voltalia

CRUACH CLENAMACRIE WIND FARM

APPENDIX 10.4 FISH AND HABITAT SURVEY REPORT

Fish and Habitat Survey of

Cruach Clenamacrie Wind Farm, Argyll, 2024

For further information on this report please contact:

Argyll Fisheries Trust
Cherry Park
Inveraray
Argyll
PA32 8XE
Telephone: 01499 302322
E-mail: info@argyllfisheriestrust.co.uk

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Fish and Habitat Survey of Cruach Clenamacrie Wind Farm, Argyll, 2024.

Background

Argyll Fisheries Trust undertook surveys of salmonid fish populations and fish habitat on two tributaries of Allt Nathais: River Luachragan and its sub-tributaries: Eas na Laraiche Moire and Allt an Taillir on behalf of WSP UK Limited.

Main findings

- Stream habitats in one survey section of the 3rd order stream channel of **River Luachragan** tributary were largely suitable for salmonid fish and potentially for freshwater pearl mussel (although none were found by this survey). Juvenile Atlantic salmon and brown trout were found by the fish survey.

- Stream habitats in 1st and 2nd order channels of **Eas na Laraiche Moire** provided suitable habitat for trout spawning and early life-stage juveniles (fry), the densities of which suggest that they may be progeny of sea-run brown trout (sea trout). The habitat was unsuitable for freshwater pearl mussel.

- Stream habitat in 1st and 2nd order channels **Allt an Taillir** was suitable for trout spawning and early life-stage juveniles (fry) but it is not known if these juvenile trout form part of a sea trout population. The habitat was unsuitable for freshwater pearl mussel.

- The surveys of the upper reaches of the Eas na Laraiche Moire and Allt an Taillir in 1st order channels found fewer or no juvenile trout which may be due to the lack of habitat resources in these smaller watercourses or obstacles to fish passage.

- Most of the habitat consisted of a mix of low-to-moderate gradient stream channel and riffle-glide flow types. Some sections of the habitat was affected by accumulation of fine sediments which are likely to be an artefact of the mature conifer tree plantation land use and small channel size.

Acknowledgements - Argyll Fisheries Trust thanks WSP UK Limited and the landowners for the opportunity to undertake this assessment of fish habitats.

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1. INTRODUCTION

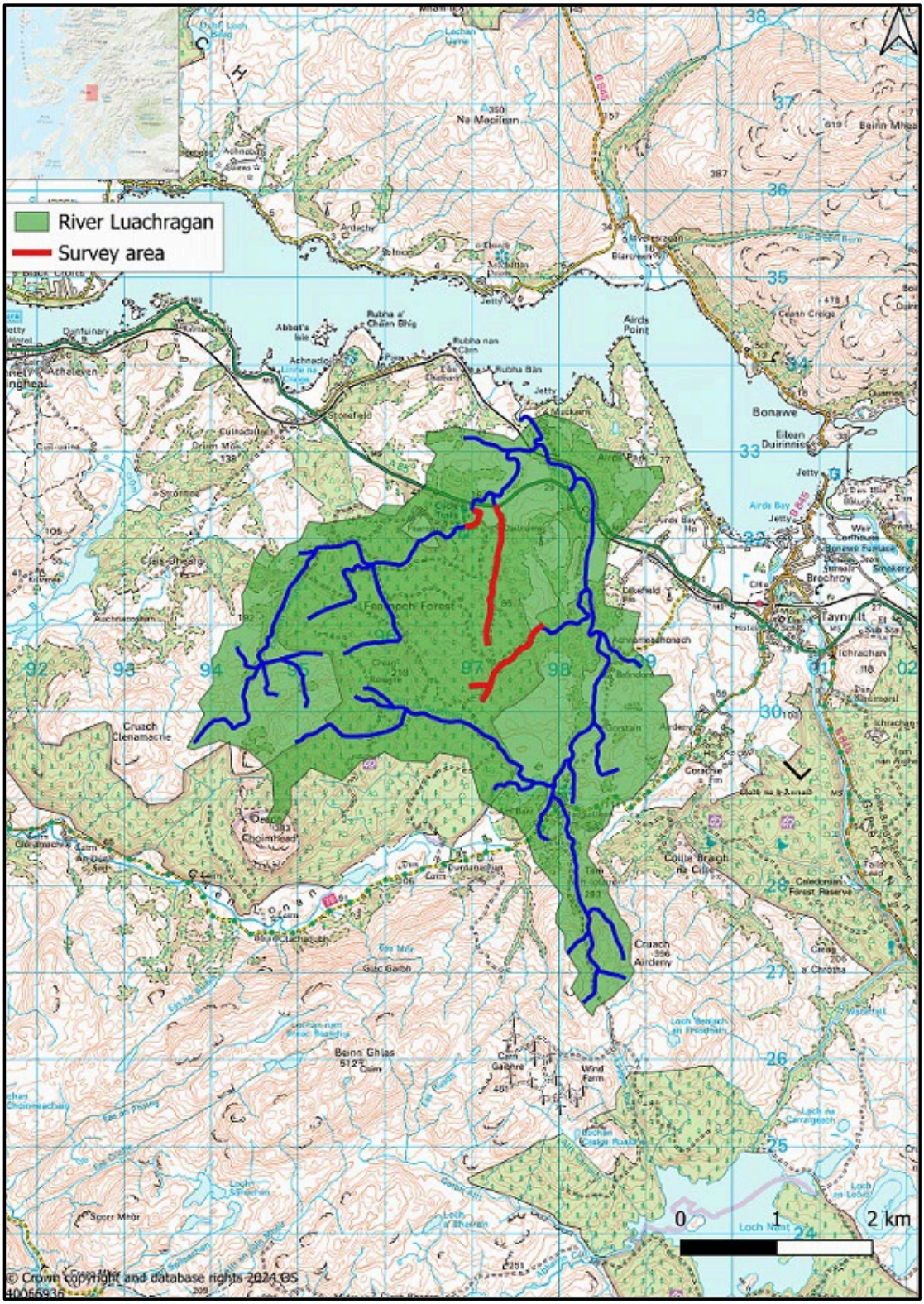
To inform the development of infrastructure at a proposed wind farm site on the southern side of Loch Etive, Argyll Fisheries Trust (AFT) undertook surveys of fish and fish habitat in the two major tributaries of Allt Nathais (Figure 1.1): the River Luachragan and Allt an Taillir and a sub tributary of the River Luachragan: Eas na Laraiche Moire. The habitat surveys were carried out in May 2024 and the fish surveys were carried out in July 2024.

The upper reaches of Allt Nathais flow from north to south via two tributaries: the River Luachragan and Allt na Taillir that drain the high ground of Cruach Clenamacrie and Creag Ruisgte.

Land use within the Allt Nathais catchment is predominantly commercial forestry and farming of livestock on semi-improved grassland on Allt an Taillir. Active forestry operations influence much of the ground adjacent to headwaters of Allt Nathais and there are also patches of broadleaf woodland present along the riparian zones of the streams.

Atlantic salmon fisheries in the area are administered by the Argyll District Salmon Fishery Board. There are no known active fisheries operating in Allt Nathais catchment area. Fish population surveys have been conducted in the lower reach of Allt Nathais and the River Luachragan by AFT in 2014 and 2023. These surveys found both juvenile Atlantic salmon (*Salmo salar)* and brown trout (*Salmo trutta*) in these watercourses downstream of impassable waterfall obstacles (AFT, 2014) and brown trout in the upper reaches (AFT, 2023).

Fig. 1.1 Location of survey reaches



2. METHODS

The survey of fish habitat was focused on the stream channels adjacent to the existing forest road network and where new roads may be constructed (Figure 2.1). The methodology used to survey fish populations and fish habitat are described below:

2.1 Habitat Surveys

To assess the fish habitat, two methods were combined to identify morphological characteristics of the river channel which infer their relative susceptibility to change and their suitability for salmonid fish and freshwater pearl mussel. The location of the start and end points of the 12 survey sections are given in Appendix II.

2.2.1 Morphological characteristics

The survey divided each watercourse into separate reaches with similar geomorphic river channel types (Table 2.1) according to a Morphological Impact Assessment Tool (SNIFFER, 2006). The tool offers a means of describing both the characteristics of the river channel (see Appendix I) and grouping these characteristics relative to their resilience and resistance to disturbance. Each site was also categorised based on the Strahler stream order (Strahler, 1952).

Table 2.1 River channel types based on resistance and resilience to change (SNIFFER, 2006)

Resistance/resilience classes	Channel types	Class	
High resistance (bed and bank) – Low resilience (bed and Bank)	Bedrock, Cascade	A	Increasing sensitivity →
High resistance (bank) Medium resistance Bed - Low resilience (bank) low resilience bed	Step-Pool, Plane bed	B	
Medium resistance (bed and Banks) - Low resilience (bed and banks)	Low gradient passive meandering	F	
Low resistance (bed and Bank) – medium resilience (bed and Bank)	Plane-riffle, Pool-riffle, Braided, Wandering	C	
Medium resistance (bank) low resistance (bed) Low resilience (bed and banks)	Groundwater dominated (Chalk)	E	
Low resistance (bed and Bank) – Low resilience (bed and banks)	Low gradient active meandering	D	

2.2.2 Fish and freshwater pearl mussel habitat suitability

Each separate section identified by the survey of geomorphic channel type was also assessed for their potential to support fish (Atlantic salmon and brown trout) and freshwater pearl mussel.
For the purposes of identifying the general suitability of the habitat for salmonid fish over the study site, the characteristics of the fish habitat were categorised (Table 2.2) in relation to the gradient of the channel, the stream bed substrates and bankside cover for fish. The categories used are: highly suitable (shaded green), suitable (shaded yellow), less suitable (shaded orange) and unsuitable (shaded red).

Table 2.2 Categories of suitability of salmonid fish habitat

Category	Line colour	Characteristics
Highly suitable		Low-to-moderate gradient. Stable mix of coarse substrates. Frequent bankside cover for fish and shaded by trees.
Suitable		Low-to-moderate gradient. Mainly stable mix of coarse & fine substrates. Bankside cover for fish present.
Less suitable		Moderate-to-high gradient. Highly unstable or compacted substrates. Bankside cover for fish present not present.
Unsuitable		High gradient. Bedrock substrates. Bankside cover for fish not present

The fish habitat survey was based on the Scottish Fisheries Coordination Centre habitat survey protocols (SFCC, 2007) which estimated the area of river habitat, the composition and stability of in-stream substrates, water flow types, and potential bank cover for fish. The location of significant features such as fish spawning sites, and obstacles to fish passage were recorded to allow mapping on Geographic Information System (GIS) software (Arc GIS version 10.6).

Photographs of the general characteristics of the watercourses were also taken (a selection of which are provided in Appendix III).

Habitat that was potentially suitable for freshwater pearl mussels was also assessed according to those characteristics described by Nature.scot.

2.2 Fish population surveys

The survey utilised electrofishing to sample fish on the 9th of July 2024 during low flow conditions when water temperatures ranged between 11 and 13ºC.

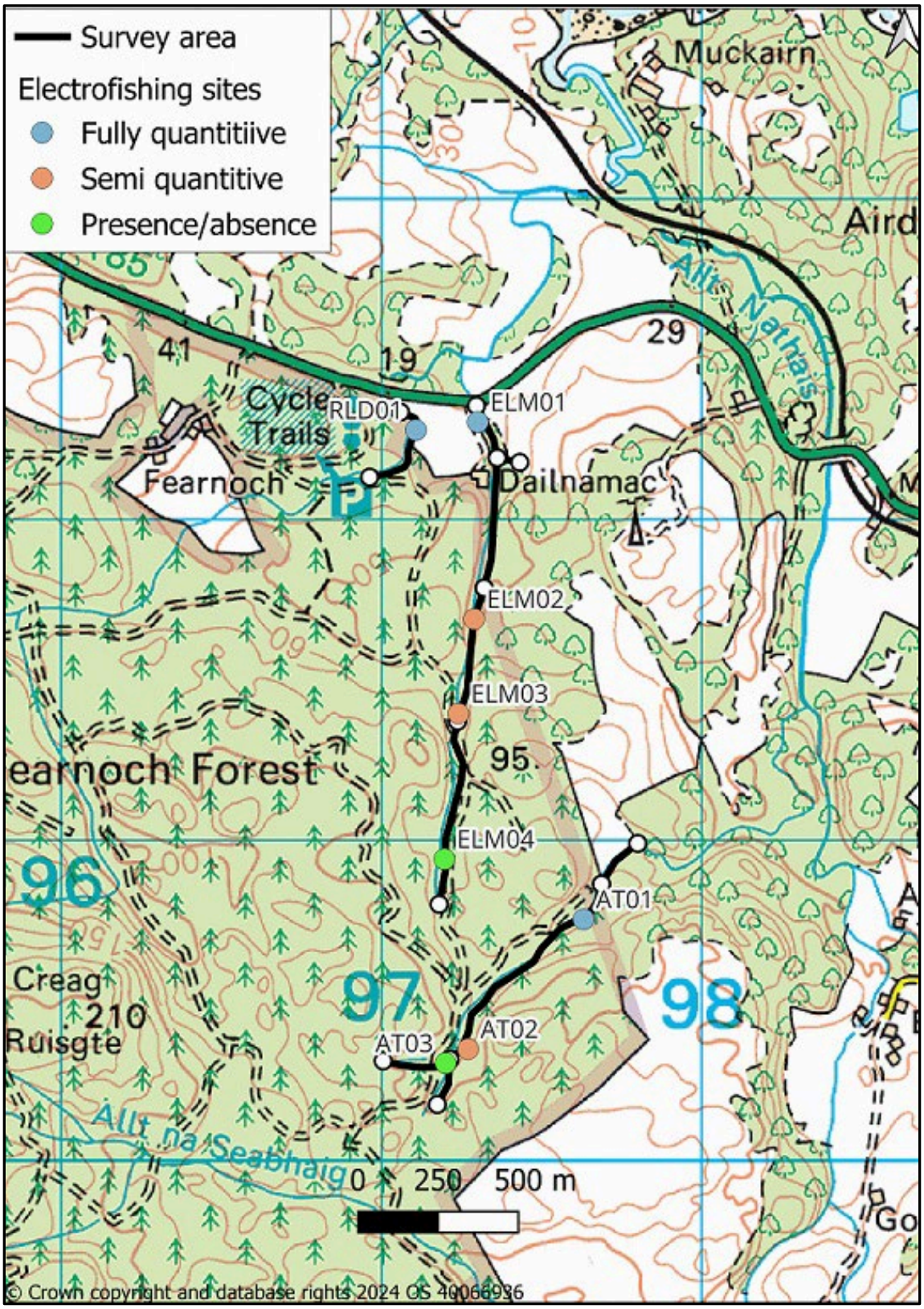
The assessment of the fish population was undertaken by electrofishing surveys at eight sites on three watercourses (Table 2.1 and Figure 2.1) according to protocols developed for the National electrofishing Programme for Scotland (Malcolm et. al., 2019b). A mixture of single and multi-pass fishing surveys were used over a known area of wetted stream habitat to provide estimates of fish density. Three sampling passes were undertaken at fully quantitative (FQ) sites and single sampling passes were made at Semi-quantitative (SQ) sites. Where the presence of fish was uncertain in smaller watercourses, a minimum of 50 m length of habitat was sampled as a single pass to identify the presence or absence (P/A) of fish.

Table 2.1 Electrofishing survey site location and survey type

Site Code	Location	Easting	Northing	Alt. (m)	Survey Type	Stream Order
RLD01	R. Luachragan	197109	732277	22	FQ	3
ELM01	Eas na Laraiche Moire	197302	732302	22	FQ	2
ELM02	Eas na Laraiche Moire	197291	731687	42	SQ	2
ELM03	Eas na Laraiche Moire	197242	731392	56	SQ	1
ELM04	Eas na Laraiche Moire	197198	730938	75	P/A	1
AT01	Allt an Taillir	197632	730750	70	FQ	2
AT02	Allt an Taillir	197272	730345	82	SQ	1
AT03	Allt an Taillir	197202	730301	86	P/A	1

The fish caught were processed at the end of each fishing pass and the fork length of all fish was measured to the nearest mm. An age class was assigned for salmonid fish only (fry 0+ years or parr >0+ years) at the time of sampling based on size observations. All fish were released after the completion of the survey. Photographs of survey sites are given in Appendix III.

Fig. 2.1 Habitat survey reaches and electrofishing survey site location



3 RESULTS

Results of the surveys are given separately for habitat (section 3.1) and fish (section 3.2). The location of the start and end points of each survey section the locations of obstacle features are given in Appendix II. Photographs of the general characteristics of the watercourses are given in Appendix III.

3.1 Habitat surveys

The results of the habitat survey coverage are summarised (Section 3.1.0) and detail is given of the stream channel characteristics (section 3.1.1) and suitability of the habitat for salmonid fish (section 3.1.2), the obstacles to fish migration and the connectivity of the habitats for fish (section 3.1.3) and for the proportion of the habitat suited to different life-stages of brown trout (section 3.1.4).

3.1.0 Summary of survey coverage

The habitat survey was undertaken on 10 sections in three reaches of stream channel (Table 3.1.0) totalling 0.421 Hectares area along 3.31 Km of stream length. The habitat survey of the main channel of a single section of the River Luachragan (RLD01) covering 0.326 Km stream length which covered 0.130 Hectares of habitat (31.0 % of all habitats surveyed).

Table 3.1.0 Summary of habitat survey sections, length (Km) and area (Ha)

Watercourse	Section ID	Strahler Stream order	No. Sections	Length (Km)	Area (ha)	Area (%)
River Luachragan	RLD01	3	1	0.326	0.130	31.0
Eas na Laraiche Moire	ELM01-04	1 & 2	5	1.632	0.155	36.9
Allt an Taillir	AT01-03	1 & 2	4	1.352	0.135	32.1
Total			10	3.310	0.421	100

The survey of the Eas na Laraiche Moire sub-tributary was divided into four sections (ELM01-04) and a small sub-tributary (ELM01-T01) over 1.632 Km stream length which covered 0.155 Hectares of habitat (36.9 % of habitats surveyed). The survey of Allt an Taillir was divided into three sections (AT01-03) and a small sub-tributary (AT03-T01) over 1.352 Km stream length which covered 0.135 Hectares of habitat (32.1 % of all habitats surveyed).

3.1.1 Stream channel characteristics

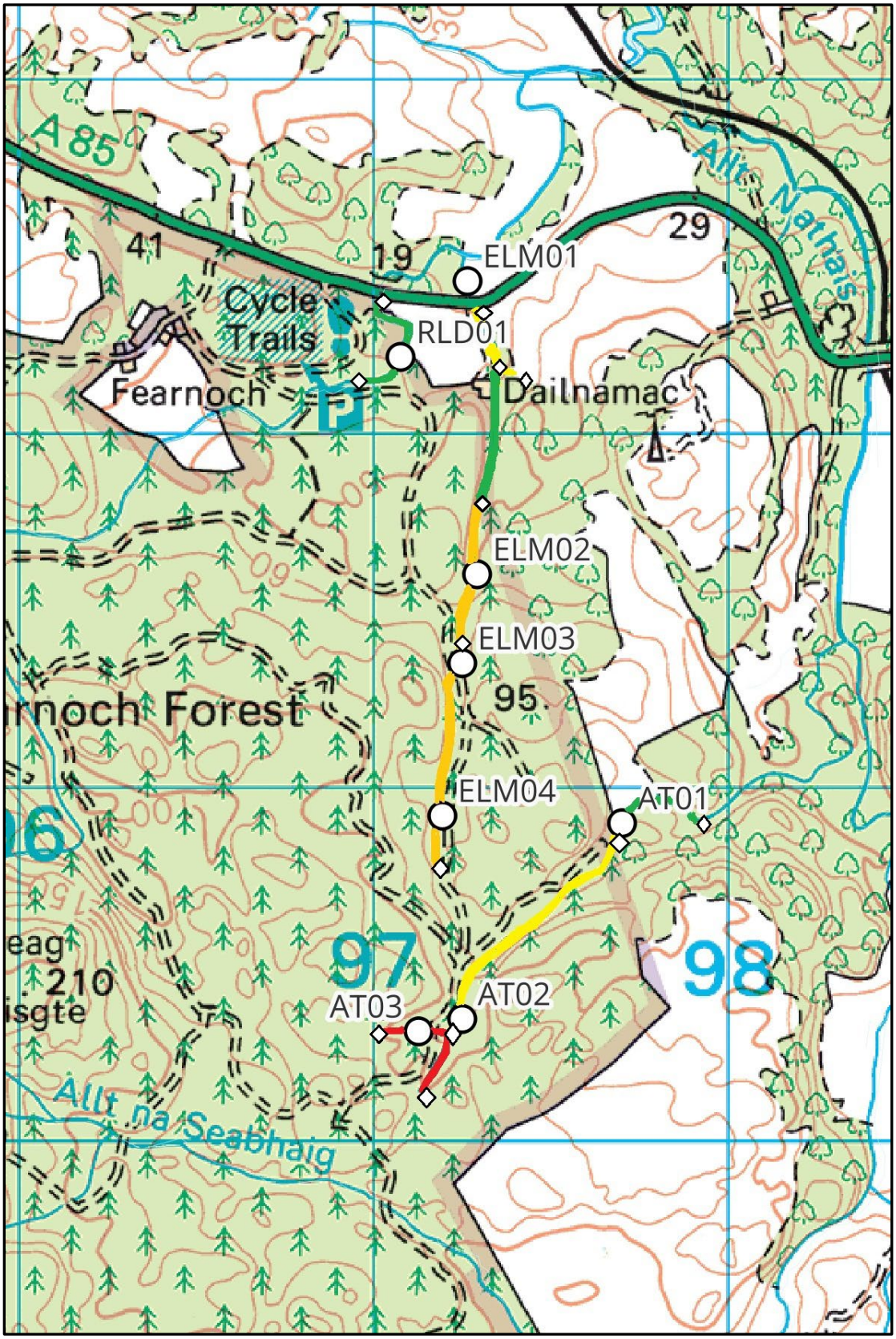
The type of river channel found (Table 3.1.1 and Figure 3.1.2) by the survey consisted mostly of (56.8 % of all habitat area) in seven survey sections of lower gradient habitat that was generally sensitive to change (class C and C/B sensitivity). A mix of more resilient channel types (43.2 % of all habitats) in three survey sections of moderate gradient habitat (classes B and B/C). Patches of resilient channel types (class A) were found (0.5 % of all habitats) in in one survey section.

Wetted stream channel width varied between 0.5 meters (sections AT03 and AT03-T01) to 1.0 m (ELM02-03) in small 1st order streams. In 2nd order stream channels, wet width varied between 1.2 (AT01-02) and 1.5 meters (ELM01). In larger 3rd order stream channels, wet width was 4.0 m (RLD01).

Table 3.1.1 Stream sensitivity class, channel type, length (Km) area (Ha) and stream order

Section ID	Class	Channel Type	Stream Order	Length (Km)	Wet width (m)	Area (Ha)	Area (%)
RLD01	B	Plane bed	3	0.326	4.00	0.1304	31.0
ELM01	C/B	Plane riffle / bed	2	0.174	1.50	0.0261	6.2
ELM01-T01	C/A	Plane riffle / Bedrock	1	0.030	0.75	0.0023	0.5
ELM02	B/C	Plane bed / riffle	1	0.411	1.00	0.0411	9.8
ELM03	C/B	Plane-riffle / Step-pool	1	0.480	1.00	0.0480	11.4
ELM04	C/B	Plane-riffle / Step-pool	1	0.537	0.70	0.0376	8.9
AT01	C/B	Plane-riffle / bed	2	0.185	1.20	0.0222	5.3
AT02	C/B	Plane-riffle / bed	2	0.779	1.20	0.0935	22.2
AT03	B/C	Step-pool / plane riffle	1	0.203	0.50	0.0102	2.4
AT03-T01	C/B	Plane riffle / bed	1	0.185	0.50	0.0093	2.2
Total				3.310		0.4205	100

Fig. 3.1.1 Stream channel sensitivity classification



3.1.2 Suitability of fish habitat

The survey found three survey sections (46.06 % of habitat area) that were assessed as being highly suitable for juvenile salmonid fish (shaded green in Table 3.1.2.1 and Figure 3.1.2), three survey sections (28.97 % of habitat) was assessed as being suitable (shaded yellow), two sections (20.35 % of habitat) was less suitable for salmonid fish (shaded orange) and thee sections (4.61 % of habitat) that were unsuitable for salmonid fish.

Table 3.1.2.1 Summary of habitat suitability for salmonid fish

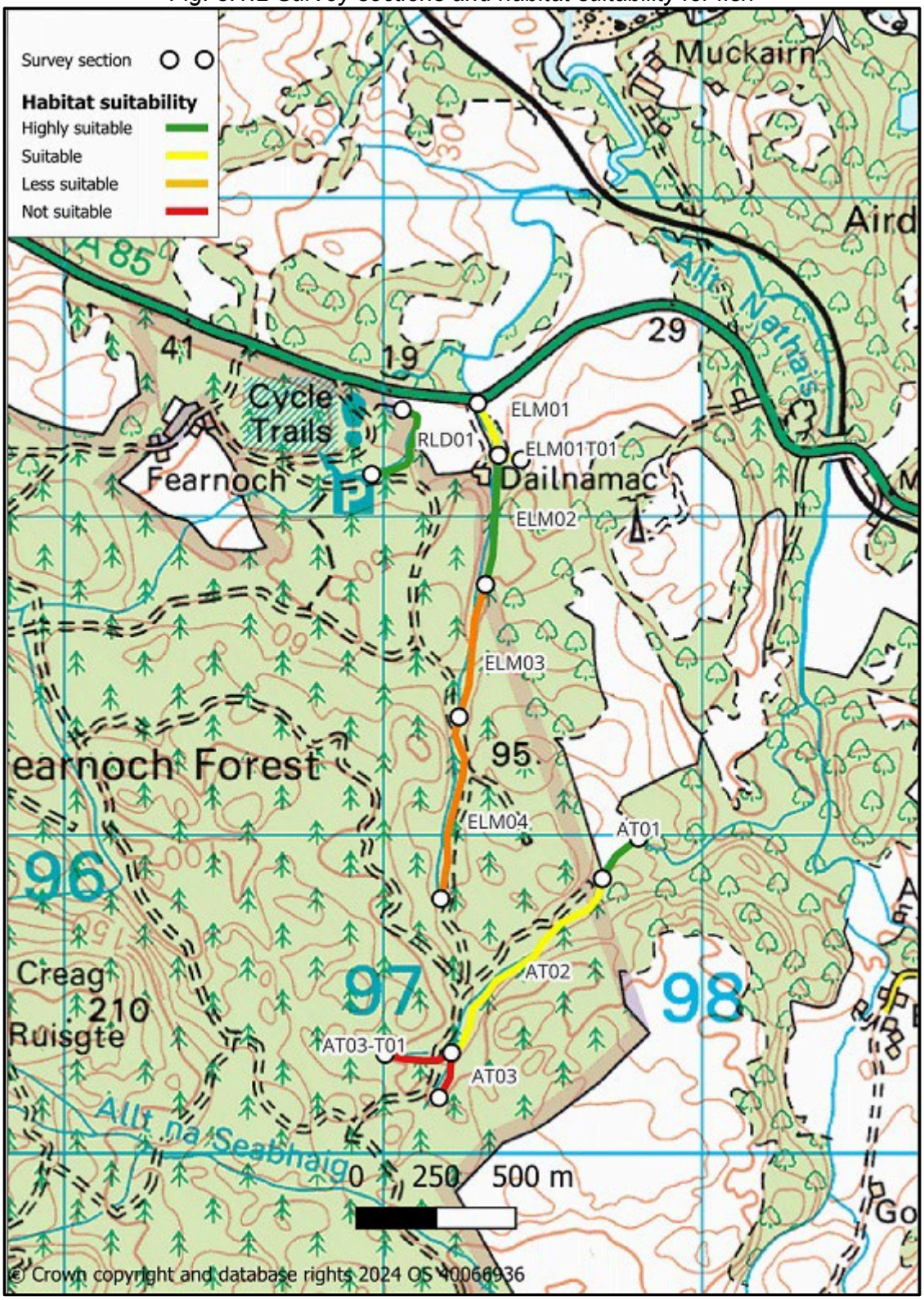
Fish Suitability	Sections	Length (Km)	Area (Ha)	% Area
Highly suitable	RLD01, AT01, ELM02	0.922	0.1937	46.06
Suitable	ELM01, T01, AT02	0.983	0.1218	28.97
Less suitable	ELM03-04	1.017	0.0856	20.35
Unsuitable	AT03, AT03-T01	0.388	0.0194	4.61
Total		3.3100	0.4205	100

Highly suitable habitat was found in the one section (Table 3.1.2.1) surveyed in the 3rd order streams sections (RLD01), one of the four sections surveyed in 2nd order channels (AT01) and one of the five sections surveyed in 1st order channels (ELM02). Suitable fish habitat was found in two sections surveyed in 2nd order channels (ELM01 and AT02) and one section surveyed in 1st order channels (ELM01-T01). Less suitable fish habitat was found in two 1st order channels (ELM03-04). Unsuitable habitat for fish was found in two sections surveyed in 1st order channels (AT03, AT03-01).

Table 3.1.2.2 Habitat suitability, stream order and survey area in survey sections

Section ID	Stream Order	Area (ha)	Area (%)
RLD01	3	0.1304	31.0
ELM01	2	0.0261	6.2
ELM01-T01	1	0.0023	0.5
ELM02	1	0.0411	9.8
ELM03	1	0.0480	11.4
ELM04	1	0.0376	8.9
AT01	2	0.0222	5.3
AT02	2	0.0935	22.2
AT03	1	0.0102	2.4
AT03-T01	1	0.0093	2.2
		0.4205	100

Fig. 3.1.2 Survey sections and habitat suitability for fish



3.1.3 Obstacles to fish passage

A total of six obstacles to upstream passage of fish were identified (Table 3.1.3 and Figure 3.1.3.3) by the survey. The obstacles to fish migration consisted of steeply sloping cascades (CSCD) in bedrock stream channels at five locations (OBS RLD-01 and ELM-04), vertical bedrock waterfalls (WF) at one location (ELM-02), a domestic water supply offtake dam (DAM) at another (ELM-03), and culverts at three locations (ELM-01, ELM-04 and ALT-01).

Table 3.1.3 Location, type, size, and pass ability of potential obstacles

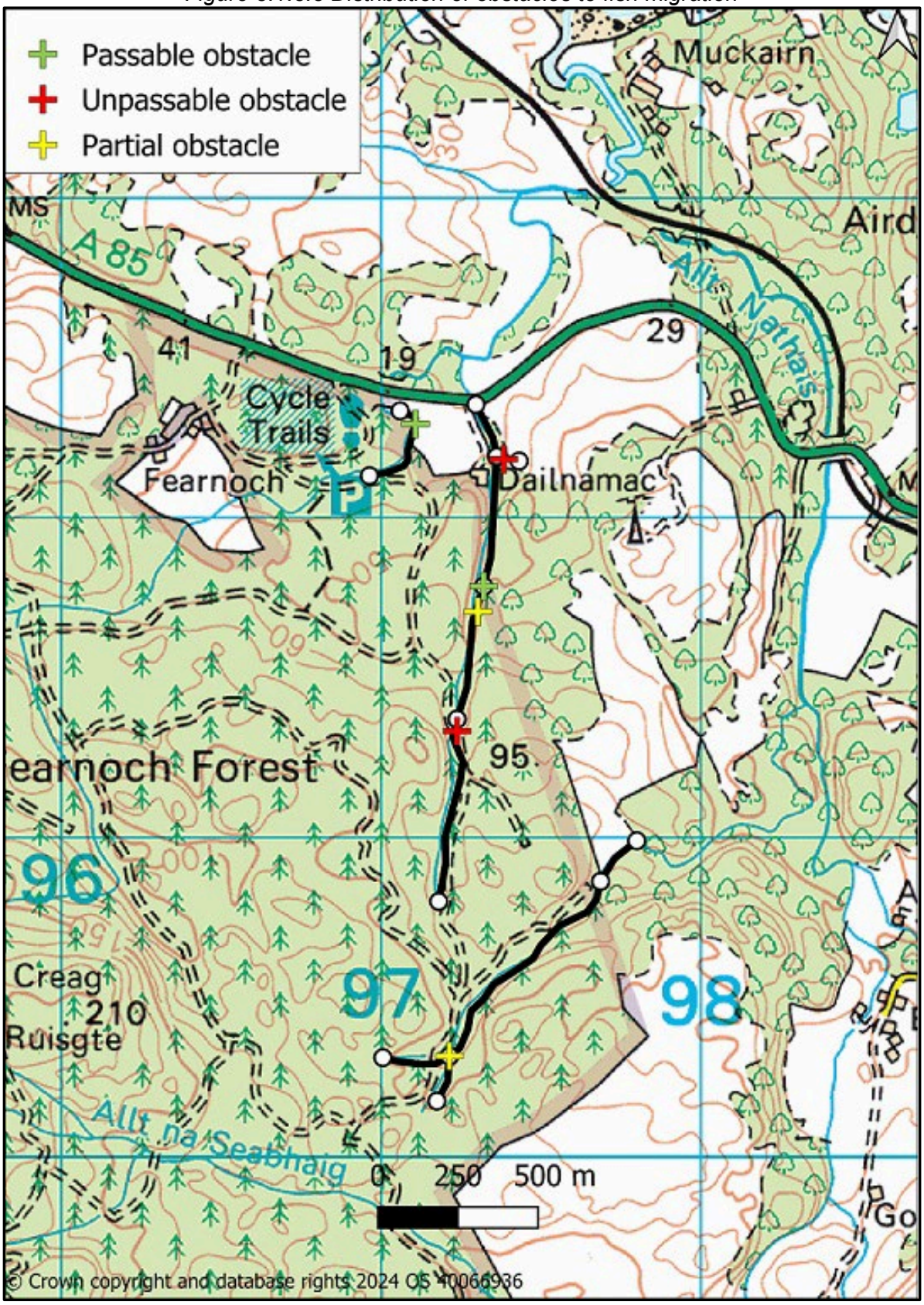
Section ID	Obstacle ID	Easting	Northing	Type	Height (m)	Length (m)	yes (S/F)	Un-sure	No (u/s)
RLD01	OBS RLD-01	197109	732292	CSCD	1.5	5	1		
ELM01	OBS ELM-01	196209	731704	CU	2	15		1	
	OBS ELM-02	197385	732181	WF	2	2			1
ELM02	OBS ELM-03	197322	731784	DAM	0.5	0	1		
ELM04	OBS ELM-04	197239	731330	CSCD/CU	4	10			1
ALT03	OBS ALT-01	197215	730313	CU	0.5	12		1	

The passage of fish at obstacles was assessed to be passable at higher flows (yes s/f) at two locations, potentially passable at two locations (unsure) and not passable at another two other locations (no u/s). The two main obstacles likely to influence the distribution of fish were OBS ELM-01 (Figure 3.1.3.1) and AT02 (Figure 3.1.3.2).

Fig. 3.1.3.1 Cascade/culvert obstacle ELM-01

Fig. 3.1.3.2 Culvert Obstacle AT02

Figure 3.1.3.3 Distribution of obstacles to fish migration



3.1.4 Proportion of habitat suited to different life-stages of brown trout

The proportion of the habitat suited to different life-stages within each survey section (Table 3.1.4 and Figure 3.1.4.1) was estimated and specific locations and area of spawning and pool refuges were recorded (see Appendix II). The distribution of spawning (Figure 3.1.4.2) and pool refuge habitat (Figure 3.1.4.3) are also described.

The proportion of the habitat suited to trout spawning ranged from none (ELM01-T01, AT03 and AT03-T01) to 8.51 % of habitat (section ELM04) and averaged 2.44 % of all habitats surveyed. The proportion of the habitat suited to trout fry (< 0+ years of age) ranged from 25 % (ELM02) to 90 % (AT03-T01) of habitat and averaged 58.0 % of all habitats surveyed. The proportion of the habitat suited to a mix of juvenile trout (fry and parr) ranged from 5 % (ELM01-T01) to 58.2 % (ELM02) of habitat and averaged 26.7 % of all habitats surveyed. The proportion of the deep juvenile habitat suited to parr (>0+ years) ranged from none (ELM01-T01, AT03 and AT03-T01) to 20.0 % (RLD01) of habitat and averaged 6.0 % of all habitats surveyed. The proportion of the habitat suited to larger adult trout ranged from none (ELM01 & T01, ELM03-04, AT02, AT03 & T01) to 10.0 % (AT01) of habitat and averaged 1.9 % of all habitats surveyed. Bedrock substrate that is not suited to any life-stage of brown trout ranged from none in six sections to 25 % (ELM01-T01) of habitat and averaged 5.0 % of all habitats surveyed.

Table 3.1.4 Proportion (%) of habitat suitable for life-stages of brown trout

Section ID	Spawning	Fry	Mixed Juvenile	Deep Juvenile	Refuge (Pool)	Bedrock
RLD01	0.54	30.0	27.6	20.0	6.9	15.0
ELM01	6.51	60.0	23.5	10.0	0.0	0.0
ELM01-T01	0.00	70.0	5.0	0.0	0.0	25.0
ELM02	5.35	25.0	58.2	10.0	1.5	0.0
ELM03	1.67	60.0	28.3	5.0	0.0	5.0
ELM04	8.51	70.0	11.5	5.0	0.0	5.0
AT01	1.35	40.0	42.8	5.0	10.8	0.0
AT02	0.43	55.0	39.6	5.0	0.0	0.0
AT03	0.00	80.0	20.0	0.0	0.0	0.0
AT03-T01	0.00	90.0	10.0	0.0	0.0	0.0
Total	2.44	58.00	26.65	6.00	1.92	5.00

Figure 3.1.4.1 Proportion (%) of habitat suitable for life-stages of brown trout

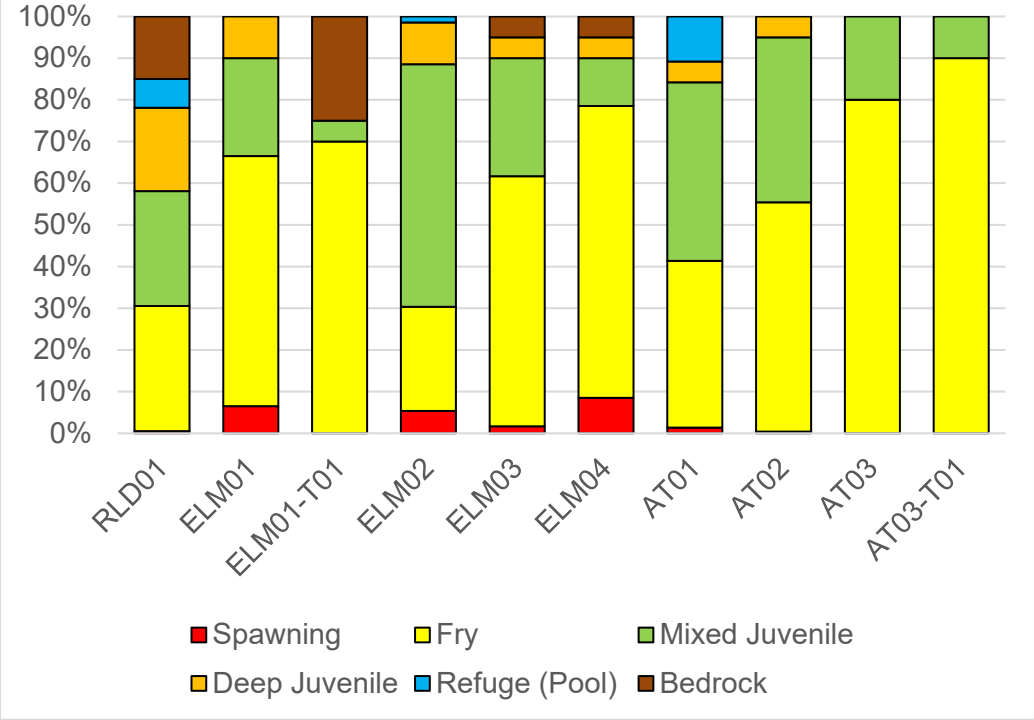
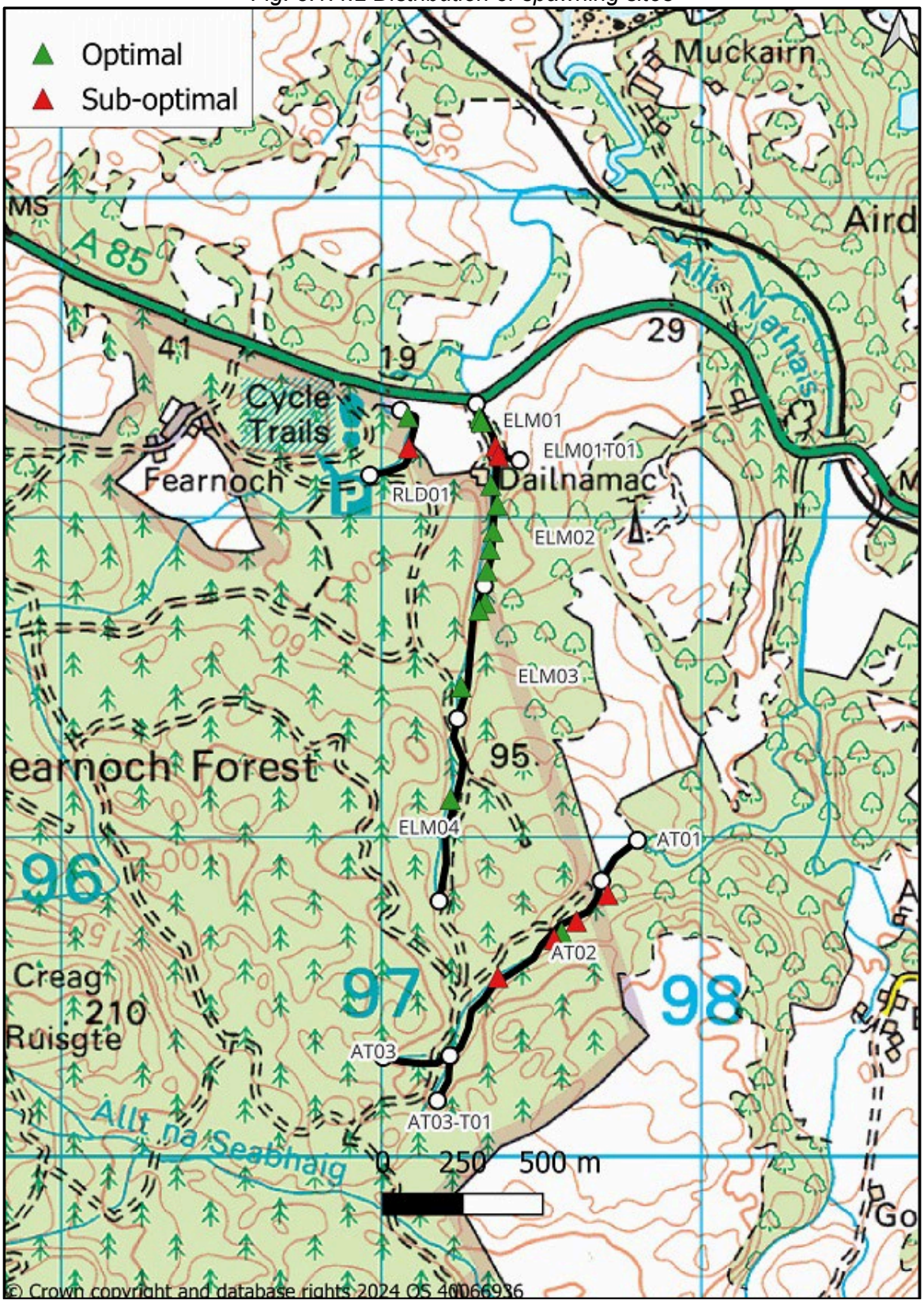


Fig. 3.1.4.2 Distribution of spawning sites



3.2 Fish Population Surveys

The results of the fish survey are described in terms of the distribution of fish across the study area (section 3.2.1), estimates of the density of fish present at survey sites (section 3.2.2), the average size of the fish found (section 3.2.3) and the habitat found at survey sites (section 3.2.4).

3.2.1 Fish distribution

The results of the surveys undertaken at eight sites (Table 3.2.1) are given in four groups based on the suitability of the habitat and presence of fish: the first group consisted of three sites in highly suitable habitat (green shaded cells) at sites RLD01, ELM02 and AT01. The average wet stream width of these survey sites ranged from 1.20 m and 4.06 m in 3rd and 2nd order stream channels. The second group where fish were found in suitable habitat (yellow shaded cell) consisted of two sites where the average wet stream width was 1.83 m in a 2nd order stream (ELM01) and 2.10 in a first order stream (AT02). The third group in less suitable habitat (orange shaded cell) consisted of two sites (sites ELM03 and ELM04) where the average wet stream width was 1.18 (where no fish were found) and 1.58 m (where fish were found) respectively in 1st order stream channels. The fourth group in unsuitable habitat (red shaded cells) consisted of one site (site AT03) where the average stream width was 0.50 m where no fish were found in a 1st order stream.

Table 3.2.1 Summary of fish survey site dimensions, area, and no. of trout sampled

Site Code	Length (m)	Avg. width (m)	Area (m²)	No. runs	Stream Order	No. trout fry	No. trout parr	No. Salmon fry	No. Salmon parr
RLD01	25	4.06	101.5	3	3	19	33	0	6
ELM01	31	1.83	56.6	3	2	51	11	0	0
ELM02	38	1.40	53.2	1	2	27	2	0	0
ELM03	32	1.58	50.4	1	1	2	2	0	0
ELM04	50	1.18	58.8	1	1	0	0	0	0
AT01	52	1.20	62.4	3	2	16	1	0	0
AT02	70	2.10	147.0	1	1	0	4	0	0
AT03	50	0.50	25.0	1	1	0	0	0	0

Atlantic salmon were found at one of the eight sites (site RLD01) where six salmon parr were found. Brown trout were found at six sites, with fry being found at five of these sites (range 2 to 33 fry) and parr at six sites (range 1 to 33 parr).

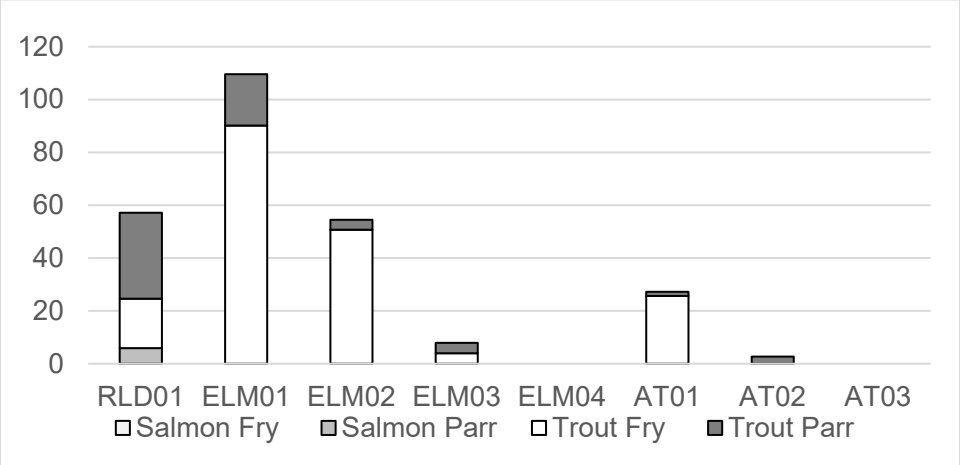
3.2.2 Estimates of fish density

At the one site sampled in 3rd order stream channels (Table 3.2.2 and Figure 3.2.2), the estimate of the density (no. of fish per 100 m²) of salmon parr was 5.91 parr per 100 m² (site RLD01). The density of trout fry at this site was 18.72 fry per 100 m² and the density of trout parr was 32.51 parr per 100 m². In the three sites sampled in 2nd order stream channels, the estimate of the density of trout fry ranged from 25.64 (site AT01), 50.75 (site ELM02) to 90.15 fry per 100 m² (site ELM01). The density of trout parr at these sites ranged from 1.60 parr per 100 m² (site AT01), 3.76 (site ELM02) and 19.44 parr per 100 m² (site ELM01). In the four sites sampled in 1st order stream channels, the estimate of the density of trout fry ranged from none at three sites (ELM04, AT02 and AT03) to 3.97 fry per 100 m² (site ELM03). The density of trout parr at these sites ranged from none at two site (ELM04 and AT03) and 2.72 parr per 100 m² (site AT02).

Table 3.2.2 Estimates of Fish density (no. per 100 m²)

Site No.	Stream order	Salmon		Trout	
		Fry	Parr	Fry	Parr
RLD01	3	0.00	5.91	18.72	32.51
ELM01	2			90.15	19.44
ELM02	2			50.75	3.76
ELM03	1			3.97	3.97
ELM04	1			0	0
AT01	2			25.64	1.60
AT02	1			0	2.72
AT03	1			0	0

Fig. 3.2.2 Density estimates of trout (no. per 100 m²) fry and parr



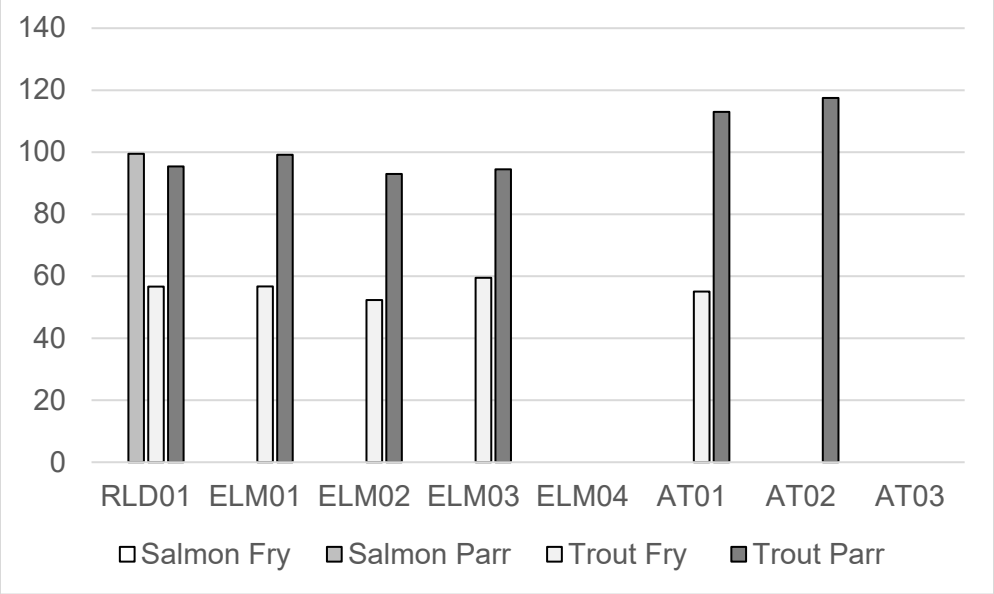
3.2.3 Average fish length

At the one site sampled in 3rd order stream channels, the average length of salmon parr was 99.50 mm (site RLD01). The average length of trout fry (Table 3.2.3 and Figure 3.2.3) was 56.67 mm and the average length of trout parr was 95.42 mm. In the three sites sampled in 2nd order stream channels, the average length of trout fry ranged from 52.30 mm (at site ELM02), 55.06 mm (AT01) to 56.71 mm (site ELM01). The average length of trout parr ranged from 93.00 mm (site ELM02), 99.18 mm (site ELM01) to 113.00 mm (site AT01). In the four sites sampled in 1st order stream channels, the average length of trout fry was 59.50 mm (at site ELM03). The average length of trout parr ranged from 94.50 mm (site ELM03) to 117.50 mm (site AT02).

Table 3.2.3 Average length (mm) of trout fry and parr

Site No.	Stream order	Salmon		Trout	
		Fry	Parr	Fry	Parr
RLD01	3		99.50	56.67	95.42
ELM01	2			56.71	99.18
ELM02	2			52.30	93.00
ELM03	1			59.50	94.50
ELM04	1				
AT01	2			55.06	113.00
AT02	1				117.50
AT03	1				

Fig. 3.2.3 Average length (mm) of trout fry and parr at survey sites



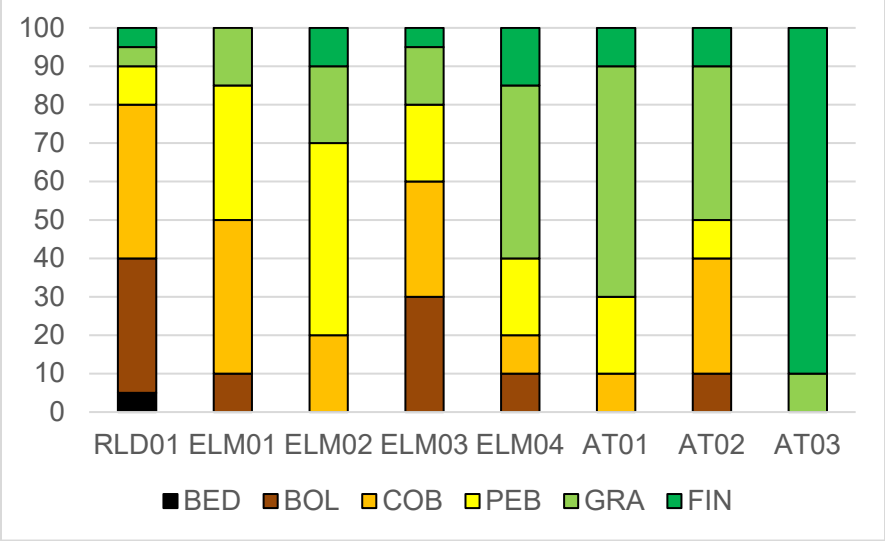
3.2.4 Habitat at survey sites

The proportion of riverbed substrates at four fish survey sites (Table 3.2.4 and Figure 3.2.4) sampled in 3rd and 2nd order streams where most fish were present consisted mostly of coarse substrate suitable for salmonid fish. The larger coarse substrates at these sites, including boulder (BOL) cobble (COB), pebble (PEB) and gravel (GRA) was higher than that of less favourable fine (FIN) substrates. The proportion of the fine substrates, which consisted of silt, sand and organic material were higher at the sites in 1st order streams.

Table 3.2.4 Proportion of stream bed substrates (%) at survey sites

Site No.	BED	BOL	COB	PEB	GRA	FIN	Stream Order
RLD01	5	35	40	10	5	5	3
ELM01	0	10	40	35	15	0	2
ELM02	0	0	20	50	20	10	2
ELM03	0	30	30	20	15	5	1
ELM04	0	10	10	20	45	15	1
AT01	0	0	10	20	60	10	2
AT02	0	10	30	10	40	10	1
AT03	0	0	0	0	10	90	1

Figure 3.2.4 Proportion (%) of stream bed substrates at survey sites



4. DISCUSSION

The findings of the fish and habitat surveys are discussed below in relation to the morphological channel type, channel resilience to change and the suitability of the habitat for salmonid fish, habitat condition and the likely distribution of fish and freshwater pearl mussel.

4.1 River Channel type and resilience

The variation in morphological channel types found in the survey infer that some of the habitat where fish were found may be susceptible to change in relation to infrastructure development and the use of water and land use.

The section of highly suitable fish habitat in the River Luachragan where Atlantic salmon and brown trout were found by the surveys consisted of moderately resilient stream channel type (class B) in the 3rd order stream (section RLD01) and one section of a 2nd order channel (ELM02) where fish were found and the 1st order channel of the upper Allt an Taillir (AT03) where the habitat was unsuitable for fish due to the small size of the channel and the fine substrates. The existing forest road follows closely to and crosses the river further upstream of section RLD01 study reach. This survey did not find any significant disturbance or settlement of fine sediments, suggesting that current use of the road has no apparent effect on this section of the river habitat. Similarly resilient channel characteristics were found in one survey section of Eas na Laraiche Moire (ELM02) where a farm track follows the river channel. This survey found no connectivity with the existing infrastructure, but there may be some influence of the fish habitat of rich supply of riverbed substrates and influence of vegetation diversity from livestock grazing.

Lower gradient stream channels which are less resilient to disturbance (class C) were found in the suitable fish habitat of the lower-most section of Eas na Laraiche Moire (ELM01) in 2nd order stream channel and it's tributary (section ELM01-T01), less suitable fish habitat further upstream in 1st order channels of Eas nam Meirleach (Sections ELM03 and ELM04) and the mix of highly suitable (AT01) and suitable fish habitat (AT02) found in Allt an Taillllir. Juvenile brown trout were found in all these habitats. Similarly to section ELM02, the habitat in section ELM01 is affected by a rich supply of substrates that provide significant areas of spawning and fry habitat but may affect the stability of riverbed substrates. The conifer plantations present in riparian zones of sections ELM03, ELM04 and AT02 appear to over-shade the channel affecting the diversity of vegetation and robustness of riverbanks. The rich supply of coarse riverbed substrates and lack of robustness of riverbanks can cause the channel to over-widening and the depth of water to become shallower.

These affects can increase the opportunities for spawning and early life-stages of trout (fry) but can reduce the proportion of habitat suitable for older trout (parr and adults). Upgrading of existing roads, the construction of new roads and other on-going forestry operations in the riparian corridor of the most susceptible channels (class C channels) has potential to further affect the condition of fish habitat. Fine sediments resulting from construction works and connectivity of road drainage has potential to increase the supply of fine sediments into the river network. An increase in supply of fine sediment may be more likely to be accumulated in the riverbed substrate matrix of the habitat with over-wide channels found in much of this channel type by this survey.

4.2 Fish habitat suitability and condition

The 1st order stream channels surveyed in sections ELM04 and AST03, where no fish were found, held fewer resources for fish and were more heavily influenced by land use. However, fish were found in larger 1st order channels in sections ELM02 and ELM03. Typically, smaller stream channels are susceptible to land use and accumulation of finer sediments. The stream bed substrates found at these sites mostly consisted of smaller fine or gravel substrates which also suggest the flow within the channel is unable to mobilise finer particles regularly, exacerbating effects of land drainage on the in-stream habitat for fish. Additionally, 1st order stream channels are also likely to become dry during drought conditions, making the presence of fish more unlikely when compared to larger 2nd and 3rd order stream channels. However, the findings of the fish surveys in much of the Eas na Laraiche Moire 1st order stream channels that are accessible to fish appear to have sufficient spawning and fry habitat to support fish populations.

The surveys indicate that fish are likely to inhabit much of the habitat surveyed in 2nd and 3rd order channels that are accessible and have sufficient habitat complexity to support different age classes of trout. The composition of the substrates in these channels is better suited to spawning, incubation of eggs provide cover for the larger juvenile life-stages (fry and parr). These channels also have occasional pool habitats that older juveniles (parr) and adult trout may utilise as refuge. There are frequent patches of potential spawning habitat that are suited to brown trout in the 2nd order tributary streams but lack deeper pool refuge to support numbers of larger adult trout. Therefore, adult trout may migrate into Eas na Laraiche Moire and Allt an Taillir from outside of the survey reaches from habitats present further downstream for spawning purposes. If this spawning habitat is utilised, the emergent fry and parr are likely to emigrate downstream into habitats where there is more pool refuge suited to larger trout.

4.3 Fish habitat connectivity and likely fish distribution

The major obstacles to fish movement influence the likely distribution of fish within the survey reaches. Fish population and habitat surveys conducted in the lower reaches of the catchment (Allt Nathais and River Luachragan) found Atlantic salmon and higher densities of brown trout (AFT, 2014). The results of this and the survey conducted further upstream in the River Luachragan suggest that the waterfall at the upstream end of section RLD01 is impassable to migratory fish. The higher densities of trout fry found by this survey also suggest that the habitat in Eas na Laraiche Moire is also accessible to migratory fish, although the size of this tributary and possibly the accessibility of the road culvert at the downstream end of survey section ELM01 limit the use of the habitat by Atlantic salmon but is suitable for sea-run brown trout (sea trout). The fish survey data suggest that the small dam found at the upstream end of survey section ELM02 is passable by trout but the bedrock cascade and forestry track culvert at the upstream end of section ELM03 may not be passable to fish. However, the habitat resources in section ELM04 may not be sufficient to support fish.

Although there were no significant obstacles to fish passage found within sections AT01 and AT02, the accessibility of migratory salmonid fish into section AT01 is less certain. The density of trout fry and parr found at AT01 may suggest that the habitat is accessible to trout from habitats downstream of the study site, but it is not known if this forms part of the the habitat accessible to migratory fish. The forestry track culvert at the upstream end of section AT02 may not be passable to fish. However, the habitat resources in section AT03 may not be sufficient to support fish.

4.4 Freshwater Pearl mussels

The fish and types of stream channel found in section RLD01 appear to have potential to support populations of freshwater pearl mussel. However, no mussels were found by this survey. The partly unstable nature of the riverbed substrates found in Eas na Laraiche Moire and finer sediments found in Allt an Taillir suggest that there may be reduced potential for these habitats to support freshwater pearl mussels.

4.5 Further monitoring of the proposed development

To detect any potential effects of the development on the water environment, surveys of fish and fish habitat can be undertaken before, during and after the construction phase of the works. Fully quantitative surveys of fish at sites downstream of where construction sites are close to the drainage and river network may be used to detect any changes because of the works.

5. CONCLUSIONS

Interpretation of the data collected by the survey undertaken in autumn 2023 provides several conclusions.

- Fish *and* habitat *surveys in* the River Luachragan *found* habitat that are suitable for *Atlantic salmon and sea trout and some potential to* support Freshwater pearl mussel.

- Fish *and* habitat *surveys in Eas na Laraiche Moire found* habitat that are suitable for *sea trout, but little potential to* support Freshwater pearl mussel.

- Fish *and* habitat *surveys in Allt an Taillir found* habitat that are suitable for *trout, but little potential to* support Freshwater pearl mussel.

- The condition of the habitats for salmonid fish are affected in smaller tributary streams by fine sediment which is likely to be because of land use. There is some evidence of instability of riverbed substrates in the suitable fish habitat in larger watercourses which is likely to reduce the suitability of the habitat for freshwater pearl mussel.

- The suitable habitat where trout were found is mostly adjacent to the existing forest road network. Any development of the infrastructure and land use should consider the prevention of disturbance of stream habitats, the riparian vegetation and ensure stream crossings allow for the passage of fish in both upstream and downstream directions.

- The fish survey sites established by this survey may be used in pre, during and post development surveys but a suitable ‘control’ site should be found on another tributary of Allt Nathais where any natural changes to fish populations may be observed.

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