

**Tangy III Wind Farm:
Fish habitat and population assessments**

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Waterside Ecology

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SUMMARY

Background

An extension to the Tangy Wind Farm on Kintyre has been proposed. Waterside Ecology was commissioned to undertake surveys of fish habitats and populations in watercourses receiving run-off from the site. Watercourses included in the study were the Tangy Burn, Allt a' Ghoirtein, Allt na Ceardaich and Allt nan Creamh. A habitat survey of potentially impacted reaches of these streams was conducted using standard walkover methods (Hendry and Cragg-Hine 1997; Summers et al., 1996, Scottish Environment Protection Agency [SEPA], 2010). The habitat survey was followed by an electric fishing survey, using Scottish Fishery Co-ordination Centre (SFCC) methods (SFCC 2007).

Main findings

- The habitat survey identified impassable obstacles to upstream migration of salmonid fish in the lower reaches of all four streams. These obstacles also appear impassable for lamprey species. Suitable climbing substrate for eels was present around the waterfalls on Tangy Burn and this watercourse may be accessible to eels.
- Tangy Burn and Allt nan Creamh are both small to medium sized streams with typical wet widths of one to three metres in the survey reaches. The majority of habitats in both streams are suitable for trout production. There was some evidence of localised siltation in Tangy Burn, apparently as a result of livestock impacts.
- Allt a' Ghoirtein is a small, shallow stream that is rarely more than one metre wide. Habitat quality for trout is poor and suitable over-winter habitat is lacking. Siltation was present at the time of survey.
- Allt na Ceardaich is a tiny, shallow stream. It is improbable that it could sustain a trout population.
- The electric fishing survey found no fish of any species in Allt a' Ghoirtein or Allt na Ceardaich. Trout were present in Tangy Burn and Allt nan Creamh. No other fish species were recorded in either stream.
- Trout fry were present at six of eight electric fishing sites in Tangy Burn. Densities were highly variable, but the mean density of 37.5 fry per 100 m² would be classified as moderate by regional standards. Trout parr were very scarce with a mean density of only 1.2 per 100 m².
- Trout fry were absent at all electric fishing sites (n=4) in Allt nan Creamh. Trout parr density was very poor, with a mean of 0.8 parr per 100m². The reason(s) for the paucity of trout in this stream are unknown, as habitats appeared capable of sustaining significantly higher densities than were present.

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1 Introduction

This report provides an assessment of fish habitats and populations in streams draining the proposed Tangy III Wind Farm site on the Kintyre peninsula, Argyll. The site includes the existing Tangy Wind Farm site. The layout of the existing site and proposed extension are shown in Annex 1.

The proposed site is drained by two large streams – the Tangy Burn and Allt nan Creamh. Two minor streams, the Allt a' Ghoirtein and Allt na Ceardaich drain the western periphery of the site. The objective of the fish survey was to provide information on the presence and distribution of fish habitats and fish species. The data sets describe baseline conditions and provide information for constraints analysis. The data are expected to inform Ecological Impact Assessment (EclA) within the Environmental Statement (ES) for the site.

2 Survey requirements and objectives

Typical concerns likely to be raised in relation to wind farm developments and watercourses include the potential for siltation or other changes to water quality that may affect sensitive aquatic habitats and species, including populations of salmonid and other fish. Where wind farms are to be constructed in areas of coniferous forestry, as at Tangy III, there may be particular concern over the potential impacts of tree felling. These include potential for nutrient release, increased risk of acidification, impacts on hydrology and increase in sediment loading, all of which can impact fish and other aquatic organisms.

The objectives of the current surveys were to:

- Describe stream habitats in the various watercourses draining the site of the proposed wind farm. In particular, to describe their suitability for the various fish species potentially present.
- Carry out an electric fishing survey to describe fish species present and their distribution within target watercourses.
- Identify key issues in relation to the potential impact of the proposed wind farm development on fish communities.

As changes to water quality potentially impact habitats receiving water runoff from the site, surveys extended a minimum of 500 m downstream from the site boundary.

3 Fish populations

3.1 Species potentially present

An online literature search including data interrogation on the National Biodiversity Network (NBN) identified records of European Eel *Anguilla anguilla*, Atlantic salmon *Salmo salar*, brown trout *S. trutta*, and three-spined stickleback *Gasterosteus aculeatus* in grid squares NR 6 2 and NR 6 3. No specific records of freshwater fish were identified from Allt nan Creamh, Allt a' Ghoirtein or Allt na Ceardaich. European eel and brown trout have been recorded at the mouth of Tangy Burn. In addition, Tangy Loch supports a fishery for brown trout¹. No records of lampreys were identified from watercourses draining the site, but Argyll Fisheries Trust (2006) identified the presence of *Lampetra* larvae (either brook lamprey *L. planeri* or river lamprey *L. fluviatilis*) in the catchment of Machrihanish Water, some 8 km south of the site.

3.2 Habitat requirements

3.2.1 European eel

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

¹ <http://www.trout-salmon-fishing.com/scotland-kintyre.htm>

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).

3.2.2 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.

3.2.3 Three-spined stickleback

Three spined sticklebacks inhabit a huge array of habitat types in both coastal and freshwaters. In the UK, they are widely distributed in all types of freshwater, from weed-choked ditches to high altitude lakes (Maitland and Campbell 1992). They hunt by sight, feeding on an array of invertebrate prey. Spawning usually takes place in spring and summer, when the males set up territories and create nests where the female deposits her eggs. The male then tends the eggs until the fry hatch and move away from the natal territory. Sticklebacks are very tolerant of pollution and may be one of the last species to be extirpated from highly polluted streams.

3.2.4 Lampreys

Three lamprey species occur in the UK: brook lamprey, river lamprey and sea lamprey *Petromyzon marinus*. River and sea lampreys are mainly anadromous, while brook lampreys are freshwater resident. 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 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.

4 Methods

4.1 Habitat survey

A walkover survey of salmonid and other fish habitats was carried out between 4th and 6th September 2013. The survey was conducted by Dr Jon Watt, an experienced fisheries ecologist. Water level was low during all surveys. Weather was bright. However, visibility into and through the water was reduced in Allt nan Creamh by the presence of strong staining and, in places, turbidity resulting from the presence of an unidentified brown, flocculent matter.

The survey method was based on (i) the Environment Agency (EA) protocols described by Hendry and Cragg-Hine (1997) and Summers *et al.* (1996), and (ii) Scottish Environment Protection Agency (SEPA) protocols (SEPA 2010). The EA and SEPA protocols are similar, but the former provide greater detail on habitat structure as well as additional data on locations and extent of spawning habitats. The additional information provided by the EA protocols can prove useful for identification of constraints or analysis of potential limiting factors for fish populations. All protocols 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 200 m in length. Areas of each habitat category were marked on 1:10,000 maps of the streams in the field, using colour codes.

Two non-standard habitat categories were defined that do not appear in the EA or Scottish Environment Protection Agency (SEPA) protocols. These were “narrow embedded” and “peat channel”. Both habitat types typically occur in the upper reaches of small upland streams. Most such streams form as wet flushes, which typically coalesce into a small channel incised through peat or earth but without any hard substrate i.e. “peat channel”. The next stage downstream was usually categorised as ‘narrow embedded’ where the still-small stream had cut down to some harder materials, usually cobble and boulder. These materials are non-mobile and set into the base of the stream in a matrix of earth or peat. Small amounts of coarse sand and gravel may be present in a thin layer. Only as the streams grow in size and collect more mobile pebbles, cobbles and gravels do the more typical salmonid habitat categories develop. Peat channels are unsuited to fish production while narrow embedded sections provide very poor habitat.

Table 1 Habitat categories used for walkover survey

Habitat category	Description
Fry habitat	Shallow habitats (mainly < 15 cm) with some cover for smaller fish in cobble and pebble. Cover not large enough to hold parr or adults that would displace fry.
Mixed juvenile habitat	Habitats with mixed depth and coarse substrates including cobble, boulder and pebble that provide cover for salmonid fry and parr. This category also includes habitat with smaller substrates if cover from roots, woody debris or undercut banks are present.
Deep pool	Over 60 cm 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.
Glide	Low or moderate gradient alluvial channel with small substrates. Lacking cover for fish. Productive only if instream macrophytes or bankside cover are present.
Narrow embedded	Small incised channels with non-mobile bed material set into peat and providing little fish cover. Very poor habitat but may support fry or small parr if spawning present nearby.
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.
Peat channel	Small channels incised through peat and lacking hard substrates. Unsuited for fish.

Obstacles to migration were recorded and photographed. Their likely passability for adult salmonids was assessed based on published guidance (SEPA 2010, SNIFFER 2010). Where possible, the height (lip to plunge pool) and length (upstream to downstream) of obstacles was measured using a tape and bob weight. Salmon are considered capable of leaping 3.7 vertical metres and trout 1.8 vertical metres (SEPA 2010). Obstacles that were higher than these figures and passable only by jumping were classified as impassable to the respective species unless it was apparent that height would decrease significantly at high flow due e.g. to downstream constrictions. Upstream of barriers that were judged clearly impassable both to salmon and trout, obstacle passability for salmonids was judged solely in relation to trout, salmon being presumed absent.

The first 200 m to 300 m of each watercourse were examined upstream of the normal tidal limit to identify the potential presence of obstacles that might determine presence of migratory fish in the main survey reaches. This was considered important due to the presence of low cliffs along the landward side of the raised beaches that characterise this section of the Kintyre coast. Waterfalls were often present where the streams cut down through these cliffs.

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 or trout in each section.

Notes were maintained on the presence of larval lamprey habitats in each section. Habitats were defined as optimal or sub-optimal based on classifications provided by Harvey and Cowx (2003). Optimal habitat was defined as stable, fine sediment (silt/sand) to a depth of 15 cm or more, in slow flowing well oxygenated water, often with a fine layer of organic detritus. Sub-optimal habitat was defined as a patchy or shallow (<15 cm) covering of fine sediment among larger substrates.

4.2 Electric fishing survey

The electric fishing survey was carried out on 11th and 12th September 2013. Water level was low or moderate except at ACe1, where it was moderate to high. Site locations are shown on Figure 1.1, 1.2 and 2 while site details are provided in Table 2 and Appendices 1 and 2. Surveys were conducted using fully and semi-quantitative methods (Scottish Fisheries Co-ordination Centre (SFCC), 2007).

Table 2 Electric fishing survey sites

Site	Catchment	Watercourse	NGR	Survey type	Area covered (m ²)
Te1	Tangy	Tangy Burn	NR 66892 27676	Semi-quantitative	173.9
Te2	Tangy	Tangy Burn	NR 67586 27775	Fully-quantitative	117.2
Te3	Tangy	Tangy Burn	NR 68780 27998	Semi-quantitative	105.5
Te4	Tangy	Unnamed 1	NR 67823 27832	Semi-quantitative	104.4
Te5	Tangy	Unnamed 1	NR 67598 28243	Qualitative	NA
Te6	Tangy	Unnamed 2	NR 68181 27883	Semi-quantitative	71.2
Te7	Tangy	Unnamed 2	NR 67990 28153	Qualitative	NA
Te8	Tangy	Allt Trasda	NR 69335 28243	Qualitative	NA
ACe1	Allt nan Creamh	Allt nan Creamh	NR 65750 29833	Semi-quantitative	94.5
ACe2	Allt nan Creamh	Allt nan Creamh	NR 67392 30216	Semi-quantitative	137.0
ACe3	Allt nan Creamh	Allt nan Creamh	NR 68028 29891	Semi-quantitative	245.3
ACe4	Allt nan Creamh	Allt nan Creamh	NR 68310 29880	Qualitative	NA
AnCe1	Allt na Ceardaich	Allt na Ceardaich	NR 65902 29287	Semi-quantitative	99.0
AGe1	Allt a' Ghoirtein	Allt a' Ghoirtein	NR 66207 28300	Semi-quantitative	186.2

Fully quantitative survey sites were isolated with stop nets to prevent fish moving into or out of the site during successive electric fishing runs. Three runs were carried out through each fully quantitative

site. A single electric fishing run was conducted at semi-quantitative survey sites and these sites were not isolated with stop nets. Fully and semi-quantitative survey sites covered the full stream width and incorporated a representative range of habitat types.

Qualitative (presence versus absence of fish) were carried out where the presence of fish was uncertain – mainly in the upper reaches of smaller watercourses. The area covered at such sites was not recorded. Fishing at qualitative sites continued for a minimum of ten minutes.

At all sites, fish were captured in hand-held dip nets then placed in bins of clean water where they were held until ready for processing. Fish were anaesthetised for processing. Salmonid fork length was measured to the nearest millimetre (mm) and eel total length was measured to the nearest cm. 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 reach. Habitat descriptions at quantitative electric fishing survey sites were collected according to the SFCC protocol (SFCC 2007).

Salmonid densities are presented as number of fish per 100 m² of wetted area (fish 100 m⁻²). The classifications provided by Godfrey (2006) are used to describe abundance in a regional context. These classifications are based on large data sets held by SFCC. The quintile ranges of salmon and trout densities (Appendix 3) allow for comparison of fishery performance against regionally 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.

Zippin density estimates are provided for the fully quantitative sites. This estimate gives absolute fish abundance with 95% confidence limits, based on the depletion in fish numbers during successive electric fishing runs through a site (SFCC 2007). Densities are given separately for fry (fish aged 0+ years) and parr (fish aged 1 year or more). The density estimates were calculated using the programme *Removal Sampling* from Pisces Conservation Ltd.

5 Existing conditions

5.1 Tangy Burn catchment

5.1.1 Obstacles to fish migration

Tangy Burn enters the sea at NR 6551 2782. A culvert at the normal tidal limit (NTL) presents a significant obstacle to the immigration of salmon or sea trout (Table 3). The downstream end of the culvert consists of a sloping concrete lip some 1.5 m high and 1.5 m long (see Appendix 8 for photograph). Water cascades down the lip onto gently sloping concrete inset with boulders and cobbles. The trash line suggested that the mouth of the culvert would not normally inundate and the obstacle may be impassable. Approximately 100 m upstream from the A83 road, a 2.4 m high waterfall presents a serious obstacle for upstream migration of salmon or trout. The waterfall drops onto rocks in shallow water and conditions for jumping are poor. Its passability is uncertain. A 3.8 m high waterfall 50 m further upstream at NR 6566 2785 appears to mark the natural limit of upstream migration for migratory salmonids. Further waterfalls in survey sections TB5, TB6 and TB7 were judged to be impassable for trout. All of the obstacles identified may be passable by eels, as rough surfaces and/or wet moss and vegetation are present that might allow eels to climb over or around the various barriers.

A weir is present at the outflow of Tangy Loch. This is around 50 cm high and appears passable close to the right bank in some flow conditions. Tangy Burn was not surveyed upstream of Tangy Loch, as these reaches would be unaffected by the proposed development.

Allt Trasda is accessible from Tangy Loch for approximately 300 m. A boulder choke at NR 6908 2845 may prevent fish from the loch ascending any further.

Table 3 Main obstacles to fish migration, Tangy Burn catchment

Watercourse	NGR	Passable?	Type	Notes
Tangy Burn	NR 6551 2782	Unknown	Culvert	1.5 m long slope of 45 degrees at downstream end of culvert. Shallow. Passable only if inundates on high spring tide (this is uncertain). Rest of culvert is inset.
Tangy Burn	NR 6561 2783	Unknown	Waterfall	2.4 m high vertical with non-adherent nappe. Drops onto shallow rock but wave may move downstream to plunge pool at higher flow.
Tangy Burn	NR 6566 2785	No	Waterfall	Several tiers, up to 3.8 m high and 2 m long.
Tangy Burn	NR 6633 2772	No	Waterfall	Waterfalls at Tangy Mill. Total drop estimated to be over 10 vertical m including a 3 m high cascade that is around 3 m long. Clearly impassable.
Tangy Burn	NR 6666 2765	No	Waterfall	Drop of 3 to 4 m over a length of 8 m. There is steep step some 2 m high part way up. Very shallow.
Tangy Burn	NR 6675 2768	No	Waterfall	4 m high. Slot at the left side of channel is 7 m long but requires several jumps of 0.7 to 1.0 m without pools. Main drop is clearly impassable.
Tangy Burn	NR 6911 2803	Yes	Weir	Outflow of Tangy Loch. 50 cm high and probably passable near right bank.
Allt Trasda	NR 6908 2845	Unknown	Boulder choke	A 60 cm jump is required onto a boulder with two further boulder chokes immediately above.
Unnamed 1	NR 6781 2800	No	Bedrock chute	1.8 m high and 1.8 m long. Very shallow.
Unnamed 1	NR 6771 2813	Unknown	Bedrock chute	8 m long dropping 3 to 4 vertical metres.
Unnamed 1	NR 6766 2836	Unknown	Waterfall	1.1 m high and 1 m long. Very shallow.
Unnamed 1	NR 6766 2837	No	Culvert	Perched 40 cm above bedrock in very shallow water.
Unnamed 2	NR 6798 2814	No	Culvert	Perched at 80 cm over shallow water.

Access into unnamed stream 1 is via a culvert beneath a track. The culvert is perched some 20 cm above the Tangy Burn but may be passable at higher flows. A sloping bedrock chute located 200 m upstream from Tangy Burn at NR 6781 2800 appears impassable. The stream is very small and further chutes and waterfalls located further upstream are also likely to be impassable due to their height and lack of plunge pools.

Access into unnamed stream 2 is also via a culvert but this is inset and appears passable. This stream is potentially accessible for some 350 m, further access being prevented by a perched culvert at NR 6798 2814. This far upstream the watercourse is small, steep and provides very poor habitat for fish.

5.1.2 Salmonid habitats

The lower 250 m of Tangy Burn, survey section TB1, are steep and flow through an incised gorge with heavy shading from broadleaf trees. Obstacles in this gorge are described above and are likely to prevent access by salmon or sea trout. Much of the habitat in the gorge is dominated by bedrock. The gradient eases in section TB2, where the stream flows between high, sloping, tree-clad banks. Here the stream is typically between 2 m and 3 m wet width with substrates of cobble, boulder and pebble and patches of bedrock.

Figure 1.1 Tangy Burn (lower) and Allt a' Ghoirtein fish habitat distribution

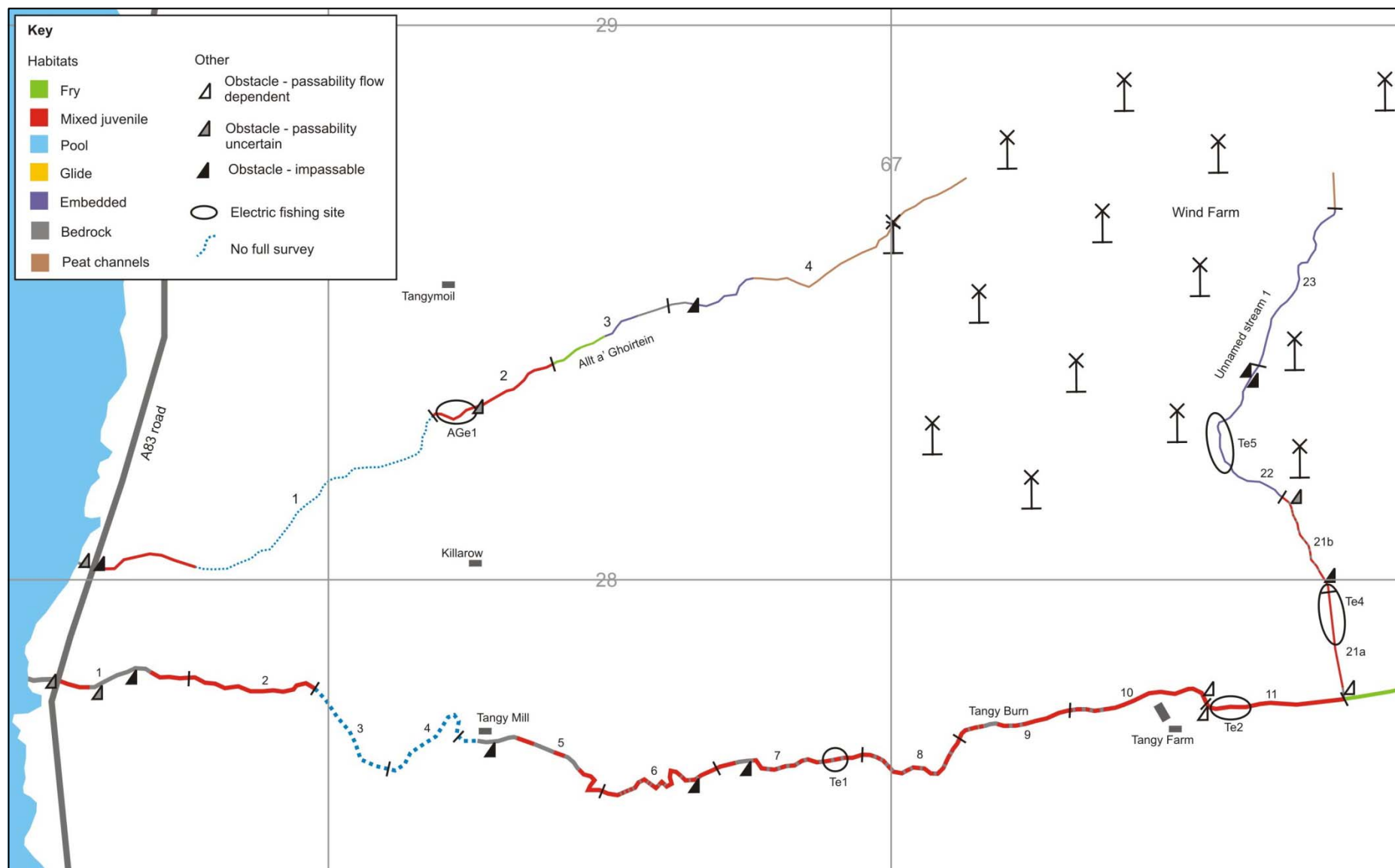
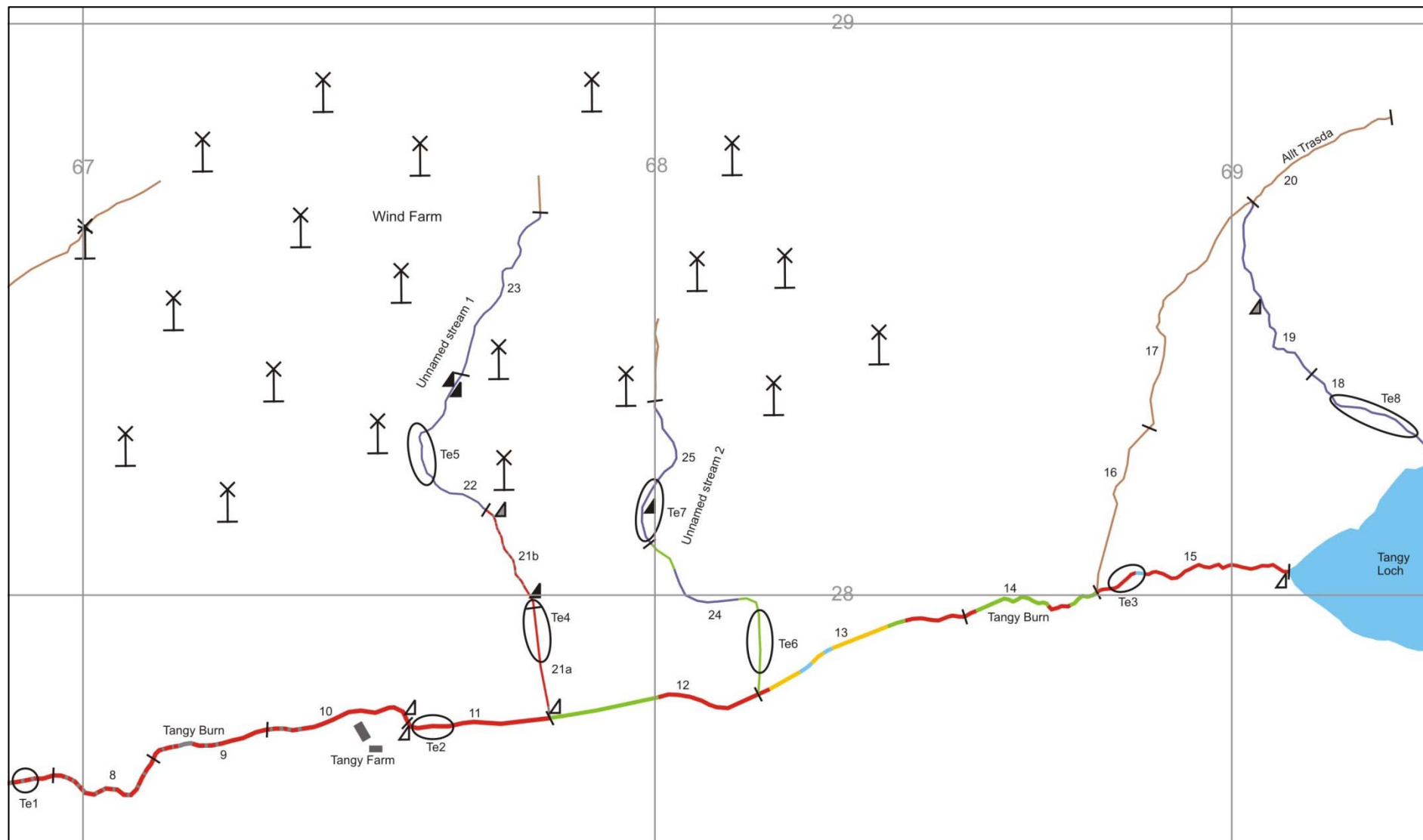


Figure 1.2 Tangy Burn (upper) fish habitat distribution



In survey sections TB3 to TB7 the stream flows mainly between very stable bedrock and/or boulder banks. These are mainly low and well vegetated, as the bedrock is covered in a layer of turf. However, some gorge-like sections are present, particularly in section TB5, some of which was inaccessible for survey. Gradient is mainly moderate to low and flow types comprise runs, pool and glides. The stream does drop over a number of cascades and waterfalls, as previously described. Depth is typically 10 to 25 cm with some deeper pools. Substrates are cobble, pebble and boulder often filled round with grit (coarse sand/fine gravel). As a result, instream cover is moderate. There are frequent bands of bedrock across the channel and all substrates are stable. Draped vegetation in the (mainly fenced) buffer strip alongside the banks provides additional overhead fish cover. Where vegetation is dominated by hazel and willow, as in parts of sections TB5 and TB6, the canopy closes over the full width of the stream. Surrounding land use is mainly improved pasture and some siltation and trampling were evident at locations where cattle have access to the stream. Patches of spawning substrate are present (see Appendix 7) but these are small and mainly of poor quality due to siltation.

The stream banks in sections TB8 to TB10 are generally lower than in the sections further downstream. Instream habitat is broadly similar with moderate gradient and stable substrates. The banks remain densely vegetated. Flow types are varied and habitats appear well suited to trout fry and parr.

Upstream from Tangy Farm, sections TB11 to TB13 have been straightened and dredged at some time in the past. Gradient in these sections is mainly low and substrates comprise pebble, cobble and large areas of sand and mud. Nevertheless some good quality spawning habitat is present at the tails of a number of glides and pools. While instream cover from substrates is limited, the fenced banks are densely vegetated and much overhead cover is provided by draped and marginal plants. Depth is typically from 5 to 15 cm. Due to lack of deep water and limited cover these survey sections are better suited to trout fry than to parr.

Sections TB14 and TB15 are immediately downstream from Tangy Loch. The channel is meandering and cut into earth banks. Some erosion and collapse are evident on the outsides of several bends. The stream is mainly between 1.5 m and 2 m wet width. Substrates are mainly of pebble and cobble with few boulders, so instream cover for larger parr is scarce. Depth is mainly 5 to 15 cm but some deeper pools are present for larger trout parr.

The total estimated area of each habitat category in Tangy Burn is provided in Table 4. Approximately 82% of the stream would be considered likely to be productive for trout i.e. either fry, mixed juvenile, glide or pool habitat. These estimates do not include sections 3 and 4, which were not quantitatively surveyed. Full descriptions of each survey section are provided in Appendices 5 and 6 and representative photographs are provided as Appendix 9.

Table 4 Estimated areas of each habitat type in Tangy Burn catchment

Watercourse	Estimated area of habitat type (m ²)							
	Fry	Mixed juvenile	Pool	Glide	Embedded	Bedrock	Peat channel	Spawning
Tangy Burn	616	4522	115	408	0	1257	0	33
Unnamed 1	0	320	0	0	224	40	0	3
Unnamed 2	208	0	0	0	286	0	0	3
Allt Trasda	0	0	0	0	268	0	289	<1

Unnamed stream 1 drains the existing wind farm site. The lower reaches in sections 21a and 21b have a wet width of approximately 1 m. Substrates are mainly of cobble and the stream provides suitable habitat for trout fry and parr, with runs, pools and some bankside cover from draped vegetation. Further upstream, habitat quality is very poor mainly comprising embedded substrates or incised peat channel.

Unnamed stream 2 has been straightened and dredged in its lower 200 m. As a result the stream is shallow and rather featureless, lacking pools or any defined thalweg. Substrate is mainly pebble, sand and gravel. Some suitable spawning habitat is present but much of the gravel and pebble exists as a thin layer over mud. Bankside cover is present in the form of draped and marginal vegetation. Further upstream, the channel is small and provides little suitable habitat.

Allt Trasda was surveyed upstream from Loch Tangy (NR 6939 2824) into the conifer forest at NR 6913 2876. It is a small stream with a typical wet width of 0.4 m. The stream has cut down through earth and peat to underlying hard material. This is mainly embedded and habitat quality is very poor. Much of the channel is densely overgrown with rushes. Depth is mainly less than 10 cm with a few deeper pools. A few small patches of grit might allow spawning but even these patches, where present, are silted and of poor quality. A larger area of gravel extending to 10 m² is present at the inflow, in the margins of Tangy Loch, but this too is very silted and of poor quality for spawning. The stream splits at the downstream end of section 20 (see Figure 1). The western channel has been partly blocked and carries little water. It is a simple, incised peat channel, lacking hard substrates and with many iron deposits. It is entirely unsuited to salmonid fish.

5.1.3 Habitats for other fish species

No extensive areas of suitable habitat for larval lampreys were recorded. Where present, any sand deposits were very small and shallow. Sufficient little patches may be available to sustain a lamprey population, if present. However, the streams inaccessibility makes this unlikely.

The stream provides cover among boulders and vegetation that is potentially suitable for eels. All obstacles appeared accessible for elvers, with wet climbing substrate available.

5.1.4 Fish populations

Trout were present at six of eight survey sites in the Tangy Burn catchment (Table 5). No other fish species were seen or caught during the surveys. Spot checks for lamprey larvae were carried out in small patches of apparently suitable habitat at sites Te1, Te2, Te3 and Te6. No larvae were found.

Table 5 Electric fishing survey results, Tangy Burn catchment (single run minimum density)

Site	Watercourse	Trout (n)		Trout density (per 100m ²)		Other fish species
		Fry	Parr	Fry	Parr	
Te1	Tangy Burn	21	4	12.1	2.3	None
Te2	Tangy Burn	137	1	116.9	0.9	None
Te3	Tangy Burn	34	2	32.2	1.9	None
Te4	Unnamed 1	1	3	1.0	2.9	None
Te5	Unnamed 1	0	0	absent	absent	None
Te6	Unnamed 2	18	0	25.3	0.0	None
Te7	Unnamed 2	0	0	absent	absent	None
Te8	Allt Trasda	1	0	present	absent	None

At sites where trout were present, mean density was 37.5 fry per 100 m², which is classified as moderate by regional standards (Appendix 3). However, fry densities were highly variable and the mean value is greatly influenced by site Te2 where the density was excellent. Mean parr density was 1.6 per 100 m², very poor by regional standards.

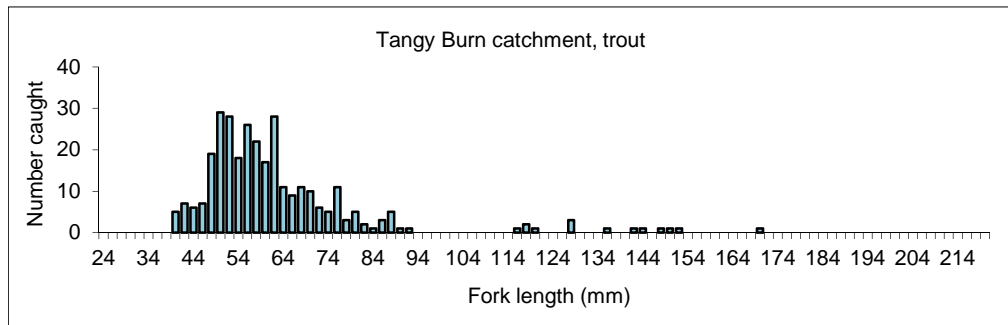
Mean fry density in Tangy Burn itself was 53.7 per 100 m², good by regional standards. Parr densities were consistently low and the mean of 1.7 parr per 100 m² would be classified as very poor. The majority of parr were aged 1+ years.

Trout fry and parr densities at site Te4 in the lower reaches of unnamed stream 1 were both very poor and trout were absent at the upper site, Te5. Fry were more abundant at the lower site in unnamed stream 2 (Te6) where density was 25.3 fry per 100 m². This probably reflects the presence of suitable

spawning habitat in this stream. However parr were absent. As in unnamed stream 1, trout were absent at the upstream sampling site (Te7).

Trout fry were present in Allt Trasda but no parr were found. The stream was too narrow and overgrown to fish quantitatively but the search covered approximately 150 linear metres of the stream above Tangy Loch. Fry were represented by a single individual suggesting that trout density in this stream is extremely low.

Figure 2. Trout size distribution, Tangy Burn catchment



5.2 Allt a' Ghoirtein

5.2.1 Obstacles to fish migration

Allt a' Ghoirtein flows beneath the A93 via a perched culvert (see Appendix 4). The downstream end is set some 1.2 m above the foreshore, close to the NTL. The strandline suggests it is unlikely that the downstream end of the culvert would inundate even on a high spring tide and its passability is therefore uncertain. At the upstream side of the A93 road the stream drops over a 2 m high cascade, which is 3 m in length. There is vertical 1 m high step at the upstream end of the cascade without a plunge pool. It seems probable that this is impassable for salmonids. Approximately 700 m further upstream at NR 6628 2835 the stream passes beneath a farm track via a culvert. This is perched approximately 1 m above the streambed and lacks a plunge pool. It too may be impassable. Some 450 m further upstream at NR 6660 2849 the stream drops over a 3 m high cascade. This stepped, lacks any pools between the tiers and is clearly impassable. All of the above obstacles appear passable for elvers.

5.2.2 Salmonid habitats

The lower 100 m of section AG1 were briefly examined, mainly to identify obstacles. Some mixed juvenile habitat is present in a channel that is approximately 1 m wide. Substrate is mainly boulder and grit and depth is mainly less than 10 cm. There are a few little pools suited to trout. The rest of section AG1 is almost completely inaccessible for survey due to dense bramble and scrub.

The quantitative survey covered the 0.7 km of habitat downstream from the existing wind farm as well as a further 0.4 km within the existing wind farm. Section AG2 is heavily shaded by broadleaf trees. The wetted channel is around 1.5 m wide and is shallow and boulder strewn. Gradient is moderate to steep with step-pool sequences. The pools are shallow, generally less than 30 cm deep. A few small patches of gravel are present that might permit spawning but the stream is silted and spawning habitat quality appeared very poor. The lower reaches of section AG3 have a moderate gradient. The channel is rather narrow, typically 0.5 m, and it runs between steeply incised banks. Habitat in the downstream parts of AG3 is suitable for trout fry.

Further upstream habitat quality is very poor and substrates are mainly embedded. Trampling from cattle was evident and the heavy, clay-like soil entering the stream had resulted in some siltation of the streambed. Further upstream in section AG4, within the boundary of the existing wind farm, the

stream is very small with a wet width of around 30 cm. Most of section AG4 is a simple incised peat channel and is unsuitable for fish.

Overall, habitat quality in Allt a' Ghoirtein is poor to unsuitable and the total area of wetted habitat is small (Table 6).

Table 6 Estimated areas of each habitat type in Allt a' Ghoirtein

Watercourse	Estimated area of habitat type (m ²)							
	Fry	Mixed juvenile	Pool	Glide	Embedded	Bedrock	Peat channel	Spawning
Allt a' Ghoirtein	50	480	0	0	107	390	90	<1

5.2.3 Habitats for other fish species

No stable areas of sand and silt suitable for larval lampreys were recorded. The stream is inaccessible to migratory lampreys. Eels potentially could access the stream and some boulder and root cover is available in the lower reaches.

5.2.4 Fish populations

A single site (AGe1) was surveyed by electric fishing. This was downstream of the farm track in habitat survey section SG2 (Figure 1). The survey covered 186 m² in some of the best quality habitat identified during the survey. No fish were seen or caught.

5.3 Allt na Ceardaich

5.3.1 Obstacles to fish migration

The quantitative survey of Allt na Ceardaich extended upstream 0.7 km from the farm track at Tangytavil (NR 6590 2929) into the conifer forest. This entire reach is inaccessible to fish due to the presence of a steeply inclined culvert that carries the stream beneath the track and under hardstands at the farm. The culvert is approximately 100 m long and is clearly impassable upstream, rendering the survey reaches inaccessible to migratory fish species.

5.3.2 Stream habitats

Upstream of the culvert the stream has a wet width of approximately 0.5 m. The first 100 m above the track has a moderate gradient and substrate of pebble and cobble. It is very shallow, typically less than 10 cm, but has some habitat that would be suitable for trout fry. There is no deeper water that would appear suitable for overwintering fry or parr. Further upstream the burn drops steeply down a v-shaped gully filled with gorse, willow and bramble. Most of this reach is unsuited to fish due to its steep gradient. Upstream of the gully the stream is very small and is mainly a simple channel without hard substrate. Much of the channel is filled with rushes and these reaches are clearly unsuitable for fish production. Overall, the reaches downstream of the proposed wind farm provide very poor fish habitat and the wetted area is small (Table 7).

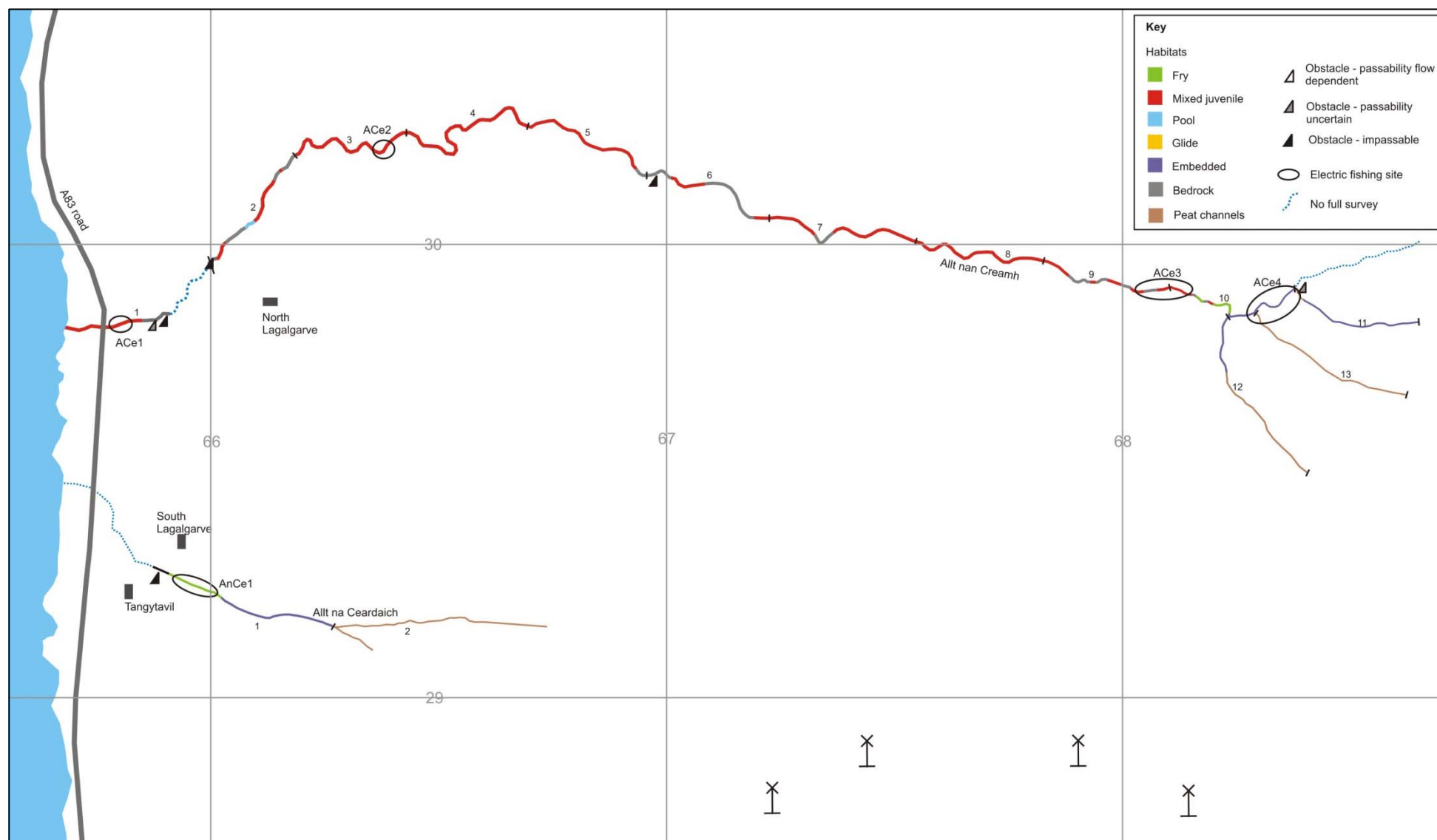
Table 7 Estimated areas of each habitat type in Allt na Ceardaich

Watercourse	Estimated area of habitat type (m ²)							
	Fry	Mixed juvenile	Pool	Glide	Embedded	Bedrock	Peat channel	Spawning
Allt na Ceardaich	50	0	0	0	135	0	68	<1

5.3.3 Fish populations

A single electric fishing site was assessed. This covered 110 linear metres of stream in habitat that appeared potentially suitable for trout fry. No fish were seen or caught.

Figure 2 Allt nan Creamh and Allt na Ceardaich, fish habitat distribution



5.4 Allt nan Creamh

5.4.1 Obstacles to fish migration

The lower reaches of Allt nan Creamh, between the sea and the cliffs behind the raised beach, were examined. The A83 road crosses the Allt nan Creamh via a bridge and the lower 120 m of stream are accessible to migratory fish species. Further upstream the channel runs within a steeply incised gorge, which could not safely be fully surveyed. Approximately 80 m upstream from the road at NR 6584 2982 the stream drops over a 3.5 m high waterfall (Table 8, Appendix 8). There is a rocky ledge part way up this waterfall that does not provide a resting area as it is shallow and turbulent. Any fish attaining this ledge would immediately be swept back downstream. The obstacle was judged to be impassable. A second impassable waterfall is present at NR 6601 2997 where the stream drops an estimated 10 to 15 m into the upstream end of the gorge. This waterfall could not be approached from downstream and it was unsafe to approach its lip to accurately measure its height with a bob weight. The drop is vertical and there is no doubt that it is impassable to salmonids due to its height. Climbing substrate was poor and this waterfall may also be impassable for eels.

Table 8 Obstacles to fish migration, Allt nan Creamh

NGR	Passable?	Type	Notes
NR 6583 2984	Unknown	Waterfall	1.2 m high waterfall requiring jump onto shallow ledge in slot.
NR 6584 2982	No	Waterfall	Height 3.5 m with a rocky ledge part way up.
NR 6601 2997	No	Waterfall	Nearly vertical and 10 to 15 m high. Clearly impassable upstream and hazardous down.
NR 6699 3015	No	Waterfall	Broad bedrock step sloping at 45 degree angle. 3 m high across full width of channel.
NR 6837 2988	Unknown	Braids and dense rush	Stream dissipates among dense rush without defined channel for distance of 20 m.

Approximately 1.4 km further upstream at NR 6699 3015 a waterfall is created by a broad, 3 m high, bedrock step with a slope of approximately 45 degree. It covers the full width of the channel and was judged impassable for trout.

A section of shallow braided channel is present at the downstream end of survey section AC11 at NR 6837 2988. Here the flow dissipates amongst dense beds of rush. It is not clear whether trout could force a way through, although eels would do so without difficulty.

5.4.2 Salmonid habitats

The lower 120 m of Allt nan Creamh, immediately upstream of the NTL, are approximately 3.5 m wide with substrate of boulder and cobble. Upstream of this the stream flows through a gorge, which was not quantitatively surveyed. Upstream of the gorge, sections AC2 to AC5 have a wet width of between 1.5 and 3 m. All five sections have moderate gradient and mixed flows with runs, riffles and shallow pools. Sections AC3 to AC6 are densely overgrown with scrub, mainly gorse, willow and bramble, making access to the channel difficult and in many places impossible. As such, estimates of habitat availability (Table 9) are based on inspections of the accessible channel only (around 20% of the total – see Appendix 6). Depth in AG2 to AG5 is typically 10 to 40 cm and availability of cover is good. The stream appears to offer moderate to good quality habitat for stream dwelling trout.

Table 9 Estimated areas of each habitat type in Allt nan Creamh

Watercourse	Estimated area of habitat type (m ²)						
	Fry	Mixed juvenile	Pool	Glide	Embedded	Bedrock	Peat channel
Allt a' Ghoirtein	56	4287	36	0	225	1743	215
							9.5

The amount of bedrock habitat increases in most of sections AG6 to AG10. These sections, in common with those further upstream, flow through conifer forest, which on the right bank has been felled and restocked. Wet width in these sections is between 0.8 and 2 m. The stream is mainly rather shallow and there is little transport of substrate.

At the time of survey, parts of the streambed in sections AG7 to AG10 were obscured with flocculent, unidentified red-brown material. Habitat quality for trout throughout these sections was classified as poor to moderate.

Further upstream the watercourse is mainly small incised peat channel providing little suitable habitat for fish. The sections within the proposed wind farm extension (AG12 and AG13) are entirely unsuitable for fish, comprising scoured, degraded, incised channels through peat and earth (see Appendix 9 for photographs).

5.4.3 Habitats for other fish species

No extensive areas of suitable habitat for larval lampreys were recorded and, where present, any little sand deposits were very small and shallow. Where present, sand was generally coarse and unstable. It was judged unlikely that the stream could sustain a lamprey population. Due to the presence of waterfalls, the stream is inaccessible to migratory lamprey species.

Allt nan Creamh provides cover among boulders, roots and vegetation that is potentially suitable for eels. However, the waterfall at the upstream end of section AC1 is likely to be impassable for eels, preventing access to the majority of the stream.

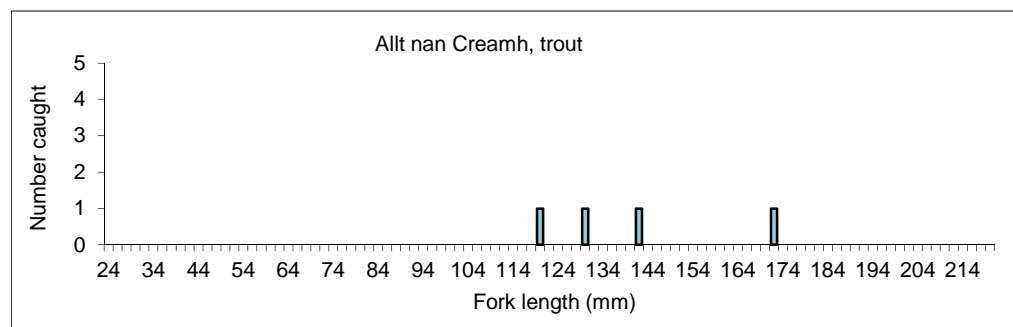
5.4.4 Fish populations

The only fish species recorded at survey sites in Allt nan Creamh was brown trout. These were present at exceptionally low densities (Table 10). Trout fry were absent at all survey sites. Parr were present at ACe2 and ACe3 and density at both sites was very poor by regional standards. The four parr captured were aged 1+ (n=3) or 2+ (n=1).

Table 10 Electric fishing survey results, Allt nan Creamh (single run minimum density)

Site	Watercourse	Trout (n)		Trout density (per 100m ²)		Other fish species
		Fry	Parr	Fry	Parr	
ACe1	Allt nan Creamh	0	0	0.0	0.0	None
ACe2	Allt nan Creamh	0	3	0.0	2.2	None
ACe3	Allt nan Creamh	0	1	0.0	0.4	None
ACe4	Allt nan Creamh	absent	absent	absent	absent	None

Figure 3. Trout size distribution, Allt nan Creamh catchment



6 Interpretation and potential scheme impacts

6.1 *Distribution of habitats and target species*

The distribution of migratory salmonids in all the surveyed streams is determined by the presence of waterfalls in the lower reaches. Due to the line of cliffs running along the landward side of the raised beach a short distance upstream of the NTL, almost all stream reaches examined are naturally inaccessible to salmon or sea trout. Salmon were absent from all electric fishing survey sites and it is likely, given the presence of waterfalls, that the trout captured in Tangy Burn and Allt nan Creamh are exclusively resident.

Trout fry were present in the Tangy Burn at moderate density, consistent with the quality of habitat. The high density at site Te2 is likely to reflect both its proximity to spawning habitat and the presence of very suitable habitat. Trout parr were scarce at all sites in Tangy Burn. Whether this reflects a weak year class or poor survival of older age classes is uncertain. Deeper pools for larger parr are scarce in Tangy Burn. Nevertheless, shallow pools with good overhead cover are relatively widespread and a higher parr density might have been expected. Trout distribution in Tangy Burn extended into the lower reaches of tributary streams draining the proposed wind farm site including unnamed stream 1, unnamed stream 2 and Allt Trasda. Of these, only unnamed stream 2 supports substantial areas of spawning habitat and this was reflected in the presence of significant numbers of trout fry. Trout were absent in the upper reaches of all three of these streams, where the majority of proposed construction would occur.

The lack of eels in Tangy Burn was unexpected, as the waterfalls seemed likely to be passable for this species. Clearly, the possible presence of eels cannot be discounted on the basis of limited survey, but if present, densities must be very low. Lampreys are almost certainly absent. Not only is the stream inaccessible, but spot checks of potentially suitable habitat revealed no larvae. When present in a stream, lamprey larvae tend to found quite readily wherever suitable habitat is present (Watt & Ravenscroft 2005).

Trout were present at unusually low density in Allt nan Creamh. No trout were seen during the habitat survey and their scarcity was subsequently confirmed by electric fishing. Three large sites were surveyed in habitat that had been judged suitable for trout production, but only three parr were found. While physical habitat quality was not high, stream structure suggested that moderate numbers of fry and parr should have been expected. The reason for the scarcity of trout in this stream is unknown, but might reflect water quality issues or, possibly, a pollution event. No other fish species were found, but given the presence of a very large waterfall in the lower reaches none was expected.

No fish were found at survey sites in either the Allt a' Ghoirtein or Allt na Ceardaich. The survey reaches of the latter were very small and shallow, and the lack of fish was expected. Allt a' Ghoirtein, while slightly larger, is nevertheless a very small watercourse and the lack of fish in the survey reaches may be natural.

6.2 *Potential construction effects*

No track layout for the proposed wind farm is currently available that would identify locations of impacts related to stream crossings. Wider, more diffuse, issues relating to wind farm developments and salmonid fish relate mainly to the exposure of large quantities of soil and the potential for siltation. Inputs of silt and other fine material including peat can cause damage to fish habitats and direct mortality to fish and ova. Similar or greater impacts would be expected in the event of any land slip resulting from the proposed development. Should the scheme proceed, silt management will be one of the most significant issues relating to watercourses. Some siltation resulting from agricultural activity, mainly trampling by livestock, was already evident especially in the Tangy Burn and Allt a' Ghoirtein. Spawning habitat in Tangy Burn is already limited in extent and any further damage or loss may be detrimental to local trout populations.

6.3 Monitoring

Monitoring requirements should be based on a formal assessment of potential risk, including that of siltation or other potential changes to water quality resulting from the development. Were this assessment to identify significant risks of deterioration in water quality, an appropriate monitoring programme should be developed. This might include assessments of hydrochemistry, freshwater macro-invertebrates or fish, dependent on the level and nature of any identified risks.

Mitigation measures are beyond the scope of this report, but will clearly have to be carefully planned and enforceable. The potential impacts identified above will require the development of mitigation including silt capture, pollution prevention and other environmental management plans. Trout spawn in autumn and early winter. This is typically a time of high rainfall, when sediment runoff can be particularly problematic. The issue of sediment control will have to be carefully managed and suitable mitigation developed. Regular monitoring of turbidity and suspended solids in watercourses during construction may help ensure that mitigation is effective.

7 References

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Appendix 1.1 Electric fishing survey sites and events

Site							Event					
Site code	NGR*	Watercourse	Runs	Width (m)	Length (m)	Area (m ²)	Voltage	Amperes	Conductivity (μS.cm ⁻¹)	Temp. (°C)	Level	Clarity
Te1	NR 66892 27676	Tangy Burn.	1	2.35	74	173.9	160	0.5	251	11.5	Low-mod	Slight staining
Te2	NR 67586 27775	Tangy Burn.	3	2.17	54	117.2	150	0.7	229	12.2	Low-mod	Slight staining
Te3	NR 68780 27998	Tangy Burn.	1	1.37	77	105.5	160	0.7	172	14	Low-mod	Coloured
Te4	NR 67823 27832	Unnamed 1.	1	1.16	90	104.4	150	0.6	198	17	Low-mod	Slight staining
Te5	NR 67598 28243	Unnamed 1.	1	NA	NA	NA	150	0.5	148	12.7	Low-mod	Slight staining
Te6	NR 68181 27883	Unnamed 2.	1	0.8	89	71.2	120	0.5	190	13.5	Low-mod	Slight staining
Te7	NR 67990 28153	Unnamed 2.	1	NA	NA	NA	120	0.5	182	13	Low-mod	Slight staining
Te8	NR 69335 28243	Allt Trasda.	1	NA	NA	NA	160		165	14.5	Low-mod	Coloured
ACe1	NR 66750 29833	Allt nan Creamh.	1	3.5	27	94.5	240	0.8	156	14	Mod-high	Coloured
ACe2	NR 67392 30216	Allt nan Creamh.	1	2.49	55	137.0	190	0.4	137	13	Low-mod	Slight staining
ACe3	NR 68028 29891	Allt nan Creamh.	1	1.68	146	245.3	190	0.4	140	13	Low-mod	Coloured
ACe4	NR 68310 29880	Allt nan Creamh.	1	NA	NA	NA	190	0.3			Low-mod	Coloured
AnCe1	NR 65902 29287	Allt na Ceardaich.	1	0.9	110	99.0	150	0.4	285	13	Low-mod	Clear
AGe1	NR 66207 28300	Allt a' Ghoirtein.	1	1.9	98	186.2	190	0.5	149	13	Moderate	Coloured

*Downstream end of site

Appendix 1.2. Depletions attained at fully quantitative electric fishing survey sites.

Site	Number 0+ salmon caught			Number 1++ salmon caught			Number 0+ trout caught			Number of 1++ trout 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
Te2	0	0	0	0	0	0	137	66	31	1	2	1

Appendix 2. Instream habitat at quantitative electric fishing sites

Site	Depth						Substrate									Flow types							
	<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
Te1	15	55	20	5	5	0	0	3	2	5	25	25	20	20	0	0	10	20	0	20	30	10	0
Te2	10	65	20	3	2	0	0	2	3	5	25	55	10	0	0	10	5	10	0	40	30	5	0
Te3	25	60	10	5	0	0	0	5	5	15	45	25	5	0	0	5	0	0	5	40	40	10	0
Te4	30	60	10	0	0	0	0	3	3	4	40	40	10	0	0	0	0	20	0	20	50	10	0
Te6	50	50	0	0	0	0	5	5	5	10	45	30	0	0	0	0	0	20	0	60	20	0	0
ACe1	Moderate to high flow. Substrate obscured. Data not recorded.																						
ACe2	10	40	40	10	0	0	0	0	2	5	5	20	68	0	0	5	10	20	0	5	45	15	0
ACe3	20	45	20	10	5	0	0	0	0	5	10	20	40	25	0	10	15	20	0	0	40	15	0
ACe4	Qualitative survey.																						
AnCe1	85	15	0	0	0	0	0	2	3	5	15	45	30	0	0	20	0	10	0	10	50	10	0
AGe1	20	50	20	10	0	0	0	5	5	2	3	25	50	10	0	0	10	10	0	0	50	20	10

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.

Site	Cover (left bank)				Cover (right bank)				Cover in wider channel
	UC	DR	BA	MA	UC	DR	BA	MA	
Te1	15	25	60	5	5	30	60	5	Moderate
Te2	5	40	50	10	0	40	25	70	Moderate
Te3	25	10	70	0	25	15	65	0	Poor
Te4	5	20	75	0	5	20	75	0	Moderate
Te6	0	5	95	0	0	5	95	0	Poor
ACe1	Qualitative survey. Little bank cover. Some draped shrubs.								Good
ACe2	0	10	85	5	0	10	90	0	Good
ACe3	10	5	90	0	0	5	95	0	Moderate
ACe4	Qualitative survey. Undercuts abundant both banks in incised channel.								Poor
AnCe1									Poor
AGe1	0	0	90	10	0	0	90	10	Moderate

Bankside fish cover: UC = undercut bank; DR = draped vegetation; BA = bare (no cover); MA = marginal vegetation (incl. tree roots).

Appendix 3. Salmonid density classification system for West Region (Godfrey 2006)

	WIDTH CLASS			
	<4 m	4 – 6 m	6 – 9 m	>9 m
Trout 0+				
0 th percentile	1.4	0.7	0.5	0.2
20 th percentile	9.9	3.0	1.1	0.8
40 th percentile	28.5	5.0	1.8	1.5
60 th percentile	44.7	12.4	2.7	2.6
80 th percentile	74.4	19.0	5.3	4.0
100 th percentile	181.3	103.5	94.6	9.8
Trout 1++				
0 th percentile	0.9	0.9	0.8	0.5
20 th percentile	3.9	2.3	1.5	0.7
40 th percentile	5.6	3.3	2.1	0.9
60 th percentile	7.6	5.4	3.2	1.5
80 th percentile	12.1	8.4	4.9	1.8
100 th percentile	66.7	30.3	10.8	6.0
Salmon 0+				
0th percentile	0.8	1.0	0.8	1.0
20th percentile	4.4	4.5	2.7	5.5
40th percentile	7.0	10.6	5.5	11.4
60th percentile	11.5	20.8	8.7	14.2
80th percentile	23.0	33.1	17.8	28.6
100th percentile	121.5	70.1	73.7	79.8
Salmon 1++				
0th percentile	0.7	0.7	0.7	0.7
20th percentile	2.6	2.4	2.5	2.9
40th percentile	4.9	3.7	5.5	4.3
60th percentile	7.9	8.0	9.0	8.0
80th percentile	13.9	13.7	12.5	11.8
100th percentile	31.8	37.3	24.0	22.4

Density in regional classification	Descriptive category used in text
Min to 20 th percentile	Very poor
20 th to 40 th percentile	Poor
40 th to 60 th percentile	Moderate
60 th to 80 th percentile	Good
80 th to 100 th percentile	Excellent

The classification is based on data from 185 survey sites, held by SFCC. The quintile densities allow for comparison of fishery performance against regionally based reference points. Classifications are based on single run minimum densities.

Appendix 4. Obstacles to fish migration

Survey section	Code	NGR	Passable	Type	Notes
TB1	TB1.1	NR 6551 2982	Unknown	Culvert	1.5 m long slope of 45 degrees at downstream end of culvert. Shallow. Passable only if inundates on high spring tide (this is uncertain). Rest of culvert is inset and fish would swim through.
TB1	TB1.2	NR 6561 2783	Unknown	Waterfall	2.4 m high vertical with non-adherent nappe. Drops onto shallow rock but wave may move downstream to plunge pool at higher flow.
TB1	TB1.3	NR 6566 2785	No	Waterfall	Several tiers. Highest is 3.8 m high and 2 m long.
TB5	TB5.1	NR 6633 2772	No	Waterfall	Waterfalls at Tangy Mill. Total drop estimated to be over 10 vertical m, including a 3 m high cascade that is around 3 m long. Clearly impassable.
TB6	TB6.1	NR 6666 2765	No	Waterfall	Drop of 3 to 4 m over a length of 8 m. There is steep step some 2 m high part way up. Very shallow.
TB7	TB7.1	NR 6675 2768	No	Waterfall	4 m high. The slot at the left side of channel is 7 m long but this would require several jumps of 0.7 to 1.0 m without pools. Main drop is clearly impassable.
TB10	TB10.1	NR 6756 2782	SF	Waterfall	0.6 m vertical without plunge pool.
TB11	TB11.1	NR 6758 2779	SF	Culvert	Perched at 15 cm. Moderate gradient in culvert.
TB15	TB15.1	NR 6911 2803	SF	Weir	50 cm high. Very shallow below. At outflow of Loch Tangy.
TB19	TB19.1	NR 6908 2845	Unknown	Boulder choke	A 60 cm jump is required onto a boulder with two further boulder chokes immediately above.
TB21a	TB21a.1	NR 6782 2780	SF	Culvert	Culvert perched at 20 cm. 6 m long sloping swim if fish can enter.
TB21b	TB21b.1	NR 6771 2813	Unknown	Bedrock chute	8 m long dropping 3 to 4 vertical metres.
TB21b	TB21b.2	NR 6781 2800	No	Bedrock chute	1.8 m high and 1.8 m long. Very shallow.
TB22	TB22.1	NR 6766 2836	Unknown	Waterfall	1.1 m high and 1 m long. Very shallow.
TB23	TB23.1	NR 6766 2837	No	Culvert	Perched 40 cm above bedrock in very shallow water.
TB24	TB25.1	NR 6798 2814	No	Culvert	Perched at 80 cm over shallow water.
AG1	AG1.1	NR 6556 2803	Unknown	Culvert	Perched at 1.2 m. Unknown if will inundate at high spring tide.
AG1	AG1.2	NR 6561 2803	Unknown	Bedrock chute	2 m high and 3 m long in narrow cleft. 1 m vertical step at upstream end. Probably impassable.
AG2	AG2.1	NR 6628 2835	Unknown	Culvert	Perched culvert without downstream pool.
AG4	AG4.1	NR 6660 2849	No	Waterfall	Height 3 m in five steps. No pools.
AnC1	AnC1.1	NR 6590 2929	No	Culvert	100 m long culvert with steep slope.
AC1	AC1.1	NR 6583 2984	Unknown	Waterfall	1.2 m high waterfall requiring jump onto shallow ledge in slot.
AC1	AC1.2	NR 6584 2982	No	Waterfall	Height 3.5 m with a rocky ledge part way up.
AC2	AC2.1	NR 6601 2997	No	Waterfall	Nearly vertical and 10 to 15 m high. Clearly impassable upstream and hazardous down.
AC6	AC6.1	NR 6699 3015	No	Waterfall	Broad slab of bedrock at 45 degree angle. 3 m high across full width of channel.
AC11	AC11.1	NR 6837 2988	Unknown	Braids	Stream dissipates among dense rush without defined channel for 20 m.

Note: SF indicates that permeability is likely to be species or flow dependent.

Appendix 5. Tangy Burn: stream survey sections and habitat description.

Watercourse	Section Code	NGR		Instream habitat notes	Banks
		Downstream	Upstream		
Tangy Burn	TB1	NR 6551 2982	NR 6571 2784	50m of good quality trout habitat upstream from the road before the first major obstacle. Then steep, inaccessible gorge. There is a further 75 m of juvenile habitat at upstream end of section. Spawning habitat is present but silted.	Mainly bedrock gorge. Heavy shade.
Tangy Burn	TB2	NR 6571 2784	NR 6598 2783	Mixed juvenile habitat with patchy bedrock. Mainly poor quality and heavily shaded. Step pool flow types at downstream end with glides in middle and upper reaches where gradient decreases.	Steeply sloping rock and earth. Dense cover of broadleaf trees with heavy shade.
Tangy Burn	TB3	NR 6598 2783	NR 6610 2756	Not fully surveyed. Moderate gradient. Habitat appears largely as TB5 with mixed juvenile trout habitat and patchy bedrock.	Stable, well vegetated banks. Fenced.
Tangy Burn	TB4	NR 6610 2756	NR 6626 2772	Not fully surveyed. Habitat appears largely as TB5 with mixed juvenile trout habitat and patchy bedrock.	Stable, well vegetated banks. Fenced.
Tangy Burn	TB5	NR 6626 2772	NR 6648 2763	Mainly inaccessible due to gorge and dense scrub. Short reach of mixed juvenile habitat at top of section.	Dense scrub and bedrock.
Tangy Burn	TB6	NR 6648 2763	NR 6670 2766	Mixed juvenile habitat with bands of bedrock. Moderate gradient. Runs and shallow pools.	Very stable banks, mainly cut through bedrock. Turf over the bedrock. Steep, 5 m wide buffer strip.
Tangy Burn	TB7	NR 6670 2766	NR 6693 2769	Mixed juvenile habitat with bands of bedrock. Moderate gradient. Runs and shallow pools.	Very stable banks, mainly cut through bedrock. Steep, 5 m wide buffer strip.
Tangy Burn	TB8	NR 6693 2769	NR 6712 2772	Mixed juvenile trout habitat with runs and pools to 40 cm deep. Substrate of cobble, boulder and pebble with bands of bedrock. Pockets of spawning habitat present.	Draped vegetation provides cover. Stable and heavily vegetated.
Tangy Burn	TB9	NR 6712 2772	NR 6733 2777	Boulder with sand, gravel and silt. Some bands of bedrock, especially in the lower part of section. Silt over stones.	Heavy shade from overhanging broadleaves on left bank. Some trampling (cattle) right bank.
Tangy Burn	TB10	NR 6733 2777	NR 6757 2780	Depth 5 to 20 cm. Boulder with sand, gravel and silt. Some bands of bedrock, especially in the lower part of section. Silt over stones.	Heavy shade, due mainly to conifers planted next to stream. Dense conifer. No livestock access.
Tangy Burn	TB11	NR 6757 2780	NR 6782 2780	Boulder, cobble and gravel. Much dense, filamentous algae. Depth 5 to 20 cm but mainly <15 cm. Riffle, run and glide sequences.	Overhead cover from bankside and marginal vegetation.
Tangy Burn	TB12	NR 6782 2780	NR 6816 2782	Straightened section. Depth 5 to 15 cm. Substrate of gravel, silt and cobble. Little patches of spawning. Generally lacks structure or variation in habitat.	Wet rough pasture. Dense iris and rush.
Tangy Burn	TB13	NR 6816 2782	NR 6845 2796	Lower reaches are shallow glide. Potamogeton, horse tail and iris. Low gradient. Substrate of mud and grit. Appears to have been straightened and dredged in past. Some spawning near top of section where more flow.	Rush pasture and iris.
Tangy Burn	TB14	NR 6845 2796	NR 6877 2800	Mainly shallow with riffle and glide sequences. Pebble and gravel substrates. Good spawning but shallow and lacks instream cover other than draped vegetation. Some good fry habitat. Top 50% is narrow incised channel with vertical banks.	Grass and rushes. Stable incised banks mainly around 1 m high.
Tangy Burn	TB15	NR 6877 2800	NR 6911 2803	Boulder with cobble and gravel. Very stable. Some silt and compaction. Spawning present.	Densely vegetated stable banks.
Allt Trasda	TB16	NR 6911 2803	NR 6882 2823	Very small stream carrying little water. Probably dredged in past. Narrow, incised channel. Substrate of grit and mud. Depth mainly 2 to 7 cm with scattered pools to 30 cm. Many iron deposits.	Dense rush which are, in many places, collapsed over the narrow channel.
Allt Trasda	TB17	NR 6882 2823	NR 6902 2863	Mix of simple incised peat channel and areas where the channel seeps through and over rushes. Hard substrates lacking. Entirely unsuitable for fish. Upper reaches have no discernable channel - just a wet band in dense rushes.	Wet rush pasture.

Watercourse	Section Code	NGR		Instream habitat notes	Banks
		Downstream	Upstream		
Allt Trasda	TB18	NR 6939 2824	NR 6914 2839	Narrow incised channel overgrown with rushes and grass. Mainly impossible to see due to narrowness of gap between banks and dense vegetation. Larger substrate is immobile and embedded. Some grit/gravel that may permit spawning. Silted with some mud. Where present gravel mainly overlies peat or mud in a thin layer. Very poor overall.	0.5 m high incised banks. Undercut and heavily overgrown.
Allt Trasda	TB19	NR 6914 2839	NR 6902 2868	Mainly deeply incised peat. Overgrown. Very poor habitat. Young stream with channel scoured down to hard material and little substrate transport. Very turbid. Depth mainly 1 to 5 cm with little pools to 20 cm. A few tiny patches of grit may allow spawning.	Incised channel. Narrow. Almost totally overgrown with rushes.
Allt Trasda	TB20	NR 6902 2868	NR 6913 2876	Tiny stream in incised ditch. Totally overgrown. Unsited to fish and would be impossible to electric fish.	Tiny incised channel.
Unnamed 1	TB21a	NR 6782 2780	NR 6781 2800	Moderate gradient. Lower reaches appear to have been straightened/dredged in past. Depth 5 to 10 cm. Run, pool and glide. Cobble and pebble. Silted.	Some trampling. Mainly low, well vegetated and stable.
Unnamed 1	TB21b	NR 6781 2800	NR 6772 2817	Depth 2 to 10 cm with a few little pools to 30 cm. Mix of bedrock and poor quality juvenile habitat. Heavily shaded. Gorge at edge of wind farm site.	Mainly steep and gorge-like. Densely overgrown with scrub (much gorse).
Unnamed 1	TB22	NR 6772 2817	NR 6766 2836	Very small shallow stream between steep, incised banks.	Flows beneath turf in many places.
Unnamed 1	TB23	NR 6766 2836	NR 6779 2866	Silt, gravel, cobble and pebble. Small incised channel. Depth 2 to 7 cm. A few reaches of pebble habitat could support trout fry.	Stable, incised peat with grasses and rush.
Unnamed 2	TB24	NR 6819 2784	NR 6800 2809	Lower reaches straightened and dredged. No thalweg. 1 m wide and 2 to 5 cm deep over gravel. Gravel mainly in thin layer over mud. Upstream from the straightened section is very poor habitat.	Densely overgrown.
Unnamed 2	TB25	NR 6800 2809	NR 6799 2834	Little stream with embedded cobble and boulder. A little grit. Very poor fish habitat. Upstream from upper survey limit is totally unsited to fish.	Very stable. Some grass and scrub in lower reaches then incised through rush and wet pasture.
Allt a' Ghoirtein	AG1	NR 6556 2803	NR 6619 2830	Probably inaccessible from sea. Lower 100 m of section is boulder and grit with a few little pools suited to trout. Rest of section totally inaccessible due to dense bramble and scrub.	Dense scrub. Mainly inaccessible due to bramble.
Allt a' Ghoirtein	AG2	NR 6619 2830	NR 6640 2839	Broad, shallow and boulder strewn. Pools to 30 cm deep but no fish seen. Lack of overwinter habitat. A few patches of gravel might permit spawning. Some siltation.	Very heavy shade beneath broadleaf trees.
Allt a' Ghoirtein	AG3	NR 6640 2839	NR 6660 2849	Small channel between steeply incised banks. Silted. A few little patches of gravel but much embedded substrate. A few little pools deep enough for trout but no fish seen. Depth mainly 1 to 10 cm.	Some trampling of heavy clay soil resulting in siltation.
Allt a' Ghoirtein	AG4	NR 6660 2849	NR 6701 2865	Very small, shallow stream. Peat and embedded substrates. Not accessible. Unsited for fish.	Mainly low stable banks.
Allt nan Ceardaich	AnC1	NR 6590 2929	NR 6628 2918	Drops steeply downhill in v-shaped valley filled with gorse, willow and bramble. Stream is 0.2 to 0.5 m wide. Steep in upper parts of section but some suitable trout fry habitat upstream from farm track.	Dense vegetation. Some erosion. Draped vegetation provides cover.
Allt nan Ceardaich	AnC2	NR 6628 2918	NR 6673 2923	Tiny ditch not suitable for fish. A little hard substrate in lower 60 m of reach. Not accessible.	Rushes fill over channel except at downstream end where stream drops into a v-shaped valley with steep gradient.
Allt nan Creamh	AC1	NR 6666 2981	NR 6600 2997	Lower 130 m is boulder strewn mixed juvenile habitat. Stream then runs through a steep gorge with waterfalls (inaccessible).	Stable scrub-clad banks.
Allt nan Creamh	AC2	NR 6600 2997	NR 6618 3020	Gorge ends at obstacle 2.1. Short section of mixed juvenile is then followed by a second minor gorge. Upstream of this bedrock alternates with mixed juvenile habitat. Top of section totally overgrown with gorse and inaccessible.	River has cut a deep v-shaped valley with an incised gorge at its base. Valley and bank tops densely covered in hazel, gorse, bramble and bracken. Much is inaccessible

Watercourse	Section Code	NGR		Instream habitat notes	Banks
		Downstream	Upstream		
					without a machete.
Allt nan Creamh	AC3	NR 6618 3020	NR 6642 3025	Steps and pools with some longer runs. Pools mainly quite shallow and depth is typically 10 to 15 cm. Good overhead cover. Boulder is dominant but gravel is widespread if poorly sorted, provided pockets of spawning habitat for stream-dwelling trout.	Dense gorse, willow and bracken. Good overhead cover from draped vegetation. Stable, low, stony bank faces.
Allt nan Creamh	AC4	NR 6642 3025	NR 6670 3026	Steps and pools with some longer runs. Pools mainly quite shallow and depth is typically 10 to 15 cm. Good overhead cover. Boulder is dominant but gravel is widespread if poorly sorted, provided pockets of spawning habitat for stream-dwelling trout.	Dense gorse, willow and bracken. Good overhead cover from draped vegetation. Stable, low, stony bank faces.
Allt nan Creamh	AC5	NR 6670 3026	NR 6697 3015	Largely as sections AC3 and AC4. Runs and pools. Juvenile trout habitat. More bedrock at upstream 50 m of section.	As sections AC3 and AC4 until upstream end, where bedrock bank faces.
Allt nan Creamh	AC6	NR 6697 3015	NR 6722 3005	Runs and shallow pools with occasional deeper scours to 45 cm deep. Depth typically 10 to 25 cm. Boulder cobble and pebble.	Gorse and bracken. Stable stony and rocky bank faces. Draped vegetation provides cover.
Allt nan Creamh	AC7	NR 6722 3005	NC 6756 2999	Cobble is dominant (50%) with boulder, pebble and gravel. Runs and little pools. Depth typically 10 to 25 cm. Very turbid with lots of flocculent peat/algae (brown). Patchy bedrock. Small pockets of gravel and pebble would allow spawning.	Conifer at left bank planted to edge of stream. Right bank clear-felled but had 50 m buffer zone with bracken and grass. Has been replanted. Bank faces mainly bare but stable.
Allt nan Creamh	AC8	NC 6756 2999	NC 6984 2994	Stream is becoming 'younger' with little transport of substrate. Very stable boulder often inset in streambed. Depth 5 to 20 cm. Runs, riffles and glides.	Some scrub willow on right bank but mainly rushes and bracken. Heavily shaded by conifers on south bank.
Allt nan Creamh	AC9	NC 6984 2994	NR 6809 2989	5 to 15 cm deep with a few pools to 25 cm. Very stable with embedded boulder and frequent patches of bedrock. Very turbid.	Stable banks with some bedrock
Allt nan Creamh	AC10	NR 6809 2989	NR 6837 2987	Small channel cut down to hard material in places. Upstream from confluence channel is very small and banks almost closed over stream.	Incised undercut banks almost closed over stream.
Allt nan Creamh	AC11	NR 6837 2987	NR 6865 2983	Very small channel cut down to hard base. Depth 2 to 5 cm with some stagnant pools. Flows beneath turf in places. Many iron deposits.	Heavily shaded by conifers. 5 m wide buffer.
Allt nan Creamh	AC12	NR 6824 2984	NR 6835 2960	Typically 2 to 5 cm deep. Channel is incised into peat. Some cobble, pebble and gravel in lower reaches but by NR 6823 2966 is totally unsuitable with degraded peat channel.	Streambed cut down to over 1 m. Incised peat. Very heavy shading.
Allt nan Creamh	AC13	NR 6829 2985	NR 6848 2970	Little incised channel with some flow beneath turf. Cut down to hard material. Depth 2 to 5 cm. Many iron deposits. Unsuitable for fish production.	Rushes and grasses with heather on drier banks.

Appendix 6. Stream survey data.

Section Code	Visible streambed (%)	Length (m)	Width (m)		Substrate		Instream cover	Bankside cover (% of bank length)		Accessible to salmon/sea trout?	Surrounding land use		Quality for trout	
			Wet	Bank	Stability	Compaction		Left	Right		Left	Right	Fry	Parr
Tangy, Tangy Burn														
TB1	80	250	2.5	5	Moderate	Partly	Moderate	<10	<10	Yes	BL	BL	Moderate	Moderate
TB2	80	250	2.2	2.5	Moderate	Partly	Moderate	<10	<10	No			Moderate	Moderate
TB3	No quantitative survey													
TB4	No quantitative survey													
TB5	20	250	2.2	2.3	Stable	Partly	Moderate	<10	<10	No	BL/IG	BL/IG	Moderate	Moderate
TB6	70	260	2.2	2.7	Stable	Partly	Moderate	10 - 25	10 - 25	No	RP	RP	Moderate	Moderate
TB7	70	270	2.2	2.7	Stable	Partly	Moderate	10 - 25	10 - 25	No	RP	RP	Moderate	Moderate
TB8	80	250	2.2	2.5	Stable	Partly	Moderate	10 - 25	10 - 25	No	IG	SC/IG	Moderate	Moderate
TB9	75	240	2.1	2.5	Stable	Compacted	Moderate	<10	<10	No	IG	BL/IG	Moderate	Moderate
TB10	80	250	1.8	2.4	Moderate	Partly	Poor	<10	<10	No	BL	CO	Moderate	Mod-poor
TB11	80	250	1.6	2	Stable	Partly	Moderate	>25	>25	No	SC/IG	IG	Good	Moderate
TB12	90	370	1.4	1.9	Stable	Uncompacted	Poor	10 - 25	10 - 25	No	RP	IG	Moderate	Poor
TB13	90	400	1.7	1.7	Stable	Uncompacted	Poor	<10	<10	No	RP/WL	WL	Poor	Poor
TB14	100	250	1.6	2	Stable	Uncompacted	Poor	10 - 25	10 - 25	No	RP	RP	Moderate	Poor
TB15	65	350	1.5	1.7	Stable	Partly	Moderate	>25	>25	No	SC/TH	SC/TH	Good	Good
Tangy, Allt Trasda														
TB16	20	330	0.5	0.5	Stable	Partly	Poor	>25	>25	No	RP	RP	Unsuitable	Unsuitable
TB17	NA	420	NA	NA	NA	NA	NA	NA	NA	No	WE/RP	WE/RP	Unsuitable	Unsuitable
TB18	5	300	0.4	0.5	Stable	Partly	Poor	>25	>25	No	RP	RP	Poor	Poor
TB19	5	370	0.4	0.5	Stable	Partly	Poor	>25	>25	No	RP	RP	Poor	Poor
TB20	30	310	0.4	0.4	Stable	Partly	Poor	>25	>25	No	CO	CO	Unsuitable	Unsuitable
Tangy, Unnamed 1														
TB21a	60	200	1.0	1.2	Stable	Partly	Moderate	<10	<10	No	IG	IG	Moderate	Poor
TB21b	25	200	0.8	1.5	Stable	Partly	Moderate	10 - 25	10 - 25	No	IG/SC	IG/SC	Poor	Poor
TB22	50	300	0.4	0.4	Stable	Partly	Poor	>25	>25	No	RP	RP	Unsuitable	Unsuitable
TB23	20	260	0.4	0.4	Stable	Partly	Poor	>25	>25	No	RP	RP	Unsuitable/ poor	Unsuitable
Tangy, Unnamed 2														
TB24	70	400	0.8	1	Moderate	Partly	Poor	>25	>25	No	IG	IG	Poor/ Unsuitable	Unsuitable
TB25	50	290	0.6	0.9	Stable	Compacted	Poor	>25	>25	No	RP	RP	Poor/ Unsuitable	Poor/ Unsuitable
Allt a' Ghoirtein														

Section Code	Visible streambed (%)	Length (m)	Width (m)		Substrate		Instream cover	Bankside cover (% of bank length)		Accessible to salmon/sea trout?	Surrounding land use		Quality for trout	
			Wet	Bank	Stability	Compaction		Left	Right		Left	Right	Fry	Parr
AG1	50	550	0.8	1.4	Stable	Compacted	Moderate	<10	<10	Partly	SC	SC	Poor	Poor
AG2	70	240	1.5	2.5	Moderate	Uncompacted	Moderate	<10	<10	No	BL	BL/IG	Moderate	Poor
AG3	50	250	0.5	0.5	Stable	Partly	Poor	>25	>25	No	RP/IG	RP/IG	Poor	Poor/Unsuitable
AG4	50	640	0.3	0.4	Stable	Compacted	Poor	>25	>25	No	MH/RP	RP	Unsuitable	Unsuitable
<u>Allt na Ceardaich</u>														
AnC1	70	370	0.5	0.7	Stable	Partly	Poor	<10	<10	No	TH/SC	TH/SC	Poor	Poor/Unsuitable
AnC2	70	340	0.2	0.3	Stable	Partly	Poor	<10	<10	No	IG	RP	Unsuitable	Unsuitable
<u>Allt nan Creamh</u>														
AC1	90	320	3.5	5	Stable	Uncompacted	Moderate	<10	<10	No	IG/RP	IG/RP	Moderate	Good
AC2	60	305	2.4	3.5	Moderate	Uncompacted	Good	<10	<10	No	RP/BL	RP/BL	Good	Good
AC3	15	380	2.1	3.2	Stable	Uncompacted	Good	10 - 25	10 - 25	No	SC	SC	Good	Good
AC4	10	390	2.1	3.2	Stable	Uncompacted	Good	10 - 25	10 - 25	No	SC	SC	Good	Good
AC5	20	350	1.8	3	Stable	Uncompacted	Good	10 - 25	10 - 25	No	SC	SC	Good	Good
AC6	20	310	1.7	2.5	Stable	Uncompacted	Moderate	10 - 25	10 - 25	No	SC/TH	SC/TH	Good	Moderate
AC7	60	340	1.7	2.2	Stable	Uncompacted	Good	<10	<10	No	CO	TH	Moderate	Moderate
AC8	40	310	1.4	1.6	Stable	Partly	Moderate	<10	<10	No	CO	SC/TH	Moderate	Moderate
AC9	20	310	1.2	1.5	Stable	Partly	Poor	<10	<10	No	CO	TH	Mod-poor	Mod-poor
AC10	50	320	0.8	1	Stable	Compacted	Mod-poor	>25	>25	No	CO	CO/TH	Poor	Poor
AC11	35	320	0.3	0.5	Stable	Compacted	Poor	>25	>25	No	CO	CO	Unsuitable	Unsuitable
AC12	90	350	0.4	1.2	Unstable	Uncompacted	Poor	<10	<10	No	CO	CO	Poor	Unsuitable
AC13	50	300	0.2	0.3	Stable	Compacted	Poor	>25	>25	No	CO	CO	Unsuitable	Unsuitable

Land use: BL=broadleaf woodland, CO=coniferous forest, IG=improved grazing, RP=rough pasture, SC=scrub, TH=tall herbs, WE=wetland.

Appendix 7. Potential spawning habitats identified during survey

Section	Code	NGR	Area (m ²)	Suitability		Washout risk	Notes
				Salmon	Trout		
TB1	TB1.1	NR 6557 2982	0.5	Poor	Poor	No	
TB1	TB1.2	NR 6561 2783	0.5	Poor	Poor	No	Silted
TB7	TB7.1	NR 6677 2767	0.5	Inaccessible	Moderate	No	
TB8	TB8.1	various	2.5	Inaccessible	Moderate	Possible	Small, scattered patches
TB9	TB9.1	NR 6713 2773	0.5	Inaccessible	Poor	No	Silted
TB11	TB11.1	NR 6759 2777	2.5	Inaccessible	Moderate	Possible	Partly silted
TB11	TB11.2	NR 6769 2779	3	Inaccessible	Moderate	No	Partly silted
TB13	TB13.1	NR 6819 2784	1.5	Inaccessible	Moderate	No	
TB13	TB13.2	NR 6841 2795	5	Inaccessible	Poor	No	Silted. Two patches.
TB13	TB13.3	NR 6844 2796	1	Inaccessible	Poor	No	Silty
TB14	TB14.1	NR 6853 2796	4	Inaccessible	Moderate	No	Some silt
TB14	TB14.2	NR 6857 2798	1	Inaccessible	Moderate	No	Some silt
TB14	TB14.3	NR 6860 2798	2	Inaccessible	Moderate	No	Some silt
TB14	TB14.4	NR 6866 2799	5	Inaccessible	Moderate	No	
TB14	TB14.5	NR 6877 2800	0.5	Inaccessible	Moderate	No	At confluence
TB15	TB15.1	NR 6886 2803	0.5	Inaccessible	Poor	No	Silted
TB15	TB15.2	NR 6899 2805	0.5	Inaccessible	Moderate	No	
TB15	TB15.3	NR 6911 2803	2	Inaccessible	Good	No	Weir pool
TB18	TB18.1	NR 6939 2824	10	Inaccessible	Very poor	No	Inflow to loch. Very heavily silted.
TB21a	TB21a.1	NR 6782 2782	3	Inaccessible	Poor	No	Silted
TB24	TB24.1	various	3.5	Inaccessible	Poor-moderate	No	Several patches where gravel layer (over mud) is deep enough to allow spawning.
AC2	AC2.1	NR 6608 3003	2.5	Inaccessible	Moderate	No	
AC2	AC2.2	NR 6610 3006	1.5	Inaccessible	Moderate	Yes	
AC3	AC3.1	NR 6632 30121	2	Inaccessible	Poor	Possible	Some sand and silt
AC7	AC7.1	NR 6734 3003	1.5	Inaccessible	Moderate	Possible	
AC10	AC10.1	NR 6821 2987	2	Inaccessible	Moderate	No	

Appendix 8. Main obstacles to upstream migration

	<p>Tangy Burn Obstacle 1.1</p> <p>NR 6551 2782</p> <p>This culvert is immediately upstream of the normal tidal limit. It was not clear whether it might inundate on a high spring tide, potentially allowing salmonid access. The algae-covered concrete with inset stones is likely to be passable for eels.</p>
	<p>Tangy Burn Obstacle 1.2</p> <p>NR 6561 2783</p> <p>The waterfalls are approximately 2.4 m high but present difficult barriers due to the shallow plunge pool. Landings are poor for jumping fish.</p>
	<p>Tangy Burn Obstacle 1.3</p> <p>NR 6566 2785</p> <p>Total height is 3.8 m. It cascades onto bedrock and was judged impassable for salmonids.</p>

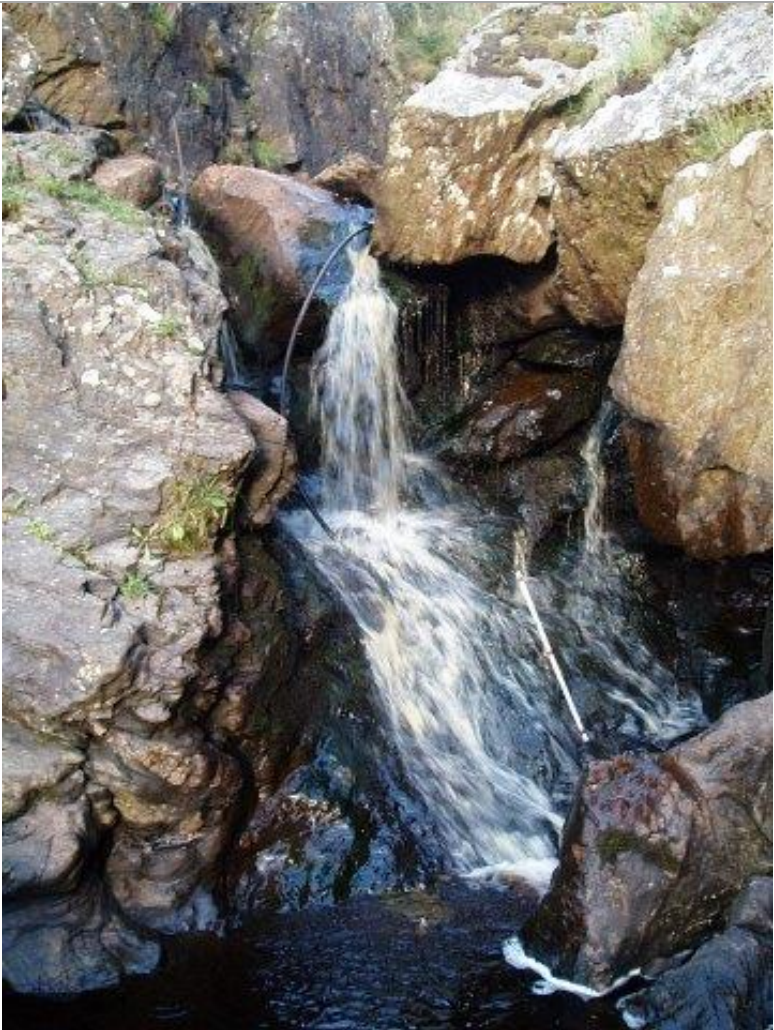

Appendix 8 contd.

	<p>Tangy Burn Obstacle 7.1</p> <p>NR 6675 2768</p> <p>This waterfall is 4 m high. It could not be approached from downstream due to the steepness of the banks and dense scrub.</p>
	<p>Allt Trasda Obstacle 19.1</p> <p>NR 6908 2845</p> <p>60 cm high boulder choke in tiny, shallow stream.</p>
	<p>Obstacle 23.1</p> <p>NR 6766 2837</p> <p>Perched culvert.</p>

Appendix 8 contd.

	<p>Allt a' Ghoirtein Obstacle AG1.1</p> <p>NR 6556 2803</p> <p>This culvert is immediately upstream of the normal tidal limit. It was not clear whether it might inundate on a high spring tide, potentially allowing salmonid access.</p>
	<p>Allt a' Ghoirtein Obstacle 4.1</p> <p>NR 6660 2849</p> <p>This 3 m high stepped cascade is impassable due to its steepness and lack of pools.</p>
	<p>Allt nan Creamh Obstacle 1.1</p> <p>NR 6583 2984</p> <p>Sumps, choke stones and cascades create a difficult obstacle. Passability uncertain.</p>

Appendix 8 contd.

	<p>Allt nan Creamh Obstacle 1.2</p> <p>NR 6584 2982</p> <p>This obstacle was judged to be impassable due to the difficult take off and the shallow ledge at 1.8 m height.</p>
	<p>Allt nan Creamh Obstacle 2.1</p> <p>NR 6601 2997</p> <p>This waterfall was estimated to be between 10 and 15 m high and could not be safely approached from downstream.</p>

Appendix 9. Habitat survey, stream habitat photographs

	<p>Tangy Burn Section 1 NR 6568 2785</p>
	<p>Tangy Burn Section 2 NR 6579 2783</p>
	<p>Tangy Burn Section 5 NR 6640 2771</p>

Appendix 9 contd.

	<p>Tangy Burn Section 7 T7 NR 6690 2768</p>
	<p>Tangy Burn Section 8 NR 6693 2769</p>
	<p>Tangy Burn Section 11 NR 6758 2779</p>

Appendix 9 contd.

	<p>Tangy Burn Section 11 NR 6772 2779</p>
	<p>Tangy Burn Section 12 NR 6802 2783</p>
	<p>Tangy Burn Section 13 NR 6819 2784</p>

Appendix 9 contd.

	<p>Tangy Burn Section 14 NR 6866 2799</p>
	<p>Tangy Burn Section 15 NR 6889 2803</p>
	<p>Tangy Burn Section 15 NR 6911 2803</p>

Appendix 9 contd.

	<p>Allt Trasda, east arm Section 19 NR 6902 2860</p>
	<p>Allt Trasda, west arm Section 17 NR 6895 2853</p>
	<p>Allt Trasda Section 17 NR 6885 2827</p>

Appendix 9 contd.

	<p>Unnamed stream 1 Section 21a NR 6781 2790</p>
	<p>Unnamed stream 1 Section 22 NR 6766 2817</p>
	<p>Unnamed stream 1 Section 23 (typical habitat) NR 6776 2858</p>

Appendix 9 contd.

	Unnamed stream 1 Section 23 (atypical habitat) NR 6777 2863
	Unnamed stream 2 Section 24 NR 6818 2792
	Unnamed stream 2 Section 25 NR 6804 2825

Appendix 9 contd.

 A photograph showing a small stream flowing over large, moss-covered rocks in a forest. The water is clear and shallow, and the surrounding vegetation is lush and green.	<p>Allt a' Ghoirtein Section 1 NR 6569 2805</p>
 A photograph showing a stream flowing through a forest. The stream is surrounded by many ferns and other green plants. The water is clear and shallow, and the surrounding vegetation is lush and green.	<p>Allt a' Ghoirtein Section 2 NR 6633 2835</p>
 A photograph showing a stream flowing through tall grass. The water is clear and shallow, and the surrounding vegetation is lush and green. A white measuring tape is visible in the foreground, indicating the location of the stream.	<p>Allt a' Ghoirtein Section 3 NR 6645 2843</p>


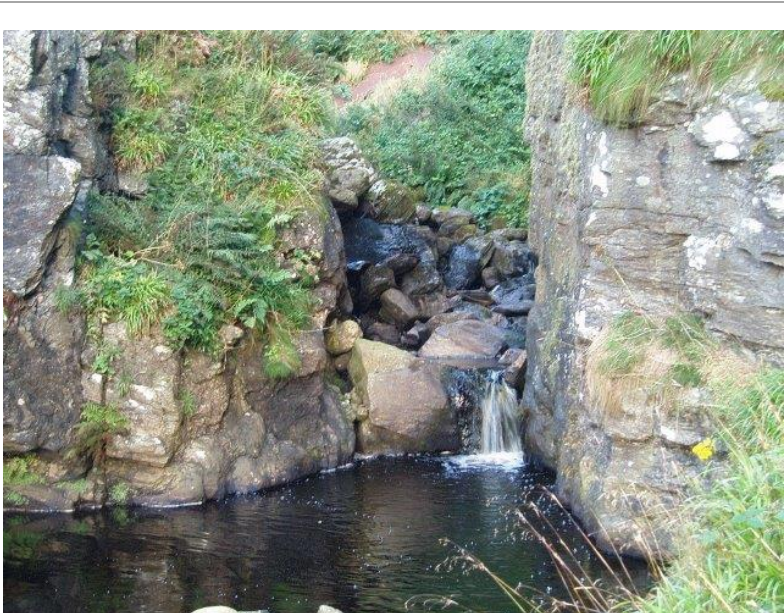

Appendix 9 contd.

	<p>Allt a' Ghoirtein Section 4 NR 6675 2854</p>
	<p>Allt a' Ghoirtein Section 4 NR 6701 2865</p>
	<p>Allt na Ceardaich Section 1 NR 6590 2929 (habitat)</p>

Appendix 9 contd.

	<p>Allt na Ceardaich Section 1 NR 6590 2929 (view upstream)</p>
	<p>Allt na Ceardaich Section 1 NR 6610 2918</p>
	<p>Allt na Ceardaich Section 2 NR 6673 2923</p>

Appendix 9 contd.

	<p>Allt nan Creamh Section 1 NR 6576 2981</p>
	<p>Allt nan Creamh Section 1 NR 6585 2982</p>
	<p>Allt nan Creamh Section 2 NR 6601 2997</p>

Appendix 9 contd.

	<p>Allt nan Creamh Section 3 (dense gorse) NR 6629 3017</p>
	<p>Allt nan Creamh Section 3 NR 6633 3021</p>
	<p>Allt nan Creamh Section 5 NR 6686 3020</p>

Appendix 9 contd.

	<p>Allt nan Creamh Section 7 NR 6732 3003</p>
	<p>Allt nan Creamh Section 9 NR 6805 2990</p>
	<p>Allt nan Creamh Section 10 NR 6824 2984</p>

Appendix 9 contd.

	<p>Allt nan Creamh Section 11</p>
	<p>Allt nan Creamh Section 12</p>
	<p>Allt nan Creamh Section 13 NR 6833 2979</p>

Annex 1. Tangy III Wind Farm. This iteration of the layout formed the basis for the fisheries surveys (note that the layout was later revised and number of turbines reduced).

