

# Aquatic baseline report for Sheskin wind farm, Co. Mayo



Prepared by Triturus Environmental Ltd. for McCarthy Keville O'Sullivan Ltd.

**February 2022**

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Please cite as:

Triturus (2022). Aquatic baseline report for Sheskin wind farm, Co. Mayo. Report prepared by Triturus Environmental Ltd. for McCarthy Keville O'Sullivan Ltd. February 2022.

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## 1. Introduction

### 1.1 Background

Triturus Environmental Ltd. were commissioned by McCarthy Keville O'Sullivan Ltd. to conduct baseline aquatic surveys to inform EIAR preparation for the proposed Sheskin wind farm project. The following report provides a baseline assessment of the aquatic ecology including fisheries and biological water quality, as well as protected aquatic species and habitats in the vicinity of the proposed Sheskin wind farm, located near Bellacorick, Co. Mayo.

Undertaken on a catchment-wide scale, the baseline surveys focused on aquatic habitats in relation to fisheries potential (including both salmonid and lamprey habitat), freshwater pearl mussel (*Margaritifera margaritifera*) (eDNA only), macro-invertebrates (biological water quality), macrophytes and aquatic bryophytes, aquatic invasive species, and fish of conservation value which may use the watercourses in the vicinity of the proposed project (**Figure 2.1**). Aquatic surveys were undertaken in September 2021.

The  $n=23$  aquatic survey sites were located within the located in the Owenmore\_SC\_010, Glenamoy\_SC\_010 and Munhin\_SC\_010 river sub-catchments. Whilst not located within a European site, the proposed wind farm site boundary (via several watercourses) shared downstream hydrological connectivity with the Glenamoy Bog Complex SAC (000500), Carrowmore Lake Complex SAC (000476), Bellacorick Bog Complex SAC (001922) and Carrowmore Lake SPA (004052).

### 1.2 Project description

A full description of the proposed project is provided in the accompanying EIAR.

## 2. Methodology

### 2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed wind farm project were considered as part of the current assessment. A total of  $n=20$  riverine sites and  $n=3$  lakes were selected for detailed aquatic assessment (see **Table 2.1**, **Figure 2.1** below). The nomenclature for the watercourses surveyed is as per the Environmental Protection Agency (EPA). Aquatic survey sites were present on the Baroosky River (EPA code: 33B08), Sheskin Stream (33S03), Glencullin River (33G03) and a number of unnamed tributaries (**Table 2.1**). The  $n=23$  aquatic survey sites were located within the located in the Owenmore\_SC\_010, Glenamoy\_SC\_010 and Munhin\_SC\_010 river sub-catchments.

Please note this aquatic report should be read in conjunction with the final Environmental Impact Assessment Report (EIAR) prepared for the proposed project. More specific aquatic methodology is outlined below and in the appendices of this report.

### 2.2 Aquatic site surveys

Surveys of the watercourses within the vicinity of the proposed wind farm project were conducted in September 2021. Survey effort focused on both instream and riparian habitats at each aquatic sampling location (see **Figure 2.1** above). Surveys at each of these sites included a fisheries assessment (electro-fishing, habitat appraisal), macrophyte & aquatic bryophyte surveys and (where suitable) biological water quality sampling (Q-sampling at riverine sites) (**Figure 2.1**). The presence of freshwater pearl mussel was assessed at each survey site with environmental DNA (eDNA) sampling undertaken for the species at  $n=3$  strategically chosen locations within the vicinity of the project. The survey approach ensured that any habitats and species of high conservation value would be detected to best inform mitigation for the wind farm project.

In addition to the ecological characteristics of the site, a broad aquatic and riparian habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). This broad characterisation helped define the watercourses conformity or departure from naturalness. All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. width, depth etc.) including associated evidence of historical drainage
- Substrate type, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type by proportion of riffle, glide and pool in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition

**Table 2.1** Location of  $n=23$  proposed aquatic survey sites in the vicinity of Sheskin wind farm near Bellacorick, Co. Mayo

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Baroosky River	33B08	Baroosky	493841	830134
A2	Baroosky River	33B08	Lenarevagh	493938	831276
B1	Unnamed stream	n/a	Sheskin	494915	827836
B2	Unnamed stream	n/a	Track crossing, Sheskin	495815	827205
B3	Unnamed stream	n/a	Track crossing, Sheskin	495736	827099
B4	Unnamed stream	n/a	Track crossing, Sheskin	495966	826856
B5	Unnamed stream	n/a	Track crossing, Sheskin	495301	826499
B6	Sheskin Stream	33S03	Sheskin	493871	827069
B7	Unnamed stream	n/a	Sheskin	493682	826643
B8	Sheskin Stream	33S03	Sheskin	494856	826025
B9	Unnamed stream	n/a	Sheskin	494568	825526
B10	Unnamed stream	n/a	Sheskin	493101	826093
B11	Unnamed stream	n/a	Sheskin	492971	825534
B12	Unnamed stream	n/a	Track crossing, Sheskin	494477	825274
B13	Unnamed stream	n/a	Track crossing, Sheskin	494326	824824
B14	Unnamed stream	n/a	Sheskin	493528	824436
B15	Unnamed stream	n/a	Track crossing, Sheskin	494118	824329
B16	Sheskin Stream	33S03	Foot Bridge	497504	824013
C1	Glencullin River	33G03	Glencullin Upper	491828	825385
C2	Glencullin River	33G03	Glencullin Upper	490767	825811
L1	Unnamed lake	n/a	Sheskin	492781	825022
L2	Unnamed lake	n/a	Sheskin	492795	824586
L3	Unnamed lake	n/a	Sheskin	492795	824462

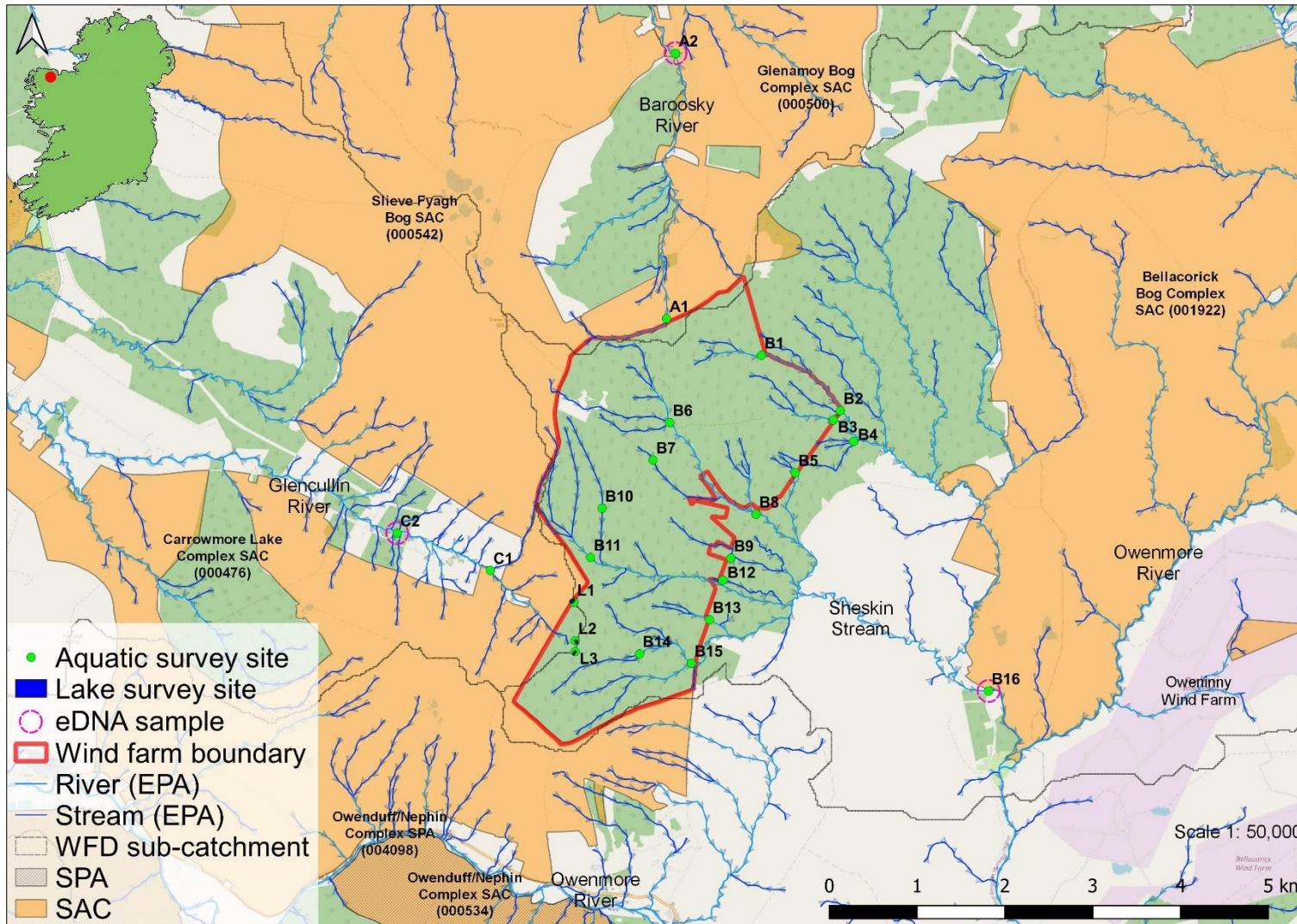


Figure 2.1 Overview of the  $n=23$  aquatic survey site and biological water quality sampling locations for the proposed Sheskin wind farm project, Co. Mayo



### 2.3 Catchment-wide electro-fishing

A catchment-wide electro-fishing (CWEF) survey of the watercourses within the vicinity of the proposed wind farm ( $n=20$  riverine sites, **Figure 2.1**) was conducted in September 2021, under the conditions of a Department of Communications, Climate Action & Environment (DCCA) licence. The survey was undertaken in accordance with best practice and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the watercourses in the vicinity of the proposed wind farm project (**Figure 2.1**) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and lamprey within the vicinity of the survey sites.

For detailed survey methodology, please refer to accompanying fisheries assessment report in **Appendix A**.

### 2.4 Freshwater pearl mussel survey

There are no known freshwater pearl mussel (*Margaritifera margaritifera*) records in the Owenmore\_SC\_010, Glenamoy\_SC\_010 and Munhin\_SC\_010 river sub-catchments. This was based on an extensive literature review and also examination of the NPWS sensitive species data requests. However, following to the precautionary principle and to account for any lacunae in data for the species, environmental DNA (eDNA) samples were collected from the Baroosky River, Glencullen River and Sheskin Stream (Owenmore tributary) and analysed for freshwater pearl mussel eDNA to confirm the species' absence within vicinity of the proposed wind farm site. Please refer to section 2.5 (eDNA analysis) below for further detail.

### 2.5 eDNA analysis

To validate site surveys and to detect potentially cryptically-low populations of freshwater pearl mussel within the study area,  $n=3$  composite water samples were collected from the Baroosky River, Sheskin Stream and Glencullen River and analysed for freshwater pearl mussel environmental DNA (eDNA) (**Figure 2.1**). Water samples were also collected from  $n=3$  survey lakes (sites L1, L2 & L3) and analysed for brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and smooth newt (*Lissotriton vulgaris*). The water samples were collected on 26<sup>th</sup> September 2021, with the sites strategically chosen to maximise longitudinal (instream) coverage within the catchment (i.e. facilitating a greater likelihood of species detection).

In accordance with best practice, a composite (500ml) water sample was collected from the sampling point, maximising the geographic spread at the site (20 x 25ml samples at each site), thus increasing the chance of detecting the target species' DNA. The composite sample was filtered on site using a sterile proprietary eDNA sampling kit. The fixed sample was stored at room temperature and sent to the laboratory for analysis with 48 hours of collection. A total of  $n=12$  qPCR replicates were analysed for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach does not provide quantitative data with regards to species abundance, it is an invaluable tool in clarifying a species' presence or absence. The detection of the target species' DNA indicates the



presence of the species at and or upstream of the sampling point. Please refer to **Appendix D** for full eDNA laboratory analysis methodology.

## 2.6 Biological water quality (Q-sampling)

The  $n=20$  riverine survey sites were assessed for biological water quality through Q-sampling in September 2021 (**Figure 2.1**). Macro-invertebrate samples were converted to Q-ratings as per Toner et al. (2005). All riverine samples were taken with a standard kick sampling hand net (250mm width, 500 $\mu$ m mesh size) from areas of riffle/glide utilising a three-minute sample. Large cobble was also washed at each site where present and samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Any rare invertebrate 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).

**Table 2.2** Reference categories for EPA Q-ratings (Q1 to Q5)

Q Value	WFD Status	Pollution status	Condition
Q5 or Q4-5	High status	Unpolluted	Satisfactory
Q4	Good status	Unpolluted	Satisfactory
Q3-4	Moderate status	Slightly polluted	Unsatisfactory
Q3 or Q2-3	Poor status	Moderately polluted	Unsatisfactory
Q2, Q1-2 or Q1	Bad status	Seriously polluted	Unsatisfactory

## 2.7 Lake macro-invertebrate communities

The  $n=3$  lake survey sites (L1, L2 & L3) were sampled for macro-invertebrates via sweep netting. A standard pond net (250mm width, mesh size 500 $\mu$ m) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the lake 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.

## 2.8 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the  $n=20$  riverine and  $n=3$  lake survey sites, with specimens collected (by hand or via grapnel) for on-site identification. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species or habitats corresponding to the Annex I habitat, 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitriche-Batrachion* (low water level during summer) or aquatic mosses [3260]' (more commonly referred to as 'floating river vegetation'). Additionally, the Annex II species slender naiad (*Najas flexilis*) was surveyed for at the three lake sites.

## 2.9 Otter signs

The presence of otter (*Lutra lutra*) at each aquatic survey site was determined through the recording of otter signs, if encountered incidentally during surveys. Notes on the age and location (ITM coordinates) were made for each otter sign recorded, in addition to the quantity and visible constituents of spraint (i.e. remains of fish, molluscs etc.).

## 2.10 Aquatic ecological evaluation

The evaluation of aquatic ecological receptors contained within this report uses the geographic scale and criteria defined in the 'Guidelines for Assessment of Ecological Impacts of National Road Schemes' (NRA, 2009).

## 2.11 Biosecurity

A strict biosecurity protocol including 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 between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced.

### 3. Receiving environment

#### 3.1 Sheskin wind farm catchment and survey area description

The proposed Sheskin wind farm is located in an upland area within the townlands of Sheskin in north-west County Mayo, approximately 6km north-west of Bellacorrick and 6km north-east of Bangor-Erris (**Figure 2.1**). The proposed wind farm site is within the Western River Basin District and within hydrometric area 33 (Blacksod - Broadhaven). The aquatic survey sites were located within the located in the Owenmore\_SC\_010, Glenamoy\_SC\_010 and Munhin\_SC\_010 river sub-catchments (**Figure 2.1**). The proposed wind farm site was drained by the Baroosky River (EPA code: 33B08), Sheskin Stream (33S03), Glencullin River (33G03) and a number of unnamed tributaries (**Table 2.1**).

The watercourses and aquatic surveys sites in the vicinity of Sheskin wind farm were typically small, upland eroding channels (FW1; Fossitt, 2000) and drainage ditches (FW4) (see **section 4** for more details). Land use practices in the wider survey area were primarily coniferous forestry (CORINE 312) bordered by peat bogs (412). In the wider survey area, the watercourses flowed over areas of Viséan sandstone, mudstone & evaporite (Geological Survey of Ireland data).

#### 3.2 Fisheries asset of the survey area

Whilst there was no fisheries data available for the Baroosky River, the downstream-connecting Glenamoy River (EPA code: 33G01) and wider Glenamoy catchment is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*), three-spined stickleback (*Gasterosteus aculeatus*) (Matson et al., 2018; Kelly et al., 2012). The river also supports sea trout (*Salmo trutta*) (McGinnity et al., 2003).

Whilst there was no fisheries data available for the Glencullin River, the downstream-connecting Carrowmore Lake and wider catchment is known to support Atlantic salmon, brown trout, sea trout, European eel, three-spined stickleback and minnow (*Phoxinus phoxinus*) (Connor et al., 2018; de Eyto et al., 2007).

The Owenmore River is a noted recreational salmon and sea trout fishery (O'Reilly, 2009) and, after several years of failure, was meeting its conservation limit for Atlantic salmon in 2020 (Gargan et al., 2021). The proposed wind farm site crosses a number of tributary streams of the Oweninny River (Owenmore River) which provides valuable salmon, sea trout and brown trout spawning and nursery habitat for the wider Owenmore River catchment (A. Donegan, IFI pers. comm., April 2021).

Fisheries data for the other (more minor) watercourses within the survey area was not available at the time of survey.

#### 3.3 Protected aquatic species data

A sensitive species data request was submitted to the National Parks and Wildlife Service for the 10km grid squares containing and adjoining the proposed wind farm project (i.e. F82, F92, F93) and was received on the 20<sup>th</sup> January 2022. A low number of records for a low number of rare or protected aquatic species were available, although none overlapped directly with the survey area (**Figure 3.1**).

A low number of otter (*lutra lutra*) records were available for the relevant grid squares, with records from the Oweninny River and Owenmore River (**Figure 3.1**). These records ranged from the 1990-2015 period (NPWS & NBDC data) and were situated in the lower gradient (lowland) areas of the respective catchments.

The Annex II macrophyte slender naiad (*Najas flexilis*) is known from Dahybaun Lough, approx. 6km south-east of the proposed wind farm site boundary (**Figure 3.1**). This lake shares no downstream hydrological connectivity with the proposed wind farm site.

The nationally rare (but unprotected) pondweed *Potamogeton x variifolius* (a hybrid between *Potamogeton natans* x *P. berchtoldii*) is known from the lower Glenamoy River (near Glenamoy Bridge) and the Munhin River (Owenmore River tributary) (**Figure 3.1**). These represent the only known Irish populations. Glenamoy Bridge is located approx. 11.5km downstream of the proposed wind farm site boundary.

Records for common frog (*Rana temporaria*) were widespread throughout 10km grid squares F82, F92, F93, although no records were available in the vicinity of the proposed wind farm. There were no records available for smooth newt (*Lissotriton vulgaris*) in the respective grid squares.

There are no known records for freshwater pearl mussel (*Margaritifera margaritifera*) in the F82, F92 or F93 10km grid squares or the Owenmore\_SC\_010, Glenamoy\_SC\_010 and Munhin\_SC\_010 river sub-catchments.

### 3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the proposed wind farm project. Only recent water quality (i.e. since 2015) is summarised below. There were no existing EPA biological monitoring data available for the smaller, unnamed watercourses surveyed.

Please note that biological water quality analysis was undertaken as part of this study, with the results presented in the **section 4** and **Appendix B** of this report.

#### 3.4.1 Baroosky River

The Baroosky River (EPA code: 33B08) drains north of the proposed wind farm site boundary before joining the Glenamoy River near Glenamoy village, which it joins approx. 6km downstream of the wind farm boundary. There was a single contemporary EPA biological monitoring station that had been recently monitored on the river. The Baroosky River achieved **Q4** (good status) at station RS33B080400 in 2020 (most recent monitoring period), approx. 5.5km downstream of the proposed wind farm boundary.

The Baroosky River (Barroosky\_010 river-waterbody) was of good WFD status in the 2013-2018 period but had a River Waterbodies Risk score of 'at risk' of achieving good ecological status (EPA data).

#### 3.4.2 Sheskin Stream

The Sheskin Stream (33S03), via a large number of first order tributaries, drains a large portion of the proposed wind farm site boundary, flowing in a south-westerly direction before joining the Owenmore

River (also known as the Oweninny River) approx. 6km downstream of the wind farm boundary. There was a single contemporary EPA biological monitoring station that had been recently monitored on the river. The Sheskin Stream achieved **Q4-5** (high status) at station RS33S030150 in 2020 (most recent monitoring period), approx. 5km downstream of the proposed wind farm boundary.

The Sheskin Stream (Sheskin Stream\_010 and Owenmore (Mayo)\_010 river-waterbodies) was of high WFD status in the 2013-2018 period and was considered 'not at risk' of achieving good ecological status (EPA data).

### 3.4.3 Glencullin River

The Glencullin River (33G03) drains to the west of the proposed wind farm site boundary, flowing in a westerly direction before joining Carrowmore Lake approx. 12km downstream of the wind farm boundary. There was a single contemporary EPA biological monitoring station that had been recently monitored on the river. The Glencullin River achieved **Q4-5** (high status) at station RS33G030025 in 2020 (most recent monitoring period), approx. 2km downstream of the proposed wind farm boundary.

The Glencullin River (Glencullin (West Mayo)\_010 and Munhin\_010 river-waterbodies) was of good WFD status in the 2013-2018 period and was considered 'not at risk' of achieving good ecological status (EPA data).



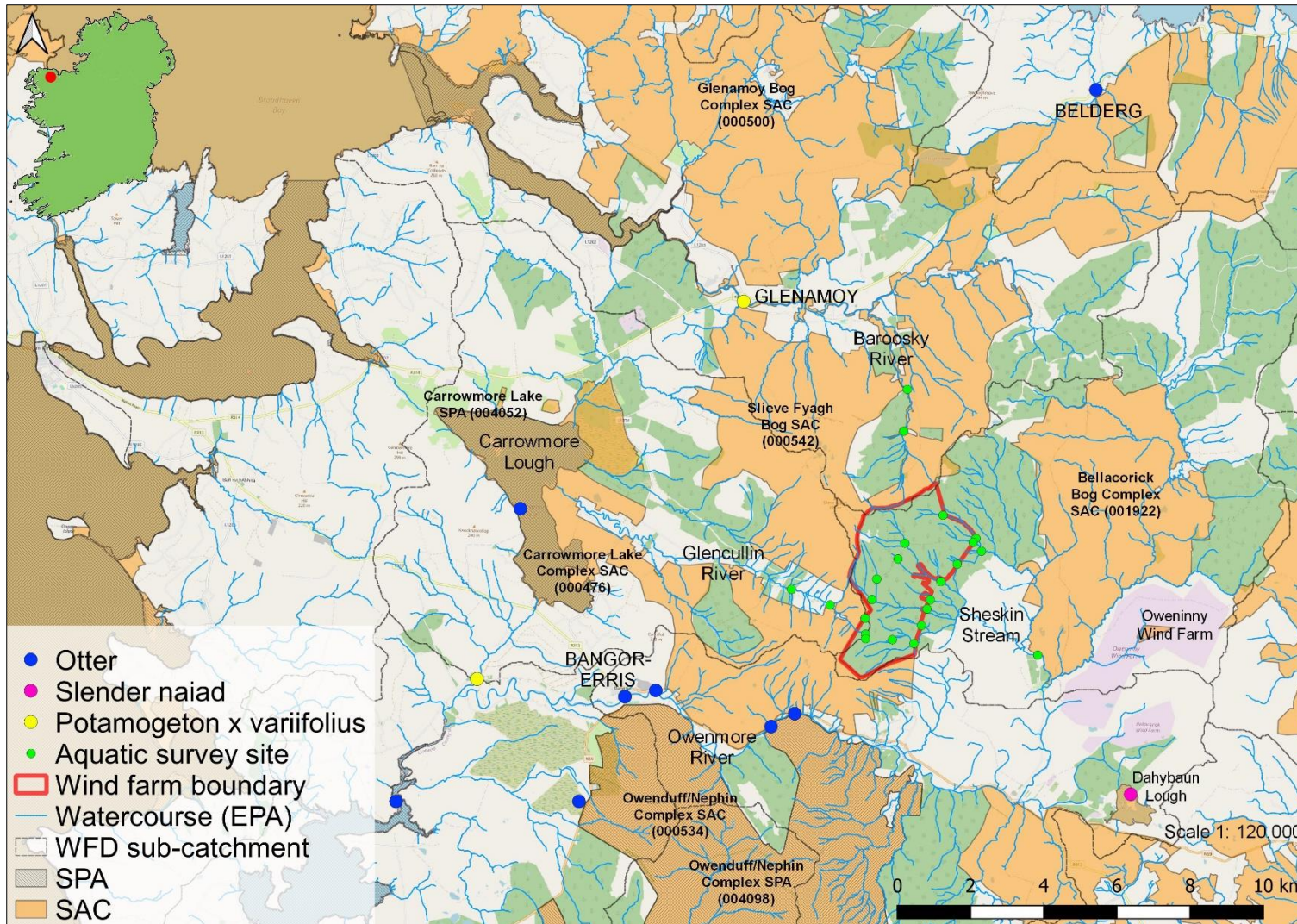


Figure 3.1 Distribution of protected species records in the vicinity of the proposed Sheskin wind farm (source: NPWS & NBDC data)

## 4. Results of aquatic surveys

The following section summarises each of the  $n=23$  survey sites in terms of aquatic habitats, physical characteristics and overall value for fish, macro-invertebrates and macrophyte/aquatic bryophyte communities. Biological water quality (Q-sample) results are also summarised for each riverine sampling site ( $n=20$ ) and in **Appendix B**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in September 2021. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.2**.

### 4.1 Aquatic survey site results

#### 4.1.1 Site A1 – Baroosky River, Baroosky

Site A1 was located on the upper reaches of the Baroosky River (EPA code: 33B08), approximately 2km downstream of the wind farm boundary. The upper reaches of the river were natural and meandered through an incised valley. Scour pools and bank undercuts were frequent, given high flow rates. The upland eroding, spate watercourse (FW1) averaged 5-8m wide and 0.2-0.6m deep, with locally deeper pools to 1m. The high-energy site featured a series of boulder-dominated cascades over a moderate gradient. Fast-flowing glide dominated with abundant pool habitat. Cobble was frequent locally. Coarse gravels were present interstitially and in pool slacks. Siltation was low, given the high-energy characteristics and peat-staining was high at the time of survey. The substrata were relatively compacted, given high flow rates. Macrophytes were absent. However, coverage of bryophytes was relatively high (50% of substrata), with abundant *Brachythecium rivulare* and frequent *Chiloscyphus polyanthos*, *Hygrohypnum* sp. and *Racomitrium aquaticum* (on tops of boulders). The moss *Fontinalis antipyretica* was occasional on larger boulder. The site was bordered by sloping wet heath (HH3) and coniferous forestry to the west, with low intensity pasture (GA1) to the east. Scattered hawthorn (*Crataegus monoygna*), fuchsia (*Fuchsia magellanica*), ash (*Fraxinus excelsior*) and Scots pine (*Pinus sylvestris*) were present along the east bank.

A total of three fish species were recorded via electro-fishing at site A1 (**Appendix A**). The site supported moderate densities of mixed-cohort brown trout (*Salmo trutta*), in addition to moderate densities of Atlantic salmon (*Salmo salar*) parr. European eel (*Anguilla anguilla*) were also present in low numbers. The site was a good-quality salmonid nursery, with some localised good-quality spawning habitat (albeit better suited to Atlantic salmon given the dominance of coarser substrata). Holding habitat was also present amongst boulder-strewn glide. European eel habitat was moderate overall, being reduced by the site's spate nature and high flows. The upland eroding site was unsuitable for lamprey due to its high energy (none recorded). The compacted nature of the bed was unsuitable for freshwater pearl mussel (*Margaritifera margaritifera*) at this site and eDNA analysis failed to detect the species within the Baroosky River (see section 4.6).

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.



Given the site is directly contiguous with the Glenamoy Bog Complex SAC (000500) (for which Atlantic salmon are a qualifying interest; NPWS, 2017a), the aquatic ecological evaluation of site A1 was of **international importance (Table 4.2)**.



**Plate 4.1** Representative image of site A1 on the Baroosky River, September 2021

#### 4.1.2 Site A2 – Baroosky River, Lenarevagh

Site A2 was located on the Baroosky River, approx. 1.3km downstream of site A1. The river averaged 10-15m wide and 0.3-0.7m deep, with the channel braiding in several locations in between meanders. The high-energy upland eroding watercourse (FW1) was dominated by very fast glide over boulder substrata. Cobble was frequent with localised interstitial coarse gravels. The natural, meandering river profile featured frequent deep pools to >1.5m (mostly associated with meanders). Siltation was low and the substrata were relatively mobile overall, despite high flows. Macrophytes were absent but coverage of bryophytes was high with abundant *Chiloscyphus polyanthos* (as per upstream) and frequent *Brachythecium rivulare*, *Hygrohypnum* sp. and more occasional *Racomitrium aquaticum*. The moss *Fontinalis antipyretica* was occasional on larger boulder. The site was bordered by improved (low-intensity) agricultural pasture (GA1) and sloping wet heath (HH3) with abundant invasive rhododendron (*Rhododendron ponticum*) along the north bank.

A total of three fish species were recorded via electro-fishing at site A2 (**Appendix A**). The site supported moderate densities of mixed-cohort brown trout, in addition to moderate densities of Atlantic salmon parr and low numbers of European eel. The site was a good-quality salmonid nursery and also provided good-quality spawning habitat (albeit better suited to Atlantic salmon given the coarse substrata). Some excellent-quality holding habitat (deep pool) was also present amongst boulder-strewn glide and in deep pools on meanders. European eel habitat was moderate overall, being reduced by the site's spate nature and high flows. The upland eroding site was unsuitable for

lamprey (none recorded). The highly-mobile nature of the bed was unsuitable for freshwater pearl mussel at this site and eDNA analysis failed to detect the species within the Baroosky River (see section 4.6).

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the location of the site within the Glenamoy Bog Complex SAC (000500) (for which Atlantic salmon are a qualifying interest; NPWS, 2017a), the aquatic ecological evaluation of site A2 was of **international importance (Table 4.2)**.



**Plate 4.2** Representative image of site A2 on the Baroosky River, September 2021

#### 4.1.3 Site B1 – Unnamed stream, Sheskin

Site B1 was located on an unnamed low order upland eroding stream (no EPA code) to the northern extent of the proposed wind farm site boundary. The upland eroding, spate watercourse (FW1) averaged 0.3m wide and 0.1-0.2m deep with bankfull heights of 0.5m. The channel profile was exclusively cascading boulder glide given the steep gradient and high energy. The stream flowed in a very narrow, deeply incised, sinuous channel with high levels of encroachment from terrestrial and bog vegetation. Peat staining was high at the time of survey. The high-energy site featured a bed comprised of boulder and cobble embedded in peat (i.e. high siltation). Macrophytes and aquatic bryophytes were absent due to its high energy, high shading and peat-stained water. The site was located in upland blanket bog (PB2) and adjoined a steeply-sloping V-shaped valley supporting coniferous afforestation (WD4).



No fish were recorded via electro-fishing at site B1 (**Appendix A**). The stream at this location was a poor-quality salmonid nursery given its diminutive size and steep gradient. It was also a poor-quality salmonid spawning habitat given the high gradient, peat base and absence of suitable spawning gravels. Holding habitat quality was also poor due to the very small size of the channel and absence of deeper pool and glide. European eel habitat was poor overall, given the steep gradient, small size and bedded larger substrata. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of **Q4 (good status)** water quality, the aquatic ecological evaluation of site B1 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.3** Representative image of site B1, September 2021

#### 4.1.4 Site B2 – Unnamed stream, Sheskin

Site B2 was located on an unnamed stream (no EPA code) at a forestry track crossing (Sheskin Way) on the proposed wind farm boundary, approx. 1.2km downstream of site B1. The upland eroding watercourse (FW1) averaged 1.5-2.5m wide and 0.1-0.3m deep, with localised deeper pools to 0.75m. Downstream of a three-bore pipe culvert, the stream flowed in a sinuous nature in a natural channel with bankfull heights of 0.5-1m. Peat-staining was high at the time of survey. The profile was predominantly shallow glide and riffle with frequent small pools. The spate channel featured frequent pools on meanders and bank scouring/erosion, with frequent overhangs. The substrata were dominated by relatively mobile cobble with frequent boulder and localised medium to coarse gravels in slacker areas and interstitial spaces. However, siltation was moderate overall. Macrophytes were



limited to localised stands of bog pondweed (*Potamogeton polygonifoliosus*) and emergent bottle sedge (*Carex rostrata*) downstream of the culvert. The bryophyte species *Chiloscyphus polyanthos* and *Brachythecium rivulare* were occasional only given mobile substrata. The stream drained coniferous forestry (WD4) upstream, with the site bordered by species-poor wet grassland (GS4) and coniferous forestry in the wider area.

Brown trout was the only fish species recorded via electro-fishing at site B2 (**Appendix A**). The site supported a moderate density of juveniles with a low number of mixed-cohort adult trout. Swift-flowing glide with abundant cobble provided some good-quality nursery habitat. The tailings of pools provided some good-quality spawning habitat (albeit compromised by siltation). Holding habitat for adults was limited in extent but, nonetheless, frequent (e.g. scour pools on meanders). Despite some suitability, no European eel were recorded. The upland eroding site was unsuitable for lamprey (none recorded). The site was not suitable for freshwater pearl mussel given the small size of the channel and mobile substrata.

Biological water quality, based on Q-sampling, was calculated as **Q4-5 (high status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and high-status water quality, the aquatic ecological evaluation of site B2 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.4** Representative image of site B2 on an unnamed stream, September 2021 (facing downstream from track crossing)

#### 4.1.5 Site B3 – Unnamed stream, Sheskin

Site B3 was located on the upper reaches of an unnamed stream (no EPA code) at a forestry track crossing (Sheskin Way). The swift-flowing upland eroding watercourse (FW1) averaged 1-1.5m wide and 0.1-0.3m deep, with localised deeper pool to 0.5m. The stream flowed in an incised, steep-sided channel with 1-1.5m bankfull heights. Bank erosion (scouring) was frequent, indicating the spate nature of the channel. The profile comprised shallow glide and riffle with occasional pool (e.g. at culvert). The stream flowed under the track via a twin-bore pipe culvert, which was not considered a migration barrier to fish except during low flows. The substrata were dominated by small cobble and mixed gravels, with occasional boulder. The substrata were relatively mobile. Siltation was low overall. Peat-staining was high at the time of survey. In the vicinity of the track crossing, the channel was open with grassy banks and low shading. Macrophytes were not recorded. However, the bryophyte species *Chiloscyphus polyanthos* was frequent, with occasional *Fontinalis antipyretica*. The site was bordered by coniferous forestry (WD4), with clear-fell (WS5) upstream and species-poor wet grassland (GS4) along the channel margins.

Brown trout was the only fish species recorded via electro-fishing at site B3 (**Appendix A**). A small, mixed-cohort population was present, with a moderate density of juveniles and a low number of small adults. The cobble-dominated glide provided good nursery habitat, whilst the tailings of pools (featuring more gravels) provided some moderate-good spawning habitat. Holding habitat was limited and suitable only for brown trout. Despite some moderate suitability no European eel were recorded. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the size of the channel and location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and good status water quality, the aquatic ecological evaluation of site B3 was of **local importance (higher value) (Table 4.2)**.





**Plate 4.5** Representative image of site B2 on an unnamed stream, September 2021 (facing downstream from track crossing)

#### 4.1.6 Site B4 – Unnamed stream, Sheskin

Site B4 was located on an unnamed stream (no EPA code), approx. 0.1km upstream of the confluence with the unnamed stream surveyed at site B3. The small upland eroding watercourse (FW1) flowed along a moderate gradient over peat through an active clear-fell area (WS5). The channel averaged <1m wide and 0.2-0.4m deep, with locally deeper plunge pools to 0.6m associated with frequent cascades over peat and occasional bedrock. Bankfull heights were 1-2m in a deeply incised channel. Fast-glide predominated with frequent plunge pools. Gross siltation of the channel was observed at the time of survey, originating from ongoing clear-felling activities. Large woody debris and brash associated with clear-felling was abundant instream, with frequent slumping of peat and brash into the stream. Sewage fungus (indicative of localised pH changes) was present. The base and banks of the channel comprised mostly peat, with abundant erosion and scouring along the channel. Very occasional single boulders were present in association with cascades. Macrophytes were not recorded although some localised *Chiloscyphus polyanthos* was present on isolated boulders. The liverwort *Marchantia polymorpha* and *Fissidens* sp. moss were abundant on peaty banks.

No fish were recorded via electro-fishing at site B4 (**Appendix A**). The small stream would likely have had little fisheries value given its diminutive size. However, clear-felling activities had reduced this value further, with gross siltation and enrichment evident. At the time of survey, the site as not capable of supporting fish or invertebrate life.

No macro-invertebrates were recorded via Q-sampling with ongoing clear-felling evidently impacted to the streams water quality. Thus, biological water quality, based on Q-sampling, was calculated as **Q1/0 (bad status) (Appendix B)**.



Given an absence of fish and aquatic macro-invertebrates, as well as Q1/0 (bad status) water quality, the aquatic ecological evaluation of site B4 was of **local importance (lower value)** (Table 4.2).



**Plate 4.6** Representative image of site B4 on an unnamed stream, September 2021, showing evident significant impacts from clear-felling

#### 4.1.7 Site B5 – Unnamed stream, Sheskin

Site B5 was located on the uppermost reaches of an unnamed stream (no EPA code) at a forestry track crossing (Sheskin Way). The small, upland eroding watercourse (FW1) was <0.5m wide but up to 0.3m deep in places. The stream resembled a slow-flowing drainage channel which had been modified historically. Upstream of the road culvert (pipe), the stream flowed in a braided fashion through an area of coniferous forestry (WD4). Downstream, the stream drained to several channels in species-poor wet grassland (GS4) and a former clear-fell area (now re-planted). The stream was heavily-silted with low flows at the time of survey and was likely non-perennial at this location (i.e. drying up in summer). A small ponding area was present immediately upstream of the pipe culvert, with a small plunge pool immediately below. Here, some exposed cobbles and coarse gravels were present but overall deep silt dominated the substrata. Bog pondweed was present near the culvert, with water horsetail (*Equisetum fluviatile*) in the small ponding area. However, terrestrial plant encroachment was very high (>95% shading). Aquatic bryophytes were absent, although *Sphagnum* sp. mosses were abundant instream upstream of the culvert. The site was bordered by mature coniferous plantation (WD4), clear-fell (WS5) and a clear-fell area (WS2) replanted with lodgepole pine (*Pinus contorta*).

No fish were recorded via electro-fishing at site B5 (**Appendix A**). The very narrow, heavily-silted stream was not of fisheries value (although it did support a range of aquatic macro-invertebrate species).



Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of high conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site B5 was of **local importance (lower value) (Table 4.2)**.



**Plate 4.7** Representative image of site B5 on an unnamed stream, September 2021

#### 4.1.8 Site B6 – Sheskin Stream, Sheskin

Site B7 was situated on the upper reaches of the Sheskin Stream (33S03), within the proposed wind farm site boundary. The small, upland eroding watercourse (FW1) was 1-1.5m wide and 0.2-0.4m deep with 0.5m high banks. The profile was of boulder-dominated glide with localised cascading areas given the steep gradient and high energy nature of the site. The bed comprised mainly of large bedded boulders with occasional large cobble and very localised patches of coarse gravel and sand. The channel supported no macrophytes due to its high energy and peat-stained water. Macrophytes were not recorded. However, the site supported occasional *Brachythecium rivulare*, *Racomitrium* sp. and *Solenium hyalina* being rare on boulders. The site was situated on upland blanket bog (PB2) and adjoined a V-shaped, afforested valley supporting mature sitka spruce (*Picea sitchensis*) plantations (WD4).

Brown trout was the only fish species recorded via electro-fishing at site B6 (**Appendix A**), with a moderate density of juveniles and a low number of small adults recorded. The site was a good quality salmonid nursery (for brown trout) given ample flows, a natural profile and coarse substrata refugia. Spawning habitat was of moderate quality locally (e.g. in small patches gravels in the edges of depositing pools below cascades). Salmonid holding habitat (brown trout only) was of good quality



locally in lower gradient glide patches below cascade zones. The site was of moderate value for European eel given the steep gradient, small size of the channel and bedded larger substrata. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the size of the channel and location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4-5 (high status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4-5 (high status)** water quality, the aquatic ecological evaluation of site B6 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.8** Representative image of site B6 on the Sheskin Stream, September 2021

#### 4.1.9 Site B7 – Unnamed stream, Sheskin

Site B7 was situated on an unnamed tributary of the Sheskin Stream (no EPA code), approx. 1.4km upstream of the Sheskin Stream confluence. The small, upland eroding spate watercourse (FW1) was 0.3m wide and 0.2- 0.3m deep with 0.5-0.7m high banks. The upland spate channel was deeply-cut into the peat in a U-shaped sinuous channel that was narrowly visible from the encroaching bog vegetation. The profile was of boulder-dominated glide with localised cascading areas given the steep gradient and high energy nature of the site. The bed comprised of bedded small boulder and cobble with very localised patches of coarse gravel and sand. The site did not support macrophytes due to its high energy, high riparian shading and peat-stained water. However, the site did support occasional *Brachythecium rivulare* on larger boulders. The site was situated on upland blanket bog (PB2) and adjoined a gently-sloping V-shaped, afforested valley supporting semi-mature lodgepole pine plantations (WD4).



No fish were recorded via electro-fishing at site B7 (**Appendix A**). The stream at this location was a poor-quality salmonid nursery given its diminutive size and steep gradient. It was also a poor-quality salmonid spawning habitat given the high gradient and paucity of suitable spawning substrata. Holding habitat quality was also poor due to the absence of deeper pool and glide. European eel habitat was poor overall, given the steep gradient, small size and bedded larger substrata. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of good status (Q4) water quality, the aquatic ecological evaluation of site B7 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.9** Representative image of site B7 on an unnamed Sheskin Stream tributary, September 2021

#### 4.1.10 Site B8 – Sheskin Stream, Sheskin

Site B8 was located on the upper reaches of the Sheskin Stream (33S03), approx. 1.5km downstream from site B6. The upland eroding stream (FW1) averaged 7-8m wide and 0.1-0.3m deep, with locally deeper pool and glide to 0.7m. The profile of the high-energy site comprised shallow glide with frequent pool and occasional riffles. Peat-staining was high at the time of survey. The substrata were dominated by mobile cobble and boulder, with localised coarse gravels present interstitially and in pool slacks. Siltation was low overall. A 7-bore pipe culvert was present at the track crossing (low-flow barrier to fish migration). Shading was moderate overall. Macrophytes were absent with the exception of rare brooklime (*Veronica beccabunga*) along channel margins. The bryophyte species *Chiloscyphus polyanthos* was occasional on instream boulders, with localised *Brachythecium rivulare*. The site was



bordered by scrubby willow (*Salix* sp.), alder (*Alnus glutinosa*) and oak (*Quercus petraea*) with scattered rhododendron, bramble (*Rubus fruticosus* agg.) and gorse (*Ulex europaeus*) scrub. Non-native montbretia (*Crocsmia x crocosmiiflora*) was present near the road crossing.

Atlantic salmon and brown trout were the only two fish species recorded via electro-fishing at site B8 (**Appendix A**). The site was dominated by mixed-cohort brown trout, including a moderate density of young-of-the-year fish. A low number of Atlantic salmon parr were recorded. The site was evidently of good value as a salmonid nursery given abundant, accessible cobble refugia and suitable glide habitat. Good-quality spawning habitat as present, though this was more suited to Atlantic salmon given the average size of substrata. Whilst deeper pools were scarce, undercut/scoured banks provided some good holding areas for adult salmonids. The pipe culverts acted as a barrier to fish migration in low summer flows. Despite some low to moderate suitability, no European eel were recorded. The upland eroding site was unsuitable for lamprey (none recorded). There was poor suitability for freshwater pearl mussel in the vicinity of the bridge given mobile substrata and evident historical gravel excavations.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population (including Atlantic salmon) and good-status water quality, the aquatic ecological evaluation of site B8 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.10** Representative image of site B8 on the Sheskin Stream, September 2021 (facing upstream from track crossing)

#### 4.1.11 Site B9 – Unnamed stream, Sheskin

Site B9 was located on an unnamed stream (no EPA code) at a local forestry track crossing (Sheskin Way), approx. 1km upstream of the Sheskin Stream confluence. In the vicinity of the road culvert (masonry box), the small upland eroding stream (FW1) averaged 0.5-1m wide and 0.1-0.2m deep. The stream flowed in a very narrow incised channel over a low gradient, with bankfull heights of 0.5m. The profile comprised slow-flowing shallow glide with frequent small pool (max. depth 0.25m) and occasional riffle areas. Given the slower-energy nature of the site, the substrata comprised a greater proportion of finer hard substrata, with fine to medium gravels and coarse sand dominating. However, these suffered from moderate to high siltation (peat). Compacted cobble was occasional in riffle areas. Peat-staining was high at the time of survey with large quantities of large woody debris (LWD) and leaf litter instream. The site was very heavily tunnelled by invasive rhododendron and, as a result, no macrophytes were recorded. However, some limited *Chiloscyphus polyanthos* was present, with *Hyocomium armoricum* present on the waterline. *Fissidens* sp. moss was abundant on the peaty banks, which featured frequent erosion (and contributed to siltation pressures). The site was bordered by scrub (WS1) dominated by rhododendron with frequent willow and alder. Coniferous forestry (WD4) was present upstream and downstream of the site.

Brown trout was the only fish species recorded via electro-fishing at site B9 (**Appendix A**), with a single juvenile recorded. The site provided poor salmonid nursery and holding habitat given its narrow, shallow, silted and heavily tunnelled nature. Some moderate-quality spawning habitat was present locally (for brown trout only). No European eel were recorded and the site offered poor suitability. There was no suitability for lamprey or freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and good-status water quality, the aquatic ecological evaluation of site B9 was of **local importance (higher value) (Table 4.2)**.





**Plate 4.11** Representative image of site B9 on an unnamed stream, September 2021 (facing downstream from tracking crossing)

#### 4.1.12 Site B10 – Unnamed stream, Sheskin

Site B10 was situated on an unnamed stream (no EPA code) at a forestry track crossing in the western extent of the proposed wind farm boundary. The narrow upland eroding watercourse (FW1) averaged 0.5m wide and 0.2-0.3m deep. The stream flowed under the access track with 0.5m high banks grading into a gently sloping V-shaped afforested valley. The first-order upland spate channel meandered through upland blanket bog (PB2) and comprised peat-stained cascade-glide habitat. The substrata were dominated by bedded small boulder and cobble with only very localised patches of interstitial mixed gravels. The site did not support macrophytes due to its high energy and peat-stained water. However, occasional *Brachythecium rivulare* was present on boulders with *Fissidens* sp. and *Racomitrium aquaticum* more locally. The riparian areas were open upland blanket bog (PB2) bordered by semi-mature lodgepole pine and spruce plantations (WD4).

Brown trout was the only fish species recorded via electro-fishing at site B10 (**Appendix A**), with a low number of juveniles recorded (no adults). The site provided poor salmonid nursery habitat given its small size and steep gradient heavily nature. Whilst some salmonid spawning habitat was present at the tailings of pools, this was also of poor quality. Holding habitat was limited to localised deep glide and was considered of moderate quality. No European eel were recorded and the site offered poor suitability given the high gradient and bedded larger substrata. There was no suitability for lamprey or freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.



Given the presence of a salmonid population and good-status water quality, the aquatic ecological evaluation of site B10 was of **local importance (higher value)** (Table 4.2).



**Plate 4.12** Representative image of site B10 on an unnamed stream, September 2021

#### 4.1.13 Site B11 – Unnamed stream, Sheskin

Site B11 was located on the upper reaches of an unnamed stream (no EPA code), located to the western extent of the proposed wind farm boundary. The upland eroding watercourse (FW1) flowed over a moderate gradient through an area of coniferous forestry (WD4). The stream averaged 0.5-1m wide in a deeply incised channel with 0.5-1m bankfull heights. The depths varied from 0.3-0.5m, with locally deeper plunge pools to 0.8m associated with small cascades over peat and bedrock. The stream was heavily peat-stained at the time of survey. The profile comprised deep swift-glide and occasional riffles over bedrock and bare peat, with localised pool. The substrata were dominated by very compacted cobble and occasional boulder, with frequent bedrock and localised interstitial gravels (also compacted). Siltation was high overall given evident peat escapement and bank erosion. The banks within the forestry block were composed primarily of peat. Given high shading and staining, macrophytes were not present. However, some *Pellia epiphylla*, *Brachythecium rivulare* and *Chiloscyphus polyanthos* was present. The site was adjoined by coniferous forestry, with species-poor wet grassland (GS4) downstream.

Brown trout was the only fish species recorded via electro-fishing at site B11 (**Appendix A**). A low density of juveniles and small adults was recorded. The fisheries value was poor overall given evident siltation/peat escapement pressures, in addition to afforestation impacts from upstream and the small size of the channel. The very narrow channel provided poor salmonid spawning, nursery and holding habitat for salmonids. However, some moderate-quality spawning and nursery habitat was present downstream of the forestry block in lower-gradient glide. European eel habitat was poor and



none were recorded. The upland eroding site was unsuitable for lamprey due to its high energy (none recorded). There was no suitability for freshwater pearl mussel given siltation pressures and the small size of the stream.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and good-status water quality, the aquatic ecological evaluation of site B11 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.13** Representative image of site B11 on an unnamed stream, September 2021

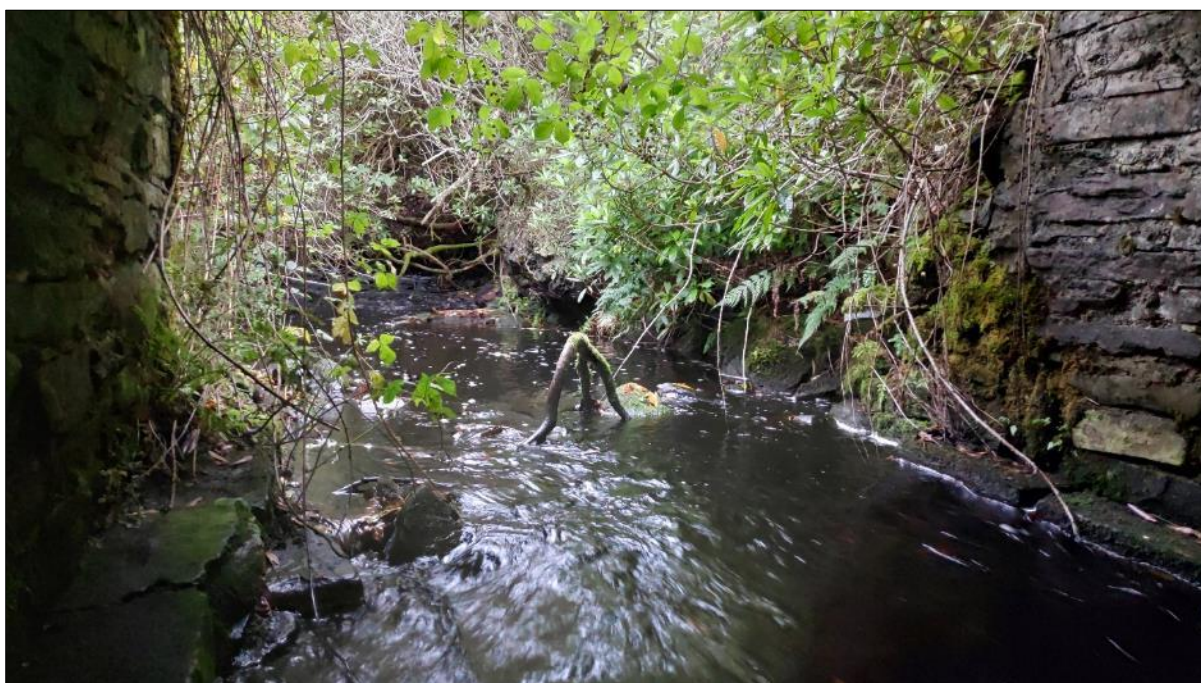
#### 4.1.14 Site B12 – Unnamed stream, Sheskin

Site B12 was located on an unnamed stream (no EPA code) at a forestry track crossing (Sheskin Way). The high-energy stream (FW1) flowed under a large masonry box culvert and averaged 2.5-2m wide and 0.2-0.5m deep. The profile comprised riffle-pool-glide sequences flowing over a moderate gradient. Deeper pools to 0.7m were present locally. Given high flow rates, the substrata were dominated by compacted cobble and boulder with localised interstitial gravels (also compacted). Siltation was moderate to high, given upstream forestry and peat escapement pressures, although no accumulations were present. Peat-staining was very high at the time of survey. The site was very heavily tunnelled (>95%) by rhododendron-dominated scrub, with willow and alder also present. As a result, macrophytes were absent. However, the bryophyte species *Chiloscyphus polyanthos*, *Brachythecium rivulare*, *Fissidens* sp. and *Hygrohypnum* sp. were occasional. Large woody debris (LWD) was abundant instream. The site was bordered by coniferous forestry (WD4) with localised areas of clear-fell (WS5) and dense scrub (WS1).

Atlantic salmon and brown trout were the only two fish species recorded via electro-fishing at site B12 (**Appendix A**). Both were present at low densities. The site was of moderate value only as a salmonid nursery and spawning habitat given high flows and compacted substrata, in addition to very high shading which reduced habitat quality. Some localised moderate-quality holding habitat was present (e.g. downstream of culvert). The rendered culvert apron (which featured a series of small steps) was considered a barrier to fish migration at lower water levels. Despite some low suitability (e.g. deep pool), the high-energy site did not support European eel at the time of survey. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given siltation pressures and compacted substrata.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population (including Atlantic salmon) and good-status water quality, the aquatic ecological evaluation of site B12 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.14** Representative image of site B12 on an unnamed stream, September 2021 (facing upstream from bridge)

#### 4.1.15 Site B13 – Unnamed stream, Sheskin

Site B13 was located on an unnamed stream (no EPA code) at a forestry track crossing (Sheskin Way). The narrow and shallow upland eroding watercourse (FW1) averaged 0.5m wide and 0.1m deep, with bankfull heights of 0.5-1m in a U-shaped channel. The first order semi-natural channel had been historically straightened and had a profile comprised of shallow glide and riffle. Pool habitat was absent near the survey site. The substrata comprised mixed gravels, sand and peat. The gravels were



relatively uncompacted but had moderate to heavy siltation. Given high flow rates, macrophytes were limited to occasional bog pondweed. The aquatic bryophyte species *Brachythecium rivulare* and *Pellia* sp. were present locally. The riparian areas were open and were dominated by recent conifer clear-fell (WS5).

No fish were recorded via electro-fishing at site B13 (**Appendix A**). The stream at this location was a poor-quality salmonid nursery, spawning and holding habitat given its diminutive size, very shallow nature and steep gradient. European eel habitat was poor overall for these same reasons. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of good status (Q4) water quality, the aquatic ecological evaluation of site B13 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.15** Representative image of site B13 on an unnamed stream, September 2021

#### 4.1.16 Site B14 – Unnamed stream, Sheskin

Site B14 was located on an unnamed stream (no EPA code) at a forestry track crossing to the southern extent of the proposed wind farm boundary. The narrow and shallow upland eroding watercourse (FW1) averaged 1m wide and 0.1-0.15m deep, with bankfull heights of 1.5-2m in a U-shaped channel. The first order upland spate channel was of moderate-energy and featured exposed small boulder and cobble-dominated glide and riffle sequences with occasional pool. The stream was crossed by a forestry access track with 1.2m pipe culvert. The substrata were dominated by large angular boulder



and cobble with occasional very coarse gravels. The coarse substrata were unbedded but suffered from moderate siltation. The site did not support macrophytes due to its higher energy and shading. However, boulders supported occasional *Brachythecium rivulare* with *Pellia* sp. liverwort on the banks near the waterline. The riparian areas supported scattered semi-mature lodgepole pine plantations (WD4) with species-poor (rush-dominated) degraded blanket bog.

No fish were recorded via electro-fishing at site B14 (**Appendix A**). The stream at this location was a poor-quality salmonid nursery and holding habitat given the overall shallow nature. Salmonid spawning habitat (for brown trout) was poor given the absence of suitable substrata. European eel habitat was poor overall given the high gradient and limited refugia (e.g. deeper pool). The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of good status (Q4) water quality, the aquatic ecological evaluation of site B14 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.16** Representative image of site B14 on an unnamed stream, September 2021

#### 4.1.17 Site B15 – Unnamed stream, Sheskin

Site B15 was located on an unnamed stream (no EPA code) near the confluence of two second-order streams, approx. 0.7km downstream from site B14. The narrow upland eroding watercourse (FW1) averaged 0.5m wide and 0.2-0.5m deep, with 0.5m high bankfull heights. The stream meandered through blanket bog with the profile comprised of peat-stained shallow glide. The substrata featured



bedded small boulder and cobble with very localised patches of interstitial mixed gravels. The site did not support macrophytes due to its high energy and peat-stained water. However, the moss *Fontinalis squamosa* moss was recorded as rare. The riparian areas were open and dominated by blanket bog bordered by mature lodgepole pine (WD4).

Brown trout was the only fish species recorded via electro-fishing at site B15 (**Appendix A**). A low density of juveniles and small adults was recorded. The site was a moderate-quality nursery for brown trout given good water flows, a semi-natural profile and the presence of coarse substrata refugia. Moderate-quality salmonid spawning habitat was present locally at the tailings of deeper glide where small pockets of gravels were present (improving moving downstream of the access track crossing). Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide and was considered of moderate quality. European eel habitat was good overall given abundant cobble and boulder refugia, although none were recorded. The upland eroding site was unsuitable for lamprey due to its high energy (none recorded). There was no suitability for freshwater pearl mussel given the small size of the stream and location in the upper reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and good-status water quality, the aquatic ecological evaluation of site B15 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.17** Representative image of site B15 on an unnamed stream, September 2021

#### 4.1.18 Site B16 – Sheskin Stream, Foot Bridge

Site B16 was located on the lower reaches of the Sheskin Stream at Foot Bridge, approx. 5km downstream of site B8 and the proposed wind farm site boundary. The river at this location represented more of a lowland depositing watercourse (FW2), swiftly flowing over a low-gradient. The river averaged 8-10m wide and 0.4-0.6m deep, with localised deeper glide and pool to >1m. The natural channel profile was dominated by deep glide with localised riffle and occasional pool. The substrata featured well-sorted mixed gravels with more localised boulder, cobble and coarse sand. Some compacted sand and silt accumulations were present along the channel margins and adjoining pool areas. The water was deeply peat-stained at the time of survey and macrophytes were limited to marginal beds of iris (*Iris psuedacorus*). Aquatic bryophytes were limited to occasional *Fontinalis antipyretica* on larger boulder. The riparian areas were largely open and supported scrub vegetation (WS1) and scattered alder. The site was bordered by raised bog (PB4), with coniferous forestry (WD4) upstream on the south bank.

A total of four fish species were recorded via electro-fishing at site B16 (**Appendix A**). The site supported high density of Atlantic salmon parr (two size classes) in addition to a low number of brown trout (juveniles and adults) and minnow (*Phoxinus phoxinus*). A low density of *Lampetra* sp. ammocoetes were also recorded. The site was an excellent-quality salmonid nursery and spawning habitat with some locally very good to excellent holding habitat by way of pools and marginal scours. European eel habitat was good overall given ample refugia although none were recorded. Lamprey nursery habitat was present but sub-optimal (compacted sand and silt), although this still supported a low a low density of *Lampetra* sp. ammocoetes. There was some moderate suitability for freshwater pearl mussel given the presence of salmonids and stable substrata (albeit siltation pressures were evident). However, eDNA analysis failed to detect the species within the Sheskin Stream (see section 4.6).

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Site B16 is located within the Bellacorick Bog Complex SAC (001922) and is thus of **international importance** (albeit no aquatic species listed as qualifying interests; NPWS, 2017b). However, the presence of a salmonid population (including Atlantic salmon), *Lampetra* sp. and **Q4 (good status)** water quality are noteworthy ecological attributes (**Table 4.2**).





**Plate 4.18** Representative image of site B16 on the Sheskin Stream, September 2021 (facing downstream from Foot Bridge)

#### 4.1.19 Site C1 – Glencullin River, Glencullin Upper

Site C1 was located on the upper reaches of the Glencullin River (33G03) approx. 1km downstream of the proposed wind farm site boundary, at the confluence with an unnamed first order tributary. The river at this location represented a high-energy, upland eroding spate channel (FW1) that averaged 2.5-3.5m wide and 0.1-0.3m deep, with localised deeper pools to 0.4m. The channel had 0.5-1m high banks grading into a gently sloping V-shaped valley. The profile comprised shallower gradient boulder-dominated glide with smaller pockets of pool and riffle. The substrate featured abundant boulder and cobble with small patches of interstitial mixed gravels in pools. The coarser boulder and large cobble substrata of the bed were stable (bedded) with mobile smaller cobble and coarse gravels. Siltation was moderate overall. Due to the high energy of the site, macrophytes were limited to some localised bog pondweed and water starwort (*Callitriche* sp.). The moss *Fontinalis squamosa* was also present locally. The riparian areas were open and featured wet semi-improved grassland (GA1) and were heavily encroached by invasive rhododendron.

Atlantic salmon and brown trout were the only two fish species recorded via electro-fishing at site C1 (**Appendix A**). Brown trout dominated the site, with mixed cohorts present. A low number of Atlantic salmon parr (two cohorts) were also recorded. The site was an excellent-quality salmonid nursery given a natural profile, high flows and coarse substrata refugia. Moderate-quality spawning habitat was present at the tailings of deeper glide where small pockets of gravels were present. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide and was considered of moderate quality. Despite some good suitability (i.e. ample refugia), the high-energy site did not support European eel at the time of survey. The upland eroding site was unsuitable for lamprey (none recorded). There was some physical suitability for freshwater pearl mussel given the



presence of salmonids and stable substrata. However, eDNA analysis failed to detect the species within the Glencullin River (see section 4.6) and siltation and <Q4 (good status) water quality would preclude the species.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Site C1 is located within the Carrowmore Lake Complex SAC (000476) (no aquatic species listed as qualifying interests; NPWS, 2017c) and is thus of **international importance**. However, the presence of a salmonid population (including Atlantic salmon) is a noteworthy ecological attribute (**Table 4.2**).



**Plate 4.19** Representative image of site C1 on the Glencullin River, September 2021

#### 4.1.20 Site C2 – Glencullin River, Glencullin Upper

Site C2 was located on the upper reaches of the Glencullin River (33G03) approx. 1.3km downstream of site C1. The high-energy, upland eroding spate channel (FW1) averaged 3-4m wide and 0.1-0.3m deep, with localised deeper pools to 0.4m. The channel had 0.5m high banks grading into a gently sloping V-shaped valley. The site featured boulder-dominated glide habitat with frequent areas of lower-gradient glide and riffle. Pool habitat was more isolated and restricted to shallower pockets below boulder outcrops. The substrata were dominated by boulder and cobble with small patches of interstitial mixed gravels in pools. The coarser boulder and large cobble substrata were stable (bedded) with only very light siltation due to the high energy nature of the site. Smaller cobble and very coarse gravel were mobile. The site did not support macrophytes due to its very high energy. It did, however, support upland aquatic bryophyte species such as *Brachythecium rivulare* and *Hygrohypnum* sp. locally on boulder tops. On submerged cobble, *Fontinalis squamosa* and

*Chiloscyphus polyanthos* was also present. The riparian areas were open and comprised wet semi-improved grassland (GA1) and mature conifer plantations (WD4) within 10-15m of the banks.

A total of three fish species were recorded via electro-fishing at site C2 (**Appendix A**). The site supported a high density of Atlantic salmon parr, with moderate densities of mixed-cohort brown trout in addition to a low number of European eel. The site was an excellent-quality salmonid nursery given a natural profile, high flows and coarse substrata refugia. Moderate-quality spawning habitat was present at the tailings of deeper pool where small pockets of gravels were present. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide and was considered of moderate quality. European eel habitat was good overall given abundant instream refugia (e.g. boulder and cobble). The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel due to the mobile bed and high gradient. Furthermore, eDNA analysis failed to detect the species within the Glencullin River (see section 4.6)

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population (including Atlantic salmon) and good-status water quality, the aquatic ecological evaluation of site B8 was of **local importance (higher value) (Table 4.2)**.



**Plate 4.20** Representative image of site C2 on the Glencullin River, September 2021

#### 4.1.21 Site L1 – Unnamed lake, Sheskin

Site L1 was located to the south-western extent of the proposed wind farm boundary and the most northerly of the three survey lakes. The small dystrophic lake (pH of 4.11; FL1 habitat) covered an area of approx. 0.19ha and averaged 0.5-2.5m deep with a bed comprised entirely of deep, soft silt (peat).



The open water areas supported locally abundant bulbous rush (*Juncus bulbosus*) and lesser bladderwort (*Utricularia minor*). The lake's quaking margins graded into blanket bog habitat and supported abundant *Sphagnum cuspidatum* and *Sphagnum subsecundum* agg. mosses. Adjoining the quaking margins, the lake supported localised stands of bogbean (*Menyanthes trifoliata*) and bog cotton (*Eriophorum angustifolium*). The lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'. These lakes are known to be species-poor, are *Sphagnum*-dominated at the margins and form an ecotone with blanket bog (O'Connor, 2015). The lake was bordered by blanket bog and mature lodgepole pine plantations (WD4) that were within 20m of the shoreline.

Whilst a targeted fisheries survey was not undertaken at this site, a composite water sample was analysed for brown trout and European eel eDNA. However, despite good suitability, no brown trout or European eel eDNA was detected (**Table 4.1; Appendix D**) and this result was considered as evidence of the species' absence at this site. Additionally, smooth newt eDNA was not detected in the water sample and this result was considered as evidence of the species' absence at this site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting of macrophytes and lake substrata (**Appendix C**).

Site L1 is partially located within the Carrowmore Lake Complex SAC (000476) and is thus of **international importance**.



**Plate 4.21** Representative image of site L1, September 2021



#### 4.1.22 Site L2 – Unnamed lake, Sheskin

Site L2 was located to the south-western extent of the proposed wind farm boundary, near to but not visibly connected to the headwaters of the Glencullin River. The small dystrophic lake (pH of 4.36; FL1 habitat) an area of approx. 0.12ha and averaged 1-3m deep with a bed comprised entirely of deep, soft silt (peat). The open water areas supported locally abundant bulbous rush, alternate leaved-milfoil (*Myriophyllum alterniflorum*) and lesser bladderwort. The lake's quaking margins graded into blanket bog habitat and supported abundant *Sphagnum cuspidatum* and *Sphagnum subsecundum* agg. mosses. Adjoining the quaking margins, the lake supported localised stands of bogbean and bog cotton. The lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'. These lakes are known to be species-poor, are *Sphagnum*-dominated at the margins and form an ecotone with blanket bog (O'Connor, 2015). The lake was bordered by blanket bog and mature lodgepole pine plantations (WD4) that were within 10m of the shoreline.

Whilst a targeted fisheries survey was not undertaken at this site, a composite water sample was analysed for brown trout and European eel eDNA. However, despite good suitability, no brown trout or European eel eDNA was detected (**Table 4.1; Appendix D**) and this result was considered as evidence of the species' absence at this site. Additionally, smooth newt eDNA was not detected in the water sample and this result was considered as evidence of the species' absence at this site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting of macrophytes and lake substrata (**Appendix C**).

Given the lake corresponds to the Annex I habitat 'Natural dystrophic lakes and ponds [3160]', the aquatic ecological evaluation of site L2 was of **county importance**<sup>1</sup> (**Table 4.2**).

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<sup>1</sup> sites containing areas of habitat listed in Annex I of the Habitats Directive "that do not fulfil the criteria for valuation of international and or national importance" (NRA, 2009).



**Plate 4.22** Representative image of site L2, September 2021

#### 4.1.23 Site L3 – Unnamed Lake, Sheskin

Site L3 was located to the south-western extent of the proposed wind farm boundary, near to but not visibly connected to the headwaters of the Glencullin River. The small dystrophic lake (pH of 5.16; FL1 habitat) an area of approx. 0.11ha and was 0.5-1.3m deep with a bed comprised entirely of deep, soft silt (peat). In comparison to lakes L1 and L2, the lake had a more complex margin with a number of small offshoot bays supporting *Sphagnum* spp. mosses and bog bean in shallow 0.5m deep clear water. The southern pond littorals supported quaking bog (PF3) with emergent bogbean transitioning into deeper open water. The quaking margins supported floating mats of *Sphagnum cuspidatum* and *Sphagnum subsecundum* agg. mosses (approx. 15% coverage of the basin). The lake basin also supported frequent bulbous rush in the open water in addition to beds of *Sphagnum* spp. moss. The lake margins were situated on blanket bog habitat (PB2). The *Sphagnum*-dominated lake margins corresponds with the Annex I habitat 'Blanket bogs [7130]'. The lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'. These lakes are known to be species-poor, are *Sphagnum*-dominated at the margins and form an ecotone with blanket bog (O'Connor, 2015). Adjoining the dystrophic lake basin, semi-mature lodgepole pine plantations (WD4) were present within 10m of the shoreline.

Whilst a targeted fisheries survey was not undertaken at this site, a composite water sample was analysed for brown trout and European eel eDNA. However, despite good suitability, no brown trout or European eel eDNA was detected (**Table 4.1; Appendix D**) and this result was considered as evidence of the species' absence at this site. Smooth newt eDNA was detected in the water sample and this result was considered as evidence of the species' presence at this site (**Table 4.1; Appendix D**).

No macro-invertebrate species of conservation value greater than ‘least concern’, according to national red lists, were recorded via sweep netting of macrophytes and lake substrata (**Appendix C**).

Given the lake corresponds to the Annex I habitat ‘Natural dystrophic lakes and ponds [3160]’, in addition to the presence of smooth newt (confirmed by eDNA analysis), the aquatic ecological evaluation of site L3 was of **county importance (Table 4.2)**.



**Plate 4.23** Representative image of site L3, September 2021

## 4.2 Biological water quality (macro-invertebrates)

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from  $n=20$  riverine sites in September 2021 (**Figure 4.1, Appendix B**).

Sites B2 (unnamed stream) and B6 (Sheskin Stream) achieved **Q4-5 (high status)** water quality, based on Q-sampling, and thus met the good status ( $\geq Q4$ ) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). These sites were elevated above Q4 (good status) based on the presence of presence of two Group A (pollution sensitive) mayfly and stonefly species, respectively, with three present in ‘fair numbers’ at each site (i.e.  $\geq 5\%$  of total sample abundance). These species included the flattened mayflies *Rhithrogena semicolorata* and *Ecdyonurus dispar* and the stonefly *Protonemura meyeri* (both sites), in addition to the stonefly *Nemoura cinerea* at site B2 (**Appendix B**).

A total of 13 no. survey sites (i.e. sites A1, A2, B1, B3, B7, B8, B10, B11, B12, B13, B14, B16 & C2) achieved **Q4 (good status)** water quality, based on Q-sampling, and thus met the good status ( $\geq Q4$ ) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). These sites achieved good status



based on the presence of  $\geq 1$  group A species in ‘fair numbers’. Such species included the flattened mayflies *Rhithrogena semicolorata* and *Ecdyonurus dispar* and the stoneflies *Protonemura meyeri* and *Nemoura cinerea*, in addition to the stoneflies *Zwicknia bifrons* (site B7 only) and *Isoperla grammatica* (sites B14 and C2 only) (**Appendix B**).

Water samples from sites B15 (unnamed stream) and C1 (Glencullin River) achieved **Q3-4 (moderate status)** water quality, and thus failed to meet the good status ( $\geq Q4$ ) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). These sites failed to achieve Q4 (good status) given the paucity of group A species ( $\leq 3\%$  of sample) (**Appendix B**).

Sites <sup>2</sup>B5 (unnamed stream) and B9 (unnamed stream) achieved **Q3 (poor status)** water quality. Therefore, these survey sites failed to meet the good status ( $\geq Q4$ ) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). These sites achieved poor status given the absence of group A species, a paucity of group B (less sensitive) species and a dominance of group C (pollution tolerant) species such as the caseless caddis *Plectrocnemia conspersa*, freshwater shrimp (*Gammarus duebeni*) and Simuliidae larvae (**Appendix B**).

Site B4 (unnamed stream) was located in an area of active clear-felling and was evidently experiencing a toxic pollution event at the time of sampling (September 2021). No live macro-invertebrates were recorded via Q-sampling of the stream and, thus, the site achieved as <sup>3</sup>**Q1/0 (bad status)** rating.

### 4.3 Lake macro-invertebrates

No rare or protected macro-invertebrate species were recorded in the sweep samples taken from  $n=3$  lake sites (**Appendix C**).

The three lakes supported a low diversity of species typical of dystrophic lake habitats. All samples were dominated by Odonata species such as the common hawkler (*Aeshna juncea*), four-spotted chaser (*Libellula quadrimaculata*) and *Coenagrion* sp. damselfly, in addition to a Gerridae (pond skater) species. Water boatman (*Sigara* sp.) were common in samples L2 and L3. The purple dun mayfly (*Paraleptophlebia cincta*), a species that occurs in slow-moving, well-vegetated acid and alkaline waters (Kelly-Quinn & Regan, 2011) was recorded from site L2. The species is highly sensitive to siltation.

The caddisfly *Agrypnia pagetana* was recorded from site L3. Whilst demonstrating a limited distribution in Ireland in lakes and ponds (primarily in the west and north), this caddisfly species is known from the north-west, including Mayo (O’Connor et al., 2020).

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<sup>2</sup> it should be noted that site B5 is a tentative Q-rating given low flows and the absence of suitable riffle areas for sampling (as per Toner et al., 2005)

<sup>3</sup> the ‘0’ suffix is added to Q-rating to indicate a suspected toxic effect (Toner et al., 2005)





#### 4.4 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the  $n=23$  survey sites. Similarly, no examples of the Annex I habitat ‘Water courses of plain to montane levels with the *Ranunculus fluitantis* and *Callitriche-Batrachion* vegetation or aquatic mosses [3260]’ (aka floating river vegetation) was recorded during the surveys. However, survey lakes L1, L2 and L3 correspond with the Annex I habitat ‘Natural dystrophic lakes and ponds [3160]’, partly based on their macrophyte and aquatic bryophyte communities.

#### 4.5 eDNA analysis

Composite water samples collected from the Sheskin Stream (FK185), Glencullin River (FK186) and Baroosky River (sample FK187) returned a negative result for freshwater pearl mussel eDNA, i.e. freshwater pearl mussel eDNA not present or was present below the limit of detection in a series of 12 qPCR replicates (0 positive replicates out of 12, respectively) (**Table 4.1; Appendix D**).

All lake water samples (FK50, FK86 & FK200) tested negative trout or European eel eDNA (0 of 12 qPCR replicates, respectively) (**Table 4.1**). However, smooth newt eDNA was detected in lake L3 (FK200) (10 of 12 qPCR replicates). This result was considered as evidence of the species’ presence at this site. No smooth newt eDNA was detected in water samples from lakes L1 or L2.

**Table 4.1** eDNA results in the vicinity of the proposed Sheskin wind farm, Co. Mayo (positive qPCR replicates out of 12 in parentheses)

Sample	Watercourse	Freshwater pearl mussel	Brown trout	European eel	Smooth newt
FK185	Sheskin Stream	Negative (0/12)	n/a	n/a	n/a
FK186	Glencullin River	Negative (0/12)	n/a	n/a	n/a
FK187	Baroosky River	Negative (0/12)	n/a	n/a	n/a
FK50	Unnamed lake (L1)	n/a	Negative (0/12)	Negative (0/12)	Negative (0/12)
FK86	Unnamed lake (L2)	n/a	Negative (0/12)	Negative (0/12)	Negative (0/12)
FK200	Unnamed lake (L3)	n/a	Negative (0/12)	Negative (0/12)	<b>Positive (10/12)</b>

#### 4.6 Invasive aquatic species

No aquatic invasive species were recorded during the survey of a total of  $n=23$  sites on the Baroosky River, Sheskin Stream, Glencullin River or unnamed tributaries or three unnamed lakes in September 2021.

Rhododendron (*Rhododendron ponticum*), a high-impact invasive terrestrial plant species in Ireland (O’Flynn et al., 2014) was recorded at survey sites A2 (Baroosky River), B8 (Sheskin Stream), B9 (unnamed stream), B12 (unnamed stream) and C1 (Glencullin River). Site A2 was located within the Glenamoy Bog Complex SAC (000500).

## 4.7 Otter signs

Whilst a dedicated otter survey was beyond the scope of this study, no otter signs (i.e. spraint, latrine, slide, prints, couch or holt) were recorded at the  $n=23$  aquatic survey sites during September 2021. However, otter are known in the downstream connecting Owenmore River Owenmore River and Carrowmore Lake (see section 3.1; **Figure 3.1**).

## 4.8 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of fisheries surveys, macrophyte and aquatic bryophyte surveys, eDNA analysis and biological water quality (**Table 4.2**).

Sites A1 and A2 (Baroosky River) were evaluated as **international importance** given their locations contiguous and within the Glenamoy Bog Complex SAC (000500), respectively. The sites both supported Atlantic salmon, which are listed as a qualifying interest for this European site (NPWS, 2017a). Lake survey site L1, being located within the Carrowmore Lake Complex SAC (000476), was of **international importance**.

Sites L1, L2 and L3 corresponded to the Annex I habitat 'Natural dystrophic lakes and ponds [3160]', whilst the *Sphagnum*-dominated lake margins at site L3 corresponded with the Annex I habitat 'Blanket bogs [7130]'. Lake survey sites L2 and L3 were of **county importance** as they represent good examples of the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'.

Sites B4 (unnamed stream) was evaluated as **local importance (lower value)**, given the absence of aquatic species or habitats of high conservation value, in addition to Q3 (poor status) water quality. Site B5 (unnamed stream) was also evaluated as **local importance (lower value)**, given the absence of aquatic species or habitats of high conservation value, in addition to Q1/0 (bad status) water quality.

The other 17 no. aquatic survey sites (i.e., A1, B1, B2, B3, B6, B7, B8, B9, B10, B11, B12, B13, B14, B15, B16, C1, C2,) were evaluated as **local importance (higher value)**. Primarily, this evaluation was due to the presence of salmonids and or  $\geq Q4$  (good status) water quality.



**Table 4.2** Aquatic ecological evaluation summary of the survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Baroosky River	33B08	<b>International importance</b>	Directly contiguous with Glenamoy Bog SAC (000500); good-quality salmonid habitat present, moderate European eel habitat, no value for lamprey; Atlantic salmon, brown trout and European eel recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A2	Baroosky River	33B08	<b>International importance</b>	Located within Glenamoy Bog SAC (000500); good-quality salmonid habitat present (including some excellent holding habitat), moderate European eel habitat, no value for lamprey; Atlantic salmon and brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B1	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4 (good status) water quality; no aquatic species or habitats of high conservation value
B2	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Good-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4-5 (high status) water quality; no other aquatic species or habitats of high conservation value
B3	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B4	Unnamed stream	n/a	Local importance (lower value)	No fisheries value due to gross siltation and enrichment (primarily from clear-felling); no fish recorded via electro-fishing; Q1/0 (bad status) water quality (no live macro-invertebrates recorded during Q-sampling); no aquatic species or habitats of high conservation value
B5	Unnamed stream	n/a	Local importance (lower value)	No fisheries value due to small size & likely non-perennial nature; no fish recorded via electro-fishing; Q3 (poor status) water quality; no aquatic species or habitats of high conservation value

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
B6	Sheskin Stream	33S03	<b>Local importance (higher value)</b>	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4-5 (high status) water quality; no other aquatic species or habitats of high conservation value
B7	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4 (good status) water quality; no aquatic species or habitats of high conservation value
B8	Sheskin Stream	33S03	<b>Local importance (higher value)</b>	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; Atlantic salmon & brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B9	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Moderate-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B10	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Moderate-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B11	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Moderate-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B12	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Moderate-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; Atlantic salmon & brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B13	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
				(good status) water quality; no aquatic species or habitats of high conservation value
B14	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4 (good status) water quality; no aquatic species or habitats of high conservation value
B15	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Moderate-quality salmonid & good-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q3-4 (moderate status) water quality; no other aquatic species or habitats of high conservation value
B16	Sheskin Stream	33S03	<b>Local importance (higher value)</b>	Excellent-quality salmonid habitat & good-quality European eel habitat, moderate value for lamprey; Atlantic salmon, brown trout, minnow and <i>Lampetra</i> sp. ammocoetes recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
C1	Unnamed stream	n/a	<b>Local importance (higher value)</b>	Excellent-quality salmonid habitat & good-quality European eel habitat, no value for lamprey, no value for freshwater pearl mussel (none recorded via eDNA analysis in Glencullin River); Atlantic salmon & brown trout recorded via electro-fishing; Q3-4 (moderate status) water quality; no other aquatic species or habitats of high conservation value
C2	Glencullin River	33G03	<b>Local importance (higher value)</b>	Excellent-quality salmonid habitat & good-quality European eel habitat, no value for lamprey, good value for freshwater pearl mussel (none recorded via eDNA analysis in Glencullin River); Atlantic salmon & brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
L1	Unnamed lake	n/a	<b>International Importance</b>	Small, shallow dystrophic lake; no brown trout, European eel or smooth newt recorded via eDNA analysis; lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]' and is situated within the within the Carrowmore Lake Complex SAC (000476)



Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
L2	Unnamed lake	n/a	<b>County Importance</b>	Small, shallow dystrophic lake; no brown trout, European eel or smooth newt recorded via eDNA analysis; lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'; good, non-designated examples of this Annex I habitat present (i.e. county importance)
L3	Unnamed lake	n/a	<b>County Importance</b>	Small, shallow dystrophic lake; no brown trout or European eel recorded via eDNA analysis; smooth newt recorded via eDNA analysis; lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'; the <i>Sphagnum</i> -dominated lake margins correspond with the Annex I habitat 'Blanket bogs [7130]'; good, non-designated examples of this Annex I habitat present (i.e. county importance)

<sup>1</sup> Common frog (*Rana temporaria*) and smooth newt (*Lissotriton vulgaris*) are protected under the Wildlife Act (1976-2021). Furthermore, common frogs are protected under Annex V of the Habitats Directive [92/42/EEC]

**Conservation value:** Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*), river lamprey (*Lampetra fluviatilis*), freshwater pearl mussel (*Margaritifera margaritifera*) and otter (*Lutra lutra*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon, river lamprey, freshwater pearl mussel and otter are also listed under Annex V of the Habitats Directive [92/42/EEC]. Freshwater pearl mussel and otters (along with their breeding and resting places) are also protected under provisions of the Irish Wildlife Acts 1976 to 2021. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Fisheries Acts 1959 to 2019, brown trout have no legal protection in Ireland.

## 5. Discussion

### 5.1 Most valuable areas for aquatic ecology

Sites B4 and B5 (both unnamed streams), being small in size and of poor ecological value, were considered of **local importance (lower value)**. Sites A1 and A2 (Baroosky River) were evaluated as **international importance** given their locations contiguous and within the Glenamoy Bog Complex SAC (000500), respectively. The sites both supported Atlantic salmon, which are listed as a qualifying interest for this European site (NPWS, 2017a). With the exception of sites B4 and B5 (both unnamed streams), all the remaining riverine survey sites (i.e. B1, B2, B3 to B16, C1 and C2) were evaluated as **local importance (higher value)**. Primarily, this was due to the presence of salmonid populations and or  $\geq$ Q4 (good status) water quality.

Atlantic salmon were recorded (via electro-fishing) from a total of 7 no. sites. These were located on the larger watercourses surveyed, namely the Baroosky River (sites A1 & A2), Sheskin Stream (B8 & B16), B12 (unnamed stream) and the Glencullin River (sites C1 and C2). Brown trout were also recorded from these sites, in addition to sites B2, B3, B6, B9, B10, B11, B12 & B15 (14 no. sites in total). Many of the watercourses surveyed only supported brown trout given their narrow, shallow and high-gradient, upland nature. The sites on the Sheskin Stream (B16) and Glencullin River (C1 & C2) provided the best overall salmonid habitat, with excellent-quality spawning habitat present at all three sites. Whilst suitability was largely absent throughout the survey sites given the upland, eroding nature of the watercourses, *Lampetra* sp. ammocoetes were recorded from a single site on the lower Sheskin Stream (site B16). A low density of ammocoetes (0.8 per m<sup>2</sup>) was recorded from sub-optimal (compacted) sand/silt accumulations. This site also featured the best-quality lamprey spawning habitat within the survey area. Despite some moderate to good suitability across most survey sites, European eel were only recorded from sites A1 and A2 (Baroosky River) and C2 (Glencullin River) (**Appendix A**).

No otter signs (i.e. spraint, latrine, slide, prints, couch or holt) were recorded at the  $n=23$  aquatic survey sites during September 2021. Suitability was typically poor given the small, high-energy, upland nature of most watercourses surveyed. However, otter are known in the downstream connecting Owenmore River and Carrowmore Lake (see section 3.1; **Figure 3.1**).

The riverine survey sites were typically unsuitable for freshwater pearl mussel given that many were located in the upper extent of river catchments, in addition to sub-optimal substrata and siltation pressures (primarily from peat escapement). Analysis of water samples collected from the Baroosky River, Sheskin Stream and Glencullin River did not detect pearl mussel eDNA (see section 4.6) and there are no known records of the species within the footprint of the proposed wind farm.

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from  $n=20$  riverine sites (**Appendix B**). With the exception of sites B15 and C1 (Q3-4, moderate status), site B9 (Q3, poor status) and B5 (Q1/0, bad status), all survey sites achieved  $\geq$ Q4 (**good status**) water quality and, thus, met the good status ( $\geq$ Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and

the Water Framework Directive (2000/60/EC). Sites B2 (unnamed stream) and B6 (Sheskin Stream) achieved **Q4-5 (high status)**.

The lakes surveyed at sites L1, L2 and L3 all corresponded to the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'. The lakes supported typical species of such habitats (O'Connor, 2015; EC, 2013) including bog bean (*Menyanthes trifoliata*), alternate-leaved milfoil (*Myriophyllum alterniflorum*) (L2 only), lesser bladderwort (*Utricularia minor*) and aquatic *Sphagnum* sp. mosses, in addition to several dragonfly and damselfly species. In comparison to the other lakes surveyed, lake L3 was shallow (often <1m) and the *Sphagnum*-dominated margins corresponded to the Annex I habitat 'Blanket bog (\* if active bog) [7130]'. Lake L3 also supported smooth newt (*Lissotriton vulgaris*) (detected via eDNA analysis). None of the lakes supported salmonids or European eel (confirmed by eDNA analysis). Lake survey site L1, being located within the Carrowmore Lake Complex SAC (000476), was of **international importance**. Lake survey sites L2 and L3 were of **county importance** as they represent good examples of the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'.

In summary, the majority of sites surveyed in the vicinity of the proposed Sheskin wind farm were of at least **local importance (higher value)** in terms of their aquatic ecology. However, enrichment pressures (primarily from upland afforestation) and peat escapement (siltation) are considerable threats to water quality in the watercourses draining the proposed wind farm site boundary. An extreme example of this was evident on an unnamed stream at site B4, where active clear-felling activities had resulted in gross siltation of the channel and an extirpation (at least temporarily) of fish and aquatic macro-invertebrates. Typically, larger watercourses with higher flow rates, such as the Baroosky River, Sheskin Stream and Glencullin River, are better able to buffer against such impacts and these watercourses generally supported the best quality aquatic habitat within the vicinity of the proposed wind farm for aquatic receptors of conservation value, such as salmonids.



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## 7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report



## 8. Appendix B – Q-sample results (biological water quality)

**Table 8.1** Macro-invertebrate Q-sampling results for the aquatic survey sites A1-A2 & B1-B8, September 2021

Group	Family	Species	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	EPA group
Ephemeroptera	Heptageniidae	<i>Rhithrogena semicolorata</i>	1	12		9				7		13	A
Ephemeroptera	Heptageniidae	<i>Ecdyonurus dispar</i>	16	13		13	5			9		1	A
Plecoptera	Capniidae	<i>Zwicknia bifrons</i> (formerly <i>Capnia bifrons</i> )									5		A
Plecoptera	Nemouridae	<i>Nemoura cinerea</i>			3	2							A
Plecoptera	Nemouridae	<i>Protonemura meyeri</i>	4	7	1	9	9			5		2	A
Plecoptera	Perlodidae	<i>Isoperla grammatica</i>								2			A
Ephemeroptera	Baetidae	<i>Alainites muticus</i>											B
Ephemeroptera	Leptophlebiidae	<i>Paraleptophlebia cincta</i>											B
Plecoptera	Leuctridae	<i>Leuctra hippopus</i>		2	1	1	1			2			B
Trichoptera	Glossosomatidae	<i>Glossosoma</i> sp.										1	B
Trichoptera	Limnephilidae	<i>Drusus annulatus</i>				1							B
Trichoptera	Limnephilidae	<i>Potamophylax cingulatus</i>							1				B
Trichoptera	Limnephilidae	Limniphilidae early instar										1	B
Trichoptera	Odontoceridae	<i>Odontocerum albicorne</i>	1				1					1	B
Trichoptera	Phryganeidae	<i>Agrypnia pagetana</i>											B
Trichoptera	Sericostomatidae	<i>Sericostoma personatum</i>	4	5									B
Odonata	Coenagrionidae	<i>Coenagrion</i> sp.							12				B
Ephemeroptera	Baetidae	<i>Baetis rhodani</i>	8	6		28	21			9		31	C
Ephemeroptera	Ephemerellidae	<i>Serratella ignita</i>		2						1			C
Trichoptera	Hydropsychidae	<i>Hydropsyche siltalai</i>										2	C
Trichoptera	Hydropsychidae	<i>Hydropsyche instabilis</i>	3	7									C
Trichoptera	Philopotamidae	<i>Chimarra marginata</i>	1									2	C
Trichoptera	Polycentropodidae	<i>Polycentropus flavomaculatus</i>	5	1		2	2			1		3	C
Trichoptera	Polycentropodidae	<i>Plectrocnemia conspersa</i>							4	1	3	1	C

Group	Family	Species	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	EPA group
Trichoptera	Polycentropodidae	<i>Plectrocnemia geniculata</i>	1							2			C
Trichoptera	Polycentropodidae	<i>Polycentropus kingi</i>											C
Trichoptera	Rhyacophilidae	<i>Rhyacophila dorsalis</i>			1							1	C
Trichoptera	Rhyacophilidae	<i>Rhyacophila munda</i>								1			C
Trichoptera	n/a	Trichoptera pupa											C
Crustacea	Gammaridae	<i>Gammarus duebeni</i>	15			9	8			1		2	C
Coleoptera	Dytiscidae	<i>Ilybius fuliginosus</i>							1				C
Coleoptera	Dytiscidae	Dytiscidae larva							1				C
Coleoptera	Dytiscidae	<i>Stictotarsus duodecimpustulatus</i>											C
Coleoptera	Elmidae	<i>Elmis aenea</i>	1			2				1			C
Coleoptera	Elmidae	<i>Limnius volckmari</i>	2	3		1				1		6	C
Coleoptera	Gyrinidae	<i>Gyrinidae larva</i>											C
Coleoptera	Gyrinidae	<i>Gyrinus minutus</i>											C
Coleoptera	Hydraenidae	<i>Limnebius truncatellus</i>											C
Coleoptera	Hydraenidae	<i>Hydraena gracilis</i>	1										C
Coleoptera	Hydrophilidae	<i>Coelostoma orbiculare</i>			1								C
Coleoptera	Scirtidae	Scirtidae larva								1			C
Diptera	Chaoboridae	Chaoboridae larva											C
Diptera	Chironomidae	Chironomid larva	3			2	2		7			4	C
Diptera	Limoniidae	<i>Eloeophila sp.</i>											C
Diptera	Pediciidae	<i>Dicranota sp.</i>				1			1	2		6	C
Diptera	Simuliidae	Simuliidae larva	1		3	5	1		34			2	C
Hemiptera	Corixidae	<i>Sigara sp.</i>											C
Hemiptera	Gerridae	Gerridae nymph									1		C
Hemiptera	Notonectidae	<i>Notonecta obliqua</i>											C
Mollusca	Sphaeriidae	Unidentified species							14				C



Group	Family	Species	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	EPA group
Mollusca	Tateidae	<i>Potamopyrgus antipodarum</i>											C
Arachnida	Hydrachnidae	Unidentified species											C
Mollusca	Lymnaeidae	<i>Ampullaceana balthica</i>											D
Annelidae	Naididae (Tubificidae)	<i>Naididae (Tubificidae)</i>				1							E
Annelidae	Oligochaeta	Unidentified species	3			3	1			1		1	n/a
<b>Abundance</b>			70	58	10	89	51	0	75	47	9	80	
<b>Q-rating</b>			Q4	Q4	Q4	Q4-5	Q4	*Q1/0	**Q3	Q4-5	Q4	Q4	
<b>WFD status</b>			Good	Good	Good	High	Good	Bad	Poor	High	Good	Good	

\* zero invertebrates were recorded during kick sampling. Site located in an active clear-fell area and evidently this had caused gross pollution of the stream

\*\* tentative rating due to poor flows and or lack of suitable riffle areas for sampling (as per Toner et al., 2005)

**Table 8.2** Macro-invertebrate Q-sampling results for the aquatic survey sites B9-B16 & C1-C2, September 2021

Group	Family	Species	B9	B10	B11	B12	B13	B14	B15	B16	C1	C2	EPA group
Ephemeroptera	Heptageniidae	<i>Rhithrogena semicolorata</i>			1	1						1	A
Ephemeroptera	Heptageniidae	<i>Ecdyonurus dispar</i>			7	8				2	1	47	A
Plecoptera	Nemouridae	<i>Nemoura cinerea</i>			3		5			6	1		A
Plecoptera	Nemouridae	<i>Protonemura meyeri</i>		10		1			1		1		A
Plecoptera	Perlodidae	<i>Isoperla grammatica</i>						4				1	A
Ephemeroptera	Baetidae	<i>Alainites muticus</i>										1	B
Ephemeroptera	Leptophlebiidae	<i>Paraleptophlebia cincta</i>											B
Plecoptera	Leuctridae	<i>Leuctra hippopus</i>		4	9	8	1	25	2		10	2	B
Trichoptera	Glossosomatidae	<i>Glossosoma</i> sp.								2			B
Trichoptera	Limnephilidae	<i>Potamophylax cingulatus</i>										1	B
Trichoptera	Limnephilidae	Limniphilidae early instar					1						B
Trichoptera	Sericostomatidae	<i>Sericostoma personatum</i>				2				4			B
Ephemeroptera	Baetidae	<i>Baetis rhodani</i>	2	14	37	11	1	8	10	8	5	47	C
Trichoptera	Hydropsychidae	<i>Hydropsyche siltalai</i>								1			C
Trichoptera	Hydropsychidae	<i>Hydropsyche instabilis</i>								1	3	12	C
Trichoptera	Polycentropodidae	<i>Polycentropus flavomaculatus</i>				5					5	1	C
Trichoptera	Polycentropodidae	<i>Plectrocnemia conspersa</i>	1	2	2		5	3	2				C
Trichoptera	Polycentropodidae	<i>Polycentropus kingi</i>					1				5	1	C
Trichoptera	Rhyacophilidae	<i>Rhyacophila dorsalis</i>				1			1			3	C
Trichoptera	n/a	Trichoptera pupa						1				1	C
Crustacea	Gammaridae	<i>Gammarus duebeni</i>	13	6	5		1	3	4	17	2	1	C
Coleoptera	Dytiscidae	<i>Stictotarsus duodecimpustulatus</i>								3			C
Coleoptera	Elmidae	<i>Elmis aenea</i>								1		1	C
Coleoptera	Elmidae	<i>Limnius volckmari</i>								1	1	1	C

Coleoptera	Gyrinidae	<i>Gyrinidae larva</i>									1		C
Coleoptera	Gyrinidae	<i>Gyrinus minutus</i>											C
Coleoptera	Hydraenidae	<i>Limnebius truncatellus</i>					1	1				1	C
Coleoptera	Scirtidae	Scirtidae larva		1			1						C
Diptera	Chaoboridae	Chaoboridae larva											C
Diptera	Chironomidae	Chironomid larva	1		3	1		6		4	6	3	C
Diptera	Limoniidae	<i>Eloeophila sp.</i>	1					2					C
Diptera	Pediciidae	<i>Dicranota sp.</i>			1			1	6			1	C
Diptera	Simuliidae	Simulidae larva	2	2			5	1			3	1	C
Hemiptera	Corixidae	<i>Sigara sp.</i>											C
Hemiptera	Gerridae	Gerridae nymph					1						C
Mollusca	Sphaeriidae	Unidentified species	3										C
Mollusca	Tateidae	<i>Potamopyrgus antipodarum</i>										21	C
Arachnida	Hydrachnidia	Unidentified species						1				1	C
Mollusca	Lymnaeidae	<i>Ampullaceana balthica</i>										3	D
Annelidae	Naididae (Tubificidae)	<i>Naididae (Tubificidae)</i>						1					E
Annelidae	Oligochaeta	Unidentified species		1	4		1				1		n/a
<b>Abundance</b>			23	40	72	38	24	57	26	50	45	152	
<b>Q-rating</b>			<b>Q3</b>	<b>Q4</b>	<b>Q4</b>	<b>Q4</b>	<b>Q4</b>	<b>Q4</b>	<b>Q3-4</b>	<b>Q4</b>	<b>Q3-4</b>	<b>Q4</b>	
<b>WFD status</b>			<b>Poor</b>	<b>Good</b>	<b>Good</b>	<b>Good</b>	<b>Good</b>	<b>Good</b>	<b>Mod</b>	<b>Good</b>	<b>Mod</b>	<b>Good</b>	



## 9. Appendix C – lake macro-invertebrate communities

**Table 9.1** Macro-invertebrate communities recorded from lakes L1, L2 & L3, September 2021

Group	Family	Species	L1	L2	L3	EPA group
Ephemeroptera	Leptophlebiidae	<i>Paraleptophlebia cincta</i>		6		B
Trichoptera	Phryganeidae	<i>Agrypnia pagetana</i>			1	B
Odonata	Aeshnidae	<i>Aeshna juncea</i>	2	1		B
Odonata	Coenagrionidae	<i>Coenagrion sp.</i>	14	25	18	B
Odonata	Libellulidae	<i>Libellula quadrimaculata</i>	3	3		B
Ephemeroptera	Baetidae	<i>Cloeon simile</i>			1	C
Trichoptera	Polycentropodidae	<i>Plectrocnemia geniculata</i>			2	C
Diptera	Chaoboridae	Chaoboridae larva			1	C
Diptera	Chironomidae	Chironomid larva	2		4	C
Hemiptera	Corixidae	<i>Sigara sp.</i>	3	28	16	C
Hemiptera	Notonectidae	<i>Notonecta obliqua</i>	1		2	C
Arachnida	Hydrachnidiae	Unidentified species	1	1		C
<b>Abundance</b>			<b>28</b>	<b>64</b>	<b>45</b>	

## 10. Appendix D – eDNA analysis lab report

**Folio No:** E12283  
**Report No:** 1 - Sheskin Wind Farm  
**Client:** Triturus Environmental Ltd  
**Contact:** Ross Macklin

## TECHNICAL REPORT

### ANALYSIS OF ENVIRONMENTAL DNA IN WATER FOR AQUATIC SPECIES DETECTION

#### SUMMARY

When aquatic organisms inhabit a waterbody such as a pond, lake or river they continuously release small amounts of their DNA into the environment. By collecting and analysing water samples, we can detect these small traces of environmental DNA (eDNA) to confirm the presence or absence of the target species within the waterbody.

#### RESULTS

**Date sample received in laboratory:** 01/11/2021  
**Date results reported:** 11/11/2021  
**Matters affecting result:** None

**TARGET SPECIES:** Freshwater pearl mussel  
*(Margaritifera margaritifera)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK185	Sheskin Stream B16	-	Pass	Pass	Pass	Negative	0/12
FK186	Glencullin River d/s C2	-	Pass	Pass	Pass	Negative	0/12
FK187	Baroosky River d/s A2	-	Pass	Pass	Pass	Negative	0/12

**TARGET SPECIES:** Brown (Sea) Trout  
*(Salmo trutta)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK50	Lake L1	-	Pass	Pass	Pass	Negative	0/12
FK86	Lake L2	-	Pass	Pass	Pass	Negative	0/12
FK200	Lake L3	-	Pass	Pass	Pass	Negative	0/12



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**TARGET SPECIES:** European eel  
(*Anguilla anguilla*)

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK50	Lake L1	-	Pass	Pass	Pass	Negative	0/12
FK86	Lake L2	-	Pass	Pass	Pass	Negative	0/12
FK200	Lake L3	-	Pass	Pass	Pass	Negative	0/12

**TARGET SPECIES:** Smooth Newt  
(*Lissotriton vulgaris*)

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK50	Lake L1	-	Pass	Pass	Pass	Negative	0/12
FK86	Lake L2	-	Pass	Pass	Pass	Negative	0/12
FK200	Lake L3	-	Pass	Pass	Pass	Positive	10/12

If you have any questions regarding results, please contact us: [ForensicEcology@surescreen.com](mailto:ForensicEcology@surescreen.com)

Reported by: MSc Gabriela Danickova

Approved by: Jennifer Higginbottom



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## **METHODOLOGY**

The samples detailed above have been analysed for the presence of target species eDNA following scientifically published eDNA assays and protocols which have been thoroughly tested, developed and verified for use by SureScreen Scientifics.

The analysis is conducted in two phases. The sample first goes through an extraction process where the filter is incubated in order to obtain any DNA within the sample. The extracted sample is then tested via real time PCR (also called q-PCR) for each of the selected target species. This process uses species-specific molecular markers (known as primers) to amplify a select part of the DNA, allowing it to be detected and measured in 'real time' as the analytical process develops. qPCR combines amplification and detection of target DNA into a single step. With qPCR, fluorescent dyes specific to the target sequence are used to label targeted PCR products during thermal cycling. The accumulation of fluorescent signals during this reaction is measured for fast and objective data analysis. The primers used in this process are specific to a part of mitochondrial DNA only found in each individual species. Separate primers are used for each of the species, ensuring no DNA from any other species present in the water is amplified.

If target species DNA is present, the DNA is amplified up to a detectable level, resulting in positive species detection. If target species DNA is not present then amplification does not occur, and a negative result is recorded.

Analysis of eDNA requires scrupulous attention to detail to prevent risk of contamination. True positive controls, negative controls and spiked synthetic DNA are included in every analysis and these have to be correct before any result is declared and reported. Stages of the DNA analysis are also conducted in different buildings at our premises for added security.

SureScreen Scientifics Ltd is ISO9001 accredited and participate in Natural England's proficiency testing scheme for GCN eDNA testing. We also carry out regular inter-laboratory checks on accuracy of results as part of our quality control procedures.



## **INTERPRETATION OF RESULTS**

- SIC: Sample Integrity Check [Pass/Fail]**  
When samples are received in the laboratory, they are inspected for any tube leakage, suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.
- DC: Degradation Check [Pass/Fail]**  
Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.
- IC: Inhibition Check [Pass/Fail]**  
The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.
- Result: Presence of eDNA [Positive/Negative/Inconclusive]**
- Positive:** DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.
- Positive Replicates:** Number of positive qPCR replicates out of a series of 12. If one or more of these are found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. Even a score as low as 1/12 is declared positive. 0/12 indicates negative species presence.
- Negative:** eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.
- Inconclusive:** Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.







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