tree with ivy	Value 2	704491	738300	Large mature tree with ivy (Beech or Popular)	PBR 9
25/09/2024	Deep Sink to Callaghan Bridge	Sycamore and Ash	Value 2	704790	738214	Large sycamore and dying ash tree, both with heavy ivy	PBR 10
25/09/2024	Deep Sink to Callaghan Bridge	Sycamore	Value 2	705252	738013	Large Sycamore with ivy	PBR 11

25/09/2024	Deep Sink to Callaghan Bridge	Ash x4	Value 2	705458	737991	4 large Ash trees with decay and ivy	PBR 12
25/09/2024	Deep Sink to Callaghan Bridge	Ash, x2 Sycamore	Value 2	705991	737829	Ash - x2, dying, Sycamore with ivy	PBR 13
25/09/2024	Dr Troy Bridge to Kilpatrick Bridge	Trees x2 (unidentified)	Value 2	706623	737626	Ivy clad	PBR 14
25/09/2024	Dr Troy Bridge to Kilpatrick Bridge	Sycamore x3	Value 3	706717	737629	Route along Sheepmore Lane/Windmill Park lane - ivy on trees	PBR 15
25/09/2024	Kilpatrick Bridge to R806 Road Bridge	Ash x2	Value 2	707980	737980	Large Ash trees with ivy and damaged branches	PBR 16
25/09/2024	Kilpatrick Bridge to R806 Road Bridge	Treeline	Value 3	708138	738019	Suitable for bat boxes - adj to Castleknock Rail Station	PBR 17
25/09/2024	Kilpatrick Bridge to R806 Road Bridge	Ash	Value 2	708309	738066	Mature Ash tree (ivy) adj to Castleknock Rail Station	PBR 18
25/09/2024	R806 Road Bridge to Talbot Bridge	Ash	Value 2	708565	738110	Ash tree with ivy and damage	PBR 19

9.7 Appendix 6 Bat Assessment Tables

Table 4.1 Guidelines for assessing the potential suitability of proposed development sites for bats, based on the presence of habitat features within the landscape, to be applied using professional judgement.

Suitability	Description Roosting habitats	Commuting and foraging habitats
Negligible	Negligible habitat features on site likely to be used by roosting bats.	Negligible habitat features on site likely to be used by commuting or foraging bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions[a] and/or suitable surrounding habitat to be used on a regular basis or by larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation[b]). A tree of sufficient size and age to contain PRFs but with none seen from the ground or features seen with only very limited roosting potential.[c]	Habitat that could be used by small numbers of commuting bats such as a gappy hedgerow or unvegetated stream, but isolated, i.e. not very well connected to the surrounding landscape by other habitat. Suitable, but isolated habitat that could be used by small numbers of foraging bats such as a lone tree (not in a parkland situation) or a patch of scrub.
Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions[a] and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only – the assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).	Continuous habitat connected to the wider landscape that could be used by bats for commuting such as lines of trees and scrub or linked back gardens. Habitat that is connected to the wider landscape that could be used by bats for foraging such as trees, scrub, grassland or water.
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protection, conditions[a] and surrounding habitat.	Continuous, high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge. High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such as broadleaved woodland, tree-lined watercourses and grazed parkland. Site is close to and connected to known roosts.

[a] For example, in terms of temperature, humidity, height above ground level, light levels or levels of disturbance.
[b] Evidence from the Netherlands shows mass swarming events of common pipistrelle bats in the autumn followed by mass hibernation in a diverse range of building types in urban environments (Korsten *et al.*, 2015). This phenomenon requires some research in the UK but ecologists should be aware of the potential for larger numbers of this species to be present during the autumn and winter in large buildings in highly urbanised environments.
[c] This system of categorisation aligns with BS 8596:2015 Surveying for bats in trees and woodland (BSI, 2015).

Figure A: Table 4.1 (p 35) Reproduced from Collins (2016).

(1) Conversion, modification, demolition or removal of buildings (including hotels, schools, hospitals, churches, commercial premises and derelict buildings) which are:

- agricultural buildings (e.g. farmhouses, barns and outbuildings) of traditional brick or stone construction and/or with exposed wooden beams;
- buildings with weather boarding and/or hanging tiles that are within 200m of woodland and/or water;
- pre-1960 detached buildings and structures within 200m of woodland and/or water;
- pre-1914 buildings within 400m of woodland and/or water;
- pre-1914 buildings with gable ends or slate roofs, regardless of location;
- located within, or immediately adjacent to woodland and/or immediately adjacent to water;
- Dutch barns or livestock buildings with a single skin roof and board-and-gap or Yorkshire boarding if, following a preliminary roost assessment, the site appears to be particularly suited to bats.

(2) Development affecting built structures:

- tunnels, mines, kilns, ice-houses, adits, military fortifications, air-raid shelters, cellars and similar underground ducts and structures; unused industrial chimneys that are unlined and brick/stone construction;
- bridge structures, aqueducts and viaducts (especially over water and wet ground).

(3) Floodlighting of:

- churches and listed buildings, green space (e.g. sports pitches) within 50m of woodland, water, field hedgerows or lines of trees with connectivity to woodland or water;
- any building meeting the criteria listed in (1) above.

(4) Felling, removal or lopping of:

- woodland;
- field hedgerows and/or lines of trees with connectivity to woodland or water bodies;
- old and veteran trees that are more than 100 years old;
- mature trees with obvious holes, cracks or cavities, or that are covered with mature ivy (including large dead trees).

(5) Proposals affecting water bodies:

- in or within 200m of rivers, streams, canals, lakes, reed beds or other aquatic habitats.

(6) Proposals located in or immediately adjacent to:

- quarries or gravel pits;
- natural cliff faces and rock outcrops with crevices or caves and swallets.

(7) Proposals for wind farm developments of multiple wind turbines and single wind turbines (depending on the size and location) (NE TIN 051 – undergoing updates at the time of writing).

(8) All proposals in sites where bats are known to be present[1]

This may include proposed development affecting any type of buildings, structures, feature or location.

Notes:

1. Where sites are of international importance to bats, they may be designated as SACs. Developers of large sites 5–10km away from such SACs may be required to undertake a HRA.

Figure B: Reproduced from Collins (2016) – page 13.

Table 2 Factors affecting the probability of bats being present.

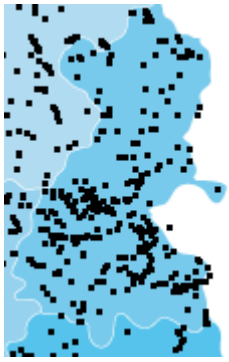
Factors affecting the probability of a building being used by bats in summer	
Increased probability	Disused or little used; largely undisturbed
	Large roof void with unobstructed flying spaces
	Large dimension roof timbers with cracks, joints and holes
	Uneven roof covering with gaps, though not too draughty
	Entrances that bats can fly in through
	Hanging tiles or wood cladding, especially on south-facing walls
	Rural setting
	Close to woodland and/or water
	Pre-20th century or early 20th century construction
	Roof warmed by the sun
	Within the distribution area of horseshoe bats
Decreased probability	Highly urbanised area with few feeding places
	Small or cluttered roof void (esp. for brown long-eared bat)
	Heavily disturbed
	Modern construction with few gaps around soffits or eaves (but be aware these may be used by pipistrelles in particular)
	Prefabricated with steel and sheet materials
	Active industrial premises
	Roof shaded from the sun
Factors affecting the probability of trees being used by roosting bats	
Increased probability	In ancient woodland or parkland
	Large trees with complex growth form
	Species that typically form cavities, such as beech, willow, oak or ash
	Visible damage caused by rot, wind, lightning strike *etc.*
	Loose bark providing cavities
Decreased probability	Coniferous plantation with no specimen trees
	Young trees with simple growth form and little damage
Factors affecting the probability of underground sites being used by roosting bats	
Increased probability	Large enough to develop stable temperature in winter
	High humidity
	Undisturbed
	Close to woodland or water (but note that bats will also use upland sites)
	Many cracks and crevices suitable for bats
Decreased probability	Small and draughty
	Heavily disturbed
	In urbanised areas
	Smooth surfaces with few roosting opportunities

Figure C: Table 2 Reproduced from Marnell *et al.* (2022).

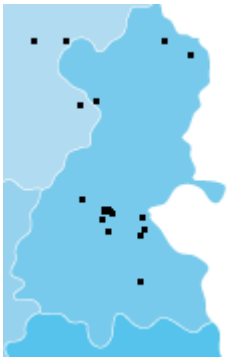
10. Bat Species Profile

10.1 Bat Conservation Ireland Bat Species Maps

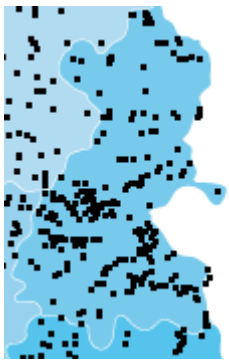
Bat records for County Dublin (Source: www.batconservationireland.org)



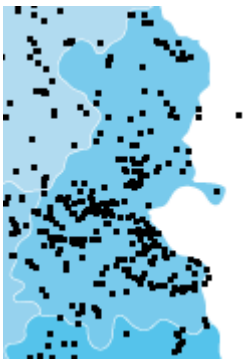
Common pipistrelle



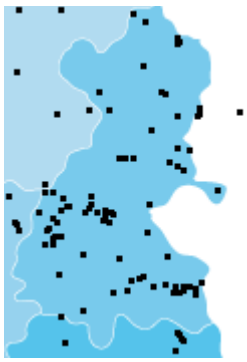
Nathusius' pipistrelle



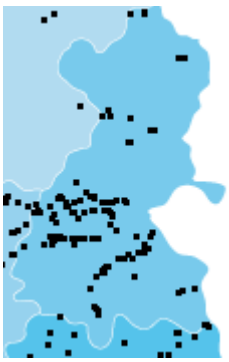
Soprano pipistrelle



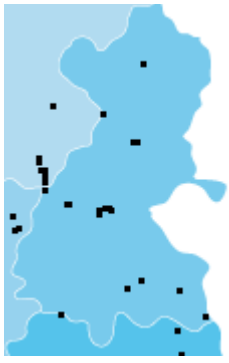
Leisler's bat



Brown long-eared bat



Daubenton's bat



Natterer's bat



Whiskered bat



Lesser horseshoe bat