Appendix 7.1
Fish Habitats Technical Report

Waterside Ecology

Eden Environment Ltd
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Allt Easach hydropower scheme:
Fish habitat and population assessments

Commissioned Report to Green Highland Renewables Limited

November 2017

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Allt Easach Hydropower Scheme: fish habitat and population assessments

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Contractor: Waterside Ecology

SUMMARY

Background

This survey of fish habitats and populations was conducted in relation to a proposed run of river hydroelectric scheme on the Allt Easach, on the west side of Loch Etive in Argyll. The proposed hydroelectric scheme would have two intakes, one on Allt Easach at NN 0630 4139, approximately 2.6 km upstream of the normal tidal limit (NTL) and a second on the Allt Lochan an Lair, an eastern tributary of Allt Easach, at NN 0650 4128. The penstock would carry water to a turbine and powerhouse that would be located at NN 0705 3951, approximately 190 m upstream from the NTL.

Potential impacts of the proposed scheme include:

- Alteration of flow and wetted area between intakes and outfall due to abstraction;
- Creation of barriers to fish migration at the intakes;
- Entrainment of fish in the pipeline;
- Construction effects on water quality.

Main findings

- The upstream limit of migration for anadromous salmonids (sea trout or salmon) was uncertain. A rock ramp at NN 0679 3979, approximately 500 m upstream of the proposed outfall may be impassable. Waterfalls and rock ramps at NN 0664 4002, some 350 m further upstream were judged clearly impassable.
- Further impassable obstacles are present in the reaches that would be subject to abstraction. These include impassable rock ramps a short distance downstream of both intakes.
- A common feature of habitats throughout the survey was the lack of good quality spawning habitat. It was judged likely that spawning habitat availability may limit salmonid densities in the survey streams.
- Five sites were surveyed by electric fishing. Trout *Salmo trutta* fry and parr were present at all of these sites, including sites upstream of the intakes, but densities were low.
- A single juvenile salmon *Salmo salar* was caught. It is considered probable that this was an immigrant from a neighbouring river.
- European eels *Anguilla anguilla* were present both up and downstream of the first impassable barrier to salmonids.
- Habitat for larval lampreys *Lampetra sp*. and *Petromyzon marinus* was very scarce and no lampreys were found during electric fishing spot-checks.

The results are discussed in relation to the proposed hydropower scheme.

1 Introduction

1.1 Background

This survey of fish habitats and populations was commissioned as part of the environmental assessment of a proposed run of river hydroelectric scheme on the Allt Easach, on the west side of Loch Etive in Argyll. The Allt Easach drains the slopes of Beinn Sgulaird, Beinn Mheadhonach and Beinn Bheag and flows in a southerly direction to enter the sea in Loch Etive at NN 070 393. The proposed hydroelectric scheme would have two intakes. The primary intake would be located on the Allt Easach at NN 0630 4139, approximately 2.6 km upstream of the normal tidal limit (NTL). A secondary intake would be located on the Allt Lochan an Lair, an eastern tributary of Allt Easach, at NN 0650 4128. The penstock would carry water to a turbine and powerhouse that would be located at NN 0705 3951, approximately 190 m upstream from the NTL. The proposed locations of the intakes and turbine are shown on Figure 1 (see page 6).

An assessment of fish habitats and populations was required as supporting information for the Environmental Impact Statement and Controlled Activities Regulation license applications for the proposed new scheme. Potential impacts of the proposed scheme include:

- Alteration of flow and wetted area between intakes and outfall due to abstraction;
- Creation of barriers to fish migration at the intakes;
- Entrainment of fish in the pipeline;
- Construction effects on water quality.

1.2 Fish populations

1.2.1 Species presence

The National Biodiversity Network Gateway lists single records of Atlantic salmon *Salmo salar*, brown trout *Salmo trutta* and European eel *Anguilla anguilla* from NN 070 393, adjacent to the NTL. Atlantic salmon and sea trout are known to be present in several rivers flowing into Loch Etive (Argyll & Bute District Council 2001; Argyll Fisheries Trust 2014) and European eels are also widespread in the area (Davies et al 2004). Argyll Fisheries Trust (2014) surveyed two sites in the lower reaches of Allt Easach and found trout and eels. Sea lampreys and *Lampetra spp*. (brook or/and river lamprey) have been recorded in the River Awe, which flows into Loch Etive some 10 km seaward of Allt Easach (Watt & Ravenscroft 2005).

1.2.2 Conservation status

The Atlantic salmon is listed on Annexes IIa and Va of the EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the Habitats Directive). Atlantic salmon receive protection, particularly from over-exploitation, under the Bern Convention (Appendix 3). Salmon in Scotland receive further protection from Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. This covers a number of regulatory areas, including legal methods of fishing and offences, close times and protection of juvenile and spawning salmon. The Atlantic salmon is listed vulnerable on the IUCN red list.

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, river and sea lamprey are listed on Annex IIa of the EU Habitats Directive. River lampreys also appear on Annex Va, which seeks to control their exploitation.

Atlantic salmon, brown trout (including sea trout), European eel, river lamprey and sea lamprey are all listed as priority species on the UK and Scottish Biodiversity Action Plan lists.

1.3 Habitat requirements

1.3.1 Salmon and 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; Youngson & Hay 1996). Trout and salmon 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. Substrate stability, the dynamics of water flow and the weather all determine the extent of siltation and washouts.

After hatching the young fry remain in the gravel, absorbing nutrient from the remaining yolk sac. On emergence, usually between March and early May, the young fry disperse and set up territories which they defend aggressively. Salmon fry prefer fast flows (>30 cm/s) and favour areas with surface turbulence (riffle habitat). They require a rough bed of pebble, cobble and gravel. 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.

Salmon that have survived their first winter (parr) prefer deeper water than fry (typically 15-40 cm) and a coarser substrate of pebbles, cobbles and boulders. 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 and salmon particularly in smaller streams. In larger rivers and lochs this may be less important, as deep water provides refuge.

1.3.2 Eels

Eel habitat requirements have received less attention than those of salmonid fish. Tesch (1977) 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. 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 Lampreys

Three lamprey species occur in the UK: brook lamprey, river lamprey and sea lamprey. Reviews of their biology and habitat requirements are provided by Maitland (2003) and Hardisty (2006).

The latter two species, like salmon, are anadromous and go to sea to feed as adults before returning to freshwater to spawn. Adult lampreys aggregate to spawn and extrude their eggs into 'nests' excavated in the riverbed. After hatching the young lamprey larvae, known as ammocoetes, drift downstream with the current. They settle in nursery habitat consisting of fine, soft substrate in well oxygenated, slow flowing water. 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 weak jumpers, so can be prevented from moving upstream by relatively low vertical barriers.

2 Objectives and survey reaches

SEPA requirements for fish surveys at hydroelectric schemes are set out in the Guidance for Applicants on Supporting Information Requirements for Hydropower Applications (SEPA 2010a). Fish habitat assessment is required for all schemes and electric fishing to determine species composition and abundance may be required in some circumstances. Scottish Natural Heritage requested that data on Atlantic salmon and brown trout populations be included in the ES in its response to the scoping report for the Allt Easach hydropower scheme.

The aims of the current surveys were to:

- Describe fish habitats, particularly salmonid habitats, in the survey reaches;
- Describe fish populations, particularly the presence, distribution and abundance of Atlantic salmon and trout;
- Provide guidance on potential impacts on fish habitats and populations that might result from the proposed development.

3 Methods

3.1 Fish habitats

A walkover survey of salmonid and other fish habitats was carried out by Dr Jon Watt of Waterside Ecology on 31st May 2017. The water level was low to moderate and the river was clear, providing good conditions for assessment of instream habitats.

The primary target species for the walkover survey were salmon and trout. The survey method was based on the protocols described by Hendry and Cragg-Hine (1997), Summers et al. (1996) and SEPA (2010a). These characterise in-stream habitats according to depth, substrate, flow and thus suitability for different age classes of salmonid. The habitat categories used during the survey and in this report are set out in Table 1. Surveys were based on contiguous sections of approximately 250 m in length. Areas of each habitat category were marked on 1:5000 maps of the river in the field, using colour codes.

Table 1 Habitat categories used for walkover survey

Habitat category	Description
Fry habitat	For salmon, shallow fast flowing habitat with substrate of pebble and cobble. For trout, shallow slow flowing habitats with substrate of pebble and cobble.
Mixed 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.
Deep pool	Over 1 m deep. Slow or eddying current. Suitable for adult salmonids if cover is present. If >1 m deep cover may be less important, as depth can provide refuge.
Spawning	Ideally well oxygenated, stable & not compacted. Typically comprising gravel and pebble. Fines (sand & fine gravel <2 mm) less than 20%. Not silted.
Bedrock	Sheet bedrock or compacted earth covering majority of streambed. No cover. Unproductive habitat.

Obstacles to migration were recorded and photographed. Their likely passability for adult salmonids was assessed. Where possible, the height (lip to water surface at base/plunge pool) and length (upstream to downstream) of obstacles was measured using a tape and bob weight. The likelihood of obstacles being passable was assessed based on data provided by SEPA (2010a), SNIFFER (2010) and the surveyor's own wide experience of fish population survey.

Areas of suitable spawning substrate were recorded. Other variables recorded in each survey section were: (i) up and downstream grid reference, (ii) wet width, (iii), stability of substrate, (iv) compaction of substrate and (v) availability of cover for fish alongside banks. The surveyor also made a subjective assessment of typical habitat quality for juvenile salmon and trout in each section.

3.2 Fish populations

3.2.1 Survey

Fish populations were surveyed by electric fishing on 24th and 30th August 2017. The survey was conducted under Scottish Government License CSM-17-150. The distribution and location of electric fishing sites (Table 2, Figure 1) was guided by the results of the habitat survey, completed before electric fishing commenced. Sites were placed in areas where suitable habitats for salmonid fish, the species most likely to be encountered, were present.

Surveys were conducted using fully and semi-quantitative methods as described by Scottish Fisheries Co-ordination Centre (SFCC 2007). Three electric fishing runs were carried out through each fully quantitative site. This permits total fish density to be established based on the depletion in fish numbers during consecutive runs (SFCC 2007). A single electric fishing run was conducted at semi-quantitative survey sites.

All survey sites (Table 2) covered the full stream width and incorporated a representative range of habitat types. Sites were photographed to aid future identification (Appendix 7.1). Full habitat descriptions (Appendix 7.3) were made at all survey sites using the SFCC (2007) protocol.

Table 2 Locations of electric fishing sites

Site code	Watercourse	NGR	Survey type	Location in relation to scheme
1	Allt Easach	NN 07037 39400	Fully quantitative	Downstream (control site)
2	Allt Easach	NN 06929 39675	Semi quantitative	Abstracted reach, accessible
3	Allt Easach	NN 06589 40451	Fully quantitative	Abstracted reach, inaccessible
4	Allt Easach	NN 06384 41882	Semi quantitative	Upstream (control site)
5	Allt Lochan an Lair	NN 06534 41373	Semi quantitative	Upstream (control site)

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 as was eel total length. Scales were collected from salmonids to assist with age determination. All fish were allowed to recover fully in clean water before being released back into the survey reaches.

3.2.2 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 aged 0+ years old i.e. young of the year and for fish aged 1 year or older. Throughout the report 0+ salmonids are referred to as fry and older juveniles as parr. Depletion estimates for fully quantitative sites were calculated using the *Removal Sampling 2* software (Pisces Conservation Ltd., 2007). The estimator used was Maximum weighted likelihood more commonly referred to as the Carle and Strub (1978) estimate. Where it was possible to calculate depletion estimates, upper and lower 95% confidence intervals are provided for densities

in the data tables. Some confidence limits were asymmetrical since, logically, the lower 95% confidence limit cannot be less than the actual number of fish caught.

The classification provided by Godfrey (2006) is used to describe fish abundance in a national 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 7.5) allow for comparison of fishery performance against nationally based 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.

4 Results

4.1 Obstacles to migration

Obstacles identified during the survey are listed in Table 2 and photographs are provided as Appendix 7.6. Obstacles are shown in relation to the proposed scheme on Figure 1.

No obstacles were identified downstream of the proposed outfall site and it can be assumed that this part of the river is accessible to migratory fish species.

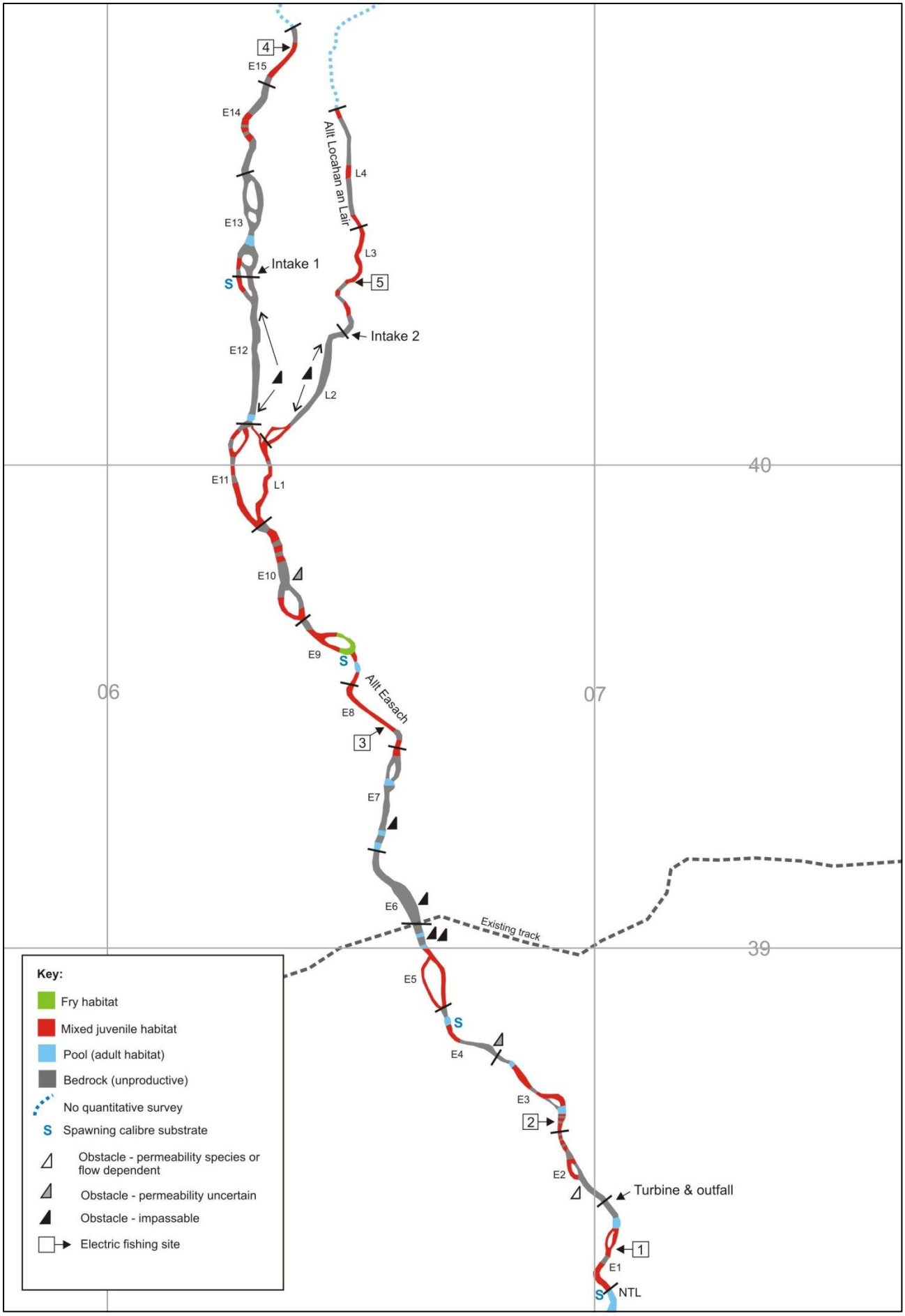
One flow dependent obstacle was identified in section E2, some 70 m upstream of the outfall site. This 25 m long rapid over sheet bedrock includes a series of rock ramps. Water depth over these ramps is shallow and they will form a depth barrier on low flow. On a spate flow, the ramps may pose a velocity barrier. However, it was judged probable that salmonids could ascend by swimming on a moderately elevated flow. The obstacle was judged passable for juvenile eels.

Table 3 Obstacles to migration

Section	NGR	Type	Passable?	Notes
E2	NN 0697 3953	Rapids/rock ramp	Yes (SF)	25 m long rapid with rock ramps. Probably passable by swimming on moderate flow.
E4	NN 0679 3979	Rock ramp	Unknown	Very shallow flow over sloping bedrock with 0.5 m high step at upstream end of 10 m long ramp.
E5	NN 0664 4002	Waterfall	No	3.5 m high and 2 m long waterfall leads to 50 m long, steeply sloping rock ramp.
E5	NN 0664 4003	Waterfall and rock ramps	No	20 m long, steeply sloping rock ramp. Shallow high velocity flow over broad bed of sheet bedrock.
E6	NN 0664 4005	Rock ramp	No	Continuation of rock ramps in section 5. Rise estimated to be 8 m vertical over 30 m of stream.
E7	NN 0657 4023	Waterfall	No	Height estimated as 6 to 7 m. Unsafe to approach. Largest of several waterfalls and cascades in section.
E10	NN 0638 4074	Rock ramp	Unknown	Shallow flow over rock ramps with steps to 1 m.
E12	NN 0631 4111	Rock ramp & waterfall	No	Extended series of cascades on rock ramps. Rises approx. 25 m over 130 m of stream. Broad shallow channel of sheet bedrock with no chance to jump at steeper sections.
L2	NN 0640 4107	Rock ramps	No	180 m long series of cascades on sheet bedrock. Broad and shallow with no chance to jump at steeper sections.

A 10 m long rock ramp in section E4, approximately 450 m upstream of the outfall site poses a more serious obstacle. It is probable that salmonids might ascend the ramp by burst swimming on a moderately elevated flow. However, the present of a 0.5 m high vertical step at the upstream end of the ramp presents difficulty, since its ascent appears to require jumping. As there is no plunge pool or standing wave downstream of the step it is possible that this obstacle is impassable.

Figure 1. Salmonid habitat distribution, proposed infrastructure, obstacles to migration and electric fishing sites.



A 100 m long reach of cascades and rock ramps is present in sections E5 and E6, extending from approximately 20 m downstream of the track to 30 m upstream. A 3.5 m high waterfall at the downstream end of this reach was judged to be impassable. Conditions for jumping are poor due to the shallow depth of the plunge pool and the poorly defined standing wave. Due to the length and height of the drop, it is improbable that salmon or trout could make a single jump to the lip of the waterfall. Any fish failing to reach the reach the lip would land on the face of the waterfall and be swept back downstream. The waterfall leads directly to a 50 m long sloping rock ramp, with an estimated gradient of 20 degrees. The ramp is approximately 15 m wide and flow over it is shallow. It clearly presents a depth barrier on a low flow and a velocity barrier at any elevated flow and was judged to be impassable for salmonids on any flow. It may be possible for eels to ascend these obstacles, but this is uncertain as climbing substrate is poor, comprising smooth bedrock. Photographs on low and high flow are included in Appendix 7.6.

A vertical waterfall in section E7 was estimated to be some 7 m high. It was not possible to approach it safely to obtain a measurement. However, it is clearly impassable for salmonids. Climbing substrate is sheet bedrock and it may also be difficult for eels to ascend. Several lesser cascades and rock ramps are present in sections E7 and E10.

A 200 long section of rapid mainly comprising sloping rock ramps in section E12 is clearly impassable for salmonids. The rapid includes steep sections that would require fish to jump, which in the absence of plunge pools would be impossible. This obstacle ends some 80 m downstream of the main intake site. A similar obstacle is present on the Allt Lochan an Lair. This extends for approximately 180 m downstream of the secondary intake, effectively isolating most of this stream from Allt Easach.

4.2 Fish habitat

4.2.1 Salmonid habitats

4.2.1.1 Allt Easach, section E1

Section E1 is downstream of the proposed turbine house and outfall. The proposed turbine house would be sited on the left bank at the upstream end of section E1. Wet width in this part of the river is typically between 7 and 11 m and the gradient is moderate. Substrate is predominantly of boulder and cobble and instream cover for juvenile salmonids is good. Some deep pool habitat suitable for adult salmonids is present (Table 4). Approximately 4 m^2 of potential spawning habitat was recorded close to the NTL and it was uncertain whether this area might ever be subject to saline influence. At the upstream end of the section a 50 m long reach of sheet bedrock leads up to the proposed outfall site.

The riverbanks are stable and composed either of turf-covered boulders or bedrock. Vegetation is largely bracken and broadleaf trees line both banks.

Table 4 Estimated areas of each habitat type, section E1

Survey section	**Wet width** (m)	**Estimated area of habitat type** (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E1	9	0	410	180	270	4

4.2.1.2 Allt Easach, sections E2 and E3

These sections would be abstracted during scheme operation. Both were judged likely to be accessible to migratory salmonids.

Section E2 is dominated by sheet bedrock and habitat quality for juvenile salmonids was classified as poor (see Appendix 7.9). E3 was mainly classified as mixed juvenile salmonid habitat. Substrates are dominated by boulders and current speed is moderate, largely with run flow type. Large, stable boulders partly exposed above the water surface create eddies and increase habitat complexity. Cover for juvenile salmonids is plentiful and habitat quality was classified as moderate to good. Smaller substrates are unstable and no significant areas of spawning habitat were recorded. The riverbanks are stable and composed either of turf-covered boulders or bedrock. There is approximately 50% cover of broadleaf trees along both riverbanks, providing dappled shade and some overhead cover among roots. General land use is conifer plantation and there is a buffer zone of approximately 20 m between the river and the plantations on each bank.

Table 5 Estimated areas of each habitat type, sections E2 and E3

Survey section	Wet width (m)	Estimated area of habitat type (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E2	8	0	560	0	1200	0
E3	7	0	1190	140	420	0

4.2.1.3 Section E4 and E5

Due to the presence of an obstacle near the downstream end of E4 it is uncertain whether these sections are accessible to migratory salmonids.

E4 provides very poor habitat quality for fish, as much of the wetted habitat is sheet bedrock. Some productive mixed juvenile is present at the upstream end of E4 and this extends throughout much of E5 where the river braids around a large island. Both of the main braided channels have substrates of boulder and cobble with typical depths between 30 and 50 cm on a low to moderate discharge. The coarse substrates provide few spawning opportunities and no substantial areas of spawning habitat were recorded in either section although small patches of spawning calibre substrate were noted in section E4, at the edges of a pool. These were judged likely to be prone to redd washout in spates as they appeared mobile. At the upstream end of E5 a waterfall and rock ramp lead up to the bridge at the forest track. The riverbanks in both sections are stable and lined with broadleaf trees. General land use is conifer plantation.

Table 6 Estimated areas of each habitat type, sections E4 and E5

Survey section	Wet width (m)	Estimated area of habitat type (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E4	7	0	280	140	700	1
E5	10	0	1400	300	400	0

4.2.1.4 Allt Easach, sections E6 and E7

The riverbed in both survey sections is mainly bedrock. Section E6 is broad and shallow, with sloping rock ramps at its downstream end. Further upstream the river becomes more entrenched and section E7 is narrow with steep, gorge-like bank faces. Several rapids and cascades are present. The deeper pools in E7 probably support small numbers of trout but overall habitat quality in both sections is very poor. Spawning habitat is lacking.

Table 7 Estimated areas of each habitat type, sections E6 and E7

Survey section	Wet width (m)	Estimated area of habitat type (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E6	15	0	0	0	3000	0
E7	6	0	0	240	1080	0

4.2.1.5 Allt Easach, sections E8 to E11

Sections E8, E9 and E11 have a moderate gradient and provide substantial areas of habitat that appear well suited to trout fry and parr, with coarse substrates and good instream cover. Wet width in E8 is equal to bed width and some additional cover is available alongside the riverbanks in the form of undercuts and tree roots. In E9 and E11 wet width is mainly less than bed width, and availability of overhead cover alongside the banks is consequently reduced. A large area of cobble, pebble and gravel substrates around the braided channels in E9 provides an estimated 10 m^2 of potential spawning habitat. This is patchily distributed amongst coarser cobble-dominated substrate in 10 to 20 cm water depth.

Table 8 Estimated areas of each habitat type, sections E8 to E11

Survey section	**Wet width** (m)	**Estimated area of habitat type** (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E8	10	0	1900	0	0	0
E9	10	380	1700	300	0	10
E10	7	0	560	0	1190	0
E11	9	0	2160	0	0	0

E11 is braided and splits around a large island at NN 163 411. Almost the entire flow goes down the right channel. The left channel carries little flow but joins the Allt Lochan an Lair after approximately 40 m. The two channels converge at the south end of the island at NN 063 408.

E10 is steeper than the sections described above and habitat is largely sheet bedrock. This section provides very poor quality habitat for salmonid fish and no spawning habitat was recorded.

The riverbanks in all of the above sections are stable and no local sources of substrate input were noted. General land use is conifer plantation. In places the conifers are within 5 m of the riverbanks. However, as the river is oriented north-south this does not result in particularly heavy shading and the banks remain well vegetated.

4.2.1.6 Allt Easach, section E12

This part of the river is almost entirely sheet bedrock and provides exceptionally poor habitat for fish. Much of the section comprises sloping rock ramps and there are several cascades and rapids. The primary intake would be located at the upstream end of the section. Here the channel splits round an island. The left channel at the island, which is approximately 12 m wide, carries most of the flow and is largely sheet bedrock. The right channel is approximately 4 m wide and has alternating reaches of bedrock and productive juvenile habitat. Both channels are stable. Bankside vegetation is mainly of grasses with occasional broadleaf trees. There is broad buffer zone between the river and the conifer plantations.

Table 9 Estimated areas of each habitat type, section E12

Survey section	**Wet width** (m)	**Estimated area of habitat type** (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E12	5	0	0	50	1500	0

4.2.1.7 Allt Easach, sections E13 to E15

These sections are upstream of the intake and would be unaffected by abstraction. In section E13 the channel is braided around some small islands. Habitat quality is very poor, mainly comprising sheet bedrock. A small patch of unstable spawning calibre substrate was recorded in E13 at NN

0630 4144, approximately 40 m upstream of the proposed intake. However, the site was revisited following spates in August and this spawning habitat was no longer present.

Sections E14 and E15 flow through moorland and heath. E14 is mainly bedrock with some short reaches of productive mixed juvenile habitat. Habitat quality improves in E15, where there is less bedrock and a preponderance of cobble, boulder and pebble substrates.

Table 10 Estimated areas of each habitat type, section E13 to E15

Survey section	Wet width (m)	Estimated area of habitat type (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
E13	10	0	100	100	2200	1
E14	7	0	350	0	1400	0
E15	7	0	700	0	280	0

4.2.1.8 Allt Lochan an Lair, sections L1 and L2

L1 provides run, riffle and shallow pool habitat with boulder, cobble and pebble substrates. Cover for fish is generally good although there are scattered patches of bedrock. Depth typically ranges from 10 cm to 40 cm. Habitat for juvenile trout appears good but spawning habitat is lacking. The section is heavily shaded by mature conifers on the right bank.

The first 50 m of L2 is braided around some small islands. The stream here is steeper than L1 with small pools and torrents. Upstream of the island the burn rises in an unbroken 180 m rock ramp, which ends immediately downstream of the intake. Water flow over the sloping ramp face is fast and shallow and it is unsuited to fish.

Table 11 Estimated areas of each habitat type, sections L1 and L2

Survey section	Wet width (m)	Estimated area of habitat type (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
L1	5	0	950	0	150	0
L2	5	0	250	0	1250	0

4.2.1.9 Allt Lochan an Lair, sections L3 and L4

A stretch of bedrock habitat extends approximately 50 m upstream of the intake site. Upstream of the bedrock section L3 is mainly 2.5 to 4 m wide with runs, riffles and shallow pools. No substantial areas of spawning habitat were recorded but there are a few scattered pockets of pebble and gravel that might allow egg deposition. Instream cover is moderate but some additional overhead cover is present beneath undercut banks. Parts of the section are shaded by thicket stage conifer. Habitat quality deteriorates through L4, where there are long reaches of sheet bedrock.

Table 12 Estimated areas of each habitat type, sections L3 and L4

Survey section	Wet width (m)	Estimated area of habitat type (m^2)				
		Fry	Mixed juvenile	Pool	Bedrock	Spawning
L3	3.5	0	595	0	280	present
L4	3.5	0	175	0	770	0

4.2.2 Habitats for other fish species

Few suitable habitats for larval lampreys were recorded in the survey area. Substrates in the reach that would be abstracted are mainly too coarse and in general the gradient is too high to permit the deposition of stable areas of fine sand or silt. A 2 m^2 patch of stable sand was recorded in section E8,

on the bend near the downstream end of the section (see Figure 1). No other substantial areas of potential larval habitat were recorded.

Many of the survey sections provide cover that is potentially suitable for eels, mainly around and beneath large boulders. However climbing substrate around the waterfalls in sections E5 and E7 is largely absent, which may limit eel access.

4.3 Fish populations

4.3.1 Salmon

A single salmon parr was caught at site 2, which is located in section E3. It was 126 mm in length and scale reading indicated an age of 2+, with slow growth until the second parr year, when annuli suggested that growth rate increased substantially. No salmon were caught at any of the other electric fishing sites.

4.3.2 Trout

Trout were caught at all five survey sites (Table 13). Mean trout fry density was 2.6 per 100 m^2 (± 2.0 sd), which would be classified as poor based on the absolute regional classification (Appendix 7.3). The highest density of trout fry was found at site 2, where the density would be classified as fair. Other sites would be classified as either poor (sites 1 and 5) or very poor (sites 3 and 4).

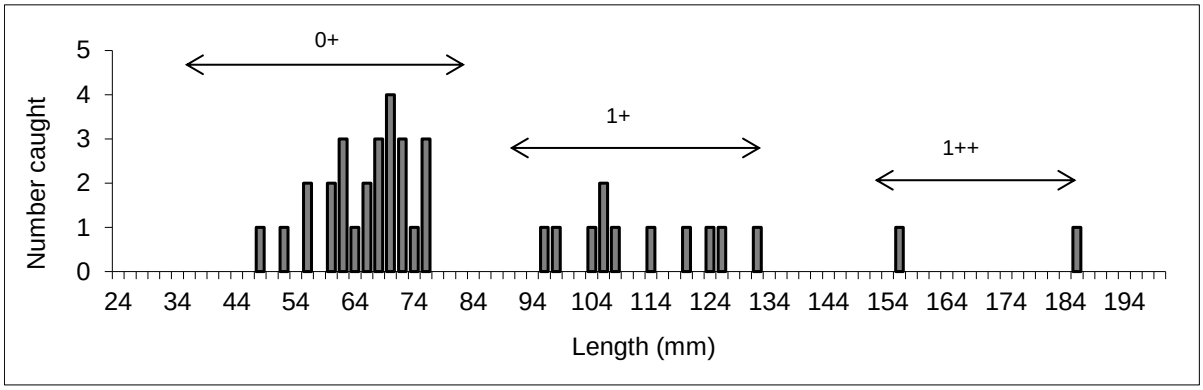
Trout parr were present at all sites and the mean density of 1.4 per 100 m^2 (± 1.2 sd) would be classified as very poor based on the absolute regional classification. Individually, all sites were classified as very poor with the exception of site 5, upstream of the Allt Lochan an Lair intake, where parr density was classified as fair.

Table 13 Electric fishing results

Site	Salmon.100m^{-2}		Trout.100m^{-2}		Eels (n)
	Fry (0+)	Parr (1++)	Fry (0+)	Parr (1++)	
1	0.0	0.0	2.8	0.7	3
2	0.0	0.7	5.9	0.7	0
3	0.0	0.0	1.4	0.7	1
4	0.0	0.0	0.6	1.3	0
5	0.0	0.0	2.5	3.5	0

Trout fry ranged in length from 48 mm to 77 mm (Figure 2) with a mean of 66.5 mm (± 7.6 sd). There was no overlap in length in the sample with the 1+ age class, which ranged from 96 to 133 mm (mean 112.6 mm ± 12.2 sd).

Figure 2. Length distribution juvenile trout (all sites combined data)



4.3.3 Other fish species

Three eels were captured at site 1. These measured 115 mm, 140 mm and 170 mm. A single eel measuring 300 mm was captured at site 3. No eels were seen or caught at the other three sites.

Spot checks for larval lampreys were made at several locations, including the sandy area in section E8 described in 4.2.1.5 above, but none were seen or caught.

5 Interpretation and potential scheme impacts

5.1 Survey limitations

Water and light conditions for the habitat survey were ideal, with low to moderate flow and bright weather. Stream discharge during electric fishing was moderate. This of itself was not considered a problem in terms of the team's ability to net fish. However, conductivities at all sites were very low (< 20 $\mu S.cm^{-1}$) and this may have reduced capture efficiency. A bankside generator with a maximum output of 510 V was used at sites 1, 2 and 3. Sites 1 and 3, both of which are in the area that would be abstracted, were fished fully quantitatively. Although fish numbers were small, the depletions attained at each of these sites (Appendix 7.4) suggest that capture efficiency was adequate. Sites 4 and 5 are upstream of the intakes, on the Allt Easach and Allt Lochan an Lair respectively. Due to the lengthy walk in, a 400 V backpack was used at these sites. The impression during surveys was that capture efficiency at site 5 was good. One trout fry was seen escaping at site 4 and efficiency at this site may have been less than at site 5 due to the deeper water. However, the water at site 4 was clear and as only a single fish was seen moving off the anode it seems likely that the estimated density at this site provides a fair reflection of the fish population present.

5.2 Quantitative summary of habitat distribution

The proposed turbine location would place the outfall at the upstream end of section E1. The natural upstream limit of migration for sea trout or salmon is uncertain, but there is little doubt that the waterfall and extended rock ramp in section 5 are impassable (see also Argyll Fisheries Trust 2014). Taking these as the upstream migratory limit it is estimated that the total area of accessible habitat is 6890 m^2, of which 6030 m^2 is upstream of the outfall and would be subject to abstraction (Table 14). Within the accessible abstracted area, some 57% was classified as productive juvenile habitat, 38% as bedrock and 5% as deep pool (Table 15). Habitat quality in the accessible abstracted area was mainly classified as poor to moderate (Appendix 7.9) and spawning habitat is extremely scarce.

Upstream of the first clearly impassable obstacles a further 17380 m^2 would be abstracted, of which 85% is in Allt Easach and 15% in Allt Lochan an Lair. Of this 17380 m^2, 45.6% was classified as productive juvenile salmonid habitat, 5% as deep pool and 49.3% as bedrock.

Table 14 Summary of habitat availability as square meters of wetted area

Reach	Sections	Wetted area (m^2)				
		Total	Fry & mixed juvenile	Deep pool	Bedrock	Spawning
NTL to outfall	E1	860	410	180	270	4
Abstraction area, accessible	E2 to E5	6030	3430	280	2320	1
Abstraction area, inaccessible	E6 to E12 L1 & l2	17380	7920	890	8570	10
All (NTL to intakes)	E1 to E12 L1 & L2	24270	10560	1350	9760	10

Table 15 Summary of habitat availability as percent of total wetted area

Reach	Sections	Percent of wetted area (%)				
		Total	Fry & mixed juvenile	Deep pool	Bedrock	Spawning
NTL to outfall	E1	100	47.7	20.9	31.4	0.0
Abstraction area, accessible	E2 to E5	100	56.9	4.6	38.5	0.0
Abstraction area, inaccessible	E6 to E12 L1 & l2	100	45.6	5.1	49.3	0.1
All (NTL to intake)	E1 to E12 L1 & L2	100	48.7	6.2	45.0	0.1

5.3 Potential effects of scheme operation on fish and fish habitats

The presence of a single salmon parr aged 2+ is difficult to interpret but may suggest that salmon occasionally spawn in Allt Easach. However, the small wetted area and lack of spawning in the accessible reach perhaps suggests this is unlikely, and Argyll Fisheries Trust (2014) considered it improbable that Allt Easach could support a sustainable salmon population. Previous electric fishing surveys around Loch Etive have occasionally found single 2+ salmon parr but no fry or 1+ parr (Alan Kettle-White, Argyll Fisheries trust, pers. comm.). Argyll Fisheries Trust consider it most likely that occasional salmon parr move into Allt Easach and similar streams from larger rivers around Loch Etive, this being made possible by the low salinity of the surface layers of the loch.

Trout were present at low density throughout in the abstracted reaches of Allt Easach. There were no substantial difference in density up and downstream of the first impassable obstacle, such as might be expected were sea trout spawning in any number in the accessible reaches. Nevertheless, the highest density was downstream of impassable obstacles and it seems probable that occasional sea trout may enter Allt Easach. The low trout fry densities at sites 1 and 2, in the accessible reach, most probably reflect the lack of spawning opportunities in the watercourse.

Formal impact assessment is outside the scope of this report. However, a number of observations can be made that would assist such an assessment.

- Salmonid densities in the accessible reaches were low and it is improbable that wetted area is a limiting factor for juvenile salmonids. Most probably, lack of spawning habitat is the limiting factor for salmonid production in the accessible reaches.
- Two obstacles are present downstream of the impassable rock ramps in section E5. The rock ramp in section E2 was judged passable on a moderate flow but it is uncertain whether the obstacle in section E4 is passable. Only 1 m^2 of spawning habitat was recorded between the obstacles in E4 and E5 and this was unstable and of poor quality, Approximately 2120 m^2 of productive juvenile habitats were recorded between the two obstacles.
- The braided habitats around the islands in sections E3 and E5 (Figure 1) are boulder strewn with typical depths in excess of 20 cm. Given standard hand-off flows, habitat availability in these channels is unlikely to be altered significantly by abstraction.
- One reach of shallow braided habitat that might be susceptible to abstraction impacts was recorded in section E9. Elsewhere the channel morphology is such that abstraction effects on wetted area would probably be slight.
- Trout densities between the impassable obstacle in E5 and proposed intakes were low. Space is unlikely to be limiting.

- No specific sensitivities were recorded near the turbine or intake locations. Habitats at all three sites are mainly bedrock.
- Impassable obstacles are present a short distance downstream of both intakes, suggesting that there will be no significant impact on upstream fish passage at either intake.
- Trout were recorded upstream of both intakes and adequate screening will be required to avoid entrainment.
- Little larval lamprey habitat was found in the survey area and no lamprey larvae were found during electric fishing. It is highly unlikely that lampreys are present in Allt Easach.
- Eels were present at low density downstream of the intakes. Abstraction is not expected to affect eels in Allt Easach. Eel density may be limited by poor access, as climbing substrate over or round waterfalls and rock ramps is scarce.

5.4 Potential construction effects

Construction works around watercourses clearly have potential to impact stream habitats and fish populations through siltation or other forms of pollution. Construction impacts may be minimised by following standard good practice procedures and pollution prevention guidance (e.g. SEPA/Environment Agency 2007; SEPA 2010b; Scottish Government 2012).

6 References

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7 Appendices

7.1 Electric fishing site photographs

	Site 1 NN 07037 39400 Downstream end of site
	Site 1 seen from downstream
	Site 2 NN 06929 39675 Downstream end of site

	Site 2 Seen from downstream
	Site 3 NN 06589 40451 Downstream end of site
	Site 3 Seen from downstream

	Site 4 NN 06384 41882 Downstream end of site
	Site 4 Seen from downstream
	Site 5 NN 06534 41373 Downstream end of site

	Site 5 Seen from downstream

7.2 Electric fishing site and event details

Code	NGR	Location	Width	Length	Voltage	Amps	Conductivity (µS.cm^{-1})	Temp (°C)	Level	Colour
1	NN 07037 39400	Left (main) channel at island. Start at downstream end of island and fish up to line of square rocks.	8.9	16	500	0.15	15	14.0	Moderate-low	Clear
2	NN 06929 39675	Downstream end is the eddy below the rocky point at left bank. Dead tree stump left bank at downstream end. Upstream end is a clear, steep riffle/torrent break.	7.5	20.5	500	0.15	15	14.5	Moderate-low	Clear
3	NN 06589 40451	Start 50 m up from bend at round midstream rock. Fish up to riffles in line with bedrock at right bank.	10.4	14.2	500	0.17	17	14.5	Moderate-low	Clear
4	NN 06384 41882	Big lichen covered rock (see photo) at left bank is downstream limit. Top of site is torrent at upstream end of a short section of bedrock.	7.4	21	400	0.15	17	14.0	Moderate-low	Clear
5	NN 06534 41373	Start at tail of glide, 1m upstream of island. Fish up to riffle line and constriction at NN 06523 41410.	4.4	46	400	0.18	18	14.0	Moderate-low	Clear

7.3 Electric fishing sites – habitat composition

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*
1	10	40	25	15	10	0	0	0	2	3	10	50	30	5	0	10	10	10	5	15	30	20	0
2	5	55	30	10	0	0	0	0	0	0	10	50	40	0	0	5	10	25	0	0	40	20	0
3	10	30	35	20	5	0	0	0	0	0	5	40	55	0	0	10	15	15	0	0	40	20	0
4	10	35	35	20	0	0	0	0	1	2	8	55	35	0	0	5	5	20	0	15	35	20	0
5	10	50	30	5	0	0	0	0	1	3	16	40	40	0	0	5	5	10	0	20	40	20	0

Site	**Left bank (% of bank length)**				**Right bank (% of bank length)**			
	Undercut	Draped	Bare	Marginal	Undercut	Draped	Bare	Marginal
1	25	0	75	0	0	0	90	10
2	0	0	90	10	0	0	90	10
3	0	0	100	0	5	5	90	0
4	20	0	80	0	15	0	85	0
5	0	0	100	0	0	0	100	0

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.

7.4 Electric fishing sites – fish depletions in consecutive runs at sites 1 and 3.

Site	Number salmon fry caught			Number 1++ parr caught			Number trout fry caught			Number trout parr caught		
	run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3
1	0	0	0	0	0	0	4	2	1	1	1	0
3	0	0	0	0	0	0	2	1	1	1	0	0

7.5 Salmonid density classification system for West Region (Godfrey 2006)

Quintile ranges for juvenile salmonid density are given below. The classification is based on data sets held by SFCC. Quintile densities allow for comparison of fishery performance against regionally based reference points.

	Absolute classification (all streams)	**Stream width class (relative classification)**			
		<4m	4-6m	6-9m	>9m
Salmon 0+					
0th percentile	0.6	1.3	1.6	0.8	0.6
20th percentile	2.4	2.4	3.5	1.6	2.7
40th percentile	6.1	5.3	6.0	10.4	8.1
60th percentile	14.6	10.7	14.0	14.0	15.9
80th percentile	26.6	17.2	35.5	21.1	45.1
100th percentile	172.4	92.8	55.1	172.4	83.9
% zero density	45.4	60.0	27.3	44.7	29.4
Salmon 1++					
0th percentile	0.5	1.4	0.8	0.5	0.5
20th percentile	1.9	2.3	2.0	1.9	1.7
40th percentile	3.6	3.3	5.0	4.4	3.2
60th percentile	5.8	6.9	6.6	5.9	4.2
80th percentile	11.3	12.2	10.8	10.9	6.6
100th percentile	40.5	30.9	40.5	22.0	24.0
% zero density	33.0	48.8	24.2	26.3	11.8
Trout 0+					
0th percentile	0.2	1.4	0.7	0.5	0.2
20th percentile	2.0	9.9	3.0	1.1	0.8
40th percentile	5.5	28.5	5.0	1.8	1.5
60th percentile	17.3	44.7	12.4	2.7	2.6
80th percentile	50.4	74.4	19.0	5.3	4.0
100th percentile	181.3	181.3	103.5	94.6	9.8
% zero density	15.7	5.0	12.1	18.4	41.2
Trout 1++					
0th percentile	0.5	0.9	0.9	0.8	0.5
20th percentile	1.6	3.9	2.3	1.5	0.7
40th percentile	3.1	5.6	3.3	2.1	0.9
60th percentile	5.3	7.6	5.4	3.2	1.5
80th percentile	8.4	12.1	8.4	4.9	1.8
100th percentile	66.7	66.7	30.3	10.8	6.0
% zero density	16.8	13.8	12.1	18.4	26.5

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

7.6 Obstacles to migration

	Obstacle E4.1 NN 0679 3979 The length of the wading staff to the broad white band near the top (arrow) is 1 m. The rock ramp is 10 m long. There is a 0.5 m vertical step at the upstream end. The lack of plunge pool makes this difficult for fish to ascend. It is not clear whether this obstacle is passable.
	Obstacle E5.1 NN 0664 4002 The lower cascade is approximately 3.5 m high. Together with the rock ramps immediately upstream this obstacle was classified as impassable for upstream migrating salmonids.
	Obstacle E5.1 From left bank.

	Obstacle E5.2 20 m long rock ramp rises approximately 6 m.
	Obstacle E5.2 on a high flow.
	Obstacle E5.2 from upstream, on low to moderate flow.

	Obstacle E5.2 from upstream, on a high flow.
	Obstacle E6.1 NN 0664 4005 Viewed from downstream. Rock ramps are approximately 35 m long and form a continuation of obstacle E5.2.
	Obstacle E6.1 viewed from left bank.

	Obstacle E7.1 Height was estimated at 6 to 7 m. It was not safe to approach to place a scale.
	Obstacle E10.1 NN 0638 4074
	Obstacle E12.1 NN 0631 4111 Total length of section of rock ramps and cascades is 130 m.

	Obstacle E12.1 Broad, shallow section of rock ramp.
	Obstacle E12.1 Cascades in middle of 130 m long obstacle.
	Obstacle L2.1 NN 0642 4107 Long sloping reach of shallow channel mainly over sheet bedrock. Stream rises approximately 30 m over 180 m.

	Obstacle L2.1 Broad, shallow section of steeply sloping rock ramp.

7.7 Stream survey sections and habitat descriptions, Allt Easach.

Section code	NGR		Instream habitat notes	Banks
	Downstream	Upstream		
E1	NN 0702 3931	NN 0701 3950	Boulder dominated mixed juvenile habitat in lower reaches leads up to pool some 50 m downstream of turbine site. From pool to turbine site is sheet bedrock.	Boulder banks giving way to bedrock at upstream end. Stable. Birch and bracken.
E2	NN 0701 3950	NN 0693 3962	Sheet bedrock continues upstream from turbine site for 80 m. Rest of section is mix of bedrock with boulder, cobble and gravel. Gradient is steep with several short rapids.	Bedrock and boulder banks provide very little overhead cover.
E3	NN 0693 3962	NN 0682 3978	Mainly boulder dominated mixed juvenile habitat with run flow type. Depth typically 30 to 50 cm. Large party exposed boulders create eddies and diversity. God cover. Reverts to sheet bedrock rock ramp immediately upstream of the pool near the tOp of the section.	Stable boulder banks with some bedrock. Little overhead cover.
E4	NN 0682 3978	NN 0670 3986	Mainly sheet bedrock with much exposed bedrock at margins. Some boulder strewn mixed juvenile habitat on bend near top of section and a 1.5 m deep pool. Top 20 m of section reverts to sheet bedrock. Rapids and rock ramps present.	Stable boulder banks with some bedrock. Little overhead cover.
E5	NN 0670 3986	NN 0664 4005	Most flow is down left channel at islands. Channels have substrate of boulder, some large and partially exposed above water surface. Some cobble and gravel. Smaller substrates are unstable. Run and torrent flow types. Rock ramps present at upstream end of islands. Waterfall and long, sloping rock ramp leads up to bridge at top of section.	Stable boulder banks with some bedrock. Little overhead cover.
E6	NN 0664 4005	NN 0656 4019	Entire section is either sheet bedrock or bedrock-dominated. Lower half of section is a broad, sloping rock ramp. This leads up to incised gorge.	10 m buffer strip to forest. Bedrock banks. Steep, narrowly incised gorge at upstream end of section.
E7	NN 0656 4019	NN 0656 4019	Steep section with predominantly bedrock substrate. Several cascades and rapids. Gradient eases in top 25 m of section where there is some poor quality mixed juvenile habitat. Flow types are mainly pool and torrent.	Mainly incised bedrock with steep bank faces. Gorge-like.
E8	NN 0656 4019	NN 0651 4053	Mixed juvenile salmonid habitat with cobble, boulder and gravel substrates. Pockets of spawning habitat. Riffle, run and glide. Depth typically 10 to 40 cm. Wet width mainly equals bed width.	Low, stable boulder banks topped with turf. Riparian broadleaves.
E9	NN 0651 4053	NN 0641 4066	Moderate current speed with substrates of boulder, cobble, gravel and a little sand. Partly stable. Spawning habitat present. Depth 15 to 40 cm. Larger boulders partly exposed at surface and create diversity. Upstream end of section is steeper with some bedrock.	Stable boulder banks. 5 to 15 m buffer zone to conifers.
E10	NN 0641 4066	NN 0634 4084	Steep section with runs, torrents and pools. Main flow at islands is in left channel, where boulder and bedrock substrate. Some fry seen. Upstream of islands is mainly bedrock with a few patches of boulder and cobble. Depth 10 to 50 cm.	Stable boulder and bedrock banks.
E11	NN 0634 4084	NN 0631 4107	Boulder and cobble runs. More bedrock at upstream end of section.	Stable boulder banks with turf.
E12	NN 0631	NN 0633	Pool at downstream end leads to long sloping rock ramp that leads all the way to the	Sloping bedrock bank faces.

Section code	NGR		Instream habitat notes	Banks
	Downstream	Upstream		
	4107	4138	intake. Most of section completely unsuited to fish production.	
E13	NN 0633 4138	NN 0629 4161	Steep and shallow. Mainly sheet bedrock and almost entirely unsuited to fish.	Sloping bedrock bank faces.
E14	NN 0629 4161	NN 0633 4177	Moderate gradient with substrates of boulder, cobble and gravel. Depth 20 to 40 cm. Productive salmonid habitat.	Stable boulder banks with turf.
E15	NN 0633 4177	NN 0636 4189	Moderate gradient with substrates of boulder, cobble and gravel. Patchy bedrock. Mainly productive salmonid habitat.	Stable boulder banks with turf.

7.8 Stream survey sections and habitat descriptions, Allt Lochan an Lair.

Section code	NGR		Instream habitat notes	Banks
	Downstream	Upstream		
L1	NN 0631 4089	NN 0633 4102	Run, riffle and shallow pool. Boulder, cobble and pebble with patches of bedrock. Depth 10 to 40 cm. Lacks spawning.	Mainly stable. Mature conifers. Conifers planted to edge.
L2	NN 0633 4102	NN 0651 4127	Steep with step-pool sequences at island near downstream end of section. Rest of section is a long, steep rock ramp that is unsuitable for fish.	Mainly exposed bedrock.
L3	NN 0651 4127	NN 0652 4149	Some good quality juvenile trout habitat. Mixed flows and substrate types.	Undercuts provide overhead cover. Conifer, some without buffer strip.
L4	NN 0652 4149	NN 0647 4176	Much sheet bedrock. This alternates with short reaches of productive trout habitat. Mainly poor.	Bedrock and boulder banks. Stable. Conifer forest.

7.9 Stream survey data, Allt Easach.

Section code	Length (m)	% visible streambed	Width (m)		Substrate		Instream cover	Bankside cover (% of bank length)		Quality for salmon		Quality for trout	
			Wet	Bank	Stability	Compaction		left	right	Fry	Parr	Fry	Parr
E1	190	98%	9	13	Moderate	Uncompacted	Good	<10	<10	Moderate	Good	Moderate	Good
E2	220	95%	8	13	Moderate	Uncompacted	Poor	<10	<10	Poor	Poor	Poor	Poor
E3	250	100%	7	9	Moderate	Uncompacted	Good	<10	<10	Poor	Good	Moderate	Moderate
E4	160	90%	7	14	Stable	Uncompacted	Poor	<10	<10	Poor	Poor	Poor	Poor
E5	210	100%	10	14	Stable	Uncompacted	Good	<10	<10	Poor	Moderate	Moderate	Moderate
E6	200	100%	15	22	Stable	Uncompacted	Poor	0	0	NA	NA	Poor	Poor
E7	220	80%	6	8	Stable	Uncompacted	Poor	0	0	NA	NA	Poor	Poor
E8	190	100%	10	10.5	Moderate	Uncompacted	Good	10-25	10-25	NA	NA	Good	Good
E9	240	100%	10	13	Moderate	Uncompacted	Good	<10	<10	NA	NA	Good	Moderate
E10	250	100%	7	12	Moderate	Uncompacted	Poor	<10	<10	NA	NA	Poor	Poor
E11	240	100%	9	10	Stable	Uncompacted	Good	<10	<10	NA	NA	Good	Moderate
E12	310	100%	5	12	Stable	Uncompacted	Poor	0	0	NA	NA	Poor	Poor
E13	240	100%	10	22	Stable	Uncompacted	Poor	0	0	NA	NA	Poor	Poor
E14	250	100%	7	9	Moderate	Uncompacted	Moderate	0	0	NA	NA	Moderate	Moderate
E15	140	100%	7	9	Moderate	Uncompacted	Moderate	0	0	NA	NA	Moderate	Moderate

7.10 Stream survey data, Allt Lochan an Lair.

Section code	Length (m)	% visible streambed	Width (m)		Substrate		Instream cover	Bankside cover (% of bank length)		Quality for salmon		Quality for trout	
			Wet	Bank	Stability	Compaction		left	right	Fry	Parr	Fry	Parr
L1	220	100	5	7	Stable	Uncompacted	Good	10-25	<10	NA	NA	Moderate	Moderate
L2	300	100	5	10	Stable	Uncompacted	Poor	0	0	NA	NA	Poor	Poor
L3	250	100	3.5	5	Moderate	Uncompacted	Moderate	10-25	10-25	NA	NA	Moderate	Moderate
L4	270	100	3.5	5	Moderate	Uncompacted	Poor	<10	<10	NA	NA	Poor	Poor

7.11 Stream habitat photographs, Allt Easach

	Section 1 NN 0702 3934
	Section 1 NN 0702 3936
	Section 1 NN 0705 3943 look up bedrock habitats to turbine site, which would be on the left bank at the tall conifers.

	Section 2 NN 0701 3950 Looking downstream from outfall site over sheet bedrock habitat.
	Section 2 NN 0694 3959 Bedrock and large boulders.
	Section 3 NN 0693 3967

	Section 4 NN 0682 3978
	Section 5 NN 0669 3988 Left channel at islands. Depth is typically 30 cm.
	Section 5 NN 0666 3991 Right channel at island. Depth on low flow was typically 20 cm.

	Section 5 NN 0666 3998
	Section 6 NN 0662 4008 Sheet bedrock.
	Section 7 NN 0659 4033.

	Section 8 NN 0662 4042
	Section 9 NN 0651 4059 Tail of island. Patches of gravel among boulder provide some spawning opportunities for stream dwelling trout.
	Section 9 NN 0648 4064 Left channel at island.

	Section 9 NN 0647 4061 Right channel at island.
	Section 10 NN 0641 4066 Boulder and bedrock.
	Section 11 NN 0630 4087

	Section 11 NN 0627 4093
	Section 12 NN 0631 4108 Sheet bedrock is predominant throughout the section.
	Section 12 NN 0633 4139 Intake site (arrow) looking over left channel at island.

	Section 12 NN 0628 4136 Right channel at island.
	Section 13 NN 0633 4138 Looking up from intake site (sheet bedrock).
	Section 14 NN 0629 4166 Looking upstream from forestry fence.

	Section 15 NN 0636 4189

7.12 Stream habitat photos Allt Lochan an Lair

	Section L1 NN 0634 4097
	Section L2 NN 0634 4103
	Section L2 NN 0648 4125 Looking up bedrock habitats to intake area.

	Section 3 NN 0650 4128 Bedrock habitat at intake area.
	Section 3 NN 0650 4132 Look downstream towards intake area.
	Section 4 NN 0653 4142