Fisheries assessment of Sheskin wind farm, Co. Mayo

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

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Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by McCarthy Keville O' Sullivan Ltd. to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Sheskin wind farm, located near Bellacorick, Co. Mayo (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project. In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the vicinity of the proposed wind farm, a catchment-wide electro-fishing survey across *n*=20 sites was undertaken (**Table 2.1; Figure 2.1**)**.** Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, lamprey and European eel (*Anguilla anguilla*), as well as other species, and helped to further inform impact assessment and any subsequent mitigation for the project.

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake a catchment-wide electro-fishing survey in the vicinity of the proposed Sheskin wind farm. Permission was granted on 26th July the survey was undertaken in late September 2021.

1.2 Fisheries asset of the survey area

The proposed survey sites were located in the Owenmore_SC_010, Glenamoy_SC_010 and Munhin_SC_010 river sub-catchments. W 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).

Fisheries 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**; **Figure 2.1**).

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

2. Methodology

2.1 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Sheskin wind farm in September 2021, following notification to Inland Fisheries Ireland (IFI) and the National parks and Wildlife Service (NPWS), under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) licence. Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank.

Salmonids, European eel and other captured fish species were transferred to a holding container with oxygenated fresh river water following capture. To reduce fish stress levels, anaesthesia was not applied to captured fish. All fish were measured to the nearest millimetre and released in-situ following a suitable recovery period.

As three primary species groups were targeted during the survey, i.e. salmonids, lamprey, and eel, the electro-fishing settings were tailored for each species. By undertaking electro-fishing using the rapid electro-fishing technique (see methodology below), the broad characterisation of the fish community at each sampling reach could be determined as a longer representative length of channel can be surveyed. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g. CFB, 2008).

The catchment-wide electro-fishing (CWEF) survey was undertaken across *n*=20 riverine sites (see **Table 2.1, Figure 2.1**).

Table 2.1 Location of *n*=20 electro-fishing survey sites in the vicinity of Sheskin wind farm, 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

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
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

2.1.1 Salmonids and European eel

For salmonid species and European eel, as well as all other incidental species, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. 50-100m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages. At certain, more minor watercourse sites or sites with limited access, it was more feasible to undertake electro-fishing for a 5-minute CPUE (**Table 3.1**).

Relative conductivity of the water at each site was checked in-situ with a conductivity meter and the electro-fishing backpack was energised with the appropriate voltage and frequency to provide enough draw to attract salmonids and European eel to the anode without harm. For the low conductivity waters of the sites, a voltage of 350-400v, frequency of 30-35Hz and pulse duration of 3-3.5ms was utilised to draw fish to the anode without causing physical damage.

2.1.2 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted box quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of sand/silt, where encountered. As lamprey take longer to emerge from silts and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed detection of European eel in sediment, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water's surface, approx. 10-15 cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

Lamprey species were identified to species level, where possible, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003).

2.2 Fisheries habitat

2.2.1 General fisheries habitat

A broad appraisal of the upstream and downstream habitat at each site was also undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e. channel profiles, substrata etc.).

2.3 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.

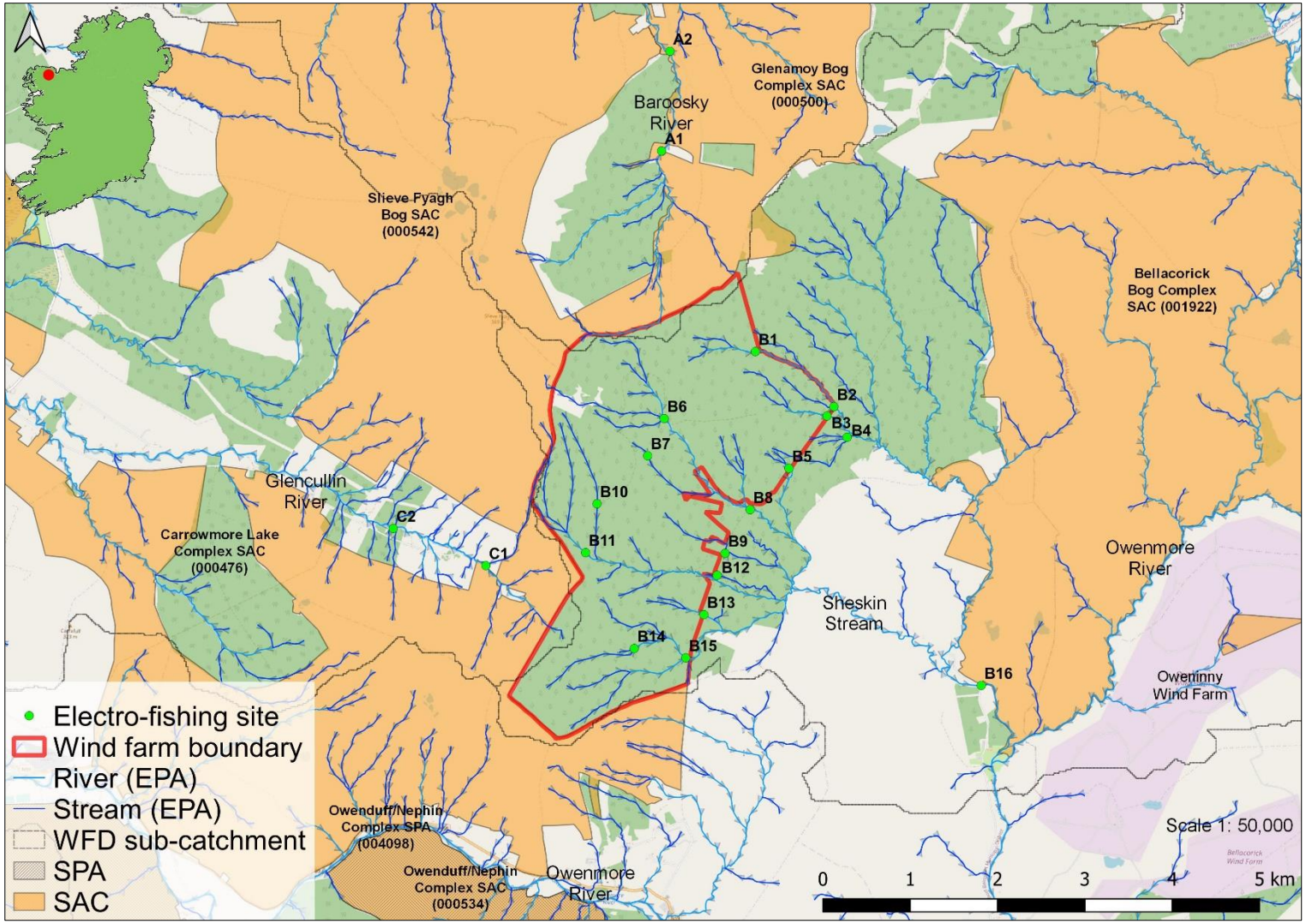

Figure 2.1 Location overview of the *n*=20 electro-fishing sites in vicinity of the proposed Sheskin wind farm, Co. Mayo

3. Results

A catchment-wide electro-fishing survey of *n*=20 sites in the vicinity of the proposed Sheskin wind farms was conducted in September 2021, following notification to Inland Fisheries Ireland (IFI) and the National Parks and Wildlife Service (NPWS). The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1 Fish stock assessment (electro-fishing)

3.1.1 Site A1 – Baroosky River, Baroosky

A total of three fish species were recorded at site A1 (**Figure 3.1**). The site supported moderate densities of mixed-cohort brown trout (*Salmo trutta*) (*n*=13 total), in addition to moderate densities of Atlantic salmon (*Salmo salar*) parr (*n*=8). A single European eel was also captured.

The site was a good-quality salmonid nursery, with some localised good-quality spawning habitat (albeit better suited to Atlantic salmon given the 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 (none recorded).

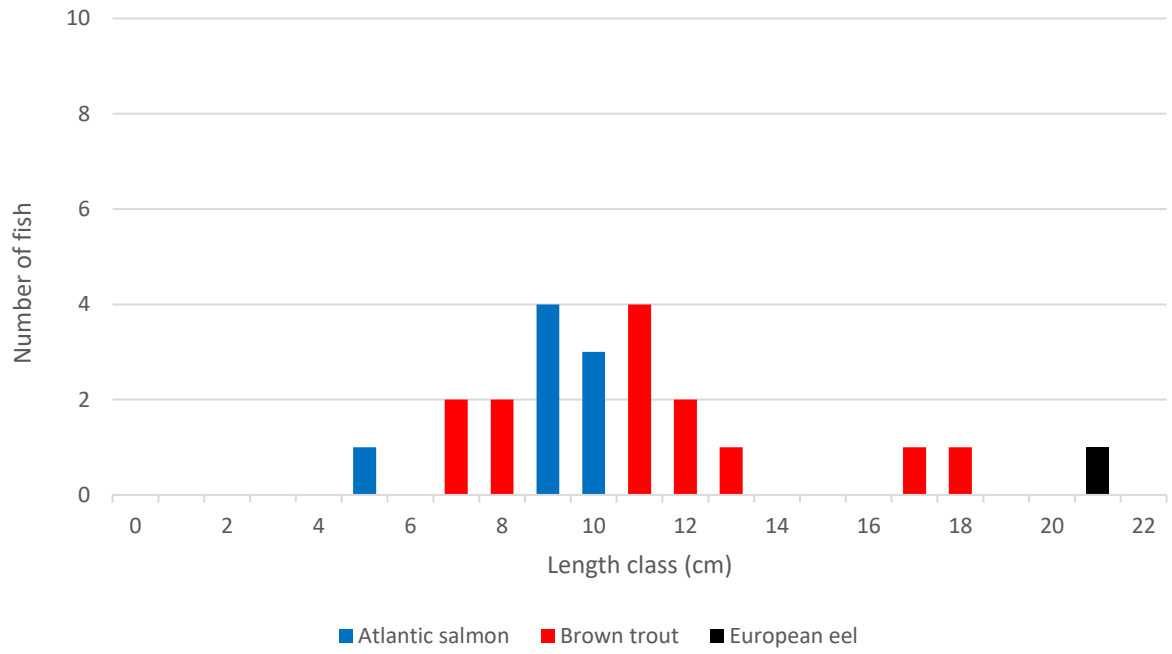

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1 on the Baroosky River, September 2021

Plate 3.1 Mixed-cohort brown trout recorded at site A1 on the Baroosky River, September 2021

3.1.2 Site A2 – Baroosky River, Lenarevagh

A total of three fish species were recorded at site A2 (**Figure 3.2**). The site supported moderate densities of mixed-cohort brown trout (*n*=17), in addition to moderate densities of Atlantic salmon parr (*n*=12) and low numbers of European eel (*n*=2).

The site was a good-quality salmonid nursery and also provided good-quality spawning habitat (albeit better suited to Atlantic salmon given the 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).

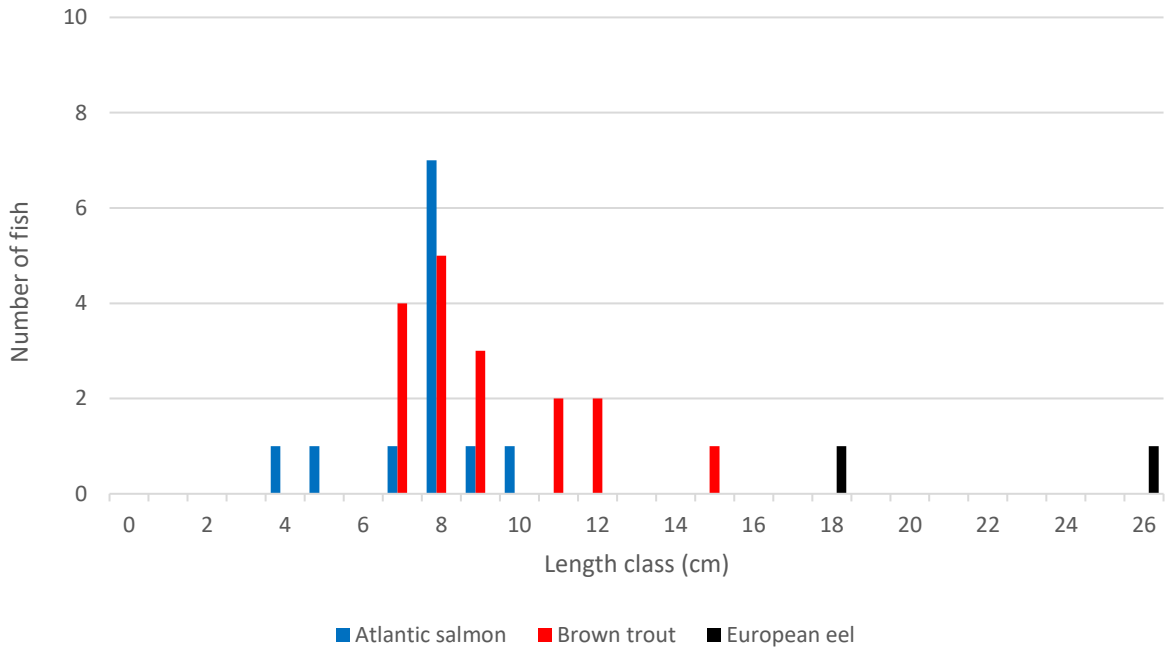

Figure 3.2 Length frequency distribution recorded via electro-fishing at site A2 on the Baroosky River, September 2021

Plate 3.2 Representative image of site A2 on the Baroosky River, September 2021

3.1.3 Site B1 – Unnamed stream, Sheskin

No fish were recorded at site B1. 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. 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).

Plate 4.3 Representative image of site B1 on an unnamed stream, September 2021

3.1.4 Site B2 – Unnamed stream, Sheskin

Brown trout was the only fish species recorded at site B2 (**Figure 3.3**). The site supported a moderate density of juveniles with a low number of mixed-cohort adult trout (*n*=19 total).

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).

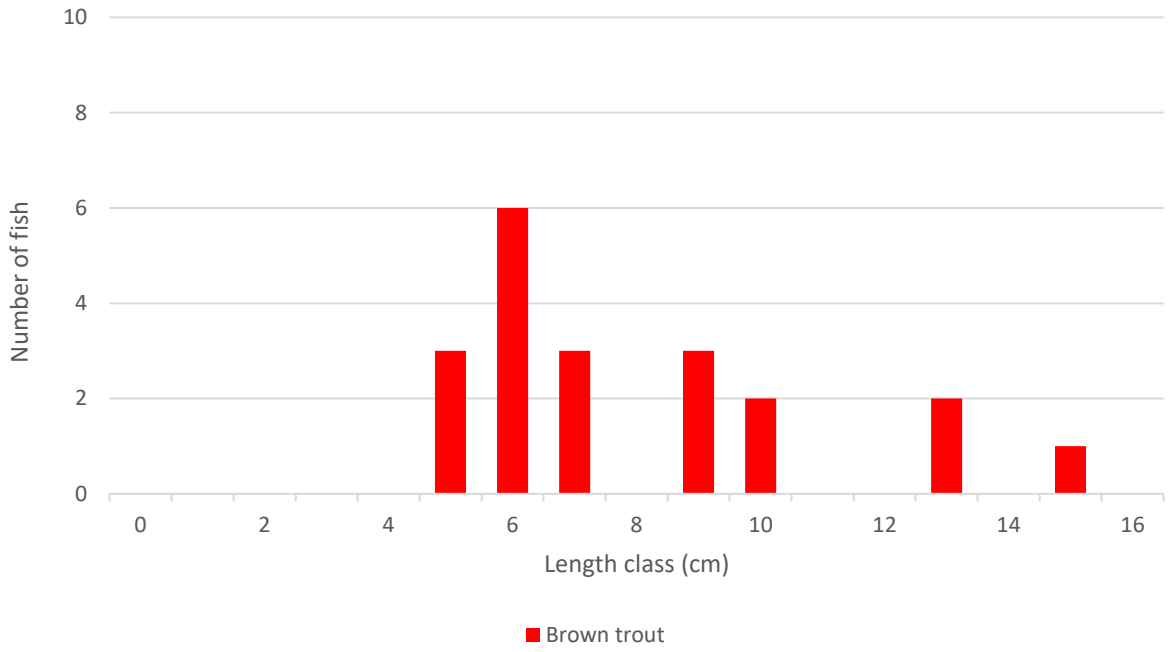

Figure 3.3 Length frequency distribution recorded via electro-fishing at site B2 on an unnamed stream, September 2021

Plate 3.4 Mixed-cohort brown trout recorded at site B2, September 2021

3.1.5 Site B3 – Unnamed stream, Sheskin

Brown trout was the only fish species recorded at site B3 (**Figure 3.4**). A small, mixed-cohort population was present, with a moderate density of juveniles and a low number of small adults (*n*=14 total).

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).

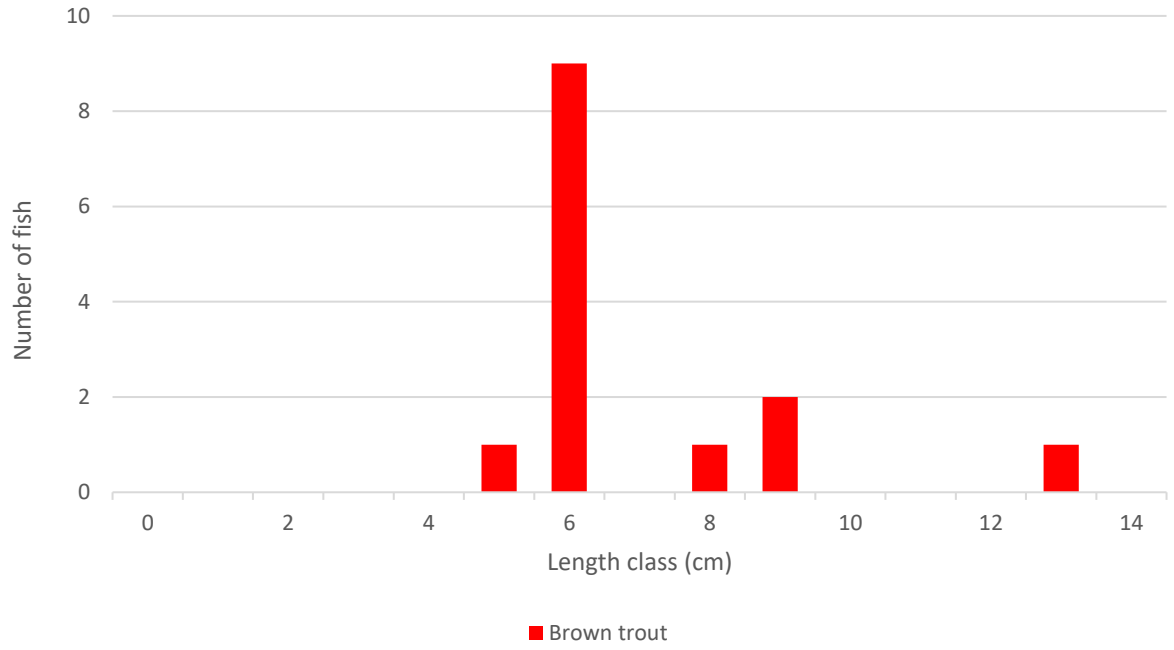

Figure 3.4 Length frequency distribution recorded via electro-fishing at site B3 on an unnamed stream, September 2021

Plate 3.5 Mixed-cohort brown trout recorded at site B3, September 2021

3.1.6 Site B4 – Unnamed stream, Sheskin

No fish were recorded at site B4. 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 life.

Plate 3.6 Representative image of site B4 on an unnamed stream, September 2021, showing evident significant impacts from clear-felling

3.1.7 Site B5 – Unnamed stream, Sheskin

No fish were recorded at site B5. The very narrow, heavily-silted stream was <0.5m wide but up to 0.3m deep in places. The stream resembled a slow-flowing peat drainage channel (with frequent ponding areas) which had been modified historically and was not of fisheries value.

Plate 3.7 Representative image of site B5 on an unnamed stream, September 2021

3.1.8 Site B6 – Sheskin Stream, Sheskin

Brown trout was the only fish species recorded at site B6 (**Figure 3.5**), with a moderate density of juveniles and a low number of small adults recorded (*n*=18 total).

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).

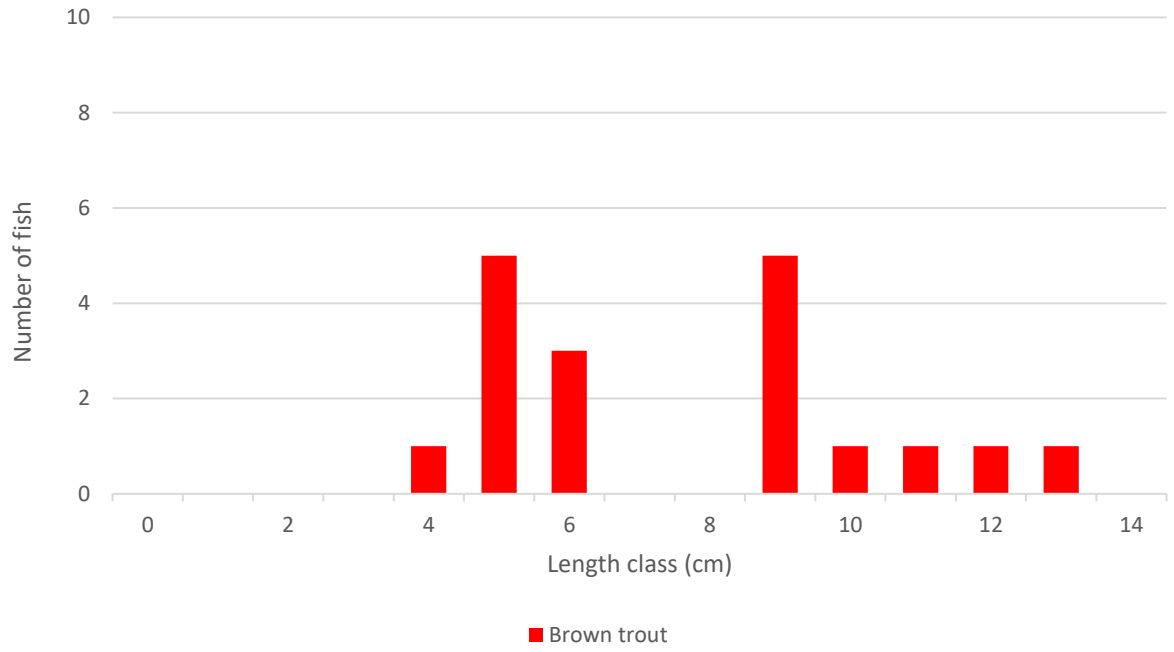

Figure 3.5 Length frequency distribution recorded via electro-fishing at site B6 on the Sheskin Stream, September 2021

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

3.1.9 Site B7 – Unnamed stream, Sheskin

No fish were recorded at site B7. 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.

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).

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

3.1.10 Site B8 – Sheskin Stream, Sheskin

Atlantic salmon and brown trout were the only two fish species recorded via electro-fishing at site B8 (**Figure 3.6**). The site was dominated by mixed-cohort brown trout, including a moderate density of young-of-the-year fish (*n*=34 total). A low number of Atlantic salmon parr (*n*=4) were also 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. Whist 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).

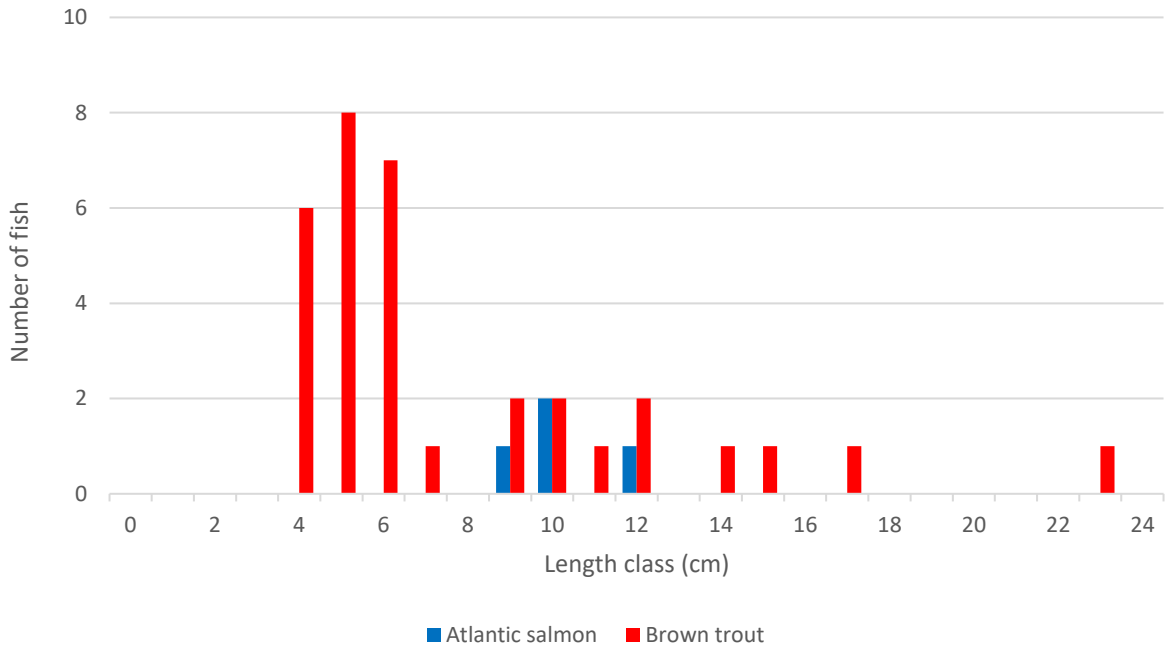

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B8 on the Sheskin Stream, September 2021

Plate 3.10 Adult brown trout recorded at site B8, September 2021

3.1.11 Site B9 – Unnamed stream, Sheskin

Brown trout was the only fish species recorded at site B9 (**Figure 3.7**), with a single juvenile recorded (*n*=1). 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.

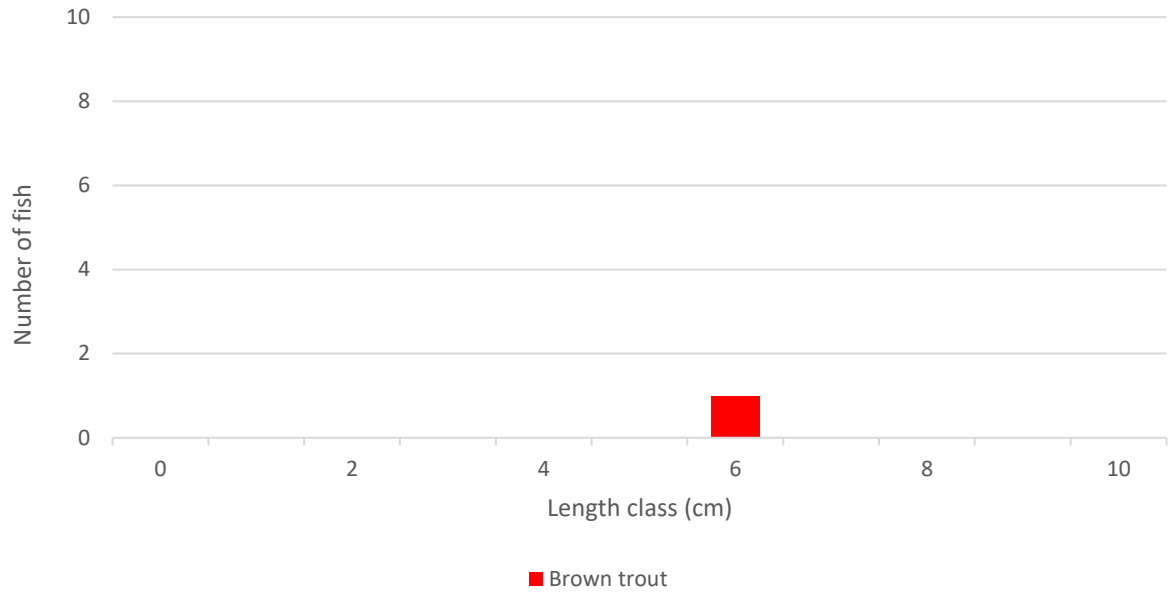

Figure 3.7 Length frequency distribution recorded via electro-fishing at site B9 on an unnamed stream, September 2021

Plate 3.11 Representative image of site B9 on an unnamed stream, September 2021

3.1.12 Site B10 – Unnamed stream, Sheskin

Brown trout was the only fish species recorded at site B10 (**Figure 3.8**), with a low number of juveniles recorded (no adults) (*n*=3 total).

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.

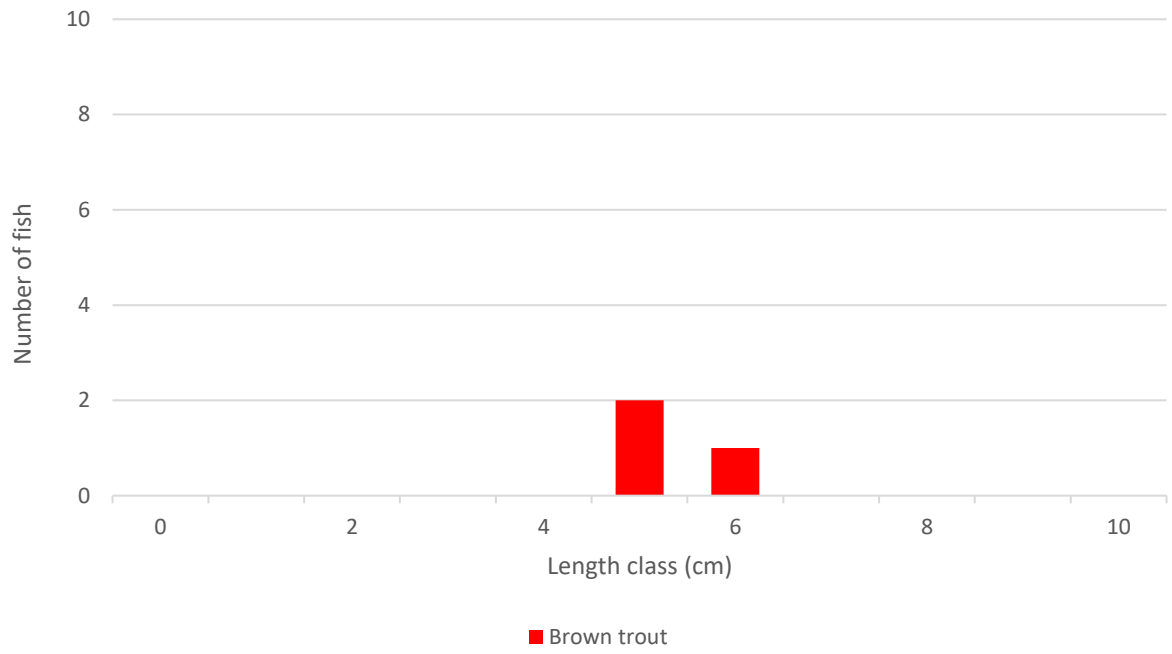

Figure 3.8 Length frequency distribution recorded via electro-fishing at site B10 on an unnamed stream, September 2021

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

3.1.13 Site B11 – Unnamed stream, Sheskin

Brown trout was the only fish species recorded at site B11 (**Figure 3.9**). A low density of juveniles and small adults was recorded (*n*=9 total). Based on the small area fished, the site supported the highest density of brown trout recorded during the surveys (**Table 3.1**).

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 (none recorded).

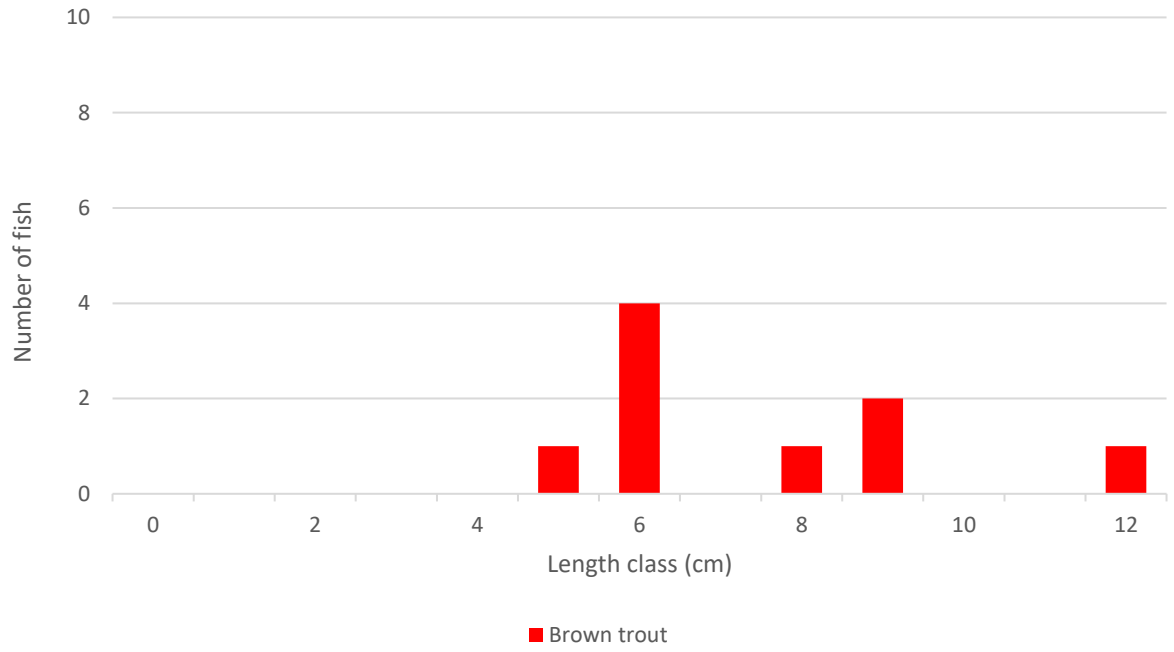

Figure 3.9 Length frequency distribution recorded via electro-fishing at site B11 on an unnamed stream, September 2021

Plate 3.13 Juvenile brown trout recorded at site B11, September 2021

3.1.14 Site B12 – Unnamed stream, Sheskin

Atlantic salmon and brown trout were the only two fish species recorded at site B12 (**Figure 3.10**). Both were present at low densities (n=*7* and n=*6*, respectively). Both adult and juvenile trout were captured.

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).

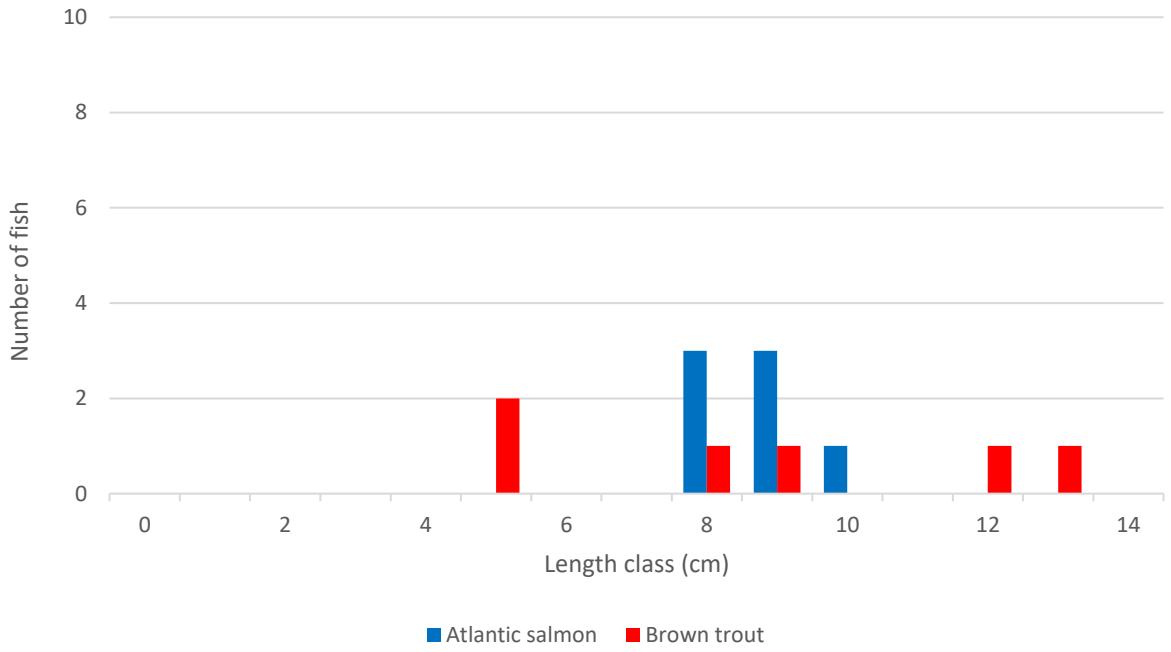

Figure 3.10 Length frequency distribution recorded via electro-fishing at site B12 on an unnamed stream, September 2021

Plate 3.14 Representative image of site B12 on an unnamed stream, September 2021

3.1.15 Site B13 – Unnamed stream, Sheskin

No fish were recorded at site B13. The upland eroding stream at this location was a poor-quality salmonid nursery, spawning and holding habitat given its diminutive size (0.5m wide), very shallow nature (0.1m deep) and steep gradient. European eel habitat was poor overall for these same reasons. The upland eroding site was unsuitable for lamprey (none recorded).

Plate 3.15 Representative image of site B13 on an unnamed stream, September 2021

3.1.16 Site B14 – Unnamed stream, Sheskin

No fish were recorded at site B14. The upland eroding stream at this location was a poor-quality salmonid nursery and holding habitat given the overall shallow nature (0.1-0.15m deep). 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).

Plate 3.16 Electro-fishing at site B14 on an unnamed stream, September 2021

3.1.17 Site B15 – Unnamed stream, Sheskin

Brown trout was the only fish species recorded at site B15 (**Figure 3.11**). A low density of juveniles and small adults was recorded (*n*=8 total).

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 (none recorded).

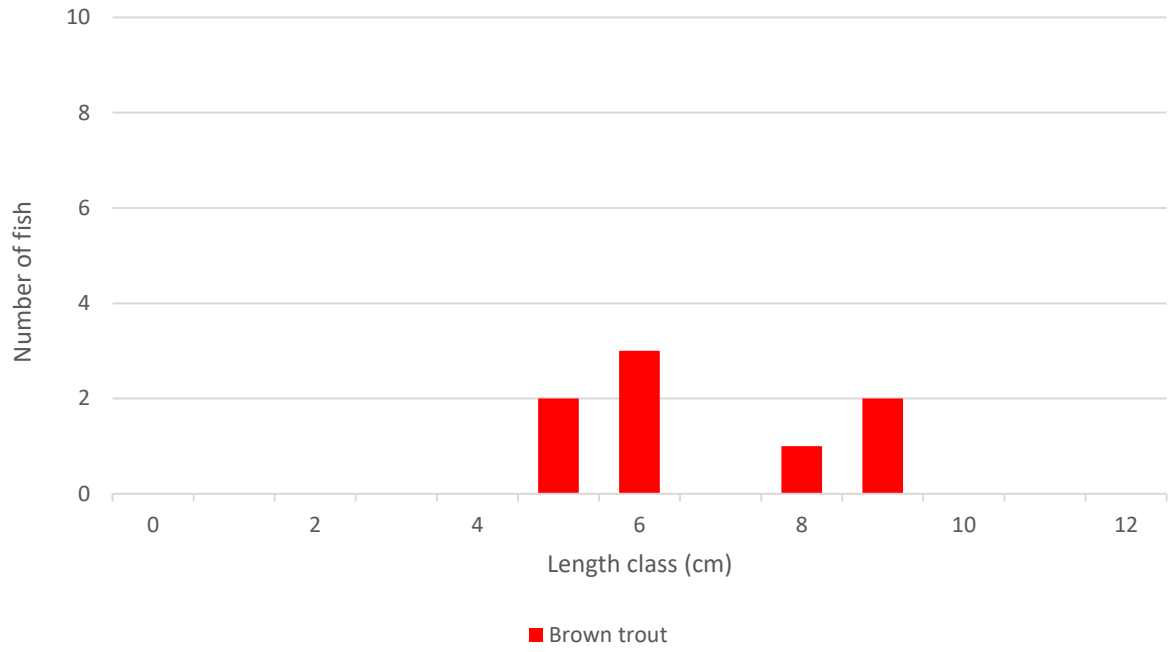

Figure 3.11 Length frequency distribution recorded via electro-fishing at site B15 on an unnamed stream, September 2021

Plate 3.17 Brown trout recorded at site B15 on an unnamed stream, September 2021

3.1.18 Site B16 – Sheskin Stream, Foot Bridge

A total of four fish species were recorded at site B16 (**Figure 3.12**). The site supported high density of Atlantic salmon parr (two size classes, *n*=44 total) in addition to a low number of brown trout (juveniles and adults, *n*=9 total) and minnow (*Phoxinus phoxinus*) (*n*=5). A low density of *Lampetra* sp. ammocoetes were also recorded (*n*=2, 0.8 per m^2 of targeted habitat). The site supported the highest

density of Atlantic salmon parr recorded during the surveys and was the only survey site to support *Lampetra* sp. or minnow (**Table 3.1**).

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.

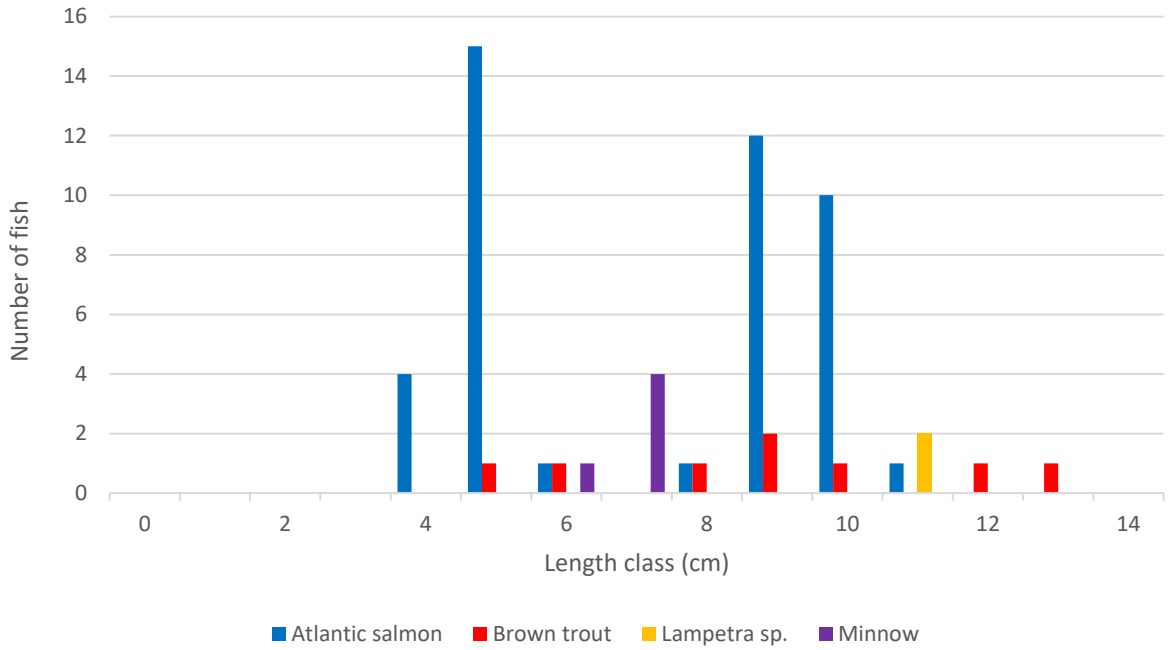

Figure 3.12 Length frequency distribution recorded via electro-fishing at site B16 on the Sheskin Stream, September 2021

Plate 3.18 Atlantic salmon parr (top) and juvenile brown trout (bottom) recorded at site B16 on the Sheskin Stream, September 2021

3.1.19 Site C1 – Glencullin River, Glencullin Upper

Atlantic salmon and brown trout were the only two fish species recorded at site C1 (**Figure 3.13**). Brown trout dominated the site, with mixed cohorts present (*n*=32 total). A low number of Atlantic salmon parr (two cohorts) were also recorded (*n*=6 total).

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).

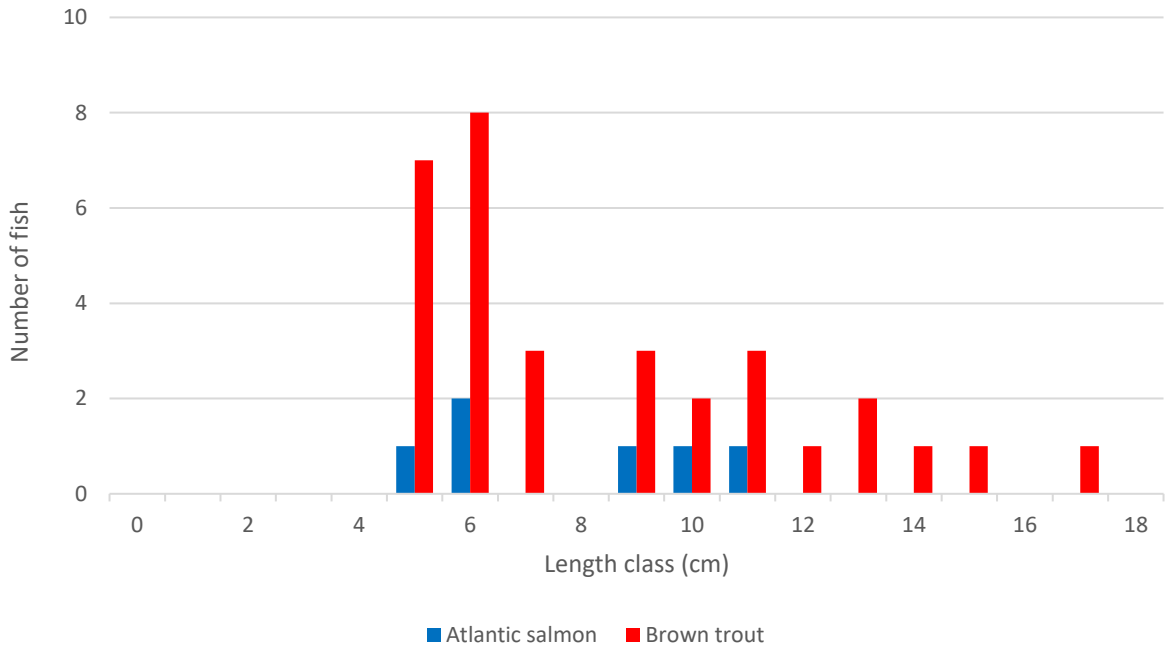

Figure 3.13 Length frequency distribution recorded via electro-fishing at site C1 on the Glencullin River, September 2021

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

3.1.20 Site C2 – Glencullin River, Glencullin Upper

A total of three fish species were recorded at site C2 (**Figure 3.14**). The site supported a high density of Atlantic salmon parr (*n*=42 total), with moderate densities of mixed-cohort brown trout (*n*=22 total) in addition to a low number of European eel (*n*=3).

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).

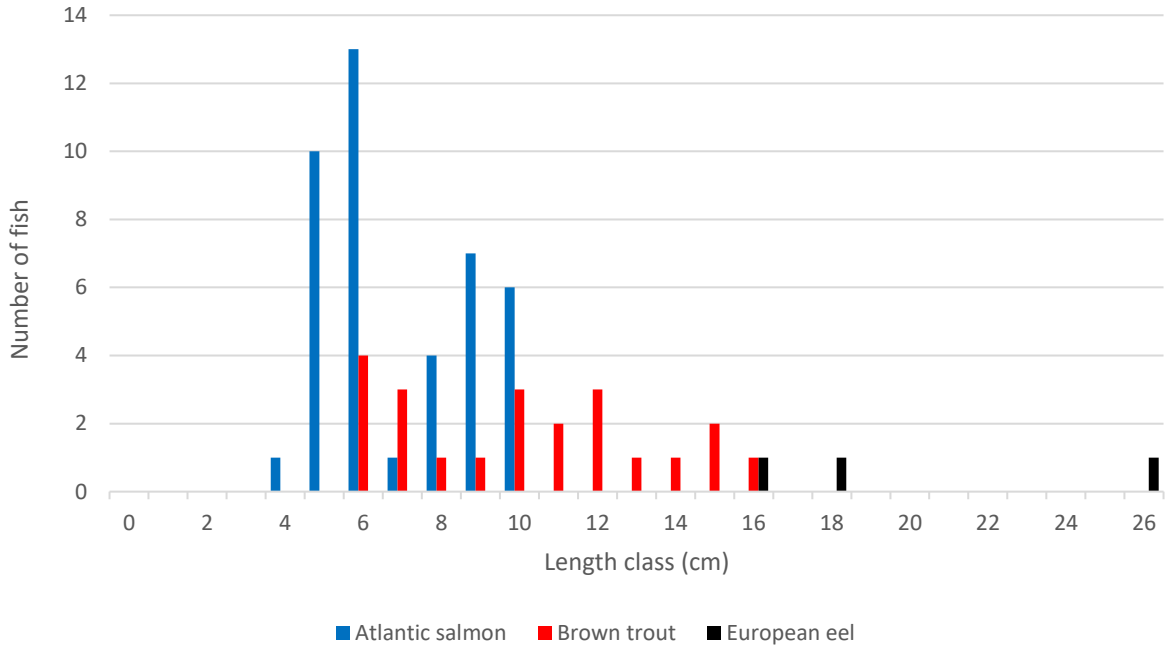

Figure 3.14 Length frequency distribution recorded via electro-fishing at site C2 on the Glencullin River, September 2021

Plate 4.20 Juvenile Atlantic salmon (top) and brown trout (bottom) recorded at site C2 on the Glencullin River, September 2021

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of Sheskin wind farm via electro-fishing in September 2021. Values in bold represent the highest densities recorded for each species, respectively. * = no. ammocoetes per m^2 of targeted habitat fished. Greyed out values indicate no fish recorded during the survey.

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)				
				Atlantic salmon	Brown trout	European eel	*Lampetra* sp.	Minnow
A1	Baroosky River	10	270	0.044	0.063	0.007	0.000	0.000
A2	Baroosky River	10	280	0.029	0.046	0.004	0.000	0.000
B1	Unnamed stream	5	75	0.000	0.000	0.000	0.000	0.000
B2	Unnamed stream	10	120	0.000	0.158	0.000	0.000	0.000
B3	Unnamed stream	10	315	0.000	0.044	0.000	0.000	0.000
B4	Unnamed stream	10	100	0.000	0.000	0.000	0.000	0.000
B5	Unnamed stream	5	12.5	0.000	0.000	0.000	0.000	0.000
B6	Sheskin Stream	5	150	0.000	0.120	0.000	0.000	0.000
B7	Unnamed stream	5	75	0.000	0.000	0.000	0.000	0.000
B8	Sheskin Stream	10	270	0.015	0.126	0.000	0.000	0.000
B9	Unnamed stream	5	20	0.000	0.050	0.000	0.000	0.000
B10	Unnamed stream	5	50	0.000	0.060	0.000	0.000	0.000
B11	Unnamed stream	5	47.5	0.000	**0.189**	0.000	0.000	0.000
B12	Unnamed stream	5	120	0.058	0.050	0.000	0.000	0.000
B13	Unnamed stream	10	100	0.000	0.000	0.000	0.000	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)				
				Atlantic salmon	Brown trout	European eel	*Lampetra* sp.	Minnow
B14	Unnamed stream	5	50	0.000	0.000	0.000	0.000	0.000
B15	Unnamed stream	5	60	0.000	0.133	0.000	0.000	0.000
B16	Sheskin Stream	10	180	**0.244**	0.050	0.000	**0.8***	**0.028**
C1	Glencullin River	10	175	0.034	0.183	0.000	0.000	0.000
C2	Glencullin River	10	210	0.200	0.105	**0.014**	0.000	0.000

4. Discussion

4.1 Most valuable sites

4.1.1 Salmonids

Atlantic salmon were recorded 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). The highest densities of salmon were present at sites B16 (Sheskin Stream) and C2 (Glencullin River) (**Table 3.2**), where two size classes (0+ and ≥1+) were recorded. Mixed juvenile cohorts were also present at sites A1 and A2 (Baroosky River) and site C1 on the Glencullin River.

Brown trout were recorded from a total of 14 no. sites (i.e. sites A1, A2, B2, B3, B6, B8, B9, B10, B11, B12 & B15, B16, C1 & C2. With the exception of sites B9 and B10, all sites containing trout supported mixed cohort populations (i.e. juveniles and adults). The highest densities of brown trout were present at sites B11 (unnamed stream) and C1 (Glencullin River) (**Table 3.2**). However, many of the watercourses surveyed supported small brown trout populations only (low abundances) given their narrow, shallow and high-gradient, upland nature. Furthermore, the survey watercourses flow over and or drain extensive areas of blanket bog. Peat-based catchments are less productive than other those flowing over other geologies (O'Grady, 2006), with reduced primary productivity, reduced macro-invertebrate communities, and, generally speaking, lower fish biomass (Richardson, 1993).

In general, the Sheskin survey sites were small, upland eroding spate channels located in the upper reaches of the respective catchments. Many were located in high-gradient areas. Stream gradient is known to be one of the principal determinants of juvenile salmonid production, with medium gradients most optimal in terms of successful recruitment and population persistence (Wood & Budy, 2009; O'Grady, 2006; Amiro, 1993). Moreover, as would be expected in catchments exposed to pressures including afforestation and peat escapement (such as those in the vicinity of Sheskin), survey sites on larger watercourses typically offered better quality salmonid habitat and supported higher densities of salmonids. Indeed, 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 (particularly for Atlantic salmon).

4.1.2 Lamprey

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^2) was recorded from sub-optimal (compacted) sand/silt accumulations. This site also featured the best-quality lamprey spawning habitat within the survey area.

Most watercourses did not support soft sediment areas suitable for ammocoete burial given very high flow rates (i.e. spate channels) and a lack of depositional areas required for larval settlement (Goodwin et al., 2008). The paucity of finer substrata not exposed to siltation (peat) pressures precluded lamprey

from most of the watercourses surveyed, in addition to high natural gradients. Owing to their relatively small morphologies, *Lampetra* species such as brook lamprey require clean, un-silted fine gravels in which to dig their redds (Lasne et al., 2010; Rooney et al., 2013; Aronsuu & Virkkala, 2014; Dawson et al., 2015) although areas may also include fractions of sand, larger gravels, and cobble (Nika & Virbickas, 2010).

4.1.3 European eel

On both a global and Irish scale, the European eel is listed as 'critically endangered' (Pike et al., 2020; King et al., 2011). European eel were only recorded (in low densities) from sites A1 and A2 (Baroosky River) and C2 (Glencullin River) (**Table 3.1**), i.e. larger, deeper watercourses. Here, the presence of larger, deeper pools and a greater complexity of refugia (e.g. boulder, macrophyte beds etc.) provided superior eel habitat compared to the smaller, higher-gradient, upland stream sites where there was a paucity of suitable refugia or deeper pool areas favoured by the species (Laffaille et al., 2003). Nonetheless, even smaller channels with poor or little overall fisheries value offer value as potential European eel migratory pathways, provided they maintain downstream connectivity to larger channels. (e.g. adult migration seawards, usually from September/October onwards).

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