Tom na Clach Wind Farm Extension:
Survey of fish habitats and populations

Appendix 11.D

Commissioned Report to BSG Ecology Ltd.

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Contractor: Waterside Ecology

SUMMARY

Background

This survey of fish habitats and populations was commissioned to inform the Environmental Impact Assessment report for the proposed extension to the Tom na Clach Wind Farm in Nairnshire. The site is drained largely by the headwaters of the Rhilean Burn. A small part of the west of the site is drained by the headwaters of Allt Seileach. The reaches of Rhilean Burn and Allt Seileach within the proposed development site have been shown by previous surveys to be inaccessible to migratory salmonids. Both streams are within the catchment of the River Findhorn, which supports economically valuable fisheries for salmon and trout.

Methods

A walkover survey of stream habitats was carried out in August 2020. This survey covered all stream reaches within the development site with potential for fish production. The survey characterised reaches according to their potential for production of salmonid fish, primarily trout. The habitat survey was followed by an electric fishing survey of suitable and representative habitats, also conducted in August 2020. The survey included 7 sites in named headwaters of Rhilean Burn: four in Allt Carn an t-Sean-liathanaich (the upper reach of the main stem of Rhilean Burn), two in Allt an t-Slugain Mhoir and one in Caochan Tom nan Clach. Single sites were surveyed in Allt Seileach and Allt a' Mhuilinn[1].

Main findings

Allt Carn an t-Sean-liathanaich

- This is the largest stream on the site with a wet width up to 4 m. Estimated wetted area of the 3.4 km survey reach was approximately 6,150 m² of which 86% was classified as productive juvenile trout habitat.
- Trout were present at all four electric fishing sites. Single run trout fry densities ranged from 2.4 to 10.3 fish.100 m^{-2}. These densities were classified as very poor or poor by regional standards. Trout parr densities exceeded fry densities at all sites, ranging from 11.1 to 23.9 fish.100 m^{-2}. Densities were classified as excellent at two sites and fair at the other two. The sample was made up mainly of 1+ and 2+ parr. No other fish species were seen or caught.

Allt an t-Slugain Mhoir

- This is a low gradient stream with a wet width of approximately 1 m. Flow types are mainly glide, run and pool. The streambed is mainly peat or sand and in places the channel is rush-filled. Little spawning habitat was recorded in the 1.8 km survey reach.

[1] At the time of survey an early iteration of the proposed layout placed one turbine within the Allt a' Mhuilinn drainage. This was subsequently dropped.

- Trout fry and parr densities at the more downstream electric fishing site were 3.7 and 13.4 fish.100 m^{-2} respectively. Fry density was classified as poor and parr density as fair. The more upstream site had to be fished non-quantitatively, as the very narrow channel did not allow survey in some places. A single trout fry was captured from a 350 m length of watercourse. It is likely that this site, at NH 8734 3596, is close to the upstream limit of trout distribution in the stream. No other fish species were seen or caught.

Caochan Tom nan Clach

- This small steep stream has a wet width of less than 1 m. Morphology is mainly step-pool and some spawning habitat was recorded close to it confluence with Allt Carn an t-Sean-liathanaich at NH 8756 3464. The first 0.3 km of stream upstream of the confluence was judged to be productive trout habitat. Habitat quality further upstream is very poor.
- Single-run trout fry and parr densities at an electric fishing site in the lower reaches were 7.0 and 15.8 fish.100 m^{-2} respectively, classified as poor for fry and good for parr. Parr were mainly aged 1+. No other fish species were seen or caught.

Minor tributaries of Allt Carn an t-Sean-liathanaich

- Three minor tributaries draining into Allt Carn an t-Sean-liathanaich were included in the habitat survey. None provided any significant areas of habitat suited to production of trout or other fish. Habitats were mainly tiny, narrowly incised channels through peat, or the channels were poorly defined and filled with vegetation.

Allt Seileach

- Only the uppermost headwaters of this stream are within the proposed development site. Here the stream has a low to moderate gradient and a wet width of around 0.5 m. The simple, incised channel cuts down to peat or hardpan. Habitat quality for trout was judged to be poor.
- Access for electric fishing was patchy, as in some places the stream is too narrow to insert an anode or net. A qualitative survey along approximately 250 m of stream found three trout parr, all aged 1+. It is likely that the survey reach (NH 8571 3367) is close to the upper limit of trout distribution. No other fish species were seen or caught.

Allt a' Mhuilinn

- The upper reaches of the stream have a moderate gradient and a wet width of around 0.8 m. Substrates of boulder, cobble and pebble are present. Flow types are mainly run and shallow pool. The stream appears to provide suitable habitat for juvenile trout and some small pockets of spawning-calibre substrate were recorded.
- Electric fishing over 160 m of apparently suitable habitat in Allt a' Mhuillin, starting at NH 8506 3510, found no fish.

The findings suggest that trout are the only fish species present on site. The largest areas of suitable trout habitat are in Allt Carn an t-Sean-liathanaich, which also provides the best quality rearing habitats for this species. However, trout were widespread in most other watercourses, albeit at rather low densities in some. Densities of trout fry were generally low, but parr densities were mainly to fair to excellent by regional standards. This may suggest that there is substantial, natural year-to-year variation in trout recruitment.

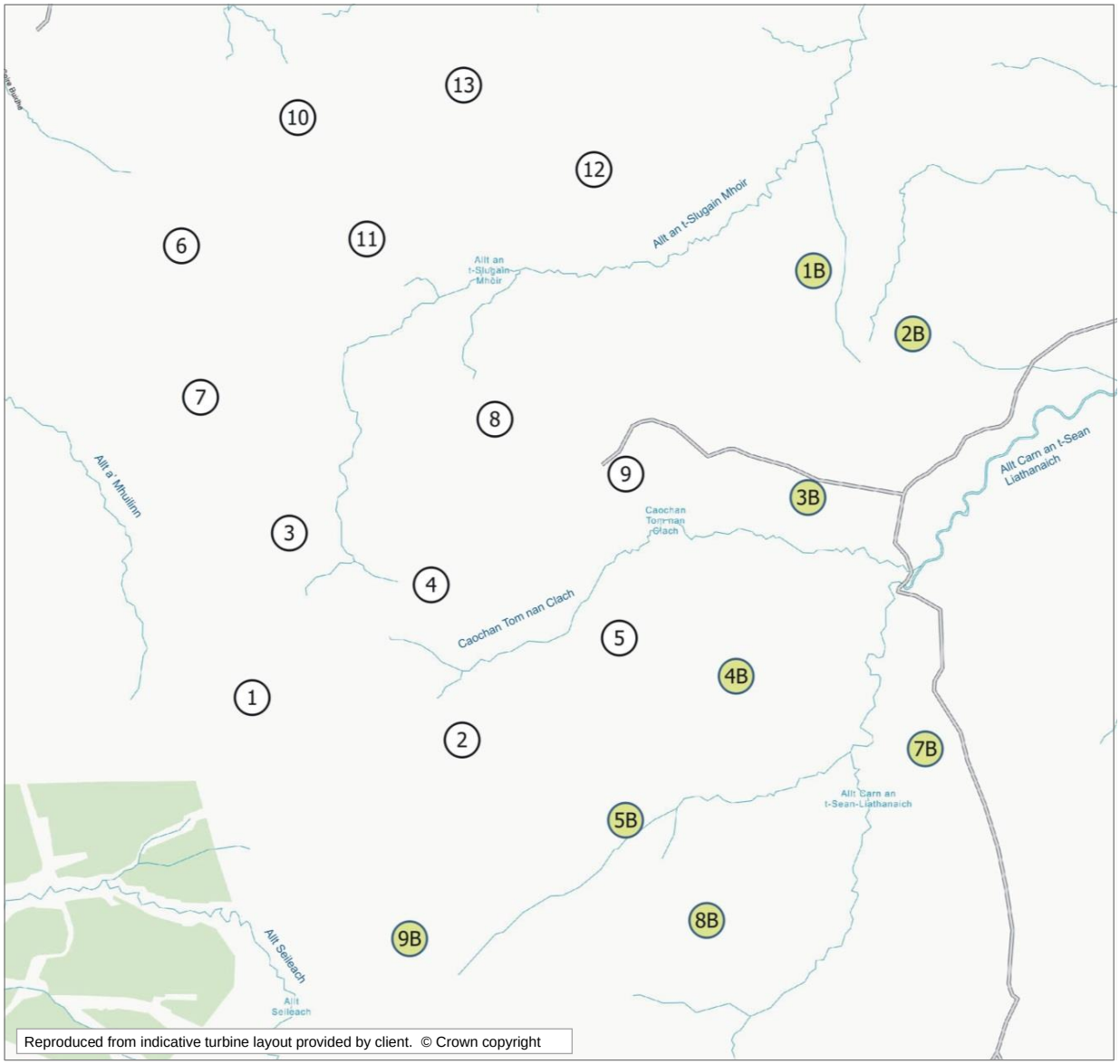
The findings are discussed in relation to the proposed development and a number of recommendations are made for mitigation and monitoring, should these be required.

1 Introduction

1.1. Proposed development

This survey of fish habitats and populations was commissioned to inform the Environmental Impact Assessment report for the proposed extension to the Tom na Clach Wind Farm south of Nairn. The proposed extension is anticipated to have 8 turbines, each of 4 mW. Site access would be via the tracks to the existing Tom na Clach Wind Farm site, an array of 13 turbines. The proposed turbine arrays of the existing wind farm and proposed extension are shown on Figure 1.

Figure 1. Turbine array: Tom na Clach wind farm (open circles) and proposed extension (yellow circles)



The site is drained largely by the headwaters of Rhilean Burn, including the following named watercourses: Allt Carn an t-Sean-liathanaich (the upper reach of the main stem of Rhilean Burn), Allt an t-Slugain Mhoir and Caochan Tom nan Clach. Seven of the proposed turbines lie within this drainage. One of the proposed turbines (9B) in the southwest of the site is on the watershed between Allt Seileach and a tributary of Allt Carn an t-Sean-liathanaich. At the time of survey one turbine was to be located in the catchment of Allt a' Mhuilinn, west of existing turbine 3, but this was subsequently dropped from the proposed development. The entire site lies within the catchment of the River Findhorn.

1.2. Fish populations

1.2.1. Species presence

The River Findhorn supports economically valuable fisheries for Atlantic salmon *Salmo salar* and brown trout *Salmo trutta*, including sea trout. European eels *Anguilla anguilla* are present, as are sea lamprey *Petromyzon mari*nus and brook lamprey *Lampetra planeri* (Watt & Ravenscroft 2005; Laughton 2010).

Laughton (2014) reported that resident brown trout are the only species present in Rhilean Burn due to the presence of a high (>5 m) waterfall near its confluence with River Findhorn. Laughton (2014) surveyed three sites in Allt Seileach and found that trout were widespread. Juvenile Atlantic salmon *Salmo salar* were present in the lower, accessible reaches downstream of Torr an Eas (NH 848 361). Based on existing information provided by Laughton, it is apparent that none of the reaches included in the current survey are accessible to migratory salmonids.

European eels have remarkably wide distribution in Scotland and may be found upstream of waterfalls that are impassable to salmonids. This is because they have the ability to climb steeply sloping barriers if suitable substrates e.g. wet moss is present. Furthermore, they have some limited ability to migrate overland in wet conditions (Tesch 2003). Given their powers of dispersal, the occurrence of eels cannot be ruled out despite the known presence of natural obstacles downstream of the site.

The small headwater streams within and around the proposed development sites are unsuited to sea lamprey, which are associated with larger mainstem rivers (Maitland 2003; Watt & Ravenscroft 2005). Brook lamprey, which are freshwater resident throughout their life, may be present upstream of waterfalls that are impassable to salmonids (Maitland 2003) so their presence, while unlikely, could not be entirely ruled out.

1.2.2. Conservation status

Brown trout (including sea trout) and European eel are both listed as priority species on the UK and Scottish Biodiversity Action Plan lists. Due to recent declines, eels are of increasing conservation interest and are protected by European (EC No 1100/2007) and Scottish (Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008) legislation. The latter makes it illegal to take eels without a license from the Scottish Government. European eels are listed as critically endangered on the IUCN Red List.

Brook lamprey is listed on Annex III of the Bern Convention and Annex II of the EC Habitats Directive.

1.3. Habitat requirements

1.3.1. Trout

The physical habitat requirements of juvenile salmonids have been subject to a considerable amount of detailed study (for reviews see e.g. Crisp 1993; Hendry & Cragg-Hine 2003; Klemetsen *et al*. 2003; Summers *et al*. 1996). Trout spawn in late autumn and early winter, depositing their eggs in redds which they excavate in gravel and pebble substrates. Eggs are often deposited in areas of accelerating flow, such as the tails of pools and glides, upstream from riffles. However, in upland streams eggs may be deposited in any areas of gravel that can be physically moved. A good supply of oxygen is essential for eggs to develop and this is facilitated by a flow of water through the gravel. Clogging with fine sediment such as silt and fine sand reduces water flow resulting in egg mortality due to lack of oxygen. Egg survival is also affected by redd 'washouts' during winter spates – the direct, physical, scouring out of eggs from the gravel.

After hatching the young remain in the gravel, absorbing nutrient from remaining yolk sac. On emergence, usually between March and early May, the fry disperse and set up territories which they defend aggressively. Trout fry prefer areas of relatively low velocity water near the streambed. Cover from stones, plants or debris is required and good cover is essential for maintaining high fry densities.

Trout parr generally favour areas of relatively low current speed where cover is available. Juvenile trout are often to be found in cover alongside the banks, in undercuts, among tree roots or in marginal vegetation. Cover remains important for adult trout, particularly in smaller streams.

1.3.2. Eels

Eel habitat requirements have received less attention than those of salmonid fish. Tesch (2003) suggests that so long as temperature and oxygen requirements are met, there are few stretches of water that are not suitable for eels. The main requirement for eels is cover, as they are averse to light and require suitable refuges during daylight hours. Partly as a result of this, eels are generally more abundant in areas of coarse substrate (Degerman et al. 2019). Eels of different size show different substrate preferences. Larger eels require large hollows, crevices or weed beds whereas small eels are sometimes abundant in cobble substrates, where they can burrow between the stones. Tree stumps, roots and other large structures provide ideal cover for eels. Eel diet is diverse, but the majority of diet consists of benthic species (Moriarty 1978; Kottelat & Freyhof 2007).

1.3.3. Brook lamprey

The brook lamprey is a non-migratory freshwater species, occurring in streams and occasionally in lakes. Brook lampreys require clean gravel for spawning, which takes place in the spring. After hatching, the larvae, known as ammocoetes, settle in soft habitats of well-oxygenated silt and fine sand. The ammocoetes are blind and spend several years in this muddy nursery habitat before metamorphosing (or transforming) from larval to adult form. Upstream migrating adult lampreys may be prevented from reaching spawning grounds by both natural and man-made barriers. They are very weak jumpers, so can be prevented from moving upstream by relatively low vertical barriers.

2 Survey needs

Generic guidance from Marine Scotland Science (MSS) in relation to fish data in Environmental Statements for wind developments (Marine Scotland Science 2015) states that:

> *In order that MSS- FL can assess the potential impact of developments the developer should provide information on all species and abundance of fish within the development area and on fisheries which depend on these.*

The above principle underpins current guidance (Marine Scotland Science 2018). Typically, Marine Scotland would expect that the following information in relation to fish should be provided:

- Site characterisation surveys including description of habitats for fish species likely to be present;
- Fish species distribution including assessment of abundance of trout and salmon, if present.
- Identification of fish species important for conservation or for supporting fisheries.

3 Aims and objectives

Typical concerns potentially arising in relation to wind farm impacts on freshwater fish and other aquatic fauna include increased sediment transport, changes to habitat or invertebrate species, and obstruction to upstream and downstream migration e.g. at stream crossing locations. Since changes to water quality can extend well downstream of their source, the current assessments included some stream reaches outside as well as within the proposed wind farm site.

The overall aim of the study was to provide data on fish habitats and populations in streams within and immediately downstream of the proposed Tom na Clach Wind Farm Extension, particularly in those reaches that might potentially be affected by changes in water quality resulting from the wind farm development. These data were collected to guide the Environmental Impact Assessment report for the site. The primary target species was brown trout. Specific objectives were to:

(i) Identify the distribution of fish habitats within and immediately downstream of the site;

(ii) Conduct electric fishing at a representative series of sites in order to characterise the fish communities in potentially impacted watercourses;

4 Methods

4.1. Habitat survey

4.1.1. Survey dates and reaches

The habitat surveys were carried out in August 2020. Survey conditions were fair, with moderate water levels. All streams carried some colour, so substrate visibility was limited by depth. Further details are provided in the Appendices and data quality is discussed in section 6.1. Survey reaches are listed in Table 1 and shown on Figure 2.

Table 1 Stream habitat survey reaches

Catchment	Watercourse	Downstream NGR	Upstream NGR
Rhilean Burn	Allt Carn an t-Sean-liathanaich	NH 8838 3538	NH 8709 3341
Rhilean Burn	Allt an t-Slugain Mhoir	NH 8760 3626	NH 8686 3547
Rhilean Burn	Unnamed tributary A	NH 8867 3565	NH 8800 3569
Rhilean Burn	Caochan Tom nan Clach	NH 8756 3464	NH 8692 3472
Rhilean Burn	Unnamed tributary B	NH 8736 3413	NH 8657 3374
Allt a' Mhuilinn	Allt a' Mhuilinn	NH 8500 3515	NH 8541 3470
Allt Seileach	Allt Seileach	NH 8570 3369	NH 8577 3336

4.1.2. Habitat survey

Reaches with the potential to be directly impacted by the proposed development (in this case, stream crossings) were surveyed by quantitative walkover. Methods were based on protocols described by Summers *et al*. (1996) and SEPA (2010). These characterise in-stream habitats according to depth, substrate, flow and thus suitability for different age classes of salmonid fish (Table 2).

Table 2 Habitat categories used for walkover survey

Habitat category	Description
Productive juvenile habitat	Habitats with mixed depth and coarse substrates including cobble, boulder and pebble that provide cover for salmonid fry and parr. Depth typically 10 to 50 cm.
Glide	Low gradient channel with small substrates. Lacking cover for fish. Productive if instream macrophytes or bankside cover are present.
Pool	Deep (≥ 80 cm) with eddying or static flow. Suitable for adult trout and parr.
Bedrock	Sheet bedrock or compacted earth covering majority of streambed. No cover. Unproductive for fish.
Hardpan	Non-standard classification. Stream form is down-cut gully scoured to hard, immobile streambed. Usually in upper reaches of first order streams. Unproductive for fish.
Peat channel	Non-standard classification. Simple incised channel through peat and earth with no hard substrate. Unproductive for fish.
Spawning	Ideally well oxygenated, stable & not compacted. Typically comprising gravel and pebble. Fines (sand & fine gravel <2 mm) less than 20%. Not silted.

In addition to habitat distribution, other variables recorded in each survey section were: (i) up and downstream grid reference, (ii) wet width, (iii) stability of substrate and compaction of substrate. The availability of cover for fish alongside banks was recorded as this can be an important factor in determining trout density, particularly in habitats where cover on the streambed is sparse.

Photographs were taken of representative habitats in each stream. In addition, surveyors made subjective assessments of typical habitat quality for juvenile trout in each reach, based on published habitat requirements and many years' experience of electric fishing in streams throughout Scotland.

4.2. Electric fishing survey

4.2.1. Field survey

Fish populations were surveyed by electric fishing between 15th and 17th August 2020. Surveys were conducted mainly using semi-quantitative methods as described by Scottish Fisheries Co-ordination Centre (SFCC 2014). A single electric fishing run was conducted at semi-quantitative survey sites. Three fully quantitative sites were surveyed: two on Rhilean Burn and one on Allt an t-Slugain Mhoir. Three runs were made through fully quantitative sites. Sites are listed in Table 3 below and their locations in relation to the turbine array are shown on Figure 2.

Table 3 Locations of electric fishing sites

Site code	Watercourse	NGR	Survey type
RB1	Allt Carn an t-Sean-liathanaich	NH 89324 36168	Semi-quantitative
RB2	Allt Carn an t-Sean-liathanaich	NH 88186 35211	Fully quantitative
RB3	Allt Carn an t-Sean-liathanaich	NH 87608 34671	Semi-quantitative
RB4	Allt Carn an t-Sean-liathanaich	NH 87372 34085	Fully quantitative
ASM1	Allt an t-Slugain Mhoir	NH 87750 36301	Fully quantitative
ASM2	Allt an t-Slugain Mhoir	NH 87341 35958	Semi-quantitative
CT1	Caochan Tom nan Clach	NH 87521 34620	Semi-quantitative
AS1	Allt Seileach	NH 85707 33670	Semi-quantitative
AM1	Allt a' Mhuilinn	NH 85058 35102	Semi-quantitative

All electric fishing sites covered the full stream width and incorporated a representative range of habitat types. Sites were surveyed using a single anode. Fish were captured in hand-held dip nets then placed in bins of clean water where they were held until ready for processing. Fish were anaesthetised for handling and were identified to species. Salmonid fork length was measured to the nearest millimetre. All fish were allowed to recover fully in clean water before being released back into the survey reaches. Habitat descriptions were made at fully- and semi-quantitative survey sites using the SFCC (2014) protocol.

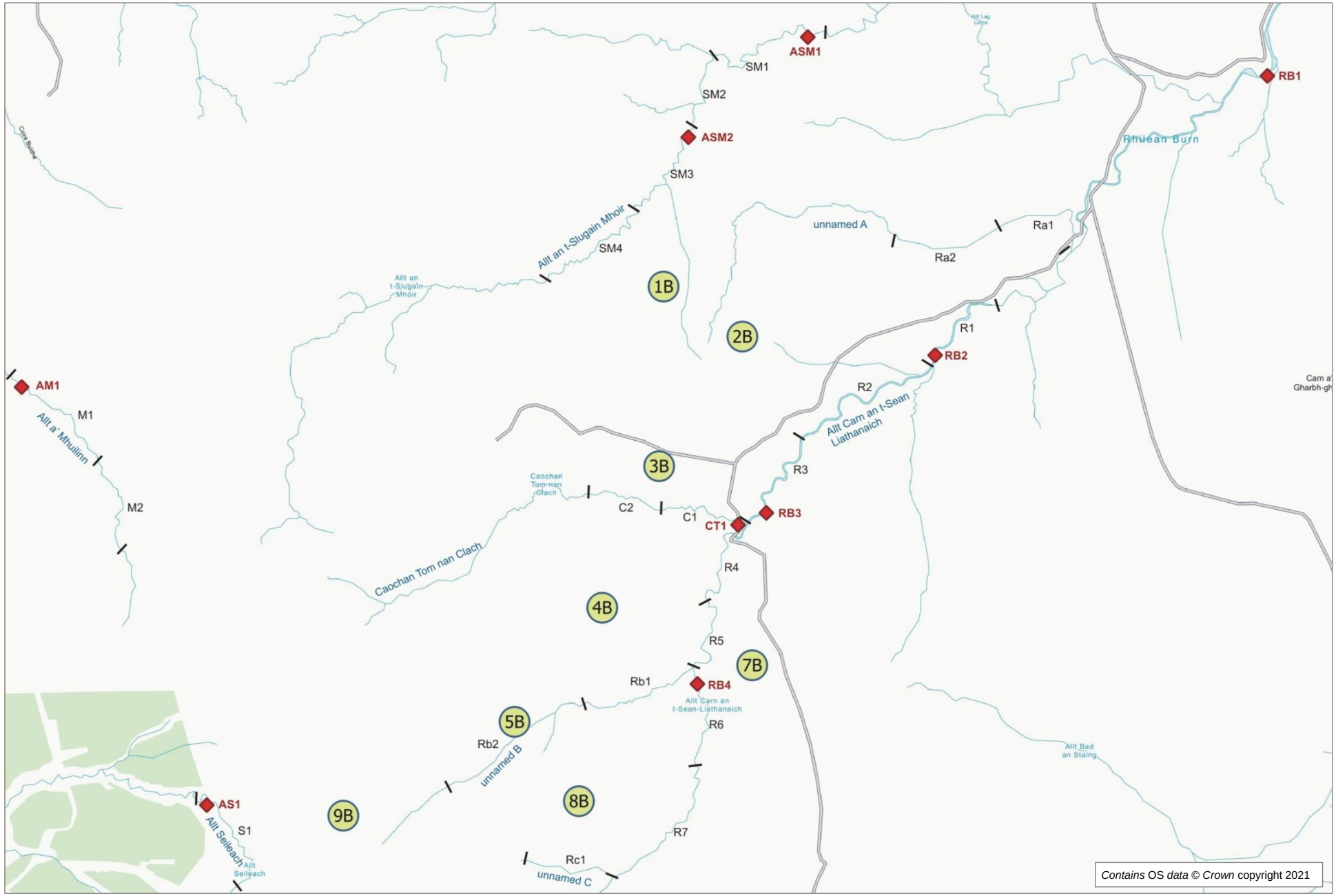
Spot checks were carried out for the presence of larval lampreys where suitable habitat (fine sand and silt) was noted within or adjacent to salmonid survey sites.

4.2.2. Data analyses and presentation

All fish densities are expressed as fish per 100 square metres of wetted stream area (fish.100m^{-2}). Salmonid densities are presented separately for fish fry and parr. Throughout this report the term 'fry' is used for salmonid fish in their first year of life (i.e. fish aged 0+ years). The term 'parr' is used for juvenile salmonid fish aged 1 year or older. Zippin estimates of total fish densities, with 95% confidence intervals, were calculated for fully quantitative sites using the programme Population Estimation by Removal Sampling (Pisces Ltd., version 2.2.2.22).

The classification provided by Godfrey (2006) is used to describe fish abundance in a regional context. The classifications are based on large data sets held by Scottish Fisheries Co-ordination Centre (SFCC). The quintile ranges of salmon and trout densities (Appendix 8.1) allow for comparison of fishery performance against regional and national reference points. The classification system is based on semi-quantitative fishing i.e. density based on number of fish captured during a single electric fishing run through an undisturbed site. Different classifications are provided for stream of various widths. All classifications presented in this report are based on stream widths of less than 4 m.

Figure 2. Habitat survey sections and electric fishing sites (red diamonds)



5 Results

5.1. Allt Carn an t-Sean-liathanaich and tributaries, habitat

5.1.1. Allt Carn an t-Sean-liathanaich

Allt Carn an t-Sean-liathanaich is the name given to the upper reaches of Rhilean Burn. The survey commenced at NH 8838 3538 and extended upstream to NH 8709 3341, a distance of approximately 3.4 km as measured along the watercourse. The seven survey sections are described in Appendixes 8.2 and 8.3 and the main features are summarised below. Photographs of all sections are provided in Appendix 8.8.

Section R1 to R3 extend from the downstream survey limit to the Caochan Tom nan Clach confluence at NH 87557 34638. In section R1 the stream has wet width ranging from 2 to 5 m, with an average estimate of 3.5 m. The lower reaches of R1 are rather unstable with some reaches where there is quite rapid bank erosion. However, the channel becomes more stable towards the upstream end of the survey section (pictured) where the banks are stable, turf-covered boulder. Undercut turf and some draped vegetation provide overhead cover for fish alongside the banks. Substrates are dominated by cobble and boulder, providing good instream cover for juvenile salmonid fish. Flow types are mainly run and riffle and depths at the time of survey were mostly in the range 15 to 40 cm. Morphology is typically plane-bed.

Further upstream through sections R2 and R3 the stream runs in a v-shaped valley and the channel is steeper and a little more entrenched. There are reaches where the morphology is step-pool and these alternate with lower gradient areas of riffle, run and glide. Wet width typically ranges from 1.5 to 3 m. Substrates are mainly large, dominated by boulder and cobble with some sand, and cover for salmonid fish appears to be good.

Habitat quality for juvenile trout in sections R1 to R3 was judged to be good (Appendix 8.3). However, spawning opportunities appeared to be quite limited, and largely restricted to small pockets of gravel stabilised around boulders.

Section R4 to R6 extend from the Caochan Tom nan Clach confluence to NH 8737 3382. Section R4 is characterised by alternating reaches of very stable substrate and more dynamic reaches where there is some ongoing erosion and deposition. The stream is strongly meandering and the banks have been breached in some places, so that new flood channels are forming. Substrates are cobble and boulder surrounded by gravel and sand, and depth is typically 5 to 40 cm. By R5 stream width is typically between 1 and 2 m. Substrates and flow types are similar to those in R4, dominated by cobble and boulder in runs, riffles and glides. There is good overhead cover from draped vegetation and undercut banks in both sections. Broadly similar habitat extends upstream through R6, although the amount of mobile material on the streambed begins to decline towards the upstream end of this section.

Overhead cover along the banks is plentiful in all three reaches in the form of undercuts and draped vegetation. The banks in R4 are quite unstable in places, but R5 and R6 are mainly stable with only very short sections of bank erosion acting as sediment sources for the channel.

Habitat quality for trout fry was judged to be good in sections R4 and R5, and moderate in R6. The stream structure provides varied habitats, with plenty of cover and structure around boulders, and suitable flow types for trout in shallow pools and glides.

Spawning habitats were recorded in R4 and R5, with some patches of apparently suitable gravels extending to over 1 m^2. Little spawning habitat was noted in R6 (pictured left), other than small pockets of gravel around boulders or deposited in pools.

By R7 much of the stream is less than 1 m wide. In places the narrow channel is closed over by turf. There are very few sources of sediment to the channel, which has cut down to mineral hardpan or peat. Habitat quality is consequently poor and it seems likely that the upper limit of trout distribution would be in this section.

A quantitative summary of habitat availability is provided in Table 4. The seven survey sections provide an estimated 6151 m^2 of wetted habitat of which 5265 m^2 or 86% provided suitable habitat for juvenile trout. This includes some areas that would also be suitable for adults, which are unlikely to grow to a large size in upland streams of this nature. Some deep pool habitat potentially suited to larger adults was also present.

Table 4 Summary of habitat availability, Allt Carn an t-Sean-liathanaich

Survey section	Length	Wetted area (m^2)					
		Productive juvenile	Deep pool	Bedrock	Hardpan	Peat/wet flush	Total
R1	310	980	105	0	0	0	1085
R2	850	1975	150	0	0	0	2125
R3	330	560	40	60	0	0	660
R4	430	630	0	15	0	0	645
R5	400	600	0	0	0	0	600
R6	430	480	0	36	0	0	516
R7	650	40	0	0	320	160	520
All	*3400*	*5265*	*295*	*111*	*320*	*160*	*6151*

5.1.2. Allt an t-Slugain Mhoir

This stream flows into Rhilean Burn at NH 8916 3608, via Allt Lag Liatre. Proposed turbine 1B is located within its drainage. The habitat survey extended from NH 8838 3538 on Allt Lag Liatre to NH 8686 3547 on Allt an t-Slugain Mhoir, a distance of approximately 1.8 km. Within this reach most of the channel was deep and little of the streambed was visible. Substrates were therefore assessed largely by feel, either by wading or probing with a wading staff. Due to the very limited assessment, the total areas of each habitat type could not be estimated. Nevertheless, it was quite clear that the great majority of the reach would be classified as deep glide or deep pool, linked by runs. It was also apparent that little hard substrate was present and that boulder, cobble and pebble was scarce.

Section SM1 (pictured below) extended about 450 m downstream of the Allt an t-Slugain Bhig confluence. The gradient in this reach is low and the channel is meandering. Some typical mixed juvenile trout habitat is present in the first 100 m of the section, with a mix of cobble, pebble and sand substrates. Elsewhere the streambed seemed mainly to be of sand overlying peat, providing little cover for fish. Depth was 15 to 50 cm, but mostly over 25 cm with glide and pool flow types. Based on channel structure and substrates, there appeared to be little spawning potential. Wet width ranged from 1 to 2 m.

Sections SM2 and SM3 upstream of the Allt an t-Slugain Bhig confluence are broadly similar to SM1, but in many places the channel is very narrowly incised into the peat and almost closed over with turf. Flow types are run, glide and pool. The streambed mainly seemed to be peat and sand, but some areas of pebble and gravel providing spawning opportunities were noted at the upstream end of SM2 and the downstream end of SM3. The stream banks are very stable peat of earth, providing no sources of larger substrates to the channel. Gradient through these sections and SM1 is less than 2%.

Section SM4 is slightly steeper than those downstream and has varied flow types with runs, riffles and pools that seem to provide habitat suited to juvenile trout. These habitats alternate with reaches of very poor quality habitat where the channel is almost entirely filled with rushes and is lacking in hard substrates. Some substantial areas of bank erosion are present at the upstream end of the reach and these provide some material, mainly sand with a little pebble and gravel, to the stream. Water crickets *Velia caprai* were quite abundant on the surface of many of the pools in section SM4; their presence suggesting that trout - a predator of water crickets - may be absent or very scarce.

Overall, the surveyed reaches of Allt an t-Slugain Mhoir were estimated to provide some 1750 m^2 of wetted habitat over the (approx.) 1770 m survey reach. Habitat suited to trout production was mainly of moderate to poor quality. Spawning habitat appeared scarce in the stream, limited to a few patches at the upstream end of SM3 and the lower reaches of SM4. The abundance of water crickets in SM4 may suggest that trout reach their upstream limit of distribution somewhere in or near this reach. Photographs of the stream are provided in Appendix 8.9 and additional data on each section are provided in Appendix 8.3.

5.1.3. Unnamed tributary A

This tiny, unnamed, first order watercourse drains the north and west side of turbine 2B. It was surveyed from its confluence with Allt Carn an t-Sean-liathanaich (NH 8867 3565) upstream for approximately 0.75 km. Downstream of the wind farm access track, which crosses the watercourse at NH 8828 3556, the channel is largely rush-filled and poorly defined. There are some open pools close to Allt Carn an t-Sean-liathanaich but these have no clear linkage to the larger stream. Upstream of the track the watercourse was either a tiny channel cut into peat with a depth less than 5 cm or was an indistinct wet flush. The watercourse was classified as unsuitable for fish production. Further details and photographs of the two survey sections Ra1 and Ra2 are provided in Appendices 8.2, 8.3 and 8.10.

5.1.4. Caochan Tom nan Clach

This small, first order stream enters Allt Carn an t-Sean-liathanaich from the west. Turbine 3B would be constructed in this drainage. The lower 0.6 km of stream was surveyed in two sections, C1 and C2.

Wet width in C1 is typically between 0.5 and 1.2 m. The stream flows between steep v-shaped banks and is quite steep with a step-pool channel form. Depth is typically 5 to 15 cm in the runs, which are interspersed with little pools to about 40 cm depth. Substrates are mainly of cobble, pebble and boulder. The gradient eases close to the confluence with Allt Carn an t-Sean-liathanaich, where pebble and gravel substrates provide some spawning opportunities. Section C2 is very narrow and in some places almost closed over beneath the turf. The streambed is mainly immobile hardpan, with bedload. Depth is typically 5 to 10 cm. Section C1 was judged to provide good trout fry habitat, but C2 is poor.

5.1.5. Unnamed tributary B

This small stream flows into Allt Carn an t-Sean-liathanaich at the upstream end of section R5. Proposed turbines 5B and 9B would be located within this minor drainage. Two sections, Rb1 and Rb2, with a total length of approximately 0.6 km, were surveyed. In the first 50 m of stream above its confluence with Allt Carn an t-Sean-liathanaich the watercourse is approximately 20 cm wet width with a streambed that includes some cobble and pebble. Depth is mainly less than 5 cm but a few little pools could support trout. Further upstream in Rb1 the channel is partly close over beneath turf and elsewhere appears too small and shallow to support a sustainable fish population. Section Rb2 was judged entirely unsuited to fish, comprising either a tiny channel partly flowing beneath the turf or an indistinct, rush-filled channel.

5.1.6. Unnamed tributary C

This small first order watercourse drains the south side of turbine 8B and flows into Allt Carn an t-Sean-liathanaich at the upstream end of survey section R7. The watercourse is mainly wet flush with a poorly defined channel. It is entirely unsuited to fish production.

5.2. Allt Carn an t-Sean-liathanaich and tributaries, fish populations

Brown trout were present at all survey sites (Table 5). Trout fry were present at all seven survey sites but in general densities were low, with single-run estimates ranging from 2.4 to 10.3 per 100 m^2 of wetted habitat. Densities at all sites were classified as either poor or very poor and the mean density of 5.3 fry.100 m^{-2} (σ = 3.5) would be classified as poor. Site ASM2, the most upstream site on Allt an t-Slugain Mhoir, was surveyed non-quantitatively, but searches for fish covered approximately 400 m of watercourse of which around 50% was fishable. Only one trout fry was caught suggesting that their density was very poor.

Trout parr density exceeded fry density at all survey sites with the exception of ASM2, where no parr were caught. Single run minimum densities ranged from 11.1 to 23.9 parr.100 m^{-2}. The mean density of 16.7 parr.100 m^{-2} (σ = 5.6) would be classified as good. Comparison of single run and Zippin densities suggests that fist run efficiency varied from 62% to 85%. Numbers of fish captured during consecutive electric fishing runs are provided in Appendix 8.5.

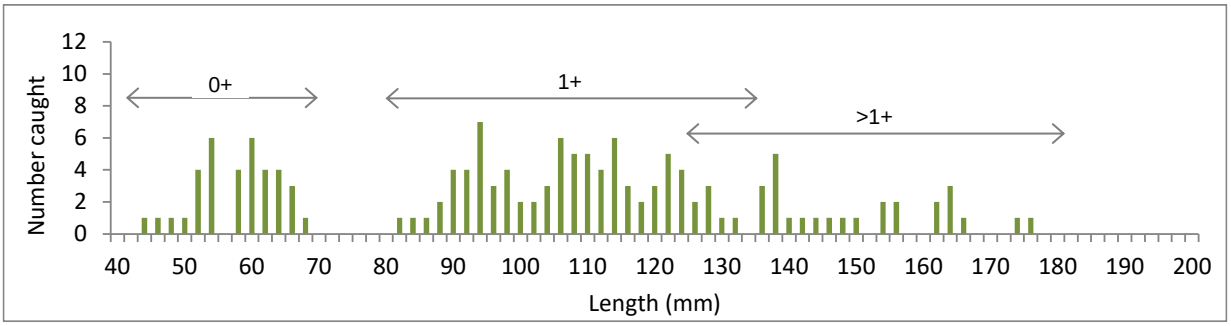
Table 5 Electric fishing results, Allt Carn an t-Sean-liathanaich and tributaries

Site	**Fry density** (fish.100m^{-2})		**Fry classification**	**Parr density** (fish.100m^{-2})		**Parr classification**
	Single run	Zippin*		Single run	Zippin	
RB1	2.4	na	Very poor	12.7	na	Fair
RB2	10.3	12.2 (12.1 - 13.0)	Poor	23.3	29.3 (28.9 – 30.6)	Excellent
RB3	7.7	na	Poor	23.9	na	Excellent
RB4	1.0	1.0 (1.0 - 1.0)	Very poor	11.1	13.1 (13.1 - 13.5)	Fair
ASM1	3.7	9.8 (8.5 - 13.8)	Very poor	13.4	21.7 (20.8 - 24.9)	Fair
ASM2	Present	na	(Very poor)	Absent	na	(Absent)
CT1	7.0	na	Poor	15.8	na	Good

*Numbers in parentheses are lower and upper 95% confidence limits for estimates at fully quantitative sites)

Length distribution data and scale readings suggest that at least three age classes of trout were present in the samples (Figure 3). Trout fry ranged in length from 43 mm to 67 mm in length (mean = 57.2 mm, σ = 6.2). Fry length did not overlap with that of older year classes. The 1+ and 2+ year classes showed some overlap. Based on scale readings the 1+ year class seems likely to have ranged from 81 mm to 137 mm in length. Too few scales were taken to be certain of the age of all parr. The smallest parr confirmed as being aged 2+ was 127 mm in length, indicating that growth rates in Allt Carn an t-Sean-liathanaich and its tributaries are variable.

Figure 3. Trout size distribution at sites in Allt Carn an t-Sean-liathanaich and tributaries



Spot checks for lamprey larvae were conducted in Allt an t-Slugain Mhoir, the only stream providing any suitable habitat. None were found.

No other fish species was seen or caught.

5.3. Allt Seileach

5.3.1. Habitat

Survey of this stream commenced at the forestry fence (NH 8570 3369) and extended upstream for approximately 0.5 km. Stream gradient is low and the channel is deeply incised into peat and earth. Wet width is typically between 0.3 and 0.8 m. In places the turf banks almost meet over the channel. In others, the channel is almost entirely filled with soft rush. Flow types are mainly glide in the broader reaches and run where the channel narrows. Little of the streambed was visible (Appendix 8.3) but wading and probing with a staff suggested that the streambed was largely hardpan or peat, providing little opportunity for trout to spawn. Overall habitat quality was judged to be poor for trout fry or parr.

5.3.2. Fish populations

Most of the surveyed reach of Allt Seileach was too narrow and closed in by turf to permit effective electric fishing survey. Therefore the survey was conducted qualitatively, checking all accessible habitats over approximately 250 m of stream, starting at the forestry fence at the downstream end of the redline planning boundary. Only three trout were caught. These ranged in length from 98 mm to 132 mm (Appendix 8.6). All three were aged 1+ and all were taken from well-defined pools. No other fish were seen or caught. As the survey was not conducted over a measured area, no densities can be calculated. Nevertheless, it is clear that trout abundance was low

5.4. Allt a' Mhuilinn

5.4.1. Habitat

In the surveyed reach, Allt a' Mhuilinn is a small first order stream with a typical wet width between 0.6 and 1.0 m. The survey covered approximately 0.7 km of stream in two sections, M1 and M2 (see Map 1). Gradient in the surveyed reach is moderate to steep and the channel is rather entrenched, flowing in a v-shaped valley. Flow types are mainly runs interspersed with shallow pools. Substrates in M1 are largely stable boulder, partly exposed above the water's surface, and more mobile pebble and cobble. Some small pockets of gravel are present that might permit spawning by trout. Habitat in M1 appeared suited to trout fry, but was rather shallow for parr. Further upstream in section M2 the stream is a simple incised channel with little bedload, and habitat quality for trout was judged to be poor.

5.4.2. Fish populations

Approximately 160 m of apparently suitable trout habitat was surveyed in Allt a' Mhuilinn. No fish were seen or caught. Water crickets were present on many of the pools.

6 Discussion and interpretation

6.1. Data quality

The streams were slightly elevated during the habitat survey and carried some peat-staining, making full inspection of the streambeds impossible. In Allt Carn an t-Sean-liathanaich, the largest watercourse, an average of approximately half the streambed was visible (range 25% to 90% in the 7 survey sections). As this stream was easily wadeable substrates that could not be seen were assessed by 'feel' underfoot. As the surveyor has some 25 years of experience of such surveys it is improbable that the inability to see all of the streambed greatly altered conclusions as to habitat availability or quality in this stream.

Even less of the streambed was visible in Allt an t-Slugain Mhoir, due to peat staining, depth and the narrowly incised nature of the channel. Again the water level was moderately elevated during the habitat survey but peat staining was also present during the electric fishing survey, which was conducted on a relatively low discharge. Careful probing with a wading staff allowed depth and substrate to be broadly identified during the habitat survey and again it seems improbable that general conclusions as to the classification of stream reaches or assessment of habitat quality were substantially affected. Peat staining probably did impact on the surveyor's ability to assess the overall availability of spawning habitat in some reaches, and availability of spawning may have been under-estimated. However, as typical spawning habitat is located in the shallower run-outs of pools and glides, where substrates were visible, the impact on habitat data quality would be expected to be slight.

Electric fishing surveys were judged to be effective and most of the fish seen were captured. Consistent and rapid depletions in fish numbers were attained during consecutive runs through the two fully quantitative sites on Allt Carn an t-Sean-liathanaich (Appendix 8.5), suggesting that these surveys achieved good levels of efficiency.

Electric fishing efficiency was lower in Allt an t-Slugain Mhoir (site ASM1) than in the two sites in Allt Carn an t-Sean-liathanaich, but consistent depletions were nevertheless attained. Overall, the electric fishing data are considered reliable and a likely to provide a realistic picture of fish presence and abundance across the site.

6.2. Distribution and abundance of fish habitats and populations

Following the survey, a revision of the proposed layout dropped all proposed infrastructure in the Allt a' Mhuilinn catchment. This stream is not considered further in the current report.

The data collected during the current survey are consistent with those provided by Laughton (2014) and suggest that resident (non-migratory) brown trout are likely to be the only fish species present within or immediately adjacent to the proposed wind farm extension.

Unsurprisingly the largest extent of productive juvenile trout habitat in the proposed development area is in Allt Carn an t-Sean-liathanaich. Almost all of the surveyed 3.4 km of stream appeared well suited to trout production, the sole exceptions being some short reaches of bedrock and some areas of poor quality hardpan and peat channel in the most upstream section, R7. Electric fishing at four sites in this stream found that trout were the only fish species present, consistent with the known presence of waterfalls further down Rhilean Burn. Trout fry densities in the stream were generally poor and were lower than parr densities. The majority of parr were aged 1+ and this cohort was relatively strong. The age profile suggests that recruitment in 2020 was rather poor, but that it may be expected to vary substantially year-to-year. A similar age profile was found at the other electric fishing sites in the Rhilean Burn catchment i.e. Allt an t-Slugain Mhoir and Caochan Tom nan Clach. Pronounced, and probably natural, annual variation in recruitment would have implications for any future monitoring, should this be required.

Allt an t-Slugain Mhoir provides relatively poor quality habitat for trout through most of the surveyed reach. The exception was the downstream end, where some hard substrates and potential spawning habitat were recorded. Moderate numbers of trout parr were recorded at electric fishing site ASM1, in this reach. Further upstream, electric fishing site ASM2 covered the upper half of habitat survey site SM3. Despite the presence of a little spawning habitat in this reach only one trout fry was caught. This and the abundance of water crickets further upstream seems to suggest that trout probably reach their upper limit of distribution within the survey reach.

Good numbers of trout parr were recorded in the lower reaches of Caochan Tom nan Clach. In common with other sites, fry were outnumbered by older year classes, mainly 1+ parr. Clearly this stream is moderately productive of trout and a little spawning habitat is present. However, the better quality habitat is restricted to the lower 300 m of stream so the total productive area is likely to be less than 300 m^2 due to the stream's small size.

Outwith the Rhilean Burn catchment potentially suitable habitat was recorded in Allt Seileach. The reaches within the proposed wind farm site comprise a small, first order headwater and habitat quality was poor. Small numbers of trout parr were found, but no fry were present. Lack of fry may suggest that the parr may have migrated into the reach from downstream. This would be consistent with the lack of spawning potential suggested by the habitat survey.

No eels were caught or seen at any of the electric fishing sites. Their absence suggests that obstacles in the lower reaches of the surveyed streams are wholly or largely impassable to the species. The lack of eels is consistent with information provided by Laughton (2014) for the surveyed watercourses.

6.3. Potential impacts of proposed development

At the time of writing no layout of the prosed track network is available. However, the positioning of the proposed turbine array suggests that few, if any, new crossing would be required. If crossings were to be required on streams where trout have been shown to be present it is recommended that brief, targeted surveys be carried out to check for the presence of spawning habitats. These should extend a short distance (perhaps 100 m) up and downstream of proposed crossing points. As spawning habitat seems likely to be limiting in most watercourses it would be preferable to micro-site crossing locations to avoid any significant aggregations of suitable substrate. Similarly, crossings of larger streams should allow for up and downstream movement of trout in streams where these have been shown to be present, or where suitable habitat exists.

The proposed development seems unlikely to pose any significant operational threat to trout populations other than at crossings. However, diffuse and point source impacts from construction works around watercourses clearly have the potential to affect stream habitats and fish populations. Typical sensitivities around wind farm developments and salmonid fish relate mainly to the exposure of large quantities of soil and the potential for siltation. Inputs of silt and other fine material including peat can cause damage to fish habitats and direct mortality to fish and ova. Spawning habitats can be particularly at risk in the event of siltation since clogging of interstitial space with fine material prevents oxygen reaching eggs and alevins. Monitoring of turbidity and suspended solids is likely to be important on all watercourses during construction to avoid deleterious impacts on these and other habitats.

In some circumstances exposure of mineral soils due to removal of blanket peat has the potential to increase leaching of potentially toxic metals such as aluminium, zinc or iron. Aluminium leaching may be a lower risk in streams draining peatland, since where levels of dissolved organic carbon are high it tends to form organic chelates, rendering it less toxic (Rosseland & Kroglund 2011). It is possible that that some monitoring of metals may be required during construction and this may best be assessed by pre-construction hydrochemical assessments of target streams unless sufficient data are already available, e.g. from baseline assessments or monitoring relating to the existing wind farm.

Construction impacts may be minimised by following standard good practice procedures and pollution prevention guidance (e.g. SEPA/Environment Agency 2007). Guidance in relation to river crossings and fish is provided by SEPA (2010b).

6.4. Recommendations

- A water quality management plan should be developed to ensure that stream habitats and fauna are protected during construction. Guidance is provided by Marine Scotland (2018).
- If any stream crossings are required for construction or operation of the wind farm extension, their design and construction should incorporate suitable mitigation measures to avoid impacts on productive fish habitats or on fish movements. Some additional survey may be needed to micro-site any crossings away from spawning habitats.
- Regular monitoring of turbidity and suspended solids will be required during construction. Any such monitoring should include a responsive element, with an on-site ECoW checking areas where active works are taking place and areas where sediment run-off may be a concern during periods of high rainfall.
- Clearly, the Environmental Impact Assessment Report should assess possible effects of construction and operation of the proposed development on resident brown trout. As previous surveys have shown the presence of Atlantic salmon in the lower reaches of Allt Seileach, and as salmon are known to be present in the River Findhorn, potential negative impacts on this Annex II species should also be assessed.

7 References

Crisp, D.T. 1993. The environmental requirements of salmon and trout in fresh water. Freshwater Forum, 3(3): 176-201.

Degerman, E., Tamario, C., Watz, J., Nilsson, P.A. & Calles, O. Occurrence and habitat use of European eel (*Anguilla anguilla*) in running waters: lessons for improved monitoring, habitat restoration and stocking. Aquatic Ecology, 53, 639-650.

Godfrey, J. D. 2006. Site condition monitoring of Atlantic salmon cSACs. Commissioned report to Scottish Natural Heritage, December 2006. Scottish Fisheries Co-ordination Centre, Pitlochry.

Klemetsen, A., Amundsen, P-A, Dempson, J.B., Jonsson, B., Jonsson, N., O'Connell, M.F. and Mortensen, E. 2003. Atlantic salmon *Salmo sal*ar L., brown trout *Salmo trutta* L. and Arctic charr *Salvelinus alpinus* L.: a review of aspects of their life histories. Ecology of Freshwater Fish, 12, 1-19.

Kottelat, M. and Freyhof, J. 2007. Handbook of European Freshwater Fishes. Cornol, Switzerland.

Laughton, R. 2010. River Findhorn Fisheries Management Plan 2010 – 2015. Spey Research Trust Report 02/09.

Laughton, R. 2014. Fish survey of the tributaries draining the proposed Tom nan Clach Wind Farm Extension. Findhorn, Nain and Lossie Fisheries Trust Report no. 01-2014.

Maitland, P.S. 2003. Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

Marine Scotland Science. 2018. Generic Monitoring Programme for Monitoring Watercourses in relation to Onshore Wind Farm Developments. August 2018.

Moriarty, C.M. 1978. Eels: A Natural and Unnatural History. David & Charles, Newton Abbot. 192pp.

Rosseland, B.O. & Kroglund, F. 2011. Lessons from acidification and pesticides, pp 387-407 in: Aas, Ø., Einum, S., Klemetsen, A & Skurdal, J. 2011. Atlantic Salmon Ecology. Wiley-Blackwell.

SEPA. 2010a. Guidance for applicants on supporting information requirements for hydropower applications. Scottish Environment Protection Agency.

SEPA. 2010b. Engineering in the Water Environment: Good Practice Guide – Sediment Management. Scottish Environment Protection Agency, June 2010.

SEPA/Environment Agency. 2007. Works and maintenance in or near water. PPG5. http://publications.environment-agency.gov.uk/PDF/PMHO1107BNKG-E-E.pdf

SFCC. 2014. Team Leader Electrofishing: manage electrofishing operations. Inverness & Barony Colleges. April 2014.

Summers, D., Giles, N. & Willis, D.J. 1996. Restoration of Riverine Trout Habitats: A Guidance Manual. Fisheries Technical Manual 1, R&D Technical Report W118, Environment Agency, Bristol.

Tesch, F. W. 2003. The Eel, 5th Edition. Blackwell Science Ltd.

Watt, J. & Ravenscroft, N.O.M. 2005. The distribution of lampreys in Scotland: National lamprey survey 2003-2004. Commissioned Report to Scottish Natural Heritage.

8 Appendices

8.1. Salmonid density classification for Moray Firth Region

	Absolute classification (all streams)	**Stream width class (relative classification)**			
		<4m	4-6m	6-9m	>9m
Salmon 0+					
0th percentile	0.51	1.5	1.0	0.7	0.9
20th percentile	5.45	8.6	7.7	11.2	4.0
40th percentile	10.70	22.6	27.5	18.7	9.9
60th percentile	14.79	35.8	42.6	26.8	15.1
80th percentile	29.37	86.8	77.3	40.4	32.3
100th percentile	67.36	186.8	196.4	97.5	114.4
% zero density	24.0	36.2	13.8	16.7	18.0
Salmon 1++					
0th percentile	1.01	1.2	1.0	0.7	0.9
20th percentile	2.18	5.3	3.7	4.9	3.0
40th percentile	6.36	11.7	10.8	9.2	6.7
60th percentile	9.49	18.9	18.4	12.4	12.1
80th percentile	16.28	30.9	25.3	22.8	16.0
100th percentile	27.66	79.0	40.9	119.1	33.4
% zero density	18.0	23.4	12.1	10.0	3.3
Trout 0+					
0th percentile	0.51	1.1	0.5	0.8	0.3
20th percentile	1.79	5.9	2.9	3.1	1.2
40th percentile	4.16	14.3	7.0	4.5	1.6
60th percentile	5.10	21.0	10.4	6.0	3.3
80th percentile	10.07	39.0	26.4	9.3	5.4
100th percentile	98.49	94.6	64.7	83.9	37.3
% zero density	12.0	17.0	8.6	18.3	23.0
Trout 1++					
0th percentile	0.57	1.4	1.0	0.6	0.6
20th percentile	1.09	3.9	2.3	1.3	1.0
40th percentile	2.72	9.1	5.2	2.3	1.7
60th percentile	4.37	13.7	7.2	4.0	1.9
80th percentile	7.61	18.1	13.3	6.1	2.7
100th percentile	14.73	80.6	23.6	46.1	8.9
% zero density	28.0	6.4	17.2	6.7	31.1

NB: All densities are based on single-run, semi quantitative survey.

Descriptive categories used in text

Density in regional classification	**Description (category) used in text**
Min to 20th percentile	Very poor
20th to 40th percentile	Poor
40th to 60th percentile	Fair
60th to 80th percentile	Good
80th to 100th percentile	Excellent

The classification is based on large data sets held by SFCC. The quintile densities allow for comparison of fishery performance against regionally based reference points. Classifications are based on single run minimum densities.

8.2. Survey sections and target notes on instream and bankside habitats

Survey section	Downstream NGR	Target notes, instream	Target notes, bank
R1	NH 88379 35376	Substantial braiding and deposition and downstream end. Channel more stable in mid and upper section. Substrate mainly cobble & boulder. Run and riffle. Lacks spawning (small pockets only).	Heather moorland. Sheep grazing. Some erosion on bends. Undercuts and draped vegetation provide overhead cover.
R2	NH 88127 35120	Narrower and more stable than preceding section. Steeper with mix of step-pool and run-riffle. Typically 15 to 30 cm deep. Good cover. Lacks spawning.	Stable with much cover from undercuts and draped vegetation.
R3	NH 87669 34823	Largely as R2. Some depositional point bars at downstream end of section. Stable mossy boulders surrounded by cobble, pebble and gravel. Runs and shallow pools. Some bedrock near upstream end. Pockets of spawning but no extensive areas.	Stable boulder under turf. Overhead cover from undercuts and draped vegetation.
R4	NH 87557 34638	Alternating section of very stable substrate and areas where there is some deposition. Width 1 to 2 m. Cobble and boulder surrounded by gravel and sand. Depth 15 to 40 cm. Spawning habitat present.	Some erosion on bends. Heather moorland, Drapes and undercuts provide cover. Some breaches of bank - flood channels forming.
R5	NH 87409 34344	Width 1 to 2 m. Cobble and boulder surrounded by gravel and sand. Depth 15 to 40 cm. Spawning habitat present.	Good overhead cover from draped vegetation and undercut banks. Heather moorland.
R6	NH 87355 34131	Boulder cobble and pebble. Pockets of gravel may permit spawning, but poor. Depth 10 to 40 cm. Runs, glides and shallow pools.	Some erosion of bank faces feeds mobile materials to channel. Drapes and undercuts provide overhead cover.
R7	NH 87369 33823	Very poor habitat. Downstream end is up to 1 m wide but stream rapidly gets very narrow further upstream. Simple incised channel with little mobile substrate - eroded down to hardpan. Runs and a few little pools. Likely to be at or close to upstream limit of fish distribution. The minor tributary from the west is unsuited to fish - more a wet flush with poorly defined channel.	Steep incised bank faces. Lots of undercuts. Rush pasture upstream and mature heather at lower end of section.
SM1	NH 87760 36298	Short reach of juvenile habitat at downstream end of section with around 50% cobble and pebble, most of the rest is sand. Low gradient. Meandering. Glide and pool. Through middle and top end of section streambed mainly sand overlying peat, providing little cover. Depth 15 to 50 cm. Little spawning potential.	Channel cut down through turf. Banks alternate between low et reaches and drier grassy areas where banks are higher above water.
SM2	NH 87425 36225	Deeply incised channel. Mainly glide but opens put near top of section with gravel and pebble substrates providing some spawning opportunities.	Channel cut down through turf. Banks alternate between low et reaches and drier grassy areas where banks are higher above water.
SM3	NH 87362 36000	Mixed section. Downstream end is run and pool with some spawning potential. Other parts are simple incised channel (mainly glide) through peat, with substrate of peat and sand.	Channel cut down through turf. Banks alternate between low et reaches and drier grassy areas where banks are higher above water.
SM4	NH 87157 35700	Runs, riffles and pools interspersed with some reaches of poor, rush-filled channel. Around 5% flows under turf. Substrates of sand, gravel and pebble provide some spawning potential. Water crickets on pools at upstream end may suggest above upper limit of fish distribution.	Eroding banks at upstream end feed substrate to channel. Elsewhere banks largely stable, steeply incised.
SB1	NH 87440 36240	Wet flush and rush-filled channel. Not suited to fish.	
SMt1	NH 87280	Entirely unsuitable. Simple drainage channel. Dry in places.	

Survey section	Downstream NGR	Target notes, instream	Target notes, bank
	35780		
Ra1	NH 88674 35648	Mainly wet flush without clearly defined channel. Some open pools, covered in water crickets suggesting no trout.	Mainly wet flush.
Ra2	NH 88276 35560	Mainly wet flush without a defined channel. Entirely unsuitable for fish production.	Mostly low and wet, no defined channel or stream banks.
C1	NH 87557 34638	Pebble and gravel at downstream end provides spawning opportunities. Runs and shallow pools. Depth 5 to 15 cm with pools to 40 cm. Appears well suited to trout fry. Cobble, pebble and boulder substrates.	Eroding banks faces provide some mobile materials to channel.
C2	NH 87247 34674	Very small channel. Little bedload. Largely immobile. Shallow. Poor habitat for trout.	Stable incised channel with steep, stable bank faces. Undercuts provide overhead cover.
Rb1	NH 87355 34131	Tiny channel, closed over with turf in places. A few little pools at downstream end might support trout, but largely unsuitable.	Incised bank faces. Turf closes over channel in places. Rushes.
Rb2	NH 87000 34014	Much of channel closed over below turf. Some wet flush through rushes. Unsuited to fish production.	Turf closes over channel in many places. Indistinct channel through rushes in others with low wet banks.
M1	NH 85000 35148	Runs and little pools. Appears well suited to trout fry but water crickets on all pools suggests probably fishless. Pockets of gravel would allow spawning. Depth 5 to 15 cm in runs with pools to 40 cm.	Stable turf and boulder banks. Good overhead cover from draped vegetation and undercuts.
M2	NH 85250 34926	Small channel with some sections running beneath turf. Incised and with little mobile substrate - hardpan bed. Occasional little pools might hold trout. Many water crickets.	Rushes and turf. Grown over channel in places.
S1	NH 85699 33688	Small incised channel. No bedload. Cut down to peat or hardpan. Some little pockets of gravel might permit spawning but poor.	Rough pasture with rushes, grasses and juniper. Steep incised bank faces. Undercuts provide overhead cover.

8.3. Habitat survey data

Section code	% visible streambed	Width (m)		Substrate		Instream cover	Bankside cover (% of bank length)		Habitat quality for juvenile trout	
		Wet	Bank	Stability	Compaction		Left	Right	Fry	Parr
R1	60	3.5	4	Unstable	Uncompacted	Good	10 - 25	10 - 25	Good	Moderate
R2	50	2.5	2.6	Stable	Uncompacted	Good	>25	>25	Moderate	Good
R3	40	2	2.2	Stable	Uncompacted	Good	10 - 25	10 - 25	Moderate	Good
R4	25	1.5	1.8	Stable	Uncompacted	Good	>25	>25	Good	Good
R5	25	1.5	1.5	Stable	Uncompacted	Good	>25	>25	Good	Good
R6	90	1.2	1.4	Stable	Partly	Good	10 - 25	10 - 25	Moderate	Moderate
R7	25	0.8	0.8	Stable	Compacted	Poor	>25	>25	Poor	Poor
SM1	10	1.3	1.3	Stable	Uncompacted	Poor	>25	>25	Poor	Moderate
SM2	25	1	1	Moderate	Uncompacted	Poor	>25	>25	Moderate	Poor
SM3	15	1	1	Moderate	Uncompacted	Poor	>25	>25	Moderate	Moderate
SM4	60	0.8	1	Unstable	Uncompacted	Poor	>25	>25	Moderate	Poor
SB1	na	na	na	na	na	na	na	na	Unsuitable	Unsuitable
SMt1	na	na	na	na	na	na	na	na	Unsuitable	Unsuitable
Ra1	70	0.5	0.6	Stable	Compacted	Poor	10 - 25	10 - 25	Unsuitable	Unsuitable
Ra2	na	na	na	na	na	na	na	na	Unsuitable	Unsuitable
C1	90	0.9	1.1	Stable	Uncompacted	Moderate	10 - 25	10 - 25	Good	Poor
C2	30	0.5	0.5	Stable	Partly	Poor	>25	>25	Poor	Poor
Rb1	25	0.4	0.4	Stable	Partly	Poor	>25	>25	Very poor	Very poor
Rb2	25	0.3	0.3	Stable	Partly	Poor	>25	>25	Unsuitable	Unsuitable
M1	80	0.9	1.1	Stable	Uncompacted	Moderate	10 - 25	10 - 25	Moderate	Poor
M2	75	0.6	0.8	Stable	Partly	Poor	>25	>25	Poor	Poor
S1	20	0.5	0.5	Stable	Compacted	Poor	>25	>25	Poor	Poor

8.4. Electric fishing survey site locations and survey event details.

Site	Watercourse	NGR	Length (m)	Width (m)	Area (m^2)	Voltage	Current (Amperes)	Conductivity	Temperature	Level	Colour
RB1	Rhilean Burn	NH 89324 36168	35	3.6	126.0	320	0.3	47	15.5	Moderate	Coloured
RB2	Rhilean Burn	NH 88186 35211	37	2.9	107.3	320	0.25	44	11.5	Moderate	Coloured
RB3	Rhilean Burn	NH 87608 34671	65	1.8	117.0	300	0.3	41	13.5	Moderate	Coloured
RB4	Rhilean Burn	NH 87372 34085	66	1.5	99.0	300	0.25	37	10.7	Moderate	Coloured
ASM1	Allt an t-Slugain Mhoir	NH 87750 36301	63	1.3	81.9	300	0.3	48	10.0	Low-moderate	Coloured
ASM2	Allt an t-Slugain Mhoir	NH 87341 35958	200		0.0	300	0.3	48	10.0	Low-moderate	Coloured
CT1	Caochan Tom nan Clach	NH 87521 34620	71	0.8	56.8	240	0.2	44	12.5	Low-moderate	Coloured
AS1	Allt Seileach	NH 85707 33670	~350 m	na	na	250	0.3	46	11.0	Moderate	Coloured
AM1	Allt a' Mhuilinn	NH 85058 35102	160	0.7	112.0	300	0.2	47	11.0	Moderate	Coloured

8.5. Depletion attained at fully quantitative electric fishing sites

Site	Number trout fry caught			Number trout parr caught			Total trout		
	run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3
RB2	11	1	1	25	4	2	36	5	3
RB4	1	0	0	11	2	0	12	2	0
ASM1	3	3	1	11	5	1	14	8	2

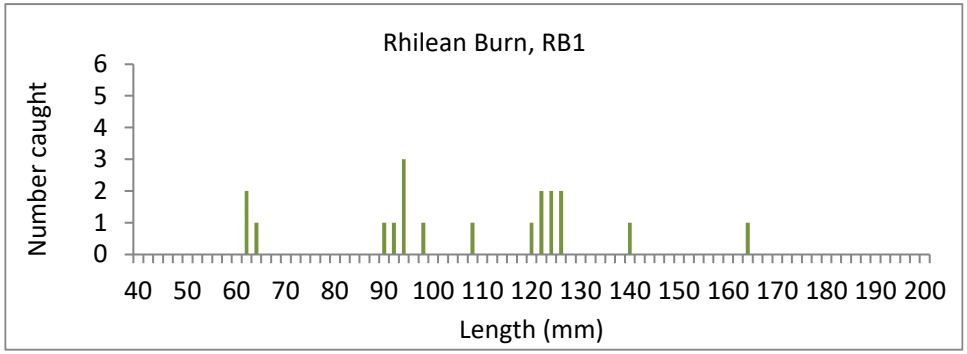
Zippin density estimates with lower and upper 95% confidence limits:

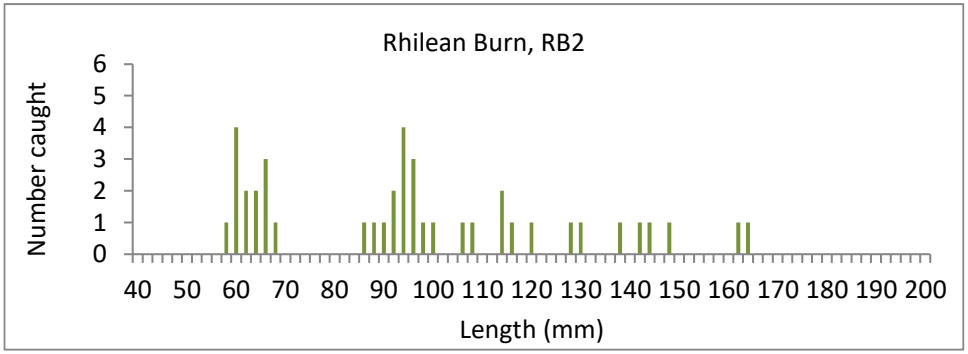
Site RB2. Trout fry density = 12.2 per 100 m^2 (95% CL = 12.1 to 13.0 per 100 m^2). Trout parr density = 29.3 per 100 m^2 (95% CL = 28.9 to 30.6 per 100 m^2)

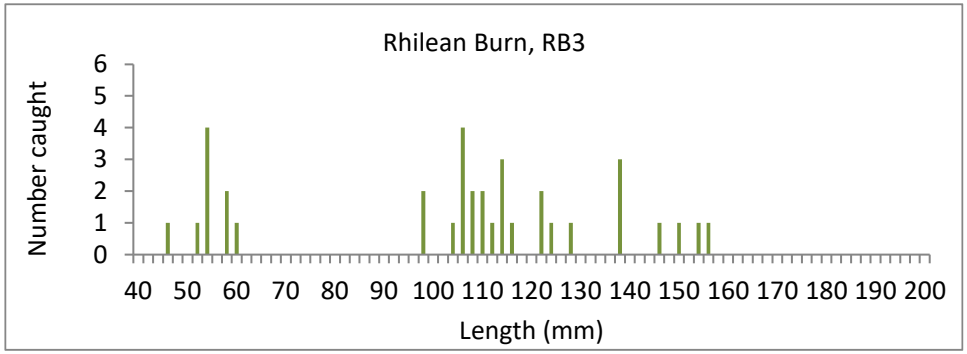
Site RB4. Trout fry density = 1.0 per 100 m^2. Trout parr density = 13.1 per 100 m^2 (95% CL = 13.1 to 13.5 per 100 m^2)

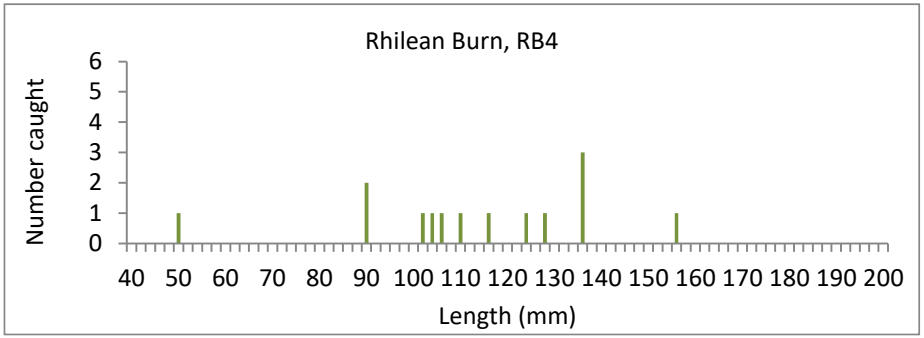
Site ASM1. Trout fry density = 9.8 per 100 m^2 (95% CL = 8.5 to 13.8 per 100 m^2). Trout parr density = 29.7 per 100 m^2 (95% CL = 28.1 to 33.8 per 100 m^2)

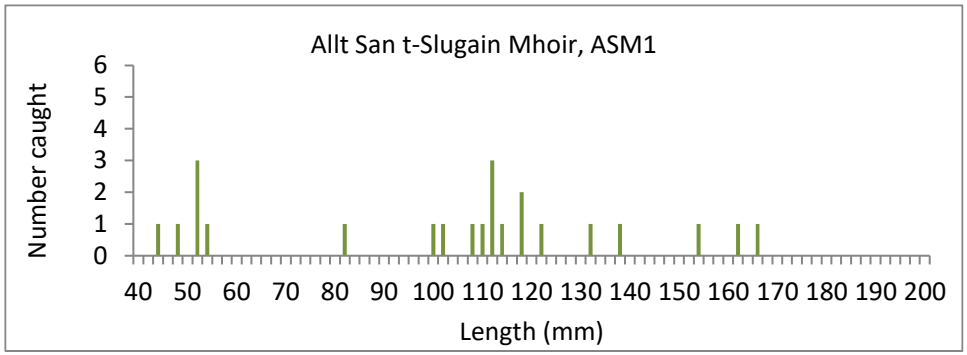
8.6. Trout size distribution at individual survey sites

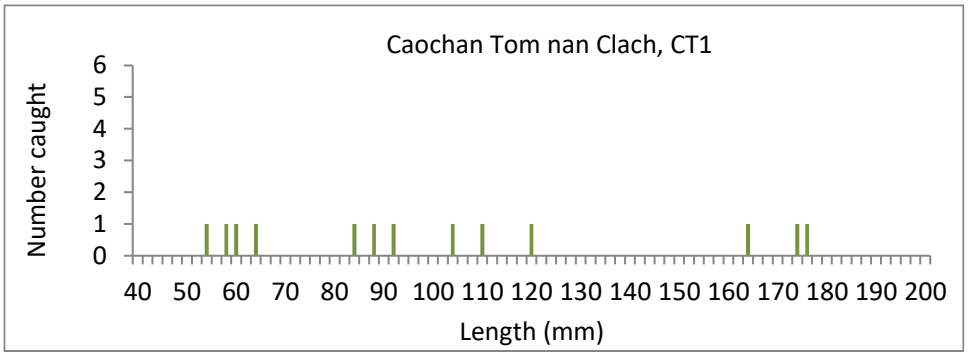




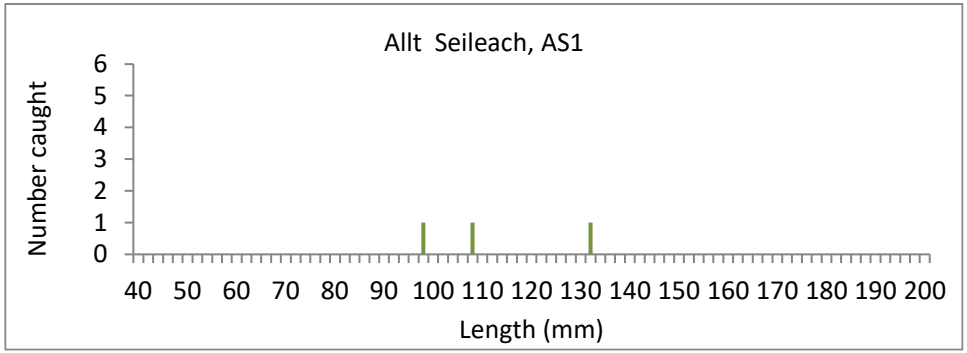








Trout size distributions contd.



8.7. Habitats at quantitative electric fishing sites

Depths, substrates and flow types

Site	**Depth in cm** (% of wetted area)						**Substrate** (% of wetted area)									**Flow types** (% of wetted area)							
	<10	*11-20*	*21-30*	*31-40*	*41-50*	*>50*	*HO*	*SI*	*SA*	*GR*	*PE*	*CO*	*BO*	*BE*	*OB*	*SM*	*DP*	*SP*	*DG*	*SG*	*RU*	*RI*	*TO*
RB1	10	35	35	15	5	0	0	0	5	10	15	35	35	0	0	5	5	10	10	20	30	20	0
RB2	5	70	25	0	0	0	0	0	2	3	15	55	25	0	0	5	0	5	0	35	45	10	0
RB3	5	20	40	25	10	0	0	0	5	5	10	30	50	0	0	2	10	20	10	28	25	5	0
RB4	10	25	35	20	10	0	0	0	5	5	10	50	30	0	0	5	5	30	0	15	40	5	0
ASM1	5	30	40	20	5	0	5	0	45	15	15	20	0	0	0	0	10	15	10	10	50	5	0
CT1	10	60	20	7	3	0	0	0	5	15	35	35	10	0	0	0	5	15	0	0	70	10	0

Cover for fish alongside banks and on streambed

Site	**Left bank (% of bank length)**				**Right bank (% of bank length)**				**Cover on streambed**
	Undercut	Draped	Bare	Marginal	Undercut	Draped	Bare	Marginal	
RB1	5	5	95	0	15	5	85	0	Good
RB2	25	5	75	0	20	20	70	10	Good
RB3	10	10	80	0	15	10	75	0	Good
RB4	15	5	85	0	10	0	90	0	Good
ASM1	60	10	30	0	60	10	30	0	Moderate
CT1	70	40	20	0	70	40	20	0	Moderate

Substrates: HO = high organic (peat); SI = silt; SA = sand; GR = gravel; PE = pebble; CO = cobble; BO = boulder; BE = bedrock; OB = obscured.
Flow types: SM = shallow marginal; DP = deep pool; SP = shallow pool; DG = deep glide; SG = shallow glide; RU = run; RI = riffle; TO = torrent.

8.8. Allt Carn an t-Sean-liathanaich, habitat photographs

	Section R1 NH 8838 3538
	Section R2 NH 8813 3512
	Section R2 NH 8803 3510

	Section R2 NH 8785 3501
	Section R3 NH 8767 3482
	Section R4 NH 8746 3447

	Section R5 NH 8736 3413
	Section R6 NH 8739 3388
	Section R6 NH 8737 3382

	Section R7 NH 8709 3341

8.9. Allt an t-Slugain Mhoir and tributaries, habitat photographs

	Allt an –Slugain Mhoir, section SM1 NH 8752 3621
	Allt an –Slugain Mhoir, section SM2 NH 8743 3623

	Allt an –Slugain Mhoir, section SM3 NH 8734 3596
	Allt an –Slugain Mhoir, section SM4 NH 8701 3561
	Allt an –Slugain Mhoir, section SM4 NH 8700 3553

	Allt an t-Slugain Bhig, near confluence with Allt an t-Slugain Mhoir NH 87443624
	Allt an –Slugain Mhoir, minor tributary, section SMt1 NH 8728 3578

8.10. Rhilean Burn minor tributaries, habitat photographs

	Unnamed tributary A, section Ra1 NH 8852 3563

	Unnamed tributary A, section Ra1 NH 8844 3567
	Caochan Tom nan Clach, section C1 NH 8739 3468
	Caochan Tom nan Clach, section C2 NH 8714 3472

	Caochan Tom nan Clach, section C2 NH 8692 3472
	Unnamed tributary B, section Rb1 NH 8736 3413
	Unnamed tributary B, section Rb1 NH 8717 3403

8.11. Allt Seileach, habitat photographs

	Section S1 NH 8570 3369 View downstream
	Section S1 NH 8570 3369 View upstream
	Section S1 NH 8580 3364

8.12. Allt a' Mhuilinn, habitat photographs

	Section M1 NH 8500 3515
	Section M1 NH 8508 3508
	Section M2 NH 8528 3491

8.13. Electric fishing site photographs

	RB1 NH 89324 36168
	RB2 NH 88186 35211
	RB3 NH 87608 34671

	RB4 NH 87372 34085
	ASM1 NH 87750 36301
	ASM2 NH 87341 35958

	CT1 NH 87521 34620
	AS1 NH 86707 33670
	AM1 NH 85058 35102