Bhlaraidh Wind Farm Extension
Appendix 5.4: Fish habitat and population baseline survey 2020

Commissioned report to SSE Renewables PLC

January 2021

Waterside Ecology
[redacted]
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Table of Contents **Page**

List of Tables **Page**

Bhlaraidh Wind Farm extension: survey of fish habitats and populations

Commissioned Report to SSE Renewables PLC, January 2021

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 Bhlaraidh Wind Farm in Inverness-shire. The site is drained largely by Allt Saigh and its tributaries. Allt Saigh flows eastward from the site into Loch Ness. One stream on the proposed access route, Allt Loch a' Chrathaich, drains south into the River Moriston. This stream was scoped out of the current survey as existing data showed it to be unsuited to fish production. Migratory salmonids (salmon and sea trout) do not have access to the development site due to the presence of natural obstacles.

Methods

A walkover survey of stream habitats was carried out in August 2020. 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 electric fishing survey included 14 sites as follows:

- Allt Saigh: 3 sites
- Lochan an Ruighe Dhuibh outflow stream: 1 site
- Loch Liath outflow and inflow streams: 5 sites
- Allt Carn Coire Rainich: 5 sites.

Main findings

Allt Saigh, NH 4137 1992 to NH 3918 2014

- This is the largest stream on the site with a wet width up to 4 m. Most of the stream provides productive trout habitat. Depth is between 15 and 45 cm and substrates are dominated by boulder and cobble, providing good cover. Spawning habitats were found to be scarce.
- Trout were present at all three electric fishing sites on Allt Saigh. Single run trout fry densities ranged from 1.3 to 31.1 fish.100 m^{-2}. These densities are classified as very poor and good respectively, by regional standards. Mean fry density was 12.2 per 100 m^2, classified as poor. Trout parr densities exceeded fry densities at two sites. Single run parr density ranged from 9.6 to 28.0 per 100 m^2, classified as fair and excellent respectively. The mean parr density of 15.9 per 100 m^2 is classified as good. Minnows were present at two sites. No other fish species was seen or caught.

Lochan an Ruighe Dhuibh outflow stream, NH 3845 2019 to NH 3842 2077

- This stream has a typical wet width of between 1.5 and 3 m. It flows into Allt Saigh via Loch Carn Tarsuinn Beag and is accessible from Allt Saigh and Lochan an Ruighe Dhuibh. The stream provides some good quality juvenile trout habitats. Small patches of gravel are widespread, providing spawning opportunities.
- Trout fry and parr were present at the electric fishing site. Fry and parr densities were 27.6 (good) and 5.3 (poor) per 100 m^2 respectively.

Loch Liath outflow and inflow streams

- The outflow stream links Loch Liath (NH 3970 2078) to Allt Saigh via Loch na Feannaig (NH 3966 2023). A boulder causeway at the outflow of Loch Liath may restrict fish movement but no clearly impassable obstacles were recorded between the two lochs. The stream provides long reaches of productive trout habitat interspersed with non-productive bedrock habitats. Channel width is approximately 2 m. Spawning habitat is scarce. Single-run trout fry and parr densities at an electric fishing site in the lower reaches were 4.8 and 7.5 fish.100 m^{-2} respectively, classified as very poor for fry and poor for parr. Minnows were abundant.
- The west inflow stream links Loch Liath at NH 3967 2105 to Loch nam Brathain at NH 3946 2156. In its lower reaches this stream is up to 1 m wide. Substrate is embedded immobile boulder and cobble, and habitat quality was judged to be poor. No spawning habitat was recorded. Electric fishing found three trout parr in a 125 m long reach, giving a density of 2.4 parr.100 m^{-2} (very poor). Trout fry were absent and no other fish species were seen or caught.
- The east inflow stream drains an unnamed loch at NH 398 216 and flows into Loch Liath at NH 3979 2096. The stream is ~1 m wide in its lower reaches. Some spawning habitat is present where it joins Loch Liath but elsewhere there is little bedload and spawning habitat is lacking. Electric fishing found a good fry density of 28.0 per 100 m^2 close to Loch Liath. Parr density was 6.0 per 100 m^2. A small cascade 50 m up from the loch may be impassable. A single trout parr was found at a survey site immediately upstream of the obstacle, but fry were absent. No fish could be found 300 m further upstream. A single 3-spined stickleback was present at the site closest to Loch Liath. No other fish species was seen or caught.

Allt Carn Coire Rainich NH 4056 2027 to NH 4009 2147

- This stream drains Coire Rainich to join Allt Saigh in the SE of the proposed development area. In its lower reaches Allt Carn Coire Rainich has a typical wet width of 1.2 m. Substrates are largely of stable boulder and cobble. Smaller substrates of gravel and pebble are scarce and spawning habitat may be limiting for trout. Five electric fishing sites were surveyed. Trout were present only at the two most downstream sites, both of which were downstream of a waterfall at NH 4053 2058.

Stream crossings

- Habitat assessments were conducted around seven proposed stream crossings. The crossings over Allt Saigh (at NH 403 203) and the Lochan an Ruighe Dhuibh outflow stream (at NH 385 207) are in reaches of productive trout habitat. Habitat quality at the three proposed crossings over the inflow streams to Loch Liath was poor; trout were present but densities were low. It is likely that fish are absent at both crossings in the headwaters of Allt Carn Choire Rainich. No significant areas of spawning habitat were associated with any of the proposed crossing locations.

The findings suggest that the largest expanses of productive trout habitat are in Allt Saigh, the Lochan an Ruighe Dhuibh outflow, the Loch Liath outflow and the lower reaches of Allt Carn Choire Rainich. Trout and 3-spined stickleback are likely to be the only native fish present on site. Minnows – often used as ‘live bait’ - were probably introduced by anglers. Comparison with past electric fishing data suggests there can be large fluctuations in trout year class strength and fish density at individual sites.

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. Where trout are present, stream crossing design should seek to minimise potential impacts on fish habitats or fish movements.

1 Background

This report sets out the results of a baseline survey conducted to support the Environmental Impact Assessment report for the proposed extension to the Bhlaraidh Wind Farm in Inverness-shire. The proposed site is drained largely by the Allt Saigh, which flows into Loch Ness, within the catchment of the River Ness. The access route (an existing track to the operational wind farm) and some peripheral areas of the site drain towards the River Morison, also in the catchment of the River Ness. The River Moriston is a SAC for freshwater pearl mussel and Atlantic salmon is a qualifying feature.

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. MSS- FL may not have local knowledge of the site and consequently the onus is on the developer to provide adequate information on which to base an assessment of risk.*

The above principle underpins current guidance (Marine Scotland Science 2018). In relation to proposed Bhlaraidh Wind Farm Extension, the scoping response from Marine Scotland (letter from Dr Emily Bridcut, 6th August 2019) has requested:

- Site characterisation surveys including electric fishing within and downstream of the site boundary;
- Consideration of cumulative impacts;
- Consideration of monitoring, including control sites;
- That the developer contact Ness DSFB and Ness & Beauly Fisheries Trust to seek advice on local fisheries.

The specification for the current suite of surveys was agreed with Ness DSFB in May 2020.

2 Fish populations

An electric fishing survey was carried out in 2014 (Waterside Ecology 2014) prior to construction of the existing Bhlaraidh Wind Farm. Fish presence in steams in the Allt Saigh catchment is summarised in Table 1. The data suggest that brown trout *Salmo trutta* and minnows *Phoxinus phoxinus* were the only species present. It should be noted that the 2014 survey did not cover several of the watercourses draining the site of the proposed extension.

Table 1 Existing fish population data from potentially impacted streams

Stream(s)	Available data	Fish species present
Allt Saigh	Three electric fishing sites	Brown trout, minnow
Allt Coire Liath	Single electric fishing site	Brown trout, minnow
Allt Carn Choire Rainich	Single electric fishing site	Brown trout, minnow
Loch Carn Tarsuinn outflow	Single electric fishing site	Brown trout

3 Aims and objectives

The overall aim of the study was to characterise fish habitats and populations in streams within and immediately downstream of the proposed Bhlaraidh 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 and quality 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 Survey reaches

The habitat and electric fishing surveys were carried out between 29th August and 1st September 2020. Survey conditions were fair, with low to moderate water levels. All streams were largely clear, but with light peat staining in the smaller watercourses. Survey reaches are listed in Table 2.

Table 2 Stream survey reaches

Stream	NGR downstream	NGR upstream
Allt Saigh	NH 41366 19921	NH 39184 20144
Lochan an Ruighe Dhuibh outflow	NH 38450 20190	NH 38420 20770
Loch Liath west inflow	NH 39667 21054	NH 39461 21562
Loch Liath east inflow	NH 39789 20958	NH 39857 21485
Loch Liath outflow	NH 39660 20232	NH 39642 20776
Allt Carn Choire Rainich	NH 40559 20265	NH 40094 21473
Allt Carn Choire Rainich, E fork	NH 40390 20861	NH 40531 21213

Although the proposed access route could potentially impact on Allt Loch a' Chrathaich, in the catchment of the River Moriston, this stream was scoped out of the current survey. Waterside Ecology (2011) surveyed the stream and found that it carries almost no water due to abstraction. It is therefore almost entirely unsuited to fish production.

4.2 Habitat survey

Reaches with the potential to be impacted by the proposed development were surveyed by a qualitative walkover by an experienced surveyor. The primary aims were i) to broadly assess trout habitat distribution and quality in potentially impacted streams; and ii) to underpin the design of the electric fishing survey. Habitat descriptions were based on protocols described by SEPA (2010) and trout habitat requirements as set out by Summers *et al*. (1996). The method broadly characterises in-stream habitats according to depth, substrate, flow and thus suitability for different age classes of trout (Table 3).

Table 3 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.

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

Proposed stream crossing locations were examined carefully. In particular, they were checked for the presence of potential spawning habitats, as these were found to be scarce in the smaller streams during the current survey as well as during past surveys related to the Bhlaraidh Wind Farm (Waterside Ecology 2011). The inspections extended approximately 50 m upstream and 100 m downstream of proposed crossing sites.

4.3 Fish population survey

Surveys were conducted mainly using semi-quantitative methods as described by Scottish Fisheries Co-ordination Centre (SFCC 2014). Survey sites are listed in Table 4 and their locations in relation to turbines and tracks are shown on Figure 1. Three sites were surveyed using fully quantitative methods.

Table 4 Locations of electric fishing sites

Site	Watercourse	NGR	Survey type	Area (m^2)
AS1	Allt Saigh	NH 40562 19852	Fully quantitative	139.4
AS2	Allt Saigh	NH 40012 20210	Semi-quantitative	156.4
AS3	Allt Saigh	NH 38868 20041	Fully quantitative	96.6
RD1	Lochan an Ruighe Dhuibh outflow	NH 38475 20591	Fully quantitative	112.2
LL1	Loch Liath outflow	NH 39560 20401	Semi-quantitative	146.0
LL2	Loch nam Brathain outflow	NH 39675 21110	Semi-quantitative	125.0
LL3	Loch Liath east inflow	NH 39794 20953	Semi-quantitative	50.0
LL4	Loch Liath east inflow	NH 39852 20979	Semi-quantitative	60.0
LL5	Loch Liath east inflow	NH 39842 21232	Qualitative	na
CR1	All Carn Choire Rainich	NH 40596 20283	Semi-quantitative	92.4
CR2	Allt Carn Choire Rainich	NH 40525 20580	Qualitative	na
CR3	All Carn Choire Rainich	NH 40504 20642	Qualitative	na
CR4	All Carn Choire Rainich, headwater E	NH 40540 21200	Qualitative	na
CR5	Allt Carn Choire Rainich, headwater W	NH 40155 21200	Qualitative	na

A single electric fishing run was conducted at semi-quantitative survey sites. Three runs were conducted at fully quantitative sites. Stop nets were deployed at fully quantitative survey sites. The inclusion of some fully quantitative site provides an indication of survey efficiency via the observed depletion in fish numbers during consecutive runs through a survey site.

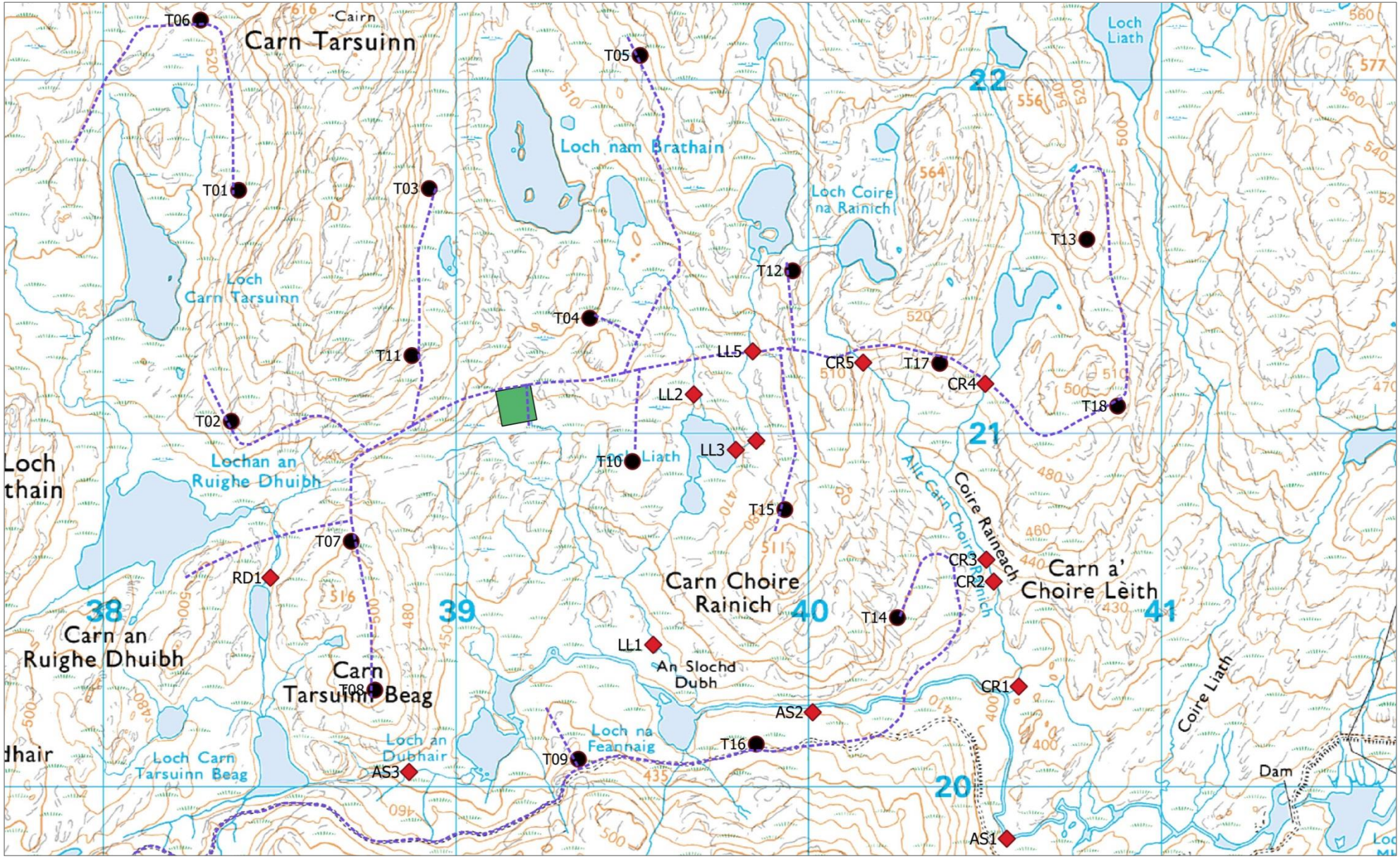
All survey sites covered the full stream width and incorporated a representative range of habitat types. Habitat descriptions were made at quantitative survey sites using the SFCC (2014) protocol. Surveys were conducted by a team of two using backpack electric fishing gear and a single anode. Event details including equipment type, voltage used and conductivities are provided as Appendix 8.2.

A number of qualitative electric fishing surveys were conducted. These involved searches for fish over relatively long reaches of stream. Such surveys were conducted either when: i) initial checks suggested no fish were present or ii) streams were too small to permit quantitative survey[1].

Four of the sites that were surveyed were also electro-fished in 2014. These sites are AS1, AS2, AS3 and CR1. The repeat surveys permit an assessment of year-to-year variation in fish densities.

[1] In very small streams only parts of watercourse may be large enough to access with an anode and dip net. This is often the case where the stream banks meet, or nearly meet, over the channel.

Figure 1 Turbine and track layout and location of electric fishing survey sites



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. Trout fork length was measured to the nearest millimetre. Scales were collected from trout to assist with age determination. Minnows were counted, but were not measured. All fish were allowed to recover fully in clean water before being released back into the survey reaches.

4.4 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 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).

The classification provided by Godfrey (2006) is used to describe fish abundance in a regional context. The classification is based on data sets held by Scottish Fisheries Co-ordination Centre (SFCC). The quintile ranges of salmon and trout densities (Appendix 8.1) permit comparison of fishery performance against regional and national reference points. The classifications are 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.

5 Results

5.1 Habitats

5.1.1 Allt Saigh

Allt Saigh is the largest stream draining the site and all of the other streams surveyed flow into it. Allt Saigh was surveyed from the dam and intake at NH 413 199 to Loch an Dubhair at NH 392 201, a distance of approximately 3.5 km. The stream has a moderate gradient with an average of approximately 2% through the surveyed reach. Wet width is typically between 2 m and 4 m. Flow types are varied, including reaches of run, glide and pool. There are several short sections of torrent/rapid and two potentially impassable waterfalls that may block upstream movements by trout. The first is located at NH 4053 2026, a short distance upstream of the Allt Choire Rainich confluence. It is a 0.9 m high drop onto sloping bedrock. A similar obstacle is present at NH 3952 2032.

Substrates in Allt Saigh are mainly coarse, dominated by boulder and cobble. Large boulders partly exposed above the surface create eddies and provide good cover for trout in many reaches. Availability of cover alongside the banks is moderate, with undercuts and some draped heather and grasses. Few substantial areas of spawning habitat were noted. The exceptions were a large patch of around 12 m² at NH 4072 1990 and a patch of 4 m² at NH 4013 2021. Elsewhere spawning was limited to small, scattered patches of gravel and pebble around large boulders or in pools.

5.1.2 Lochan an Ruighe Dhuibh outflow

This stream is at the western periphery of the proposed development area. It has a typical wet width of between 1.5 and 3 m. The lower reaches, between Loch Carn Tasuinn Beag and the small unnamed lochan at NH 384 205, are mostly steep mixed juvenile habitat with some small bedrock shelves. Some potential spawning habitat is present near the lochan. Upstream of the lochan the stream has a relatively low gradient (photograph right) and flow types of glide, run and shallow pool. No extensive areas of spawning habitat were noted but small patches of gravel are widespread. Trout were seen throughout the stream during the walkover survey. No impassable obstacles to fish migration were noted between Allt Saigh and Lochan an Ruighe Dhuibh.

5.1.3 Loch Liath outflow and inflow streams

Loch Liath outflow stream. The outflow at Loch Liath is partially blocked by a stone causeway. This appeared impassable on a low flow. It is not clear whether it may become passable on a high loch level. The outflow stream has a typical wet width of around 2 m. The reaches close to Loch Liath provide moderate quality, very stable juvenile trout habitat with runs and glides. Substrate is a mix of cobble, boulder and bedrock. The gradient and proportion of bedrock increase some 250 m downstream of the loch. The gradient eases around NH 3949 2058 and substrates revert to cobble and boulder. There is some braiding of the channel and a few patches of potential spawning habitat are present. The stream flows into Loch na Feannaig, a small lochan along the course of Allt Saigh, at NH 3966 2023.

East inflow (from Loch Coire na Rainich). This small stream has a wet width of approximately 1 m. A little spawning habitat is present in the loch margin, where the stream flows in. A short cascade some 50 m upstream from Loch Liath presents a substantial barrier for upstream migration[2]. There is little bedload, stream substrates being embedded and immobile. Habitat quality for trout becomes increasingly poor moving upstream towards Loch Coire na Rainich. No spawning habitat was recorded between Loch Liath and Loch Coire na Rainich. A waterfall that is clearly impassable was recorded at NH 39835 21311, so there is no linkage for upstream migration between the two lochs.

West inflow (from unnamed lochan east of Loch nam Brathain). The stream is around 1.2 m wide in its lower reaches. Substrates are stable, embedded cobble and boulder with some reaches of bedrock. There is no bedload and no spawning habitat was recorded. Habitat quality for trout is poor,

[2] Electric fishing subsequently found good numbers of juvenile trout downstream of this but very few upstream.

but trout were seen during the habitat survey as far upstream as the outflow from the small loch adjacent to Loch nam Brathain (NH 3945 2170).

5.1.4 All Carn Choire Rainich and tributary

This stream drains Loch Coire na Rainich and flows into Allt Saigh at NH 4057 2025. It is lower reaches (pictured) the stream has a wet width of 1.0 to 2.0 m, but is mainly less than 1.5 m wide. The streambed is very stable with substrates of boulder and cobble. There is little bedload and spawning habitat appeared very scarce, confined to a few tiny (<0.1 m^2) patches of gravel amongst the larger material. Depth is typically between 5 and 20 cm but some deeper pools are present. Overhead cover alongside the banks is abundant. A 2 m high waterfall at NH 4053 2058 appears impassable for upstream migrating trout and represents the upper limit of movement for fish from Allt Saigh. Upstream of the waterfall the gradient is moderate and habitat appears to be suitable for juvenile trout. The stream splits at NH 4039 2086. Allt Carn Coire Rainich itself is the (smaller) west fork, with a wet width of less than 0.5 m. The small stream provides poor quality habitat for trout. After 120 m it becomes very steep and appears unsuited to fish production.

The east fork is the larger of the two streams but habitat quality is poor with an immobile bed of boulder, cobble and bedrock. No spawning habitat was recorded and habitat quality for trout appears very poor. A 3 m high waterfall at 4041 2090 is clearly impassable. Some potentially suitable habitat for trout is present in the lower-gradient reaches that extend 150 m downstream from the unnamed loch. However, no fish were seen.

5.2 Trout density and distribution 2020

Trout were present at 10 of the 14 survey sites (Table 5). Densities were highly variable and where trout were present, densities ranged from very poor to excellent by regional standards.

Table 5 Electric fishing results, single run minimum densities

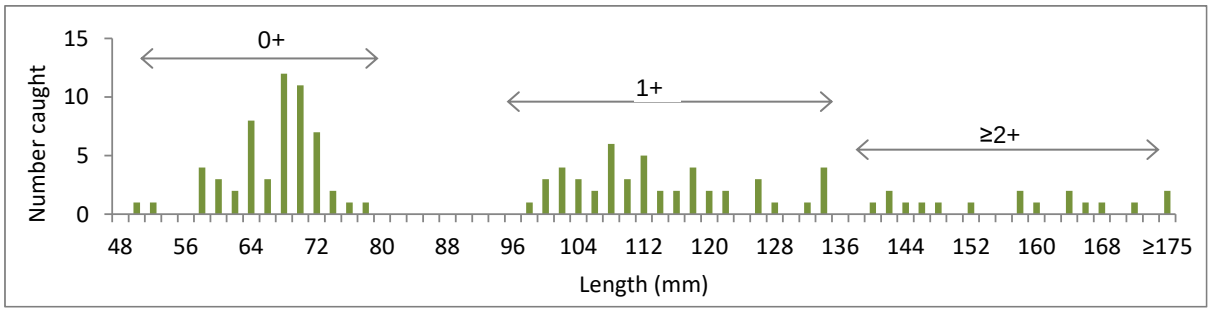
Site	Number caught (N)		Density (fish.100m^{-2})		Classification		Other fish species
	Fry	Parr	Fry	Parr	Fry	Parr	
AS1	6	14	4.3	10.0	Very poor	Fair	None
AS2	2	15	1.3	9.6	Very poor	Fair	Minnow (2)
AS3	30	26	31.1	28.0	Good	Excellent	Minnow (15)
RD1	31	6	27.6	5.3	Good	Poor	None
LL1	7	11	4.8	7.5	Very poor	Poor	Minnow (32)
LL2	0	3	0.0	2.4	-	Very poor	None
LL3	14	3	28.0	6.0	Good	Poor	3-sp. stickleback (1)
LL4	0	1	0.0	1.7	-	Very poor	None
LL5	0	0	0.0	0.0	-	-	None
CR1	3	8	3.2	8.7	Very poor	Poor	None
CR2	0	0	present	present	na	na	None
CR3	0	0	0.0	0.0	-	--	None
CR4	0	0	0.0	0.0	-	-	None
CR5	0	0	0.0	0.0	-	-	None

5.2.1 Allt Saigh

Trout were present at all three of the survey sites on Allt Saigh. Trout fry densities were very poor at the two more downstream sites, but were good at AS3, which is located approximately 100 m upstream of Loch an Dubhair. Trout parr were also plentiful at this site and the single-run density of 26.9 parr.100 m^{-2} is classified as excellent by regional standards. Trout parr densities were classified as fair at the other two sites on Allt Saigh. Sites AS1 and AS3 were fished fully quantitatively, providing estimates of 'true' fish densities. Data showing the depletions between consecutive electric fishing runs are provided in Appendix 8.3, along with Zippin estimates of true fry and parr densities. Zippin estimates of fry and parr densities at AS1 were 6.0 and 15.0 fish.100 m^{-2} respectively. Estimates at AS3 were 31.9 fry. 100 m^{-2} and 32.2 parr.100 m^{-2}.

The fry (0+) year class at sites on Allt Saigh was clearly defined and did not overlap with the 1+ year class (Figure 2). The 1+ and 2+ year classes did overlap in length, and too few scales were taken to ascertain with certainty how many of each was present. Scale readings indicated that the length of the 1+ cohort ranged from 98 mm to at 134 mm. Too few scales were taken from larger fish to determine ages but it seems likely that at least two further cohorts, 2+ and 3+, were present in the sample.

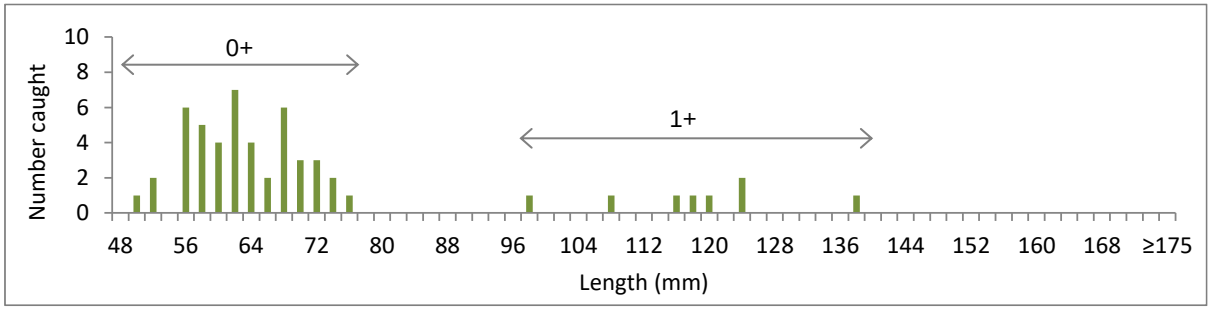
Figure 2 Trout length distribution, Allt Saigh



5.2.2 Lochan an Ruighe Dhuibh outflow

Trout fry were present at a good density at RD1 on the outflow stream from Lochan an Ruighe Dhuibh. Parr density was poor. All of the parr in the sample were aged 1+ (Figure 3). Zippin density estimates for fry and parr were 48.2 and 8.4 fish.100 m^{-2} respectively (Appendix 8.3).

Figure 3 Trout length distribution, Lochan an Ruighe Dhuibh outflow



5.2.3 Loch Liath outflow and inflow streams

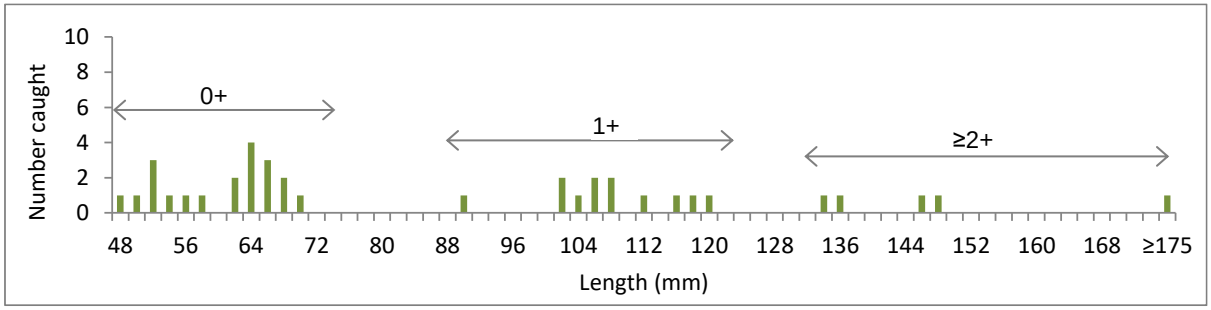
Trout fry and parr densities at LL1 in the outflow stream from Loch Liath were very poor and poor respectively. Site LL2 was in the west inflow stream and only three parr were caught in 125 m of stream, yielding a classification of very poor. No fry were seen or caught in this stream.

Sites LL3, LL4 and LL5 were in the east inflow stream. LL3 covered the entire stream between the loch and the cascade/bedrock 50 m further upstream. Fourteen fry and 3 parr were caught, giving single-run densities of 28.0 and 6.0 fish.100 m^{-2}. LL4 covered 60 m of stream immediately upstream

of the cascade and the catch was a single trout parr, indicating a step-change in fish density at the obstacle. No fish were caught at LL5, approximately 300 m further upstream.

Fry ranged in length from 48 mm to 70 mm. Parr, which may include some mature fish, ranged in length from 90 to 235 mm.

Figure 4 Trout length distribution, Loch Liath outflow and inflow streams

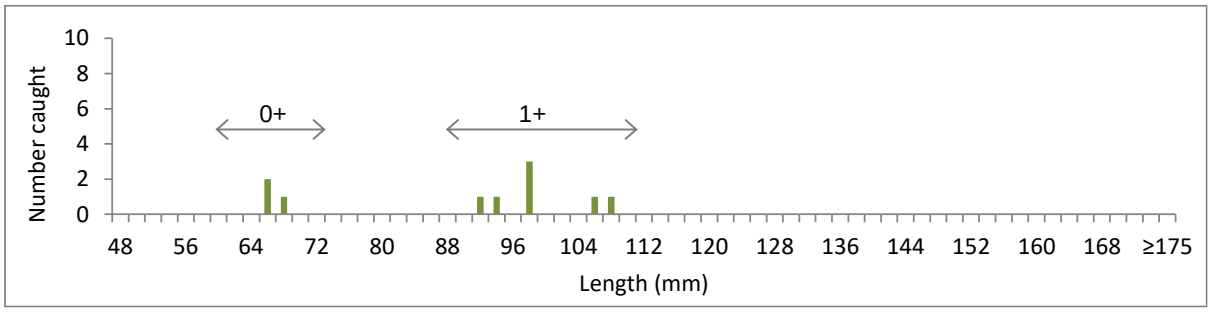


5.2.4 Allt Carn Choire Rainich and tributary

Five sites were surveyed in this drainage, but fish were present only at the two most downstream sites. Both these sites, C1 and C2 are downstream of the 2 m high waterfall at NH 4053 2058, around 350 m upstream of Allt Saigh. Fry densities at CR1 were classified as very poor, while parr density was poor (Table 5 above). CR2 was fished non-quantitatively, but trout fry and parr were present. The absence of trout at CR3, CR4 and CR5 seems to suggest the waterfall marks the upstream limit of their distribution.

The sample of trout from CR1 included fry and 1+ parr (Figure 5). One larger trout, probably at least 2+ years of age was noted in the sample from CR2 but fish were not measured at that (qualitative) survey site.

Figure 5 Trout length distribution, Allt Carn Choire Rainich



5.3 Presence of other fish species

Minnows were caught at three sites, two in Allt Saigh and one in the outflow stream from Loch Liath. The only other fish seen or caught was a single 3-spined stickleback *Gasterosteus aculeatus* at LL2, in the lower reaches of the east inflow stream, accessible from Loch Liath.

5.4 Stream crossings

Stream crossing assessments are summarised in Appendix 8.5. The proposed crossing over Allt Saigh (at NH 403 203) is in a reach dominated by large boulder with some bedrock. Current speed is moderate to fast and channel width is approximately 4 m. The banks are stable. Habitat quality for trout was judged to be moderate, due to the presence of some bedrock. No spawning habitat was recorded at the location, which is broadly typical of the reach.

Good quality, productive trout habitat is present at the proposed crossing over the Lochan an Ruighe Dhuigh outflow stream (at NH 385 207). The reach that would be impacted has a slow to moderate

current speed and substrates of cobble and pebble. No substantial areas of spawning habitat were recorded at or adjacent to the proposed crossing but small pockets of gravel and pebble may permit trout to create small redds. The proposed crossing site is typical of much of the stream. Trout fry were seen during the inspection and fry densities were good at electric fishing site RD1 a short distance downstream.

Habitat quality at all the three of the proposed crossings over the inflow streams to Loch Liath was judged to be poor. Stream width at these locations is around 1 m and the streambeds are largely immobile. No spawning habitats were recorded at or adjacent to any of the three proposed crossing locations. Electric fishing surveys were conducted at or around two of the proposed crossings (sites LL2 and LL5) on the west and east inflow streams respectively, and while trout were present densities were very low. No electric fishing took place at the more upstream of the two proposed crossings of the west inflow (NH 395 214) but trout were seen during its inspection.

Trout habitat quality at the two proposed crossings in the headwaters of Allt Carn Choire Rainich is poor. Both streams are very small, with wet widths less than 1 m and a lack of mobile substrates. Spawning habitat is lacking. Qualitative electric fishing around both crossings (sites CR4 and CR5) found no fish.

6 Discussion and interpretation

6.1 Data quality

The habitat survey was non-quantitative and intended to fulfil three purposes: i) to broadly assess trout habitat quality in potentially impacted streams; ii) to underpin the design of the electric fishing survey, and iii) to inspect proposed stream crossing sites for presence of key habitat types (especially spawning habitat). The survey was conducted by Jon Watt, who has over 25 years' experience of fish habitat and electric fishing surveys in a wide range of streams across Scotland. While the assessments of habitat quality were in part subjective, they were based on the surveyor's extensive experience and reflected the known habitat preferences of target species i.e. trout. It is likely, therefore, that the habitat assessments were adequate for their stated purpose.

All of the streams carried some light peat staining, which is typical of upland highland streams. As a result some parts of the streambed in the surveyed reaches could not be seen. This was particularly the case in narrower sections of headwater streams. It is conceivable that this might have impacted on the surveyor's ability to assess the presence of spawning habitat in such reaches, resulting in an under-estimation of its availability. This is unlikely to have had a significant impact for three reasons. First, it was abundantly clear that there was little bedload and no significant source of gravel and pebble substrates in the headwater reaches where visibility was significantly affected. Secondly, electric fishing data (in particular the scarcity or absence of fry) generally matched the surveyor's assessment of spawning potential. Finally, as typical spawning habitat is usually located in the shallower run-outs of pools and glides, or in stream margins, where substrates were visible, any impact of peat staining on the assessment of spawning potential 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 three fully quantitative sites (Appendix 8.3), suggesting that the surveys achieved good levels of efficiency and are likely to provide a reliable assessment of the relative abundance of trout across the site.

6.2 Fish and habitat distributions

6.2.1 Fish community

The electric fishing survey showed that the fish community in streams on the development site is dominated by brown trout. As these have no access to the sea, the trout populations of all streams can be assumed to be resident. The only other native fish species encountered was three-spined stickleback, which was caught in the east inflow stream to Loch Liath. Three-spined sticklebacks are widely distributed in Scotland and were one of the original post-ice age colonisers (Maitland 2007). The distribution of three-spined sticklebacks has been constrained by waterfalls and other obstacles but, like trout, their distribution has expanded through human intervention as well as by natural means. It is not known whether the trout or stickleback populations at Bhlaraidh arrived as part of their natural post-glacial range expansion, or whether they may have been introduced by man at some time in the past.

Common minnows, the only other fish species encountered, are probably not native to highland Scotland and those encountered in the Allt Saigh catchment are likely to be relative recent introductions. Minnows are often used by anglers as live-bait for trout and this has led to their accidental introduction to many Scottish waters. Further introductions by anglers have probably been deliberate, tipping live minnows into waterbodies at the end of day's fishing in the belief that they will provide feeding for trout. It may in fact be detrimental to trout populations, as the presence of minnows can lead to reduced recruitment and growth due to competition for food (Borgrstøm et al. 1996; Museth et al. 2007).

No eels were caught or seen at any of the electric fishing sites. Their absence suggests that obstacles downstream of the survey reaches are wholly or largely impassable to the species.

The data are largely consistent with those from the previous survey of some of the watercourses (Waterside Ecology 2014), which also identified the presence of trout and minnows in the Allt Saigh catchment. No three-spined sticklebacks were caught in 2014, but that survey did not extend to Loch Liath.

No surveys took place within the lochs on the site either during the current survey or that of 2014. The lochs are mainly small and appear to be quite shallow, based on surround topography and the presence of emergent vegetation. It is unlikely that further fish species are present in them, although this unconfirmed. There are no records of Arctic charr *Salvelinus alpinus* from these lochs, although the species is present in a number of larger, deeper lochs in the Ness system (Maitland & Adams 2018).

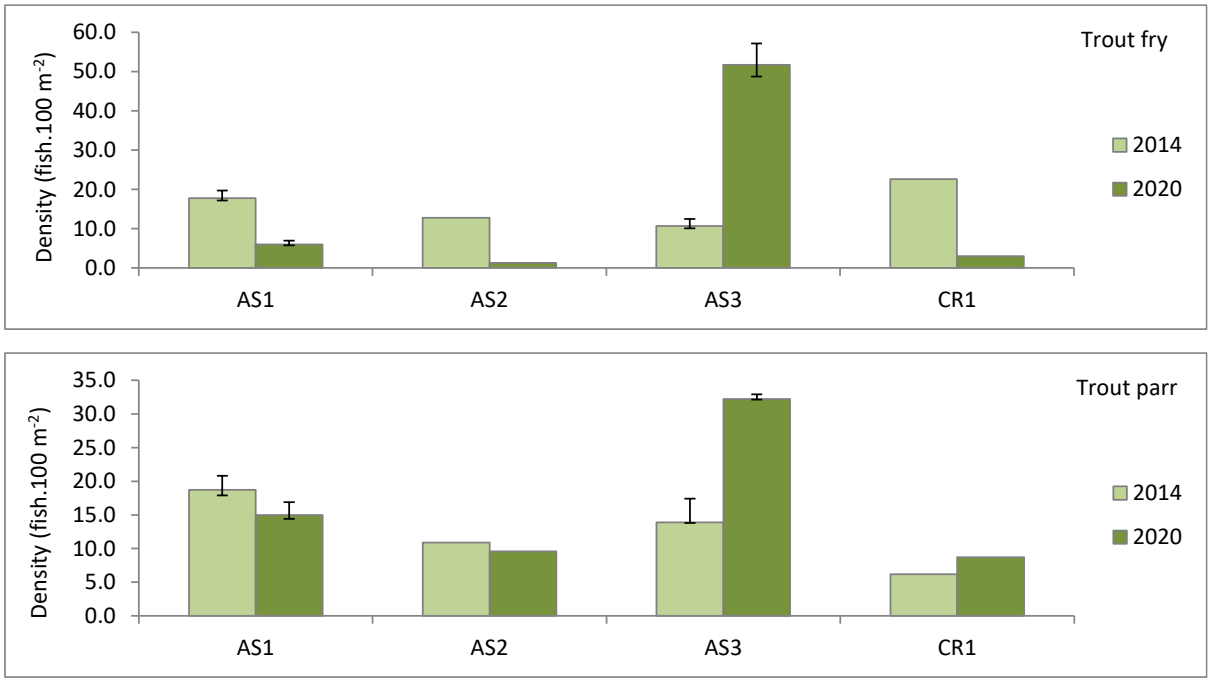
6.2.2 Trout, densities in 2014 and 2020

Figure 6 below shows trout densities during 2014 and 2020 at four sites that were surveyed during both years. The 2014 data are included as Appendix 8.7. There was substantial variation in densities of trout fry between the two years of survey at all four sites. Trout fry density decreased greatly at sites AS1 and AS2 in Allt Saigh and also at CR1 in Allt Carn Choire Rainich. The decrease at AS1 was statistically significant. Given the magniture of declines and the relatively high capture efficiency during both years of survey, there is little doubt that declines at AS2 and CR1 are also true reflections of reduced fry numbers, not artefact. In contrast, there was a significant and very substantial increase in trout fry density at AS3.

Trout parr densities at AS1, AS2 and CR1 differed little between 2014 and 2020. However, density at AS3 in 2020 was approximately double that in 2014, and the change was statistically significant.

Overall, the data suggest that there may be substantial spatial and temporal variation in trout recruitment in streams around the site. This will have implications for monitoring should this become a condition of planning consent.

Figure 6 Trout fry and parr single-run densities at four sites surveyed in 2014 and 2020



Zippin densities provided with 95% confidence limits for AS1 and AS3. Other densities are single run minima.

6.2.3 Habitat availability and quality

The largest expanses of fluvial trout habitat are in Allt Saigh itself. With a wet width of over 3 m this is by some way the largest watercourse in the study area and almost of the available habitat is suited to trout. Trout density across the three electric fishing sites in Allt Saigh was variable, but the excellent densities of parr at site AS3 confirm that the stream has good potential for trout production.

The outflow stream from Lochan an Ruighe Dhuibh also provides good quality trout habitat and fry were present at good densities at the single survey site. The stream provides small patches of potential spawning habitat, which are widespread but not extensive. No obstacles were recorded in this stream, which links the lochan to Allt Saigh.

Habitat quality in the outflow stream from Loch Liath was variable and some substantial reaches of bedrock habitat are present. Nevertheless, at 1.5 m wide it is one of the larger streams on the site and no clearly impassable obstacles were noted that would prevent fish movements between Loch Liath and Allt Saigh.

In general, the other streams on the site provide relatively poor habitat quality for trout, and it seems likely that availability of spawning habitat is a limiting factor in most reaches. The smaller streams, including the east and west inflows to Loch Liath and Allt Choire Rainich, have few sources of spawning calibre substrate. Materials eroding from the upper hill slopes are likely to be trapped by headwater lochs and the stable stream banks provide no local sources of gravel and pebble. The paucity of fry in most reaches reflects this.

No assessment was made of the lochs themselves but it should be noted that these provide the largest expanses of trout habitat on the site, their total wetted area likely to be one or more order of magnitude greater than that of the streams. The lochs also provide the primary recreational angling resource on the site.

6.3 Potential impacts

Diffuse and point source impacts from construction works around watercourses clearly have the potential to affect stream habitats and fish populations. These may be propagated downstream into standing waters. 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 Monitoring

Marine Scotland Science has requested that future monitoring be considered in the Environmental Impact Assessment Report. Repeat surveys in two streams during the current study showed that fish abundance may fluctuate substantially over time and, importantly, that the direction of these fluctuations may differ between sites. If fish are to be assessed as part of any future monitoring programme the likelihood of such fluctuations will have to be considered, as this has implications both for the design of a monitoring programme and for the interpretation of monitoring results.

The ability to detect impact during any future monitoring programme may be enhanced by the inclusion of control sites. This would be standard practice for any such study (Marine Scotland Science 2018). Suitable control sites may be present in the Allt Loch an t-Sionnach system, a sub-catchment of Allt Saigh east of the proposed development. It may also be appropriate to establish control sites further upstream in the Allt Saigh system, albeit these may experience some residual impact related to the existing wind farm. Previous surveys conducted in both these areas (Waterside Ecology 2012 & 2014) show that the fish populations of Allt Loch an t-Sionnach and upper Allt Saigh have many similarities with those in the current study area. Furthermore altitudes and underlying geologies are also comparable. Despite these similarities, impact and control streams could be individually affected by variables unrelated to wind farm construction or operation. Thus any future change in fish numbers may not, of itself, provide compelling evidence of wind farm impacts without corroborating evidence from hydrochemical monitoring or direct observations of incidents e.g. by an Ecological Clerks of Works. The existence of past data is also likely to be an important component of any interpretation of future change, by providing some indication of the level of 'natural' annual fluctuations at a sub-set of sites.

Due to the inter-site variability in fish numbers, as well as variability in the degree and direction of annual fluctuations, replication will be an important element of any monitoring programme. Several monitoring sites would be required in the larger watercourses. It should also be noted that Ness District Salmon Fishery Board has requested that monitoring should include the lower reaches of Allt Saigh, which are accessible from Loch Ness, as these may be a spawning area for ferox trout[3].

Data from the current survey suggest that quantitative fish monitoring in some of the smaller watercourses, e.g. the west inflow to Loch Liath, would not be worthwhile as the very low densities

[3] Ferox are variety of large, piscivorous trout which, in some systems, are genetically distinct from other trout.

found there would make detecting change difficult. Qualitative survey of such streams should be considered.

6.5 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).
- Stream crossing design and construction should incorporate suitable mitigation measures to avoid impacts on productive fish habitats. This will be most important at the crossings of Allt Saigh and the Lochan an Ruighe Dhuibhe outflow stream.
- Stream crossings should be constructed in manner that does not impede local fish movements. While the trout populations are resident, these fish will undergo local movements associated with development and reproduction. Trout were shown to be present in all watercourses other than the headwaters of Allt Choire Rainich.
- 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.
- Monitoring of fish should be an element of any future water quality monitoring plan. The design of any fish monitoring programme should be guided by the results of the current and past studies of fish in the Allt Saigh catchment. Fish monitoring should be spatially co-ordinated with hydrochemical monitoring.

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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 Electric fishing 2020, site and event details

Code	East	North	Survey date	Location	Length (m)	Width (m)	Voltage	Amps	Conductivity ($\mu S.cm^{-1}$)	Temp (°C)	Level	Colour
AS1	240562	819852	30/08/2020	Downstream end of site is downstream end of rock face at left bank. Upstream end is 2.5 m downstream of bedrock point in right bank (most downstream of series of points)	41	3.4	350	0.3	38	12.5	Moderate	Clear
AS2	240012	820210	01/09/2020	Downstream end is run out of glide (net placed across long oblong rock). Upstream end is top one of two large, 1.5 m triangular rocks.	46	3.4	350	0.3	40	12.5	Moderate	Clear
AS3	238868	820041	30/08/2020	Start at downstream end of glide, 4 m downstream of big flat rock by left bank. Clear stopper at upstream end.	46	2.1	350	0.3	40	12.5	Moderate	Clear
RD1	238475	820591	01/09/2020	Start at downstream end of glide just upstream of where wet flush enters at left bank. Upstream end is the top of the narrow reach 1 m upstream of a large instream boulder.	51	2.2	350	0.25	33	12.0	Moderate	Clear
LL2	239675	821110	31/08/2020	Downstream end is the run into a long glide. Upstream end is approximately 10 m upstream of the island. Fish both sides of island.	125	1	350	0.25	33	12.5	Low	Clear
LL3	239794	820953	31/08/2020	Start by left bend. Fish up to pool at NH 39679 21210	50.0	1.0	350	0.25	33	12.5	Low	Clear
LL4	239852	820979	31/08/2020	Start at loch. Fish up to little waterfall.	60.0	1.0	350	0.25	33	12.5	Low	Clear
LL5	239842	821232	31/08/2020	Immediately upstream of little waterfall.	na	na	350	0.25	33	12.5	Low	Clear
LL1	239560	820401	31/08/2020	Qualitative search around proposed crossing.	73	2	380	0.25	28	12.5	Low	Clear
CR1	240596	820283	01/09/2020	Bottom of site is half way round the Z-bend. Top is waterfall (45 degree bedrock slope).	66	1.4	350	0.25	32	13	Moderate	Clear
CR2	240525	820580	31/08/2020	Tail of pool and into plunge poll below waterfall (qualitative site)	na	na	350	0.25	32	13	Moderate	Clear
CR3	240504	820642	31/08/2020	50 m upstream of waterfall. Start above bedrock ledge upstream of large pool.	na	na	350	0.25	30	13	Moderate	Clear
CR4	240540	821200	31/08/2020	Qualitative search of approximately 200 m of stream around proposed crossing.	na	na	350	0.25	30	13	Moderate	Clear
CR5	240155	821200	31/08/2020	Qualitative search of approximately 200 m of stream finishing at loch.	na	na	350	0.25	32	13	Moderate	Clear

8.3 Depletions 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
AS1	6	1	1	14	4	2	20	5	3
AS3	30	13	4	27	3	1	57	16	5
RD1	31	11	3	6	2	0	37	13	3

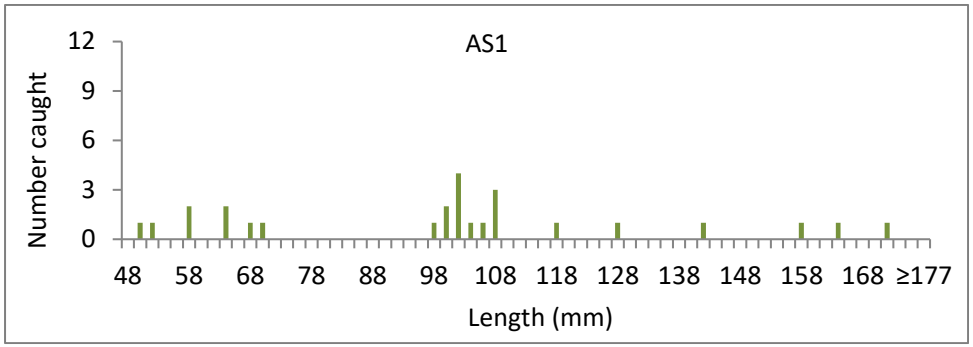
Zippin density estimates with lower and upper 95% confidence limits:

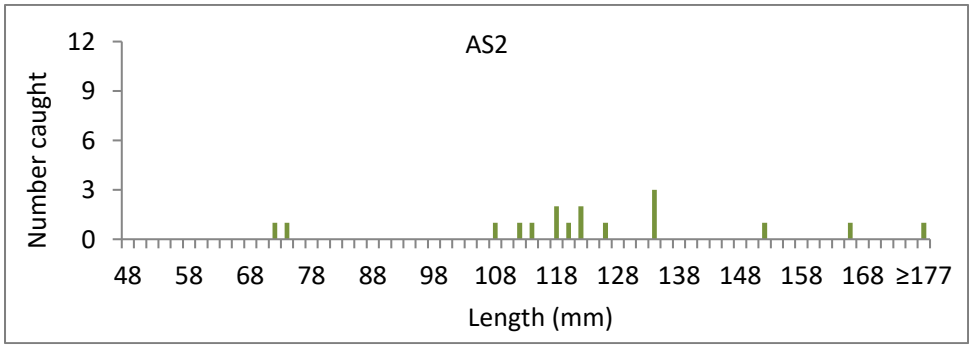
Site AS1. Trout fry density = 6.0 per 100 m^2 (95% CL = 5.7 to 7.0 per 100 m^2). Trout parr density = 15.0 per 100 m^2 (95% CL = 14.3 to 16.9 per 100 m^2)

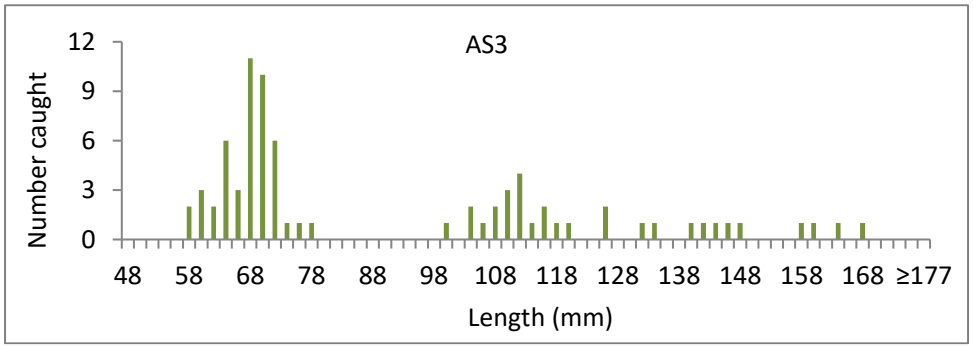
Site AS3. Trout fry density = 31.9 per 100 m^2 (95% CL = 30.1 to 35.2 per 100 m^2). Trout parr density = 9.9 per 100 m^2 (95% CL = 19.8 to 20.3 per 100 m^2)

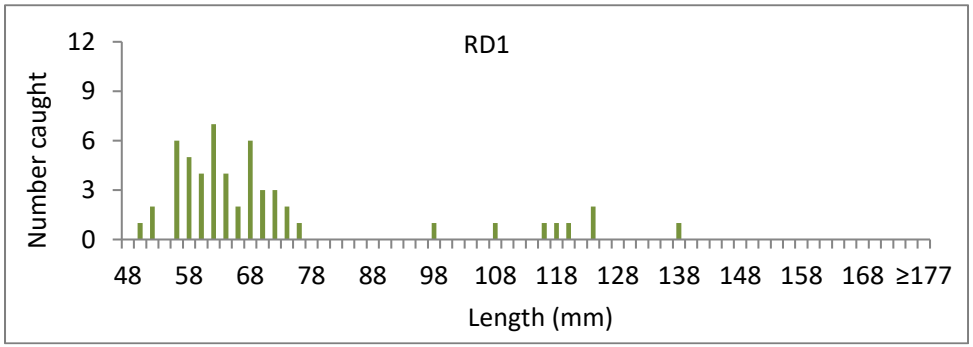
Site RD1. Trout fry density = 48.2 per 100 m^2 (95% CL = 46.6 to 51.9 per 100 m^2). Trout parr density = 8.4 per 100 m^2 (95% CL = 8.3 to 9.1 per 100 m^2)

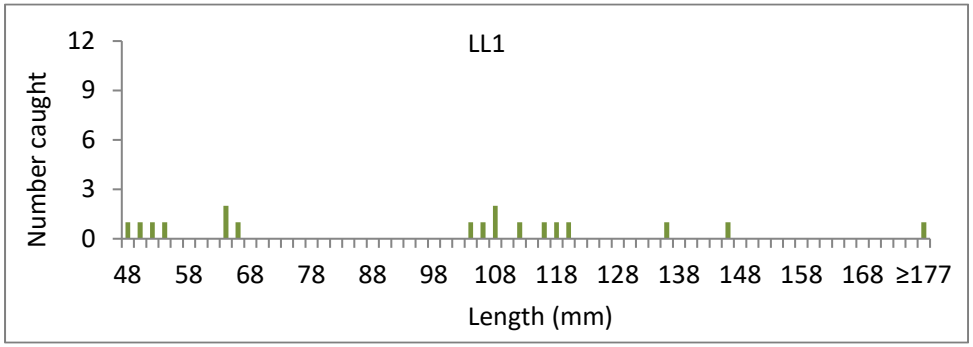
8.4 Trout size distribution at individual survey sites (quantitative sites only)

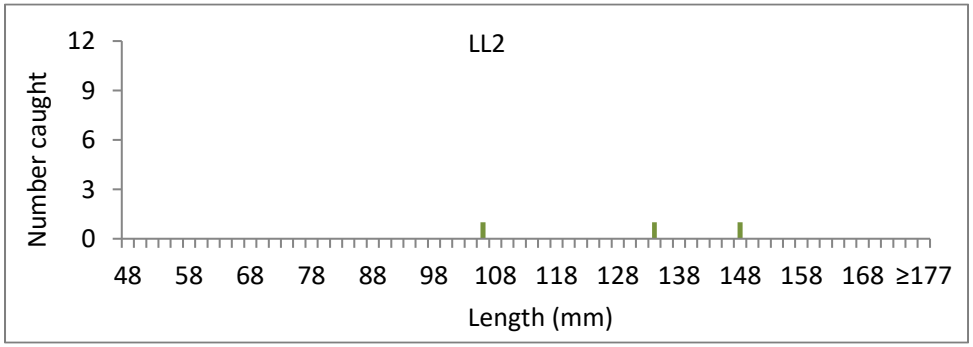


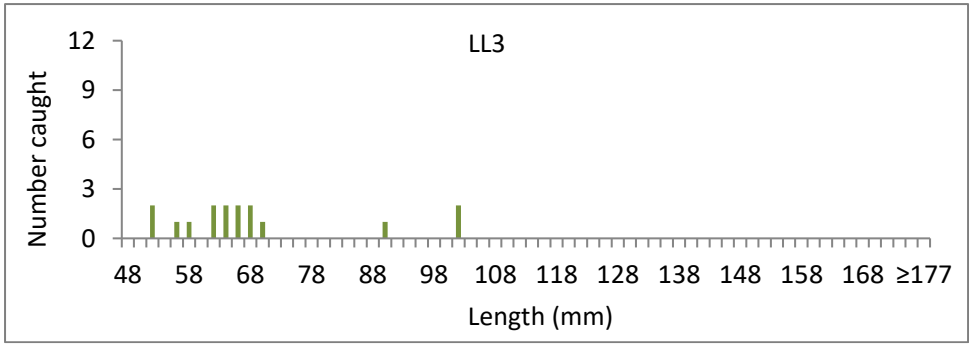


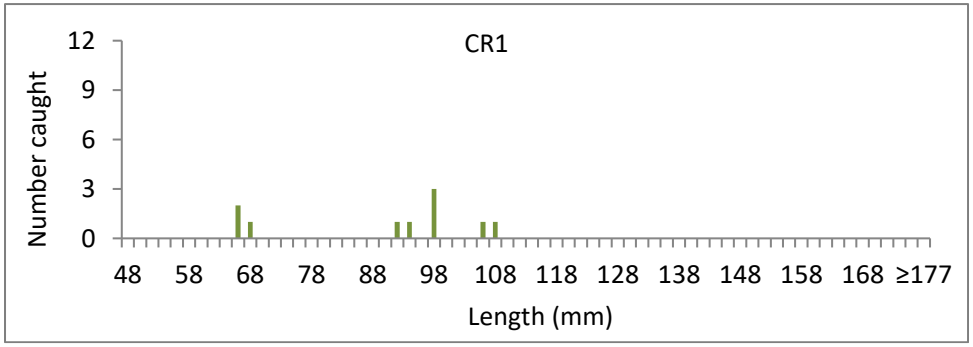









LL3
Number caught
12
9
6
3
0
48 58 68 78 88 98 108 118 128 138 148 158 168 ≥177
Length (mm)


CR1
Number caught
12
9
6
3
0
48 58 68 78 88 98 108 118 128 138 148 158 168 ≥177
Length (mm)

8.5 Stream crossing assessments

	Allt Saigh NH 4027 2025 Proposed crossing is in a reach dominated by large boulder with some bedrock. Moderate quality trout habitat. Spawning habitat absent. Trout present at electric fishing sites both upstream and downstream.
	Lochan an Ruighe Dhuibh outflow stream NH 3850 2071 Productive juvenile trout habitat. Small pockets of gravel and pebble may permit spawning but no substantial areas of spawning habitat noted. Trout present at this location. Trout fry at good density at site RD1, downstream of proposed crossing.
	Loch Liath west inflow (outflow from unnamed lochan to east of Loch nam Brathain) NH 3967 2121 Poor to moderate quality trout habitat. Lacks spawning habitat. Trout present at low density.

	Loch Liath west inflow (outflow from unnamed lochan to east of Loch nam Brathain) NH 3960 2143 Moderate quality trout habitat. Trout observed up and downstream.
	Loch Liath east inflow NH 3983 2124 This picture is approximately 20 m upstream of the proposed crossing, but habitat is similar at both locations. Immobile streambed of boulder and cobble. No spawning. Poor trout habitat. Electric fishing over a ~130 m reach extending up and downstream from the proposed crossing found no fish. One parr caught at a site ~300 m downstream suggests trout may be present but at extremely low density.
	Allt Carn Choire Rainich NH 4012 2123 Largely bedrock. Very poor habitat for trout. No fish found at electric fishing site CR5, extending up and downstream of proposed crossing. Probably fishless.

	Allt Carn Choire Rainich, east fork NH 4012 2123 Stream is approximately 0.6 m wide with immobile bed of cobble and boulder. Poor trout habitat. No fish found at electric fishing site CR4, extending up and downstream of proposed crossing. Probably fishless.

8.6 Photographs of electric fishing sites

	Allt Saigh AS1 NH 40562 19852
	Allt Saigh AS2 NH 40012 20210
	Allt Saigh AS3 NH 38868 20041

	Lochan an Ruighe Dhuibh outflow RD1 NH 38475 20591
	Loch Liath outflow stream LL1 NH 39560 20401
	Loch Liath west inflow LL2 NH 39675 21110

	Loch Liath east inflow LL3 NH 39794 20953
	Loch Liath east inflow LL5 NH 39842 21232
	Allt Carn Choire Rainich CR1 NH 40596 20283

	Allt Carn Choire Rainich CR2 NH 40525 20580
	Allt Carn Choire Rainich CR4 NH 40501 21140
	Allt Carn Choire Rainich CR5 NH 40155 21200

8.7 Electric fishing data 2014

2014 site code	2020 site code	NGR	Watercourse	Trout per 100m² (95% confidence limits)		Single run minimum density (class)		Minnows (n)
				Fry	Parr	Fry	Parr	
1		NH 40562 19852	Allt Saigh	17.8 (17.2 - 19.7)	18.7 (17.9 - 20.8)	12.2 (poor)	12.2 (moderate)	5
2		NH 40012 20210	Allt Saigh	15.5 (15.3 - 16.0)	11.5 (10.2 - 11.6)	12.8 (poor)	10.9 (moderate)	5
3		NH 38864 20036	Allt Saigh	10.7 (10.1 - 12.5)	13.9 (13.7 - 17.3)	7.2 (poor)	10.8 (moderate)	60
C2		NH 40596 20283	Allt Coire Rainich	41.0 (37.0 - 48.5)	10.3*	22.6 (good)	6.2 (poor)	0

*All runs minimum density