River Brora Fisheries Review & Management Plan 2020 to 2025

Prepared by Waterside Ecology on behalf of Brora District Salmon Fisheries Board

River Brora Fisheries Review & Management Plan 2020 to 2025

Contacts in relation to this document

Brora District Salmon Fisheries Board	Clerk to Board: Neil Wright, MA (Hons) MRICS Galbraith, 17 Old Edinburgh Road, Inverness, IV2 3HF neil.wright@galbraithgroup.com 01463 245368
Waterside Ecology	Jon Watt, PhD, MIFM jon@watersideecology.co.uk 01687 450298 Isabel Isherwood Isabel@watersideecology.co.uk

Citation: Watt, J. & Isherwood, I. 2020. River Brora Fisheries Review & Management Plan 2020 to 2025. Commissioned report to Brora District Salmon Fisheries Board, November 2020.

Table of Contents **Page**

List of Tables **Page**

1 INTRODUCTION

The River Brora has a long history as a sport fishery for salmon and sea trout, which would have colonised the river after the last ice age. As well as providing sport to anglers, both species have in the past been netted in considerable numbers in the rivermouth, Loch Brora and along nearby coasts. These and the other fish species that the river supports are not only a valuable economic resource, but also an important part of the local natural and cultural heritage, and an invaluable component of catchment biodiversity. This Fisheries Management Plan is aimed at ensuring they have a sustainable future.

The current plan builds on the work of others; notably the Management Plan for the period 2003 to 2008 prepared by Colin Carnie, which contains much useful data and some clear recommendations for future management. Some of Carnie's recommended actions remain unimplemented and, where still appropriate, have been carried forward into the current document, where they are supplemented by new data and observations.

This document is intended to fulfil two purposes. The first is to provide a series of management actions aimed at protecting or enhancing fish populations and the habitats that support them. In this regard it has a similar to purpose to Fisheries Management Plans (FMPs) that now cover most of the significant fisheries throughout Scotland.

Its second function is to provide the first detailed and quantified assessment of fish habitats within the Brora catchment, and to report on juvenile stocks within these habitats. Without information on the distribution, abundance and quality of fish habitats it is very difficult, perhaps impossible, to suggest objective advice on management. Likewise, management of salmonid fish in freshwater should reflect the currents status and distribution of young fish. Substantial parts of this document are therefore taken up with describing and quantifying habitats for spawning, juvenile and adult fish as determined by a full walkover survey of the catchment conducted during 2018.

The 2018 walkover survey covered over 150 km of watercourse, including all of the main rivers and larger accessible tributaries. Large data sets were collected during these surveys, and these are provided electronically elsewhere. In addition, several hundred geo-referenced photographs were taken, providing an additional baseline data set and allowing anyone with an interest to take a 'virtual walk' around the catchment all the way into the headwater streams. The habitat data and photographic archive provide essential tools to guide management for many years into the future; they are not intended to gather dust or be seen as part of a job done, but as a resource to help guide many jobs to come.

The current FMP briefly describes the Brora catchment and the fish populations it supports. It then goes on to set out the current status of habitats and fish populations within each of five sub-divisions within the catchment. It presents an analysis based on these data of issues potentially affecting fish populations, or that may in future threaten their long term sustainability. Finally, these data and observations are formulated into a series of proposed management actions, some relevant across the whole catchment and others specific to particular sub-divisions or streams. An earlier draft of the proposed Action Plan was circulated to members of the Brora District Salmon Fisheries Board, landowners and fisheries proprietors in 2019 and their feedback has been incorporated into the current version.

A number of the actions proposed within the Plan will inevitably have to be developed and modified around the needs of other users of the catchment – including deer stalking interests,

farming and renewable energy development. This is explicitly acknowledged in the text. Further work remains to agree which actions can be taken forward and at what scale, as well as to formulate these actions into detailed and fundable projects on the ground. The Plan is therefore intended as a living document. It should be reviewed regularly based on the Board's progress in executing agreed actions and on future monitoring data.

2 AIMS AND OBJECTIVES

The primary aim of the current management plan is to provide a framework for the maintenance of healthy, resilient and sustainable salmon and trout populations in the catchment of the River Brora and to guide the protection and enhancement of the habitats that support them. While salmon and trout are the primary focus, the plan is intended to cover all native freshwater fish species in the Brora catchment.

The proposed lifespan of the Plan is five years. During this time it will be subject to regular review and, where necessary, updating.

Specific objectives of the Plan are to:

- Maintain and where necessary improve the densities of juvenile salmon and trout in the Brora catchment.
- Maintain or maximise smolt output in order to stabilise or enhance the number of returning adult fish.
- Promote the restoration of degraded stream habitats and protect those that are currently healthy.
- Build resilience into the system to enable it to cope with climate change impacts, expected to include higher summer water temperatures and an increase in the magnitude and frequency of spates.

While the focus is very much on fish it is hoped that the proposed actions will benefit wider biodiversity in the Brora catchment. The Brora District Salmon Fisheries Board will therefore seek partnerships with other interested and willing parties to assist with delivery.

Figure 1. River Brora catchment showing main watercourses and landmarks referred to in text.

3 MANAGEMENT STRUCTURES, RESOURCES AND MANAGEMENT UNITS

3.1 Brora District Salmon Fisheries Board

3.1.1 Remit and funding

The management and protection of the River Brora fisheries stock is delivered by the Brora District Salmon Fisheries Board (BDSFB). DSFBs are created by statute, and once constituted, they assume a range of statutory powers and duties, including a regulatory function in certain areas such as stock protection. The revenue for a Board's work is generated privately. Salmon fishing rights in Scotland are private heritable titles that are registered separately from land. As such these titles can be bought and sold like any other property. In Scotland, the cost of the local administration, protection and improvement of the fisheries is privately financed by the proprietors. The district boards, including the BDSFB, finance their work by levying a rate on the salmon fishery owners in the district.

Elected representatives of those owners provide the core of the membership of the Board. However, since 1986, the boards are required also to include representatives of salmon anglers and salmon netsmen in the district, unless there are none, or none willing to stand. A further revision to the constitution of the Boards was made in 1999 amending certain restrictions on board sizes and duties.

The Board's statutory remit is set out by the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003, which consolidated the vast majority of the Scottish salmon and freshwater fisheries law into a single Act. The 2003 Act is the key governing legislation for Scotland's district salmon fishery boards, and it sets out the provisions for the constitution, composition and financing of the boards. It is also the framework for a number of other important regulatory areas, including legal methods of fishing and offences, close times, local regulatory measures, protection of juvenile and spawning salmon, passage of salmon, and general powers relating to appointment of water bailiffs and enforcement of salmon and freshwater fisheries law. A number of amendments were made to the 2003 Act by the Aquaculture and Fisheries (Scotland) Act 2007. The Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 allows Boards to make applications to Ministers for a greater range of statutory measures to allow them to manage and conserve the fish and fisheries in their district. The Boards' remit does not extend to non-salmonid species or to resident brown trout upstream of impassable obstacles.

Scotland's boards are represented at national level by Fisheries Management Scotland. Fisheries Management Scotland was formed in 2016 and represents District Salmon Fishery Boards, River Tweed Commission and Fisheries Trusts and Foundations in Scotland. Its stated aims are to:

- Promote and ensure the best fisheries management for the protection, preservation and development of Scotland's wild salmon and freshwater fish, along with their fisheries and environment.
- Represent the interests of our member organisations.

3.1.2 Resources

At the time of writing the Brora DSFB employs two full time water bailiffs who also conduct other aspects of fisheries management including electric fishing surveys and, when operational,

hatchery duties. Both bailiffs have basic SFCC electric fishing qualifications. A seasonal bailiff is usually employed between June and September each year.

The Board has a Clerk, who co-ordinates much of the Board's business including dealing with external consultants and acting as liaison with the various proprietors and landowners.

The DSFB has access to a fully operational hatchery. This is sites on the Oldtown Burn and is gravity fed from that stream. It consists of a series of hatchery trays and seven tanks. According to Carnie (2002) the hatchery has capacity for a maximum of 200,000 fry but if fish are grown until late summer capacity would be closer to 70,000.

The DSFB owns electric fishing equipment as follows: Electracatch WFC911 and anodes, along with various stop nets and ancillary equipment for juvenile survey work and broodstock collection.

3.2 Angling clubs

There are three angling clubs at present: the Loch Brora Angling Club, the Golspie Angling Club and the Dornoch & District Angling Association. The angling clubs have access to Loch Brora, which is fished by boat only. All boats are launched from the north bank on Gordonbush Estate by agreement. The town water is administered by the board (but owned by Gordonbush estate and Uppat estate). There are season tickets available for local residents and day and week tickets for visitors.

3.3 Others

3.3.1 Marine Scotland and Marine Scotland Science

Marine Scotland is a Directorate of the Scottish Government and is responsible for the integrated management of Scotland's seas, including fisheries. The Freshwater Fisheries Laboratory at Pitlochry was subsumed into Marine Scotland in 2009 and its activities fall within the operation of Marine Scotland Science (MSS), the scientific Division of Marine Scotland. The purpose of science within Marine Scotland is to:

- provide expert scientific, economic and technical advice and services on issues relating to marine and freshwater fisheries, aquaculture, marine renewable energy, and the aquatic environment and its flora and fauna
- provide the evidence to support the policies and regulatory activities of the Scottish Government through a programme of monitoring and research
- perform regulatory and enforcement activities
- represent the Scottish Government at national and international meetings.

MSS recently commissioned two wide ranging national electric fishing surveys of juvenile salmonids throughout Scotland, including on the catchment of the River Brora. MSS is responsible for stock assessments underpinning the Conservation of Salmon (Scotland) Regulations 2016, which set river by river limits on the exploitation of salmon.

3.3.2 Scottish Environment Protection Agency

The Scottish Environment Protection Agency (SEPA) is a non-departmental public body of the Scottish Government. It has a wide-ranging role in environmental protection including the control of polluting discharges. It is responsible for delivery of the EU Water Framework Directive. Protection of aquatic environments is implemented in part through the Water

Environment (Controlled Activities) (Scotland) Regulations 2011 – more commonly known as the Controlled Activity Regulations (CAR). These regulate a wide range of potential impacts on aquatic environments including water abstraction (including for hydropower schemes), discharges, gravel extraction and river engineering. SEPA also administers some funds aimed at restoring rivers and streams.

3.3.3 Scottish and Southern Energy

Scottish and Southern Energy (SSE) has no formal role in fisheries management in the catchment but it does have significant interests in power generation and operates the weir and fish pass at Dalnessie. It also has interest in wind generation within the catchment. SSE takes a pro-active role in fisheries management and employs a trained and highly experienced fish ecologist to assist in this. SSE helped fund the development of the current FMP by part-funding the walk-over survey in 2018.

3.3.4 Scottish Natural Heritage

Scottish Natural Heritage (SNH) is not directly involved in fisheries management. However, as Atlantic salmon and lampreys are listed on Annex II of the Habitats and Species Directive they take an active interest in the conservation of these species. SNH has responsibility for delivery of conservation objectives with Sites of Special Scientific (SSSIs) and Special Areas for Conservation (SACs) in the catchment.

3.3.5 North Atlantic Salmon Conservation Organisation (NASCO)

NASCO is an international organization, established to conserve, restore, enhance and rationally manage Atlantic salmon through international cooperation. Regulatory and other measures established by NASCO have greatly reduced harvests of Atlantic salmon all around the North Atlantic. Only Governments are members of NASCO, which has six Parties: Canada, Denmark (Faroes, Greenland), the European Union, Norway, the Russian Federation and the USA. The UK may rely on licence conditions and domestic legislation to implement measures adopted by NASCO after it has left the EU, but this is uncertain.

3.4 Management units

3.4.1 Units defined for management planning

For the purposes of data presentation and management planning the current document recognises five Management Units, based on sub-catchments. These are as follows (see also Figure 1 above):

- **Lower Brora**: mainstem of River Brora from sea to Loch Brora.
- **Middle Brora:** Includes Loch Brora and tributaries, and the mainstem of the River Brora from the loch to the confluence with the Black Water at Balnacoil.
- **Upper Brora**. River Brora upstream of the Black Water confluence including tributary streams and headwaters (sometimes referred to as Dalreavoch Brora).
- **Black Water**: Including Black Water, Abhainn Srath na Sealga, Coirefrois Burn, headwater streams and other tributaries excluding River Skinsdale. In the text, “lower Black Water” refers to the reach downstream of the River Skinsdale confluence.
- **Skinsdale**. River Skinsdale from its confluence with the Black Water, including Garvary Burn, Allt an Ealaidh and other tributary streams.

3.4.2 Ownership

The following estates own land within the Brora catchment.

- Loch Choire
- Borrobol
- Dalnessie
- Ben Armine (Sutherland Estate)
- Balnacoil
- Tressady
- Dalreavoch (Sutherland Estate)
- Sciberscross
- Dunrobin (Sutherland Estate)
- Gordonbush
- Uppat
- Cadogan

Further details of land and fishery ownership in each management unit are provided in Tables 1 to 4 and an ownership map is provided as Figure 2.

Table 1 Ownership, Lower Brora

Estate	Watercourses
Uppat	Right bank of lower River Brora from loch to sea.
Cadogan	Left bank of lower River Brora from loch to sea.

Table 2 Ownership, Middle Brora

Estate	Watercourses
Gordonbush	Left bank of Loch Brora. Tributaries including Allt Smeorail and Oldtown Burn. Left bank of River Brora from Ascoile Burn to Loch Brora. Also the left riverbank and angling rights upstream as far as Balnacoil. Tributaries include Ascoile Burn/Allt a' Mhuilinn.
Uppat	Right bank of Loch Brora. Carrol Burn, Allt Coire Aghasaig, Ducharry Burn
Dunrobin	Right bank of River Brora from Balnacoil to Loch Brora; Scottarie Burn.
Balnacoil	Land along left bank of River Brora from Balnacoil to Ascoile Burn; however does not own the riverbanks itself or the angling rights. Allt Ach a'Bhathaich.

Table 3 Ownership, Upper Brora

Estate	Watercourses
Dalnessie	Allt Gobhlach and tributaries; Allt a' Bhaid Leathain; An Crom Allt to NC 646 198; upper Allt Preas a' Chraicinn; Allt nan Con-Uisge. Both banks of river Brora from headwaters to Cnocan (NC 648 144), left bank only from Cnocan to NC 668 135; tributaries Allt an Eisg and Allt na h-Innse Mor.
Ben Armine	An Crom Allt upstream of NC 646 198

Tressady	Right bank of River Brora from Cnocan (NC 648 144) to Dalreavoch (NC 750 086); Includes tributaries Allt Coire Chaorachaidh and Corrish Burn.
Dalreavoch	Left bank of River Brora from NC 668 135 to Dalreavoch (NC 750 086), and both banks from here to road bridge at NC 755 088; Includes tributaries Allt a Mhuilt, Allt an Eisg, and Allt Fearna
Dunrobin	Right bank of River Brora from bridge downstream of Dalreavoch (NC 755 088) to Balnacoil.

Table 4 Ownership, Black Water

Estate	Watercourses
Loch Choire	Allt na Seilich Bige and tributaries; right bank of Allt na Seilch Moire; right bank of Abhainn Srath na Seilge from bothy (NC 665 247) to Caochan na Luibe (NC 657 238)
Ben Armine	Left bank of Allt na Seilch Moire; left bank of Abhainn Srath na Seilge from bothy (NC 665 247) to Caochan na Luibe (NC 657 238); both banks of Abhainn Srath na Seilge from NC 657 238 to bridge above Dalbreck (NC 735 171). Allt Coire a' Mhile, Allt Coire an Fhaicnich and upper Allt an Loin Earraich. Coirefrois Burn from NC 703 153 to Loch an t-Slugaite, left bank only upstream of loch.
Dalreavoch	Right bank of the Black Water from Balnacoil to bridge above Dalbreck (NC 735 171); Coirefrois Burn from confluence to NC 703 153, Allt a Mhuilinn Duibh
Balnacoil	Balnacoil Estate owns the left bank of the Black Water from the bridge above Dalbreck (NC 735 171) to the Skinsdale confluence, and owns the land adjacent to the river from here to Balnacoil, but does not own the river bank itself. Lower Allt an Loin Earraich; Long Pool Burn
Gordonbush	Owns angling rights and left bank from Balnacoil to the Skinsdale confluence.
Dalnessie	Coirefrois Burn right bank upstream of Loch an t-Slugaite.

Table 5 Ownership, Skinsdale

Estate	Watercourses
Loch Choire	Upper Allt an Ealaidh from loch to confluence with Allt Coir' an Eas. Left bank of Allt Coir' an Eas
Borrobol	Upper Skinsdale from sheilings (NC 765 235) up to Allt an Ealaidh confluence with Allt Coir' an Eas. Allt a'Choire Bhuidhe, Allt Preas a'Chamraig.
Ben Armine	Right bank of Allt Coir' an Eas; Upper Garvary burn and tributaries to NC 750 207, just over 1 km upstream of the confluence with the River Skinsdale
Balnacoil	Balnacoil owns the land around the Skinsdale from the confluence with the Black Water up as far as the sheilings at NC 765 235, but does not own the watercourse itself or the riverbanks Owns the lower reach of the Garvary Burn from the Skinsdale to NC 750 207
Gordonbush	Owns the Angling rights and riverbanks from the Black Water confluence up to the sheilings at NC 765 235

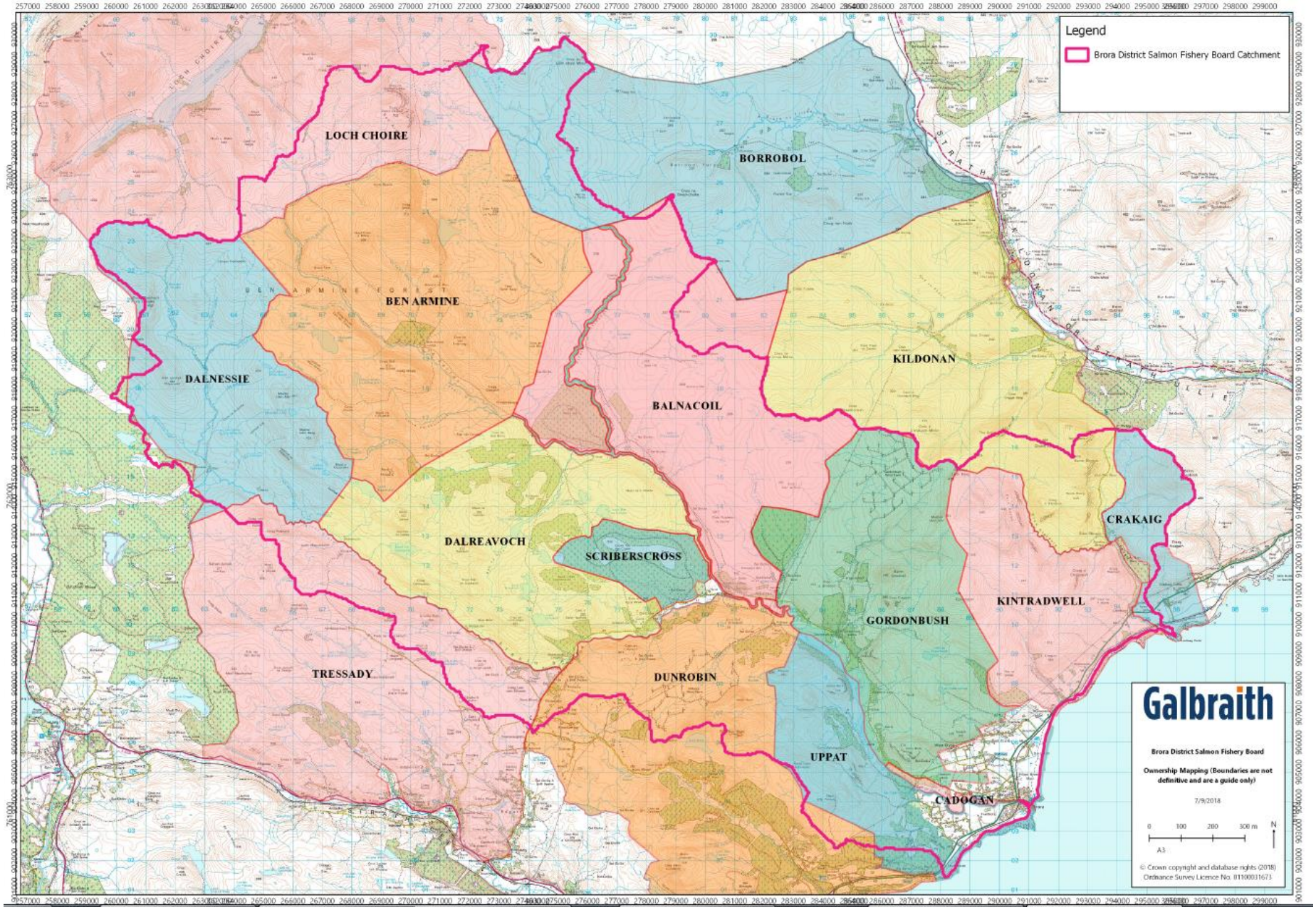
3.5 Other relevant plans and documents

The current document recognises the relevance of a number of other plans and documents, which relate in whole or part to management of the catchment or its fisheries. These include:

- Management Plan for the River Brora 2003 – 2008 (Carnie 2002)
- Report on the electro-fishing survey of juveniles carried out in August 2003 with recommendations and additions to the Management Plan (Carnie 2003)

- East Sutherland Deer Management Group, Deer Management Plan http://esutherlanddmg.deer-management.co.uk/deer-management-plan/
- Sutherland Biodiversity Action Plan https://www.caithness.org/atoz/sutherland/actionplan2003/index.htm
- The River Basin Management Plan for the Scottish River Basin District: 2015 – 2027. https://www.sepa.org.uk/media/163445/the-river-basin-management-plan-for-the-scotland-river-basin-district-2015-2027.pdf
- Moray Firth Seal Management Plan (Butler et al. 2008).

Figure 2. Land ownership within the catchment

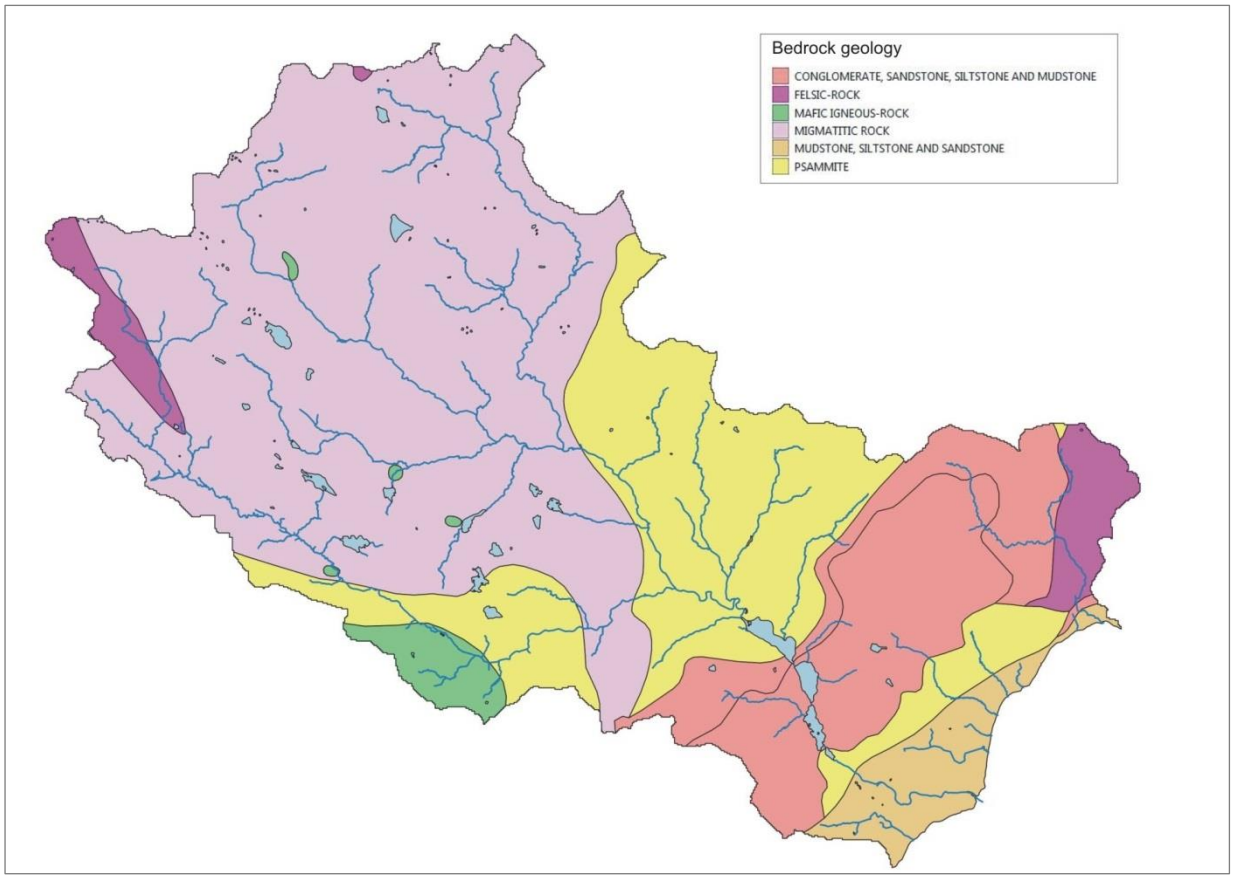


4 THE RIVER BRORA CATCHMENT

4.1 Geology

A simplified map of the bedrock geology of the River Brora catchment is shown below. The geology changes west to east in a series of broad bands. The upper reaches of the River Brora, Black Water and River Skinsdale all drain migmatic rocks and psammites. These are broad categories of metamorphosed sediments, common in northern Scotland, and part of the Moine supergroup. East of Loch Brora, the river flows mainly through un-metamorphosed sedimentary rocks, mainly sandstones and mudstones. The geology of the upper catchment is relatively hard, as the metamorphosed rocks weather slowly. The influence of the underlying geology on the watercourses in the catchment is felt in the low to moderate conductivity of the water and a moderate degree of 'buffering' against changes in levels of acidity.

Figure 3. Bedrock geology in the Brora catchment

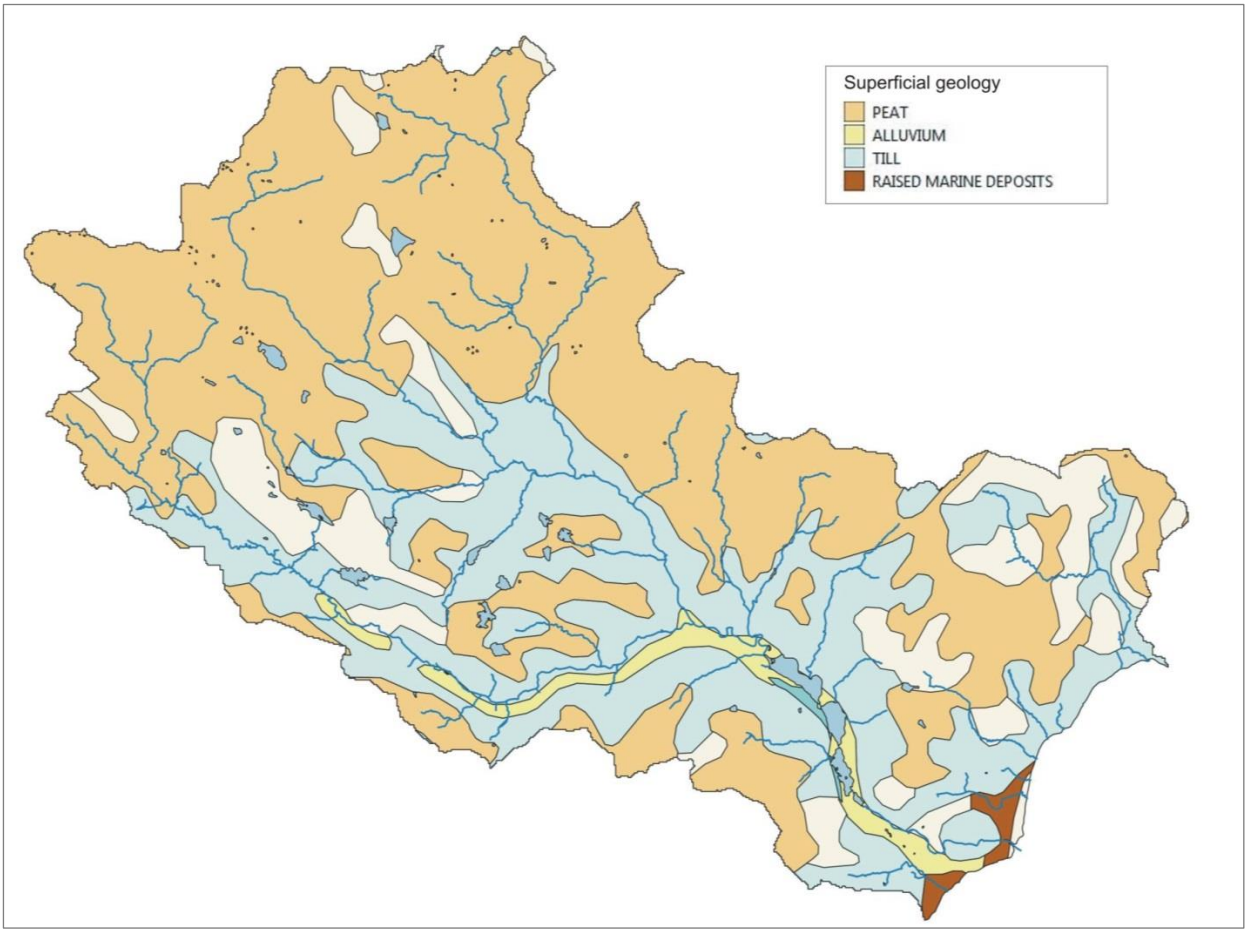


The bedrocks that underlie the catchment are ancient, and have been subject to numerous changes over time. Changes include glaciation and, more recently, the formation of blanket peat. Rain and frost continue to weather the rocks. The rivers and streams have themselves added to these changes and the processes of erosion and deposition are ongoing. It should not be forgotten that rivers are transporters of sediments as well as of water, and that this sediment transport is a vital component of the formation of fish habitats. Where rivers cut through glacial deposits or older riverine 'alluvial' deposits changes can be relatively fast; this may be seen in erosion on the outside of bends in rivers and deposition on the inside where current speed is sufficiently slow.

The superficial (also known as drift) geology of the catchment is shown in Figure 4. Most of these superficial deposits are unconsolidated sediments such as gravel or sand and they form relatively thin, discontinuous patches over the underlying bedrock. Many are largely classified by their origin. For instance, tills are derived from the erosion and transport of materials, often derived from bedrock, by the moving ice of a glacier. Tills may be deposited some distance 'down-ice' of their origin in the form of moraines. Alluvium refers to loose, unconsolidated soil or sediment that has been shaped by water in some form. Other drift materials are classified by their composition and this includes 'peat', which results from the incomplete decomposition of plant remains in waterlogged conditions. As peat formation occurred after the ice age, peat in the Brora catchment is often found on top of layers of till or moraine deposits.

The map below is at a very coarse scale but highlights a number of features that are pertinent to the management of riparian habitats. Of particular interest is the relative distribution of peat, tills and alluvium. Till is present in broad areas around the Brora and Black Water sub-catchments. In very general terms, this type of drift geology is likely to be suited to agriculture and forestry, as are the alluvial soils alongside the River Brora. In contrast, the River Skinsdale flows through an extensive area of peat. Surface glacial material are restricted to a narrow strip along the river (not visible at this map scale) [1], with peat extending closely into the riparian zone. This distribution of surface material has implications for riparian management in each management unit and this is considered further in sections 9 and 10.

Figure 4. Superficial geology in the Brora catchment



[1] Detailed drift and bedrock geology may be viewed via the British Geological Survey interactive map pages: http://mapapps.bgs.ac.uk/geologyofbritain/home.html

4.2 Land cover and use

Land Cover Scotland data (LCS88) collated by the Macauly Land Use Research Institute show that the predominant land cover types in the catchment are blanket bog and heather moor (Figure 5). These land cover categories broadly coincide with the superficial geology types identified as peat and till on the map above. The predominant land use in the upper catchment is sporting, with most of the headwater areas managed for red deer. All of the catchment falls within the East Sutherland Deer Management Group (ESDMG). The ESDMG website[2] suggests that the blanket bog and moorland area are grazed both by red deer and sheep, with red grouse also being locally important in some areas. The balance of these objectives varies between ownerships, but red deer are an important objective throughout. During the 2018 survey of the catchment it was apparent that red deer graze very widely, while sheep grazing is largely restricted to the lower ground. Sheep grazing is most prevalent along the River Brora upstream of Balnacoil, including many reaches between Balnacoil and Dalnessie and further upstream into the headwaters. Grazing pressure in some reaches is intense.

Cattle are grazed along parts of the River Brora between the loch and Balnacoil and also around Craigton. Carnie (2002) provided data showing that cattle and sheep numbers in the lower catchment had increased over the decades, but no recent data have been compiled. The impression formed during the walkover survey was that in most parts of the catchment, with the exception of the upper River Brora around Dalnessie, deer browsing and grazing were likely to have the most significant impact on vegetation structure with additional, but localised, impacts from farmed livestock. Further details of grazing effects in riparian habitats are provided elsewhere in this document.

Woodlands make up a very small area within the catchment, although this has increased since the LCS88 data were compiled as result of woodland grant schemes. A recent map of native and near native woodland is provided below, based on Scotland-wide survey data[3]. This includes a substantial block around Coirefrois Burn that was planted the last 15 years and is not shown on the LCS88 data. Woodland Grant Scheme (WGS) blocks on the upper River Brora between Braegrudie and Craigton, and on the hill to the south of the River Brora upstream of the loch are not shown below as they are too recent.

There is relatively little coniferous forestry in the catchment. The largest block is between Sciberscross and Balnacoil. This extends to approximately 11 km^2 but is well back from the River Brora. There is a smaller block of approximately 4 km^2 forming a triangle between the lower reaches of the River Skinsdale and the Black Water. This too has been kept well back from the river and is not drained by any significant tributaries. A third block is present north of Ascoile. This is shown as ‘recently ploughed land’ on Figure 5 above. It was planted in 1982 and some has recently been felled. Other small conifer blocks are present near Gordonbush and Ben Armine Lodge. Overall, forestry planting and operations have had little impact on the rivers within the catchment and, as pointed out by Carnie (2002), forestry is not seen as problem to fisheries or fish populations. The sole exception is in the forestry block near Ben Armine Lodge, where wind thrown trees and forest debris may threaten to restrict fish access into Allt Coire a’ Mhile (see section 6.5.2).

[2] http://esutherlanddmg.deer-management.co.uk
[3] https://map.environment.gov.scot/sewebmap/?layers=habmos-NativeWoodlandSurveyScotland&extent=-300849,475191,722793,1268192

Figure 5. River Brora catchment main land use classifications (LCS88)

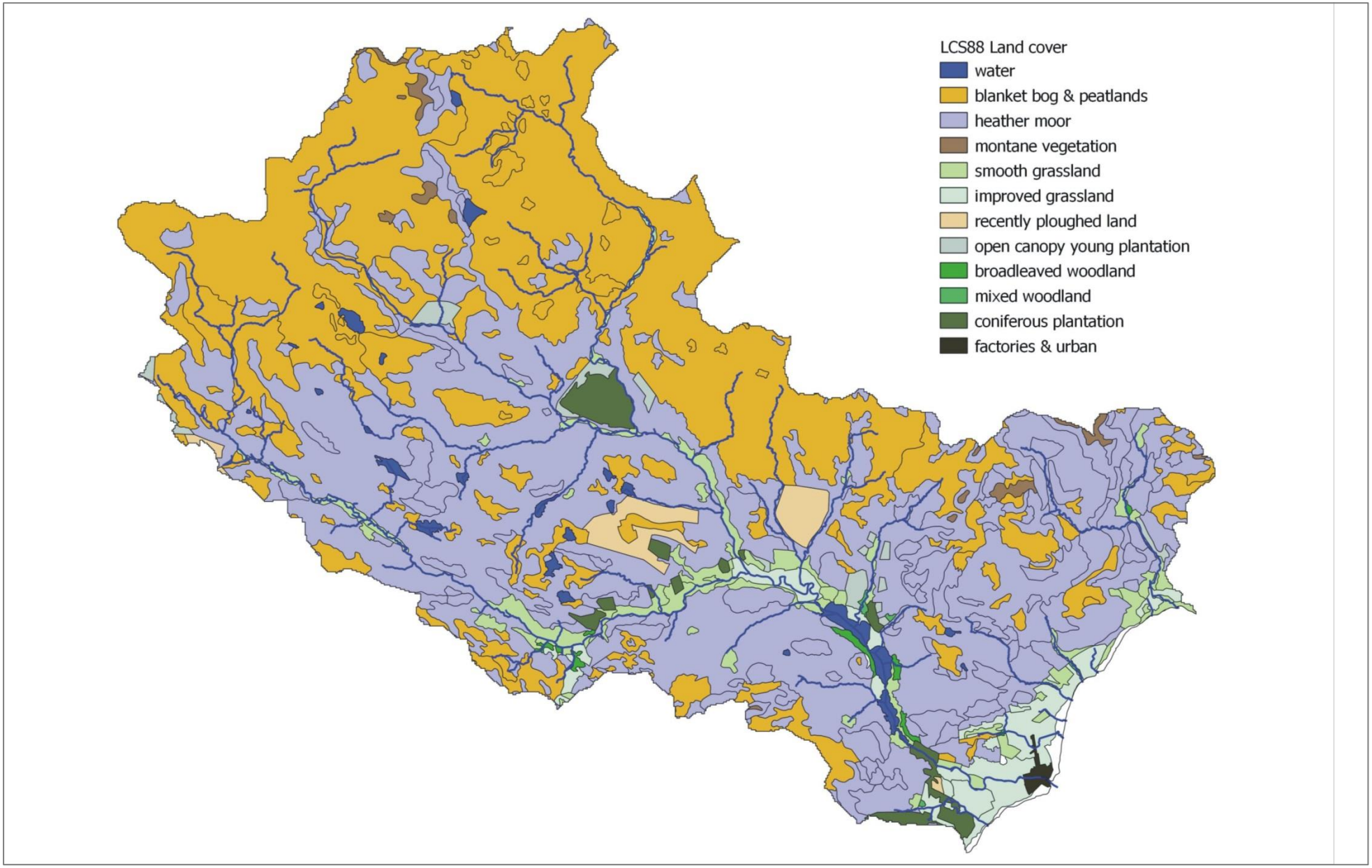
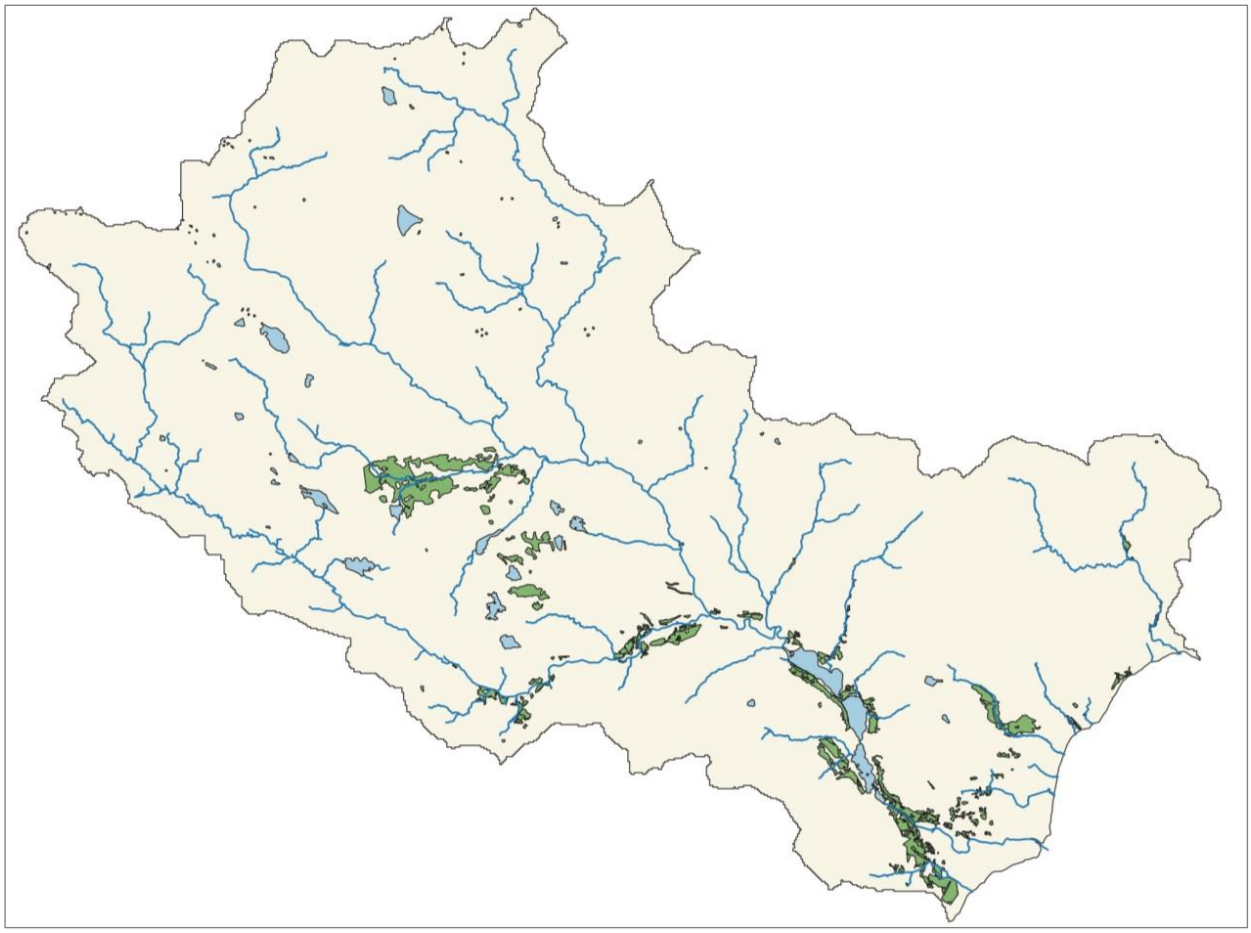


Figure 6. River Brora catchment, extent of native and near-native woodland



4.3 Hydrology

4.3.1 Flows

The River Brora has a catchment area of 434 km^2. Mean annual daily flow at Bruachrobie on the lower River Brora, where there is a SEPA gauging station, is approximately 12.0 cubic meters per second[4]. The annual maximum flow is typically more than ten times greater than this, usually exceeding 150 cubic meters per second ($m^3.s^{-1}$). Even greater flows occur in some years and maximum flow during 2002 exceeded 300 $m^3.s^{-1}$. The 95% exceedance at Bruachrobie – roughly equating to a low summer flow – is approximately 1.0 $m^3.s^{-1}$.

The flow regime of the River Brora is largely natural and there are no significant impoundments (reservoirs). A weir at Dalnessie (NC 631 153) diverts some of the flow from the upper River Brora to the Shin catchment to supplement hydroelectric generation at Lairg/Loch Shin. The impact of this is likely to be greatest on the River Brora upstream of the Black Water confluence at Balnacoil, as there are no major tributary streams above this point. It is worth noting that the Black Water at Balnacoil has a larger upstream catchment area than the River Brora at the same location. Despite the abstraction, the River Brora upstream of Balnacoil is identified by Scottish Environment Protection Agency as having 'good ecological potential'. The abstraction is considered further in section 4.3.2 below.

[4] https://nrfa.ceh.ac.uk/data/station/info/2002

There are several lochs within the catchment of the River Brora. The largest of these is Loch Brora, which is located downstream of the River Brora/Black Water confluence. Loch Brora has a surface area of 225 ha (2.25 km^2). All of the other lochs in the catchment are much smaller[5], with surface areas not exceeding 45 ha. In this respect the River Brora differs substantially from the neighbouring River Helmsdale, which has very large headwater lochs which store rainwater and release it relatively slowly compared to flowing waters. As a result, the upper catchment of the Brora system has a rather more flashy nature than its neighbour, responding relatively quickly to rainfall events without the ameliorating effect of storage in large lochs.

4.3.2 Abstraction

The off-take at Dalnessie is the sole large-scale abstraction within the catchment. Water is abstracted via a cut that carries part of the flow of the upper River Brora westwards into the Feith Osdail in the catchment of the River Shin. There is no storage and water is provided downstream of the weir as a hands-off flow delivered via the fish pass. The volume of the hands-off flow varies through the course of the year (A. Stephen, SSE, pers. comm.). It is highest in the periods April to June and September to October. The early increased flow was initiated to protect a recognised early run of sea trout, which ascend (or used to ascend) the river during the spring. The later increase is intended to protect the autumn spawning migration.

Throughout the period 1st April to 30th September the operator (Scottish and Southern Energy) is obliged to provide 21 freshets. These are more properly understood as increases in hands-off flow as true freshets would require storage. The 'freshets' can therefore be provided only during periods when the river level is rising naturally. During such periods additional flow is provided mainly via the scour valve at the weir. As they are reliant on naturally increased discharge the timing of the freshet regime is variable.

The offtake itself is screened to prevent smolts passing into the cut and Feith Osdail. A number of screen designs have been used in the past, but the current screen is a vertical bar design with a 12 mm spacing. The fish pass is of a pool and step design and flow through it can be varied by the operation of a sluice.

Sediment management is viewed as an ongoing issue by the operator, as sand accumulates in the chamber and top of pool of the fish pass following some spate events. Agreement has been reached with SEPA that this material may be disposed of on land rather than being reintroduced to the river downstream where it might impact negatively on juvenile salmonid habitats[6].

4.4 Water quality

The Brora catchment is sparsely populated and lacks large areas of intensively farmed arable land, which might impact on water quality. Indeed Carnie (2002) points out that the area under cultivation within the catchment has declined substantially over the past century.

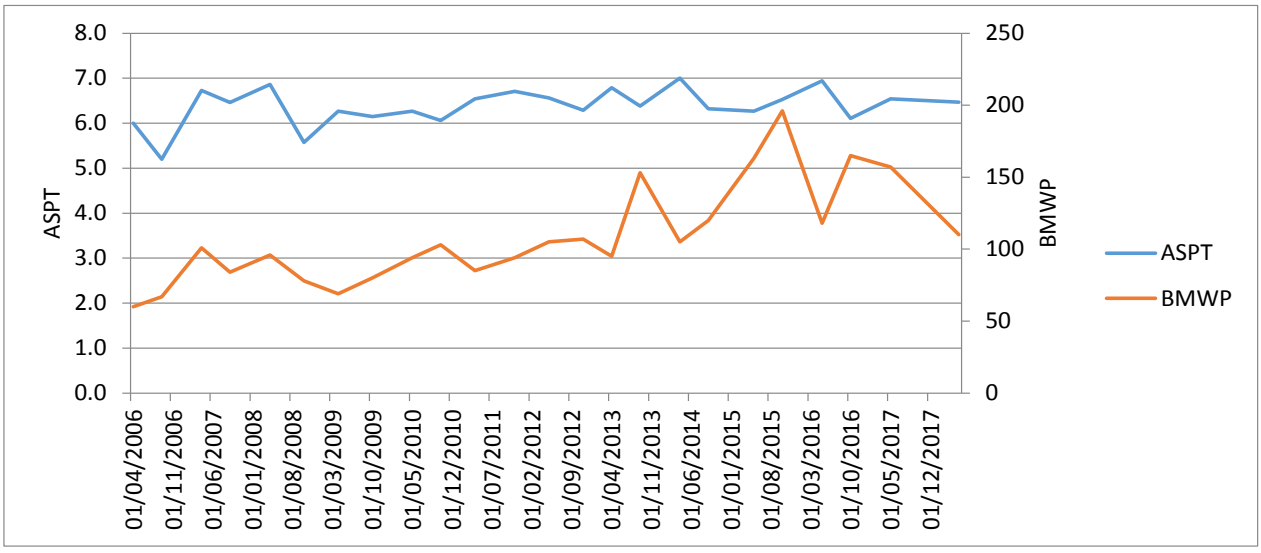
[5] SNH, Standing Waters Database http://gateway.snh.gov.uk/pls/apex_cagdb2/f?p=111:3:
[6] Information on the operation and design of the Dalnessie intake was provided by Dr Alistair Stephen (SSE).

The Scottish Environment Protection Agency (SEPA) has monitored freshwater macroinvertebrates at a site on the lower River Brora since 2006. Aquatic invertebrates are used as biological indicators to assess the general quality of streams and rivers. The production of biotic indices to assess water quality is an established method using the BMWP (Biological Monitoring Working Party) and ASPT (Average Score Per Taxon) scoring systems. These scores were primarily developed for identifying organic pollution, but are widely used as indicators of general stream health. The scoring system is based on the pollution sensitivity of each invertebrate family. The ASPT scale is 1 to 10. A score of 1 is allocated to the most pollution tolerant families and 10 to the most sensitive. The BMWP index is the sum of the group scores for the sample. The ASPT (Average Score Per Taxon) index is the average score for the groups present in the sample. Thus a low score for the BMWP or ASPT indices for a sample of invertebrates indicate possible pollution while high scores indicate good water quality.

Data collected between 2006 and 2018 suggest that water quality may have improved slightly over that period (Figure 7). The stable and reliable ASPT score has consistently been above 6.0 for the past ten or more years. This score would be classified as 'excellent' and indicates that water quality is more than adequate to sustain salmonid populations if other aspects of the environment are suitable. The BMWP index has similarly remained above the threshold of 85 for 'excellent' for at least a decade.

Two other sites have been sampled periodically by SEPA, but lack long term data. One of the sites is by Dalreavoch on the upper River Brora, which was sampled on five occasions between 2005 and 2015. ASPT scores ranged mainly from 6.4 to 7.0, and BMWP from 119 to 136 (Appendix X) indicating excellent water quality. Samples taken in autumn 2006 were an exception with ASPT and BMWP scores of 5.8 and 76, both classified as 'good' and well within the tolerance of salmonid fish. The second site is on Allt Ach' a' Bhàthaich/Allt a Mhuilin at Ascoile, sampled on eight occasions between 2007 and 2013. All ASPT scores were excellent as were BMWP scores, with a single exception (good) in March 2007.

Figure 7. ASPT and BMWP water quality scores, River Brora, 2005 to 2018



The lists of species provided by SEPA suggest a community dominated by Ephemeroptera, Trichoptera and Plecoptera – the angler's mayflies, caddisflies and stoneflies respectively. These are species of clean, well oxygenated watercourses, underscoring the generally high standard of water quality in the river. These species also form a large part of the diet of juvenile

salmon and trout. Some of the SEPA samples included very large numbers of Baetid species – small mayflies that are favoured by drift feeding salmon.

No specific pollution threats were recorded during the 2018 walkover survey. Overall, the data suggest good or excellent water quality within the catchment. It is worth noting that all of the available invertebrate data are from low down in the catchment and that data from River Skinsdale, Black Water and the upper reaches of River Brora are lacking as are data from tributary streams. While it is improbable that water chemistry is a significant issue in these upper reaches, sedimentation due to peat erosion may be a problem in some watercourses. Additional data on invertebrate populations may be useful in better understanding stream productivity and food resources for juvenile salmonids within the upper catchment.

4.5 Designations

The catchment includes a number of sites designated for their natural heritage. These are:

- Lairg and Strathbrora Lochs Special Protection Area (SPA). These are a series of lochs designated for their populations of black-throated divers. Within the Brora catchment the SPA includes Loch Beannach (NC6814), Loch na Gaineimh (NC6912), Loch Bad na h-Earba (NC7613) and a second Loch Beannach near Dalreavoch (NC7411).
- Caithness and Sutherland Peatlands Site of Special Scientific Interest/SAC consisting of two designated areas - Skinsdale Peatlands and Coir' an Eoin Peatlands. Skinsdale Peatlands SSSI extends across most of the hill ground drained by the River Skinsdale, encompassing the headwater streams. It extends north into parts of the Helmsdale catchment. The primary qualifying interest is the blanket bog habitat. Other qualifying interests include otter, peat pools and clear-water lochs with aquatic vegetation and poor to moderate nutrient levels. The blanket bog habitat was assessed by SNH in 2011 as being in 'unfavourable, declining' condition, with trampling identified as the main negative pressure[7]. The SSSI forms parts of the following land holding: Ben Armine, Loch Choire, Borrobol and Balnacoil (Gordonbush own parts the river).

  The Coir' an Eoin peatland SSSI lies to the north of Balnacoil and east of the Black Water. It is drained by a number of tributary streams flowing either west into the Back Water or South into the River Brora. It is notified for its blanket bogs and associated habitats as well as for golden plover. Assessments by SNH suggest that the SSSI is affected by overgrazing and it categorised as 'unfavourable, recovering' in 2009[8]. It lies almost entirely within the Balnacoil Estate land holdings.
- Carrol Rock (SSSI) is on the side of Loch Brora. This site has been notified for the birch wood that extends for about 2.5 km along the south shore of Loch Brora. The birch wood has established on block scree beneath Carrol Rock. The block scree birch woodland habitat is considered to be of national importance.

The designation of these sites is likely to be complementary to the interest of the fisheries and fish populations and the peatland areas in particular have a high value within the catchment. As previously noted by Carnie (2002), the protection of peat-based wetlands in headwater areas is positively beneficial, as they act as slow release reservoirs, benefitting the hydrology and ecology of the river.

[7] https://sitelink.nature.scot/site/1439

[8] https://sitelink.nature.scot/site/385#features

5 FISH SPECIES IN THE RIVER BRORA CATCHMENT

5.1 Atlantic salmon

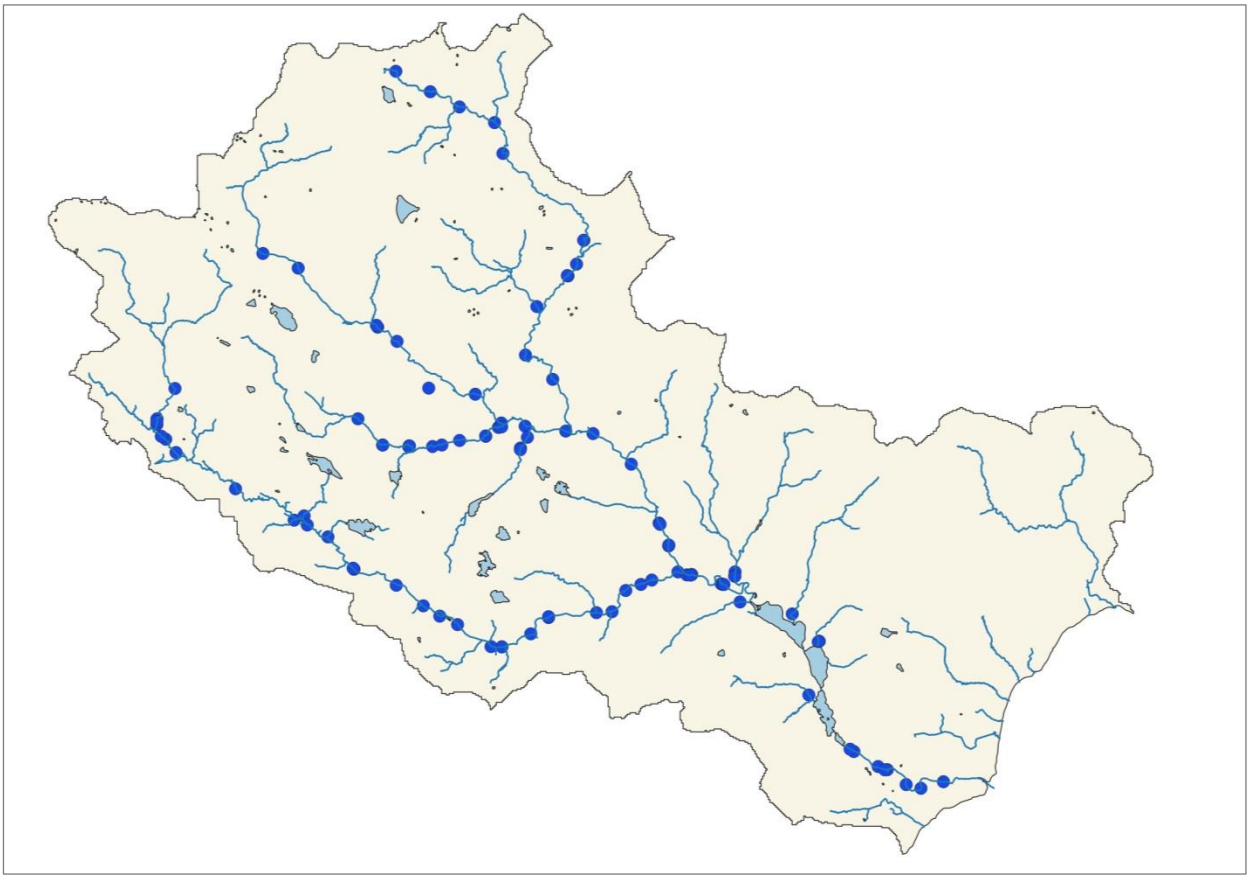
Salmon are the most economically important fish species in the Brora catchment and are the focus of much of the fishery management and angling effort. Current and past survey data suggest they are widespread in all of the larger watercourses where they have access from the sea. The full extent of their distribution remains uncertain, as survey data from tributary streams is limited. Furthermore, the upstream limit of salmon distribution in some parts of the system is uncertain.

On the River Brora itself, adult salmon typically migrate as far upstream as the waterfall approximately 1 km upstream of Dalnessie at NC 628 161. This waterfall is normally a barrier to salmon due to its height and the rather shallow plunge pool. However, electric fishing in 2018 found small numbers of salmon fry upstream of it, indicating that it is not always a total barrier.

The upstream migratory limit of the Blackwater is believed to be a rapid/cascade at NC 662 222, approximately 5.5 km upstream of Ben Armine Lodge. No juvenile salmon were found upstream of this natural obstacle during electric fishing surveys in 2003 or 2018. It is not known whether sea trout can ascend this obstacle. Coirefrois Burn is thought to be accessible to NC 691 162, where there is a waterfall.

Surveys conducted in 2020 showed that the upstream limit of salmon distribution on the River Skinsdale extends at least as far upstream as the headwaters of Allt an Ealaidh, to within approximately 1 km of Gorm-loch Beag. Their distribution in the larger tributaries including Garvary Burn is uncertain.

Figure 8. Distribution of juvenile salmon based on electric fishing surveys 1999 to 2020



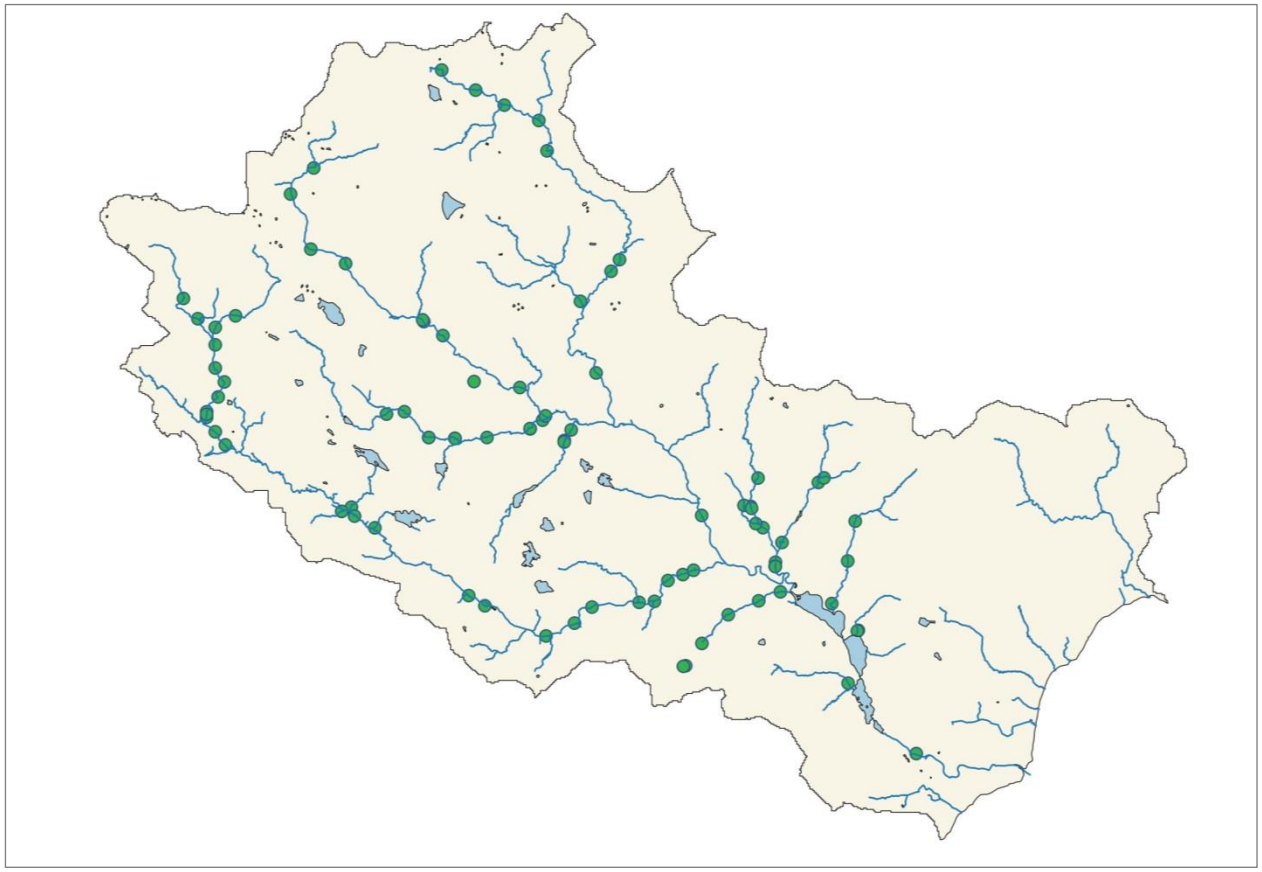
5.2 Trout

Trout are very widespread in the River Brora catchment. Migratory sea trout provide a valuable component of the rod fishery on the river and on Loch Brora. Resident brown trout are present in most of the hill lochs and these too provide a range of angling opportunities.

Juvenile trout are either absent or present at rather low density at most electric fishing sites in the larger watercourses (see section 7). However, where survey data are available trout numbers in tributary streams have been relatively high. It is widely thought that sea trout may be able to ascend the falls upstream of Dalnessie (West Galloway Fisheries Trust 2001; A. Stephen pers. comm.).

Although data are sparse, it seems likely that many of the smaller streams in the catchment may be of great importance to trout. As sea trout numbers have fluctuated markedly over the decades there would be value in attaining a greater understanding of spawning and rearing areas for this stock component.

Figure 9. Distribution of juvenile trout based on electric fishing surveys 1999 to 2020



5.3 Arctic charr

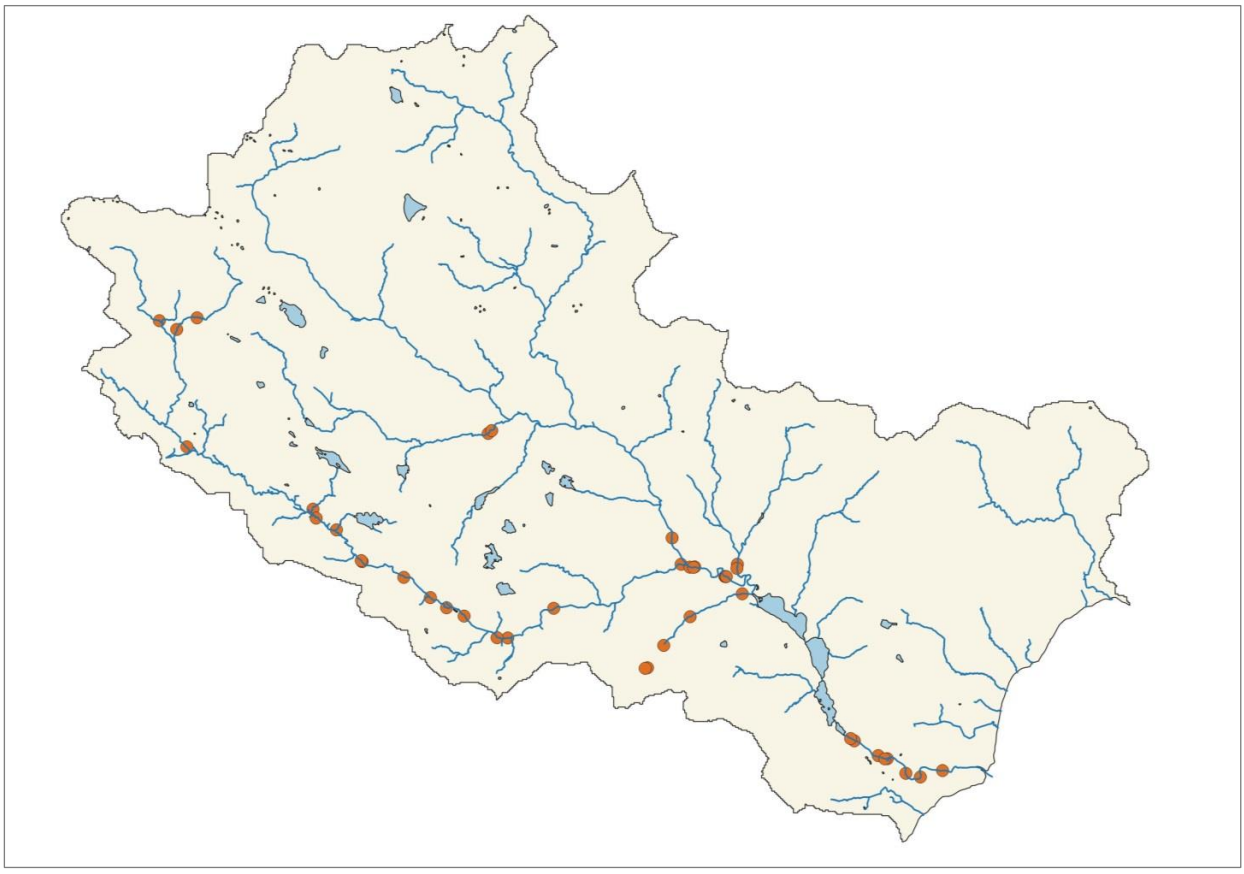
The Arctic charr is the most northerly freshwater fish in the world, occurring as far north as Ellesmere Island only 800 km from the North Pole. Arctic charr are a salmonid species, like trout and salmon, and are of considerable conservation value within the UK. They are listed on the Scottish Biodiversity Action Plan as a priority species. All Scottish populations are now purely freshwater resident, but would have been established in the post-glacial period by sea-going races of charr migrating into freshwater to spawn.

Arctic charr occur in three lochs in the Brora catchment (Maitland & Adams 2018): Loch Brora, Loch nan Eòin (Coirefois Burn sub-catchment) and Glas-loch Mòr (headwaters of An Crom-Allt, a tributary of the River Brora above Dalnessie). Little is known of the biology of these fish in the Brora catchment. The populations of charr in Loch Brora and Glas-loch Mòr are almost certainly extant and they are occasionally caught by trout anglers. The last known record from Loch nan Eòin was 1972, but as charr are rarely caught and the loch is remote this population may also remain extant.

5.4 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 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.

Figure 10. Distribution of European eels based on survey data 2001 to 2020



Adult eels migrate downstream in the autumn and undergo long migrations to spawn at sea in the western Atlantic. Their young return to UK waters as larvae before transforming into small, translucent ‘glass eels’, which ascend rivers in the spring. Due to their ability to migrate short distances overland European eels can often be found in streams that are inaccessible to other migratory fish species. Survey data (Figure 10) show that eels are widespread in the River Brora and that they have been recorded throughout the river into its headwaters upstream of Dalnessie. In contrast, they have only rarely been recorded during surveys of the Black Water and have not been recorded on the River Skinsdale. A direct observation of an eel was made

during the 2018 habitat survey of Coirefrois Burn and a similarly sized eel of around 30 cm was captured nearby during electric fishing in 2020. A single eel was caught during electric fishing on the lower Black Water in 2020. The paucity of eel records from the Black Water/Skinsdale part of the catchment is striking. This may be explained by eels having difficulty ascending the near-vertical waterfall at Balnacoil, which appears to have few opportunities for them to climb up adjacent rock faces. The falls at Achness may also present a substantial obstacle to eels.

There have been substantial declines in eel populations throughout Europe, with numbers perhaps now as low as 5% of historic levels. Due to these declines eels are of increasing conservation interest and are protected by European (EC No 1100/2007) and Scottish (Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008) legislation. The latter makes it illegal to take eels without a license from the Scottish Government. European eels are listed as critically endangered on the IUCN Red List.

5.5 Lampreys

Three lamprey species occur in the UK: brook lamprey *Lampetra planeri*, river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*. Adult lampreys aggregate to spawn and extrude their eggs into 'nests' excavated in the river bed. After hatching the young lamprey larvae, known as ammocoetes, settle in nursery habitat consisting of fine, soft substrate in well oxygenated, slow flowing water. The ammocoetes are blind and feed on fine particulate matter such as diatoms, algae and bacteria. Ammocoetes 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.

Parts of the Brora catchment were surveyed for the presence of lampreys in 2004, during a national survey for these species (Watt & Ravenscroft 2005). *Lampetra* larvae, either brook or river lamprey, were found at seven sites extending from the lower River Brora to Braegrudie. Metamorphosed larvae (known as transformers) were found at two sites and these were identified as brook lamprey. Lamprey larvae have been found in the lower reaches of streams around Loch Brora where suitable habitat is present. No records of river or sea lampreys have been identified from the River Brora, although the lower reaches may be suitable for the latter. Lampreys are of some conservation interest and all three UK species are listed on Annex II of the EU Habitats Directive.

5.6 Three-spined stickleback

Three spined sticklebacks have been recorded at some electric fishing sites around Loch Brora including Allt a' Mhuillin, Allt Smeorail, and from the River Brora as far upstream as Craigton. They are a common and widespread native fish. They are of no particular conservation or fisheries interest.

5.7 Perch

Perch have recently been reported as having being caught occasionally in Loch Brora in the past two years[9]. This species is not native to northern Scotland and it is not known how perch found their way into the loch. In some parts of the UK perch are a popular sporting fish, keenly

[9] Brora DSFB meeting, August 2019

targeted by anglers. Perch are handsome creatures and their flesh is firm, white, and very good eating.

However, their presence in Loch Brora is a concern. While the bulk of their diet is made up of invertebrate prey – primarily crustaceans and insects - they are also predators of smaller fish. Maitland (2007) notes their voracious appetite and reports a two-inch long perch being found dead with a one inch long stickleback stuck in its gullet. The potential for negative impacts of perch on juvenile trout or salmon in the loch is uncertain. In addition to concerns over direct impacts from predation by perch on salmonid fry, there may be potential for competition between perch and native fish for invertebrate prey.

6 DISTRIBUTION AND QUALITY OF SALMONID HABITATS

6.1 2018 habitat survey

6.1.1 Aims and objectives

The aim of the 2018 walkover habitat survey of the Brora catchment was to obtain quantitative and qualitative assessment of salmonid habitats in the River Brora catchment. Specific objectives were to:

- Assess the distribution of juvenile, adult and spawning habitats in accessible reaches of the catchment;
- Assess the quality of the above habitats;
- Map and quantify the availability of each habitat type;
- Identify the location of obstacles to salmonid migration;
- Determine the status of riverbanks with regard to collapse and erosion;
- Briefly describe riparian habitats including presence of trees and canopy cover.

The intention was that the survey data would form the basis for development of the current fishery management plan as well as a strategic resource for use in objective management of the fishery and the habitats that support it.

6.1.2 Methods

6.1.2.1 Field surveys

The walkover survey was method was developed through discussions with RBDSFB. The primary target species was salmon, but many of the data collected are equally relevant to trout. The survey method included aspects of the Environment Agency (EA) protocol described by Hendry & Cragg-Hine (1997). In particular, the EA method was used to characterise in-stream habitats according to depth, substrate, flow and thus suitability for each life stage of salmonids. When applied by experienced surveyors this method provides a reasonably quick way to assess the distribution and quality of salmonid habitats over large areas. Due to time constraints and the large areas requiring survey, the quantitative surveys were based on contiguous sections of up to 1 km in length. Within these, areas of productive juvenile habitat, spawning habitat and adult habitat were recorded directly onto 1:10,000 scale maps in the field, using colour codes for each habitat category. A list of habitat types recorded during the survey is provided in Table 6. Example photographs of each category are provided as Appendix 15.1.

Table 6 Salmon habitat categories used for walkover survey

Habitat category	Description
Fry	For salmon, shallow fast flowing habitat with substrate of pebble and cobble. For trout, shallow slow flowing habitats with substrate of pebble and cobble.
Mixed juvenile	Habitats with mixed depth and coarse substrates including cobble, boulder and pebble that provide cover for salmonid fry and parr. Depth typically 10 to 40 cm.
Deep juvenile	As above, depth > 40 cm
Shallow glide	Low gradient channel with small substrates. Lacking cover for fish. May be productive, especially for trout, if instream macrophytes or bankside cover are present. Depth < 0.8 m.
Deep glide	As shallow glide but depth > 0.8 m. May provide adult habitat.
Pool	Slow or eddying current. Suitable for adult salmonids if cover is present. If very deep cover may be less important, as depth can provide refuge.

Habitat category	Description
Bedrock	Sheet bedrock or compacted earth covering majority of streambed. No cover. Unproductive for fish.
Peat channel	Non-standard classification. Simple incised channel through peat and earth with no hard substrate. Unproductive for fish.
Spawning	Ideally well oxygenated, stable & not compacted. Comprising pebble and small cobble (salmon) or gravel and pebble (trout). Sand less than 20%. Not silted.

Other attributes recorded in each survey section were wet width, bed width, proportion of braided channels and streambed stability.

Sections were rated for the presence of streambed cover for juvenile salmonids as either poor, moderate or good. Cover is important for maintaining high juvenile densities. The surveyors also made a subjective assessment of the overall quality of juvenile habitats in each section as unsuitable, poor, moderate or good. These assessments, although subjective, were based on the documented preferences of each species and age class and the surveyors' own wide experience of fish surveys throughout Scotland spanning over four decades.

An adapted version of the SFCC methodology was used for assessment of river and stream banks. This included recording of land-use, access by grazers, riparian buffers and fencing. Erosion and collapse of riverbanks and presence of riparian trees were assessed separately for right and left banks as a proportion (%) of bank length.

6.1.2.2 Quantification

Estimates of the wetted area of each habitat type were made from the colour-coded maps made in the field. Area was estimated by multiplying the length of each habitat category within a survey section by the mean wet width of the survey section. This method assumes that the average width of each habitat type is equal, so may be prone to some error. It is improbable that these errors would greatly affect estimates of productive area of juvenile habitats, since in most sections these were the dominant categories and therefore likely to be closest to the average value for wet width. The method may under-estimate the wetted area of pool habitats, as these features are often wider than other habitat types. This is of little consequence for analyses, as the distribution and quality of holding pools is likely to be of more significance than their precise area.

The area of individual units of spawning habitat was estimated in the field and recorded separately. Spawning habitat occurs within other habitat categories (usually fry habitat) so the area of spawning habitat is omitted from estimates of total wetted area of a section.

6.1.3 Surveyed reaches, dates and conditions

The surveyed reaches are set out in Table 7. They included all of the three largest rivers i.e. River Brora, Black Water and River Skinsdale. Many of the larger tributaries were also included, especially where these seemed likely on the basis of catchment size, gradient and aerial imagery to provide suitable spawning habitat for salmon or sea trout. Due to time constraints it was not possible to survey some of the smaller tributaries, even where these are accessible to migratory salmonids. No surveys of lochs took place. The total linear length of surveyed habitats was in excess of 150 km.

Table 7 Survey reaches, 2018 walkover habitat survey

Area	Waterbody	Downstream	Upstream	Length (km)
River Brora below Loch Brora (Lower River Brora)	River Brora, lower	NC 9041 0399	NC 8627 0501	5.9
River Brora from Loch Brora to Balnacoil (Middle River Brora0	River Brora, loch to Balnacoil	NC 8295 1000	NC 8072 1100	4.2
	Oldtown Burn	NC 8521 0844	NC 8530 0907	0.7
	Duchary Burn	NC 8609 0510	NC 8578 0467	0.6
	Allt Coire Aghaisgaeig	NC 8503 0663	NC 8494 0656	0.2
	Carroll Burn	NC 8513 0661	NC 8357 0799	1.8
	Allt a'Chairn	NC 8500 0716	NC 8440 0717	0.2
	Allt Smeorail	NC 8442 0928	NC 8447 0964	0.6
	Scottarie Burn	NC 8293 1000	NC 8216 0991	0.8
	Allt Ach a' Bhàthaich (Ascoile)	NC 8270 1062	NC 8244 1101	1.0
River Brora above Balnacoil (Upper River Brora)	River Brora below Dalnessie	NC 8068 1096	NC 6323 1521	24.6
	River Brora above Dalnessie	NC 6323 1521	NC 6298 1874	5.3
	Allt Gobhlach	NC 6298 1874	NC 6026 2255	5.8
	Allt a'Bhaid Leathain	NC 6262 1931	NC 6318 2043	1.7
	An Crom Allt	NC 6305 1867	NC 6565 2044	4.3
	Allt Preas a'Chraicinn	NC 6535 2069	NC 6488 2115	0.8
	Allt nan Con-uisge	NC 6268 1581	NC 6111 1700	2.6
Black Water to Skinsdale confluence (lower Black Water)	Black Water	NC 7875 1482	NC 7684 1568	2.7
	Long Pool Burn	NC 7750 1575	NC 7743 1614	0.4
Black Water above Skinsdale confluence (upper Black Water)	Black Water	NC 7684 1568	NC 6617 2206	14.6
	Allt a Mhuilinn Duibh	NC 7560 1585	NC 7463 1399	2.6
	Allt Coire an Fhaicnich	NC 7295 1711	NC 6962 1757	4.9
	Allt Coire a' Mhile	NC 7010 1943	NC 7019 2051	1.5
	Allt an Loin Earraich	NC 7390 1691	NC 7333 1884	3.0
	Coirefrois Burn	NC 7458 1596	NC 6853 1564	8.2
	Allt an Eòin	NC 7158 1511	NC 7100 1479	0.8
	Abhainn Srath na Seilge	NC 6617 2206	NC 6656 2467	3.2
	Allt na Seilich Bige	NC 6656 2467	NC 6735 2735	4.5
	Allt na Seilich Mòire	NC 6657 2468	NC 6887 2585	3.4
	Allt an Inne Mhòire	NC 6732 2495	NC 6807 2472	0.6
Skinsdale	River Skinsdale	NC 7686 1572	NC 7428 2623	16.6
	Garvary Burn	NC 7583 1979	NC 7246 2295	11.6
	Allt a Ghorm-Loch Mhòir	NC 7246 2295	NC 7162 2323	1.0
	Allt Garbh Bheag	NC 7530 2231	NC 7237 2133	3.5
	Allt Crithinn	NC 7482 2113	NC 7530 2231	1.6
	Allt an Ealaidh	NC 7428 2623	NC 7053 2748	6.0
	Allt Coir' an Eas	NC 7303 2678	NC 7127 2536	3.3
	Allt a' Choire Bhuidhe	NC 7270 2815	NC 7456 2776	1.3
	Allt Preas a'Chamraig	NC 7423 2694	NC 7270 2815	2.5

Much of the walkover survey took place during May, June and July 2018. This was a period of prolonged dry and hot weather as result of which water levels were mainly very low. This should be kept in mind when interpreting the quantitative data as estimates of wetted widths, and areas derived from these, are likely to be close to the natural minimum for most surveyed reaches.

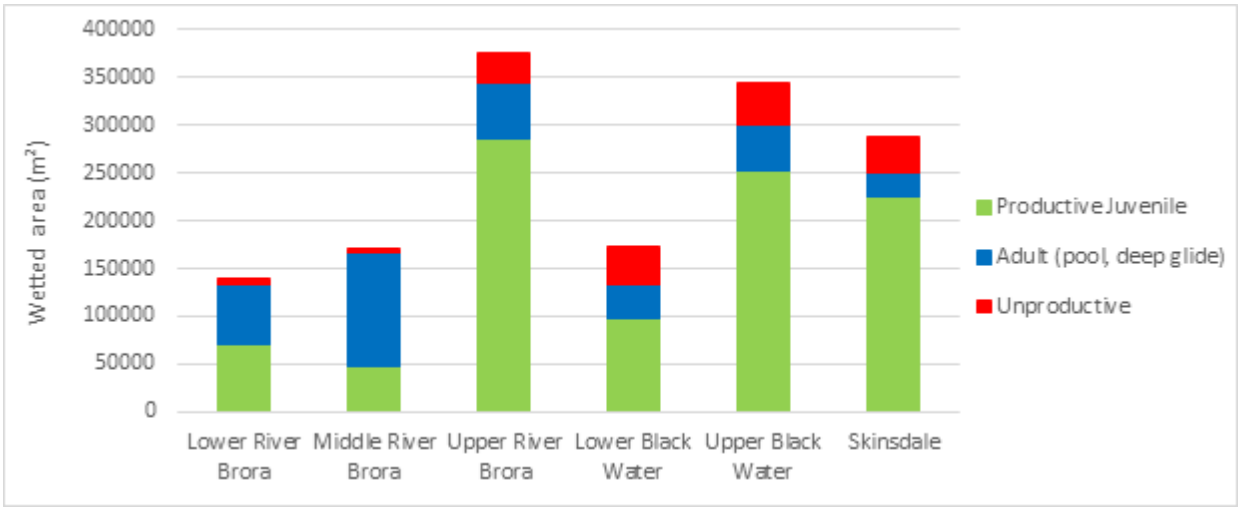
6.2 Catchment overview

Unlike many Highland rivers the River Brora catchment is relatively low-gradient throughout, with very few natural or manmade obstacles to fish movement. The lack of obstacles makes the greater part of the catchment accessible to salmon and sea trout returning to the river to spawn.

The 2018 walkover survey focussed on accessible habitats in the larger watercourses so a full inventory of obstacles is unavailable other than for surveyed reaches. Within the ~150 km of watercourse that was surveyed, none was upstream of natural obstacles that were considered clearly impassable to salmon or sea trout at all times[10]. The accessible reach is considered to include habitats upstream of the waterfall on the upper River Brora at Dalnessie since a) it has long been maintained that sea trout can ascend it and b) an electric fishing survey during 2018 found small numbers of salmon fry upstream of it.

Based on estimates made largely during low summer flows, the minimum wetted area of the surveyed reaches was estimated to be approximately 1.5 million m^2 or 150 Ha. The proportions of productive juvenile habitats (fry, mixed and deep juvenile), adult habitat (pool and deep glide) and unproductive habitat (other categories) in each part of the survey area is shown on Figure 11. These data may under-estimate productive habitats, as some juvenile production is expected from shallow glide habitats. However, densities in these areas would generally be low due to lack of cover. Clearly these data exclude the smaller streams outwith the surveyed reaches, so they must be considered as underestimates. A full breakdown of habitat availability in each area is given in Table 8 and further details are provided in the sections covering individual management units.

Figure 11. Wetted area and distribution of productive juvenile and adult habitats



The data in Figure 11 demonstrate two clear findings. First, with the exception of the Middle River Brora the majority of wetted habitat in each part of the catchment is expected to be productive of juvenile salmon and trout. This is a major strength, as large expanses of suitable juvenile habitat are a prerequisite for high levels of smolt production. Secondly, productive habitats are widespread and abundant in all three of the larger sub-catchments: Upper River Brora, Black Water and Skinsdale. Each of these is expected to make a very significant contribution to the maintenance of migratory fish populations and the fisheries they support.

[10] Falls on Abhainn Abhainn Srath na Sealga (BlackWater) are thought usually to be impassable to salmon but it is less clear whether they are passable to sea trout.

Figure 12. Location of known obstacles to migration

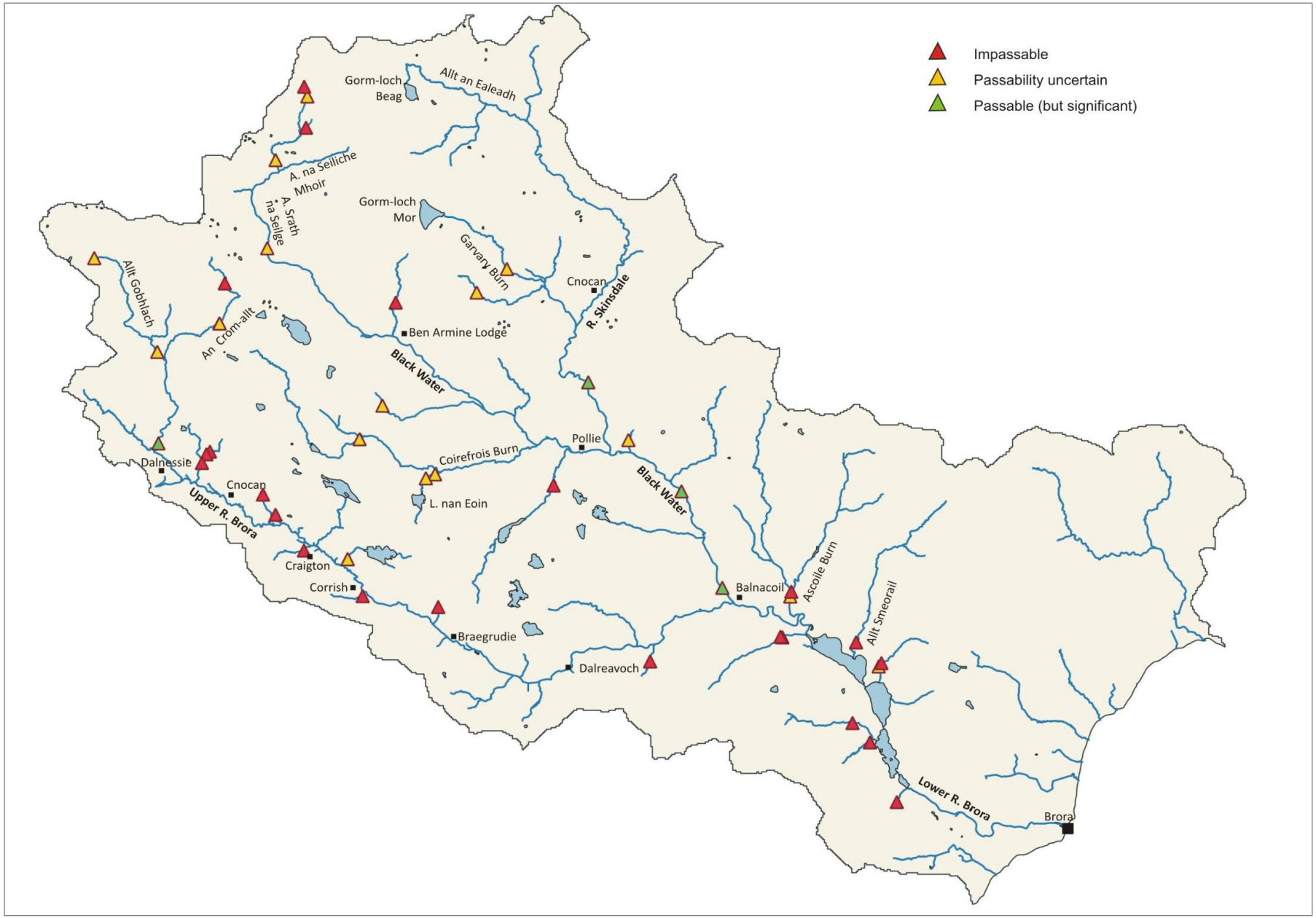


Table 8 Distribution of each habitat category

Habitat type	Area of habitat (m²)					
	Lower R. Brora	Middle R. Brora	Upper R. Brora	Lower Black Water	Upper Black Water	Skinsdale
Fry habitat	750	6,639	44255	1,800	21,088	33,505
Mixed juvenile	32,060	34,535	234136	44,835	219,113	177,334
Deep juvenile	38,340	7,440	8130	50,160	12,875	14,620
Pool	63,040	118,550	12620	35,860	29,161.50	11,421
Shallow glide	0	1,600	17093	0	1,777	13,498
Deep glide	0	0	45943	0	17,981	14,308
Bedrock	4,800	1,510	11935	39,690	40,407	22,335
Peat channel	0	0	1215	0	930	0
Total	**138,990**	**170,274**	**375,327**	**172,345**	**343,333**	**287,021**
Spawning*	233	1,456	2,633	200	3,679	2,279

*Spawning habitats overlap with fry and other habitat categories

Juvenile habitat quality is summarised in Table 9. It is important to note that 'all fry' habitat includes mixed juvenile habitats, as these would be expected to support fry as well as parr. Thus there is duplication within the area estimates. Overall, an estimated 66% of habitat potentially suited to salmon fry was judged to be of good quality for this age class and a further 29% was classified as moderate quality. The proportions varied somewhat between areas, and in the Black Water habitats were mainly judged to be of moderate quality for fry.

Habitat quality for parr was also predominantly judged as good, with an estimated 62% in this class. A further 33% was classed as moderate. Again, the good classification predominated in most areas with the exception of the Black Water where similar proportions were classified as good and moderate.

In conclusion, juvenile habitats within the catchment of the River Brora were found to be abundant, widespread and largely of good quality.

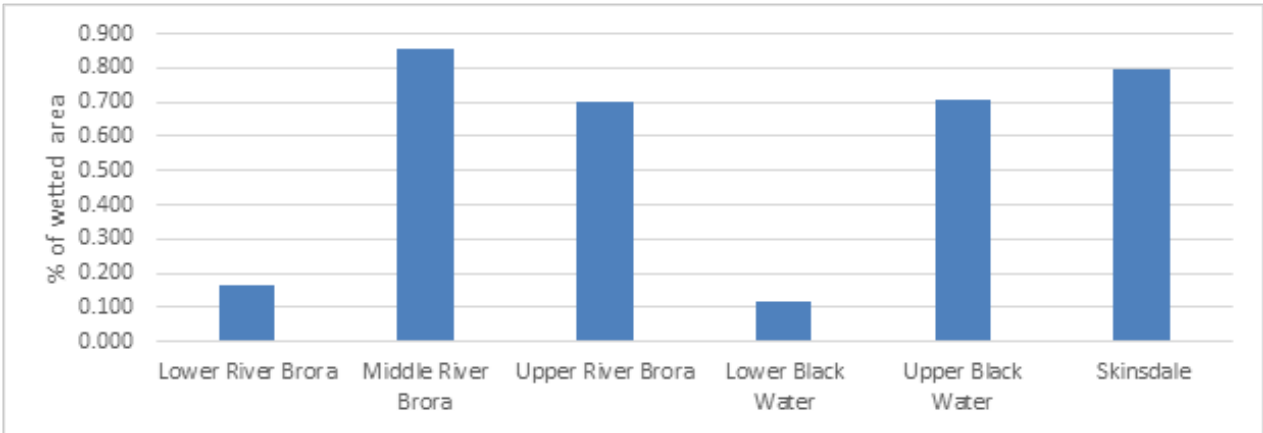
Table 9 Quality of juvenile salmon habitat in the Brora catchment

Juvenile habitat type	Quality	Area of habitat (m²)						
		Lower R. Brora	Middle R. Brora	Upper R. Brora	Lower Black Water	Upper Black Water	Skinsdale	total
All fry (fry + mixed juvenile)	Good	18,300	36,015	214,639	9,800	112,998	159,912	551,664
	Moderate	14,510	2,290	50,737	30,200	103,118	42,358	243,213
	Poor	0	1,320	5,815	6,635	15,725	8,269	37,764
Parr (mixed + deep juvenile)	Good	66,220	31,110	169,219	31,650	116,074	121,165	535,438
	Moderate	4,180	9,785	57,026	51435	106,252	62,483	291,161
	Poor	0	1,080	7,621	11,910	9,662	8,234	38,507

The availability of potential spawning habitats is shown in Figure 13 below as a percentage of the wetted area in each part of the catchment. The distribution across each area is broadly in proportion to the wetted area, ranging from a little over 0.85% on the middle River Brora to 0.7% on the upper River Brora. The exceptions are the lower River Brora and the lower Black Water which are both lacking in substantial areas of spawning habitat. The lower River Brora has extensively engineered banks and as a result natural erosion processes are very limited, with minimal input of new material to the river to maintain spawning habitats. Lack of spawning

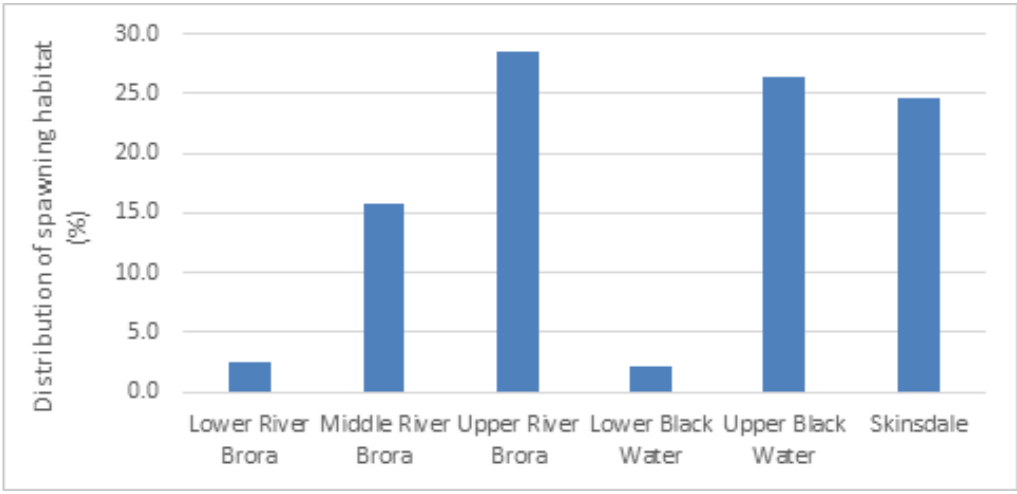
habitat on the lower Black Water probably reflects its gorge-like nature, but as water level was somewhat elevated when this reach was surveyed it is possible that some areas of potential spawning habitat were obscured and not recorded.

Figure 13. Spawning habitat as a percentage of wetted area



Similarly, a look at the distribution of spawning habitat across the catchment (Figure 14) shows that the Lower River Brora and Lower Black Water hold very little of the total spawning habitat in the catchment (2.5 and 2.2% of the total for the catchment, respectively). The Middle River Brora holds 15.8%, while the Upper River Brora, the Upper Black Water and the River Skinsdale hold around 25% each. In other words, spawning habitat is heavily concentrated in the upper parts of the Brora catchment.

Figure 14. Distribution of potential spawning habitat in the Brora catchment (%)



The spawning habitat data above are very broad brush and suggest it is widely distributed. However, the spatial relationship between spawning habitat and adult habitat (secure resting areas) may be important in ensuring a good uptake of spawning opportunities. Likewise, for optimum survival of juveniles spawning habitats should be located in proximity to suitable rearing habitats. Therefore the juxtaposition of habitat is important. The Lower River Brora provides a good example. While this reach holds some very good mixed juvenile habitat, the nearest substantial areas of spawning habitat are upstream of the loch in the Middle River Brora near Balnacoil. This might result in the river downstream of the loch being under-populated with juveniles. The local distribution of spawning habitats in each part of the catchment is considered further in the following sections.

6.3 Lower River Brora (sea to Loch Brora)

6.3.1 Obstacles to migration

There are no obstacles to migration on the Lower River Brora.

6.3.2 Instream habitats

The Lower River Brora is broad with a typical wet width of between 20 m and 30 m. It is relatively deep with numerous holding pools suited to adult salmon and trout. Where present, much of the juvenile habitat was classified as 'deep' juvenile habitat (Table 10). Substrate through most survey sections tends to be dominated by boulder and larger cobbles. Fry habitat and spawning habitat, both composed of smaller substrates, are therefore sparse. A detailed morphological assessment of this reach is provided by Moir (2020), who highlights the lack of sediment input to the river below the loch. In large part this is due to the presence of Loch Brora, which acts as sediment trap, preventing the movement of substrates from the reaches above. In addition, a long history of bank stabilisation and modification has led to the loss of sediment inputs from erosion of the riverbanks. The construction, probably over at least a century, of numerous engineered structures to enhance angling opportunities has further modified natural river flows and process. The overall result is a river that Moir describes as 'fossilised' i.e. extremely stable with minimal movement or turnover of sediment. This is reflected in instream habitats that are very stable with some armouring of the riverbed, a lack of smaller substrates and an overall loss of natural river processes.

Table 10 Salmon habitat availability in the lower River Brora management unit

Reach	Length (km)	Area of habitat (m²)						
		Fry	Mixed & deep juv.	Pool	Shallow glide	Deep glide	Bedrock	Spawning (m²)
R. Brora below loch	5.9	750	70400	63040	0	0	4800	233

Despite the significant impact of bank and instream engineering downstream of the loch there remain large expanses of habitat that appear well suited to juvenile salmonid production (Table 9). An estimated 50% of the wetted area was classified as mixed or deep juvenile habitat and suited to the production of parr. Habitats exclusively suited to fry are scarce as noted above, due to the lack of smaller substrates.

6.3.3 Banks and riparian habitats

The section of the Lower River Brora downstream of the loch has stable, vegetated banks and bank-faces, with numerous modifications intended to deflect current and/or reinforce the riverbanks. In total, 27 sections of modification were recorded during the survey and it is likely that many other sections of modified or reinforced bank have become obscured by vegetation or turf over the passage of time. There is very little grazing along the banks in the lower river, many parts of which are managed for angling by selective removal and maintenance of scrub and tree boughs. Away from the main angling pools scrub is plentiful and there are patches of tree cover, with an estimated 12 to 15% of each stream bank clad in riparian trees (Table 11). Trees provide some shading, particularly those along the right (southern) bank, and the depth of water in this section may help reduce high summer water temperatures, although as the river is wide the effect may be slight. Further details of riverbanks are provided by Moir (2020), along with a useful discussion of how current morphological processes may relate to the river's natural state.

Table 11 Summary data for riparian zone, lower River Brora

Reach	Riparian trees (% of bank length)		Erosion & collapse (% of bank length)		Intense grazing (% of bank length)	
	Left	Right	Left	Right	Left	Right
R. Brora below loch	12.4	15.2	2.5	0.8	0.0	0.0

6.4 Middle River Brora (Loch Brora to Balnacoil)

6.4.1 Obstacles to migration

There are no obstacles to migration on the River Brora itself in the reaches between Loch Brora and Balnacoil. Most of the larger tributary streams are accessible only in their lower reaches. The accessible lengths downstream of impassable obstacles, or to where gradients and habitats become unsuitable, are set out in Table 13 below (section 6.4.3).

6.4.2 Instream habitats

6.4.2.1 Loch to Balnacoil

At low water level the first 1 km of river upstream of Loch Brora appears almost as an extension of the loch. However depositional features and bank erosion indicate this not the case at higher flows. Maximum depth is unknown but is clearly over 1.5 m and wet width is 40 to 60 m. Visible substrates comprise sand and peat. Cover for fish, other than that provided by deep water, appears to be almost entirely lacking. Further upstream, above the confluence of Ascoile Burn, there is more flow with riffle and glide sequences over substrates of pebble, small cobble and sand. These provide little cover for parr but are suitable for salmon fry, especially in the shallower, faster flowing sections. Some large areas of good quality spawning habitat suitable for trout and salmon are present. The clean gravels and coarse sand may also be suited to Arctic charr and brook lamprey.

The 1.4 km of river immediately downstream of the Black Water confluence provide large areas of good quality rearing habitats for juvenile salmon. The average gradient is higher than in the reaches further downstream and mean substrate size is larger, with a higher proportion of cobble and boulder. These larger substrates are stable and provide suitable cover for juvenile salmon. Trout parr would be expected to be present in slower reaches, although due to high current speed and a lack of overhead cover most habitats are best suited to juvenile salmon. The areas of juvenile habitat are interspersed with deep pools that are clearly well suited to holding adult salmon. This part of the river is an important and productive part of the fishery.

Table 12 Salmon habitat availability in the middle River Brora management unit

Reach	Length (km)	Area of habitat (m²)						
		Fry	Mixed & deep juv.	Pool	Shallow glide	Deep glide	Bedrock	Spawning (m²)
R. Brora loch to Balnacoil	4.2	4,560	28,880	116,160	1,120	0	0	1,220
Tributary streams (to loch and river)	5.9	530	14,644	2390	480	0	1,510	2,354
Total	10.1	5,090	43,524	118,550	1,600	0	1,510	3,574

6.4.3 Tributary streams

Seven tributary streams were included in the survey and summary data for individual streams are provided in Appendix 15.3. All of the tributary streams included in the survey provide good quality mixed juvenile habitats, with largely stable and uncompacted substrates. Although the total area of spawning habitat offered by these burns is not large, it is very good for trout and numerous trout redds were observed here in late 2018. Salmon are known to spawn in several of the burns including Carroll Burn, Allt Smeorail, Oldtown Burn, Scottarie Burn and Ascoile Burn. The upstream limits of access/useful habitat for migratory salmonids in each stream are provided in Table 13 below.

Table 13 Tributary streams, accessible length and wetted area

Watercourse	Upstream limit	Accessible length (km)	Accessible area (m^2)	Comment
Oldtown Burn	NC 85298 09073	0.7	2,345	Small stream but good quality fry and parr habitat. Salmon and trout present.
Ducharry Burn	NC 85777 04667	0.6	900	Small stream with good mixed juvenile habitat with and spawning in lower reaches.
Allt Coire Aghaisgaeig	NC 84940 06560	0.2	320	Short accessible reach of good fry and parr habitat
Carrol Burn (incl Allt a'Chairn)	NC 83572 07989	2	5,370	Excellent fry and parr habitat with abundant good spawning, particularly for trout
Allt Smeorail	NC 84470 09642	0.6	3,300	Good quality spawning habitat in accessible reaches. High densities of juvenile salmon.
Ascoile Burn	NC 82440 11010	1	5,770	Some high quality juvenile habitats in accessible reaches. Salmon and trout present.
Scottarie Burn	NC 8216 0991	0.8	1,549	Straightened channel in lower reaches, with filamentous algae. Moderate cover for fry and parr.

6.4.4 Banks and riparian habitats

6.4.4.1 Loch to Balnacoil

Upstream from the loch to Balnacoil the river banks are unfenced pasture, intensively grazed by sheep and cattle. Bank-faces are bare and eroding or collapsing along 30 to 40% of each bank. The river channel is moderately mobile as it meanders through this low-lying area of flood plain. Large side and point bars, formed by deposition of pebble, gravel and cobble, are present on the bends and there is some braiding. Cover alongside the banks is lacking and habitat quality for trout is generally poor.

Some channel and bankside modifications have been made, both for angling purposes in the form of current deflectors creating lies for salmon, and for bank protection, mainly in the form of boulder reinforcements along the bank faces. These modifications are particularly frequent towards the top of the section in the better angling water. There are no riparian trees; flow is

quite slow through this reach and the lack of shade may increase the risk from high water temperatures during hot summers; although deep sections within this reach probably provide some refuge for fish, as may Loch Brora.

Table 14 Summary data for riparian zone, lower River Brora

Reach	Riparian trees (% of bank length)		Erosion & collapse (% of bank length)		Intense grazing (% of bank length)	
	Left	Right	Left	Right	Left	Right
R. Brora loch to Balnacoil	0.0	0.0	30.4	40.2	100.0	100.0
Tributary streams (to loch and river)	21.0	21.4	NR	NR	NR	NR

NR = not recorded

6.4.4.2 Tributary streams

Oldtown Burn flows through mixed pasture and scrub in its lower reaches, then deciduous woodland upstream of the road. It is well-shaded by trees throughout, and has good bankside cover provided by tree roots, boulders and undercuts. There are small amounts of bank erosion due to spates, but in general the banks appear very stable, especially upstream of the road where the stream becomes increasingly entrenched between bedrock and boulder banks.

Ducharry Burn runs through open moorland with heather and bracken. There are scattered deciduous trees along the banks. Upstream of the road the stream is entrenched in a narrow valley with bedrock and boulder banks; downstream of the track the banks are boulder and turf. Banks are quite stable throughout with little erosion and good over from undercuts and draped heather.

The lower reaches of Carrol Burn run through pasture, changing to open moorland then recently-planted Woodland Grant Scheme upstream of the farm. There is little erosion, all on the outside of bends in the low gradient section downstream of the farm. Bankside cover is provided by boulders, draped heather and some undercuts. The banks are mainly stable boulder and turf, changing to a mix of boulder, bedrock and peat above the farm. There are no riparian trees.

The lower accessible reaches of Allt Smeorail are meandering and there are some substantial stretches of eroded bank face, some of which may enhance spawning opportunities by feeding substrates to the channel. Close to the loch the banks are mainly open and bare, but trees line parts of both banks closer to the upstream migration limit near the road.

The lower reaches of Scottarie Burn run through semi-improved pasture. The banks are bare, unfenced, heavily grazed and lack trees or shrubs. Trees and shrubs are present along both banks upstream of the pasture, where the stream is more entrenched.

The first 0.5 km of Ascoile Burn upstream of its confluence with River Brora meanders through wet rough pasture. The banks are mainly quite low to the water and in places are eroding on the outside of the meanders. There are one or two scattered patches of shrubs, but the banks are largely bare of trees. Upstream of the road both banks are lined with alders, but there is little regeneration. Here the banks are stable, and mainly of boulder and turf. Moving upstream the density of trees and shrubs increases as the stream becomes more entrenched towards the upstream limit of migration.

6.5 Upper River Brora (Balnacoil to headwaters)

6.5.1 Catchment

The River Brora is formed by the merging of an Crom Allt and Allt Gobhlach, some 5 km upstream of Dalnessie. In its upper reaches it typically has a wet width of 6 to 8 m. Approximately 1 km upstream of Dalnessie it is joined from the west by Allt nan Con-uisge, a substantial stream with a wet width of around 2.5 m in its lower reaches. The river turns sharply southeast near the confluence to reach Dalnessie, where an intake transfers a proportion of the flow towards the Shin catchment. The headwater streams and Allt nan Con-uisge all drain large expanses of peatland/blanket bog. Heather moorland surrounds much of the River Brora itself in these reaches.

Between Dalnessie and Corrish, a distance of around 10 km, the river meanders through a low gradient flood plain in a flat-bottomed valley. The mean gradient is approximately 0.2%. It is joined by several tributaries, all of which are quite small with wet width of less than 2 m. The River Brora in these reaches is typically around 6 to 10 m wide. The gradient increases somewhat in the 9 km of river between Corrish and Dalreavoch, with an average of around 0.7%. The broad - mainly shallow - river is stony with a low to moderate current speed. From Dalnessie to Dalreavoch the majority of the ground immediately adjacent to the river is rough pasture, with moorland on the surrounding hill slopes, some recently planted with native broadleaves under Woodland Grant Schemes.

The entire reach from Dalnessie to Dalreavoch is oriented roughly north-west to south-east. At Dalreavoch the river turns east-north-east, and the 7.5 km reach from Dalreavoch to Balnacoil continues shallow, stony and increasingly wide, with a typical width of 12 to 18 m. Here, the river flows mainly through pasture with scattered areas of broadleaf woodland. Away from the river the surrounding slopes are largely open heather moorland with some native woodland and conifer plantation.

6.5.2 Obstacles to migration

The River Brora is accessible to migratory fish from Balnacoil to Dalnessie, and no significant obstacles were recorded along the mainstem during the walkover survey. An intake weir at Dalnessie enables water to be abstracted and diverted towards the Shin catchment via a cut running into Feith Osdail. There is a fish pass on the weir and smolt screens are installed to prevent fish entering the cut.

Roughly 1.5 km upstream of Dalnessie at NC 628 161, there is a substantial waterfall (Dalnessie Falls). Local information suggests that the falls are passable to sea trout but not salmon; however exploratory electric fishing surveys in 2018 found very small numbers of salmon fry in the reach upstream of the waterfall, indicating that adult salmon must be capable of ascending the falls under certain conditions.

A further 3.5 km upstream of Dalnessie Falls a cascade at the lower end of Allt Gobhlach may be impassable, although this unconfirmed. The stream drops approximately 1.5 m over a bedrock outcrop. As the plunge pool is shallow it seems likely that it would be difficult for fish to make the ascent. If it is confirmed that the reach upstream of Dalnessie Falls is accessible, further assessment of this obstacle may be worthwhile as there are long reaches of habitat apparently well suited to both sea trout and salmon further upstream.

The minor tributaries that were assessed during the walkover survey are accessible for varying distances and the upstream migratory limit could not be determined with confidence in all cases. Estimated accessible length for each is set out in Table 14, section 6.4.3.2 below.

6.5.3 Instream habitats

6.5.3.1 River Brora

The upper River Brora is largely shallow, with a stable substrate of mixed boulder, cobble and pebble offering excellent habitat for juvenile salmonids. The estimated total area of juvenile habitat in this part of the catchment was approximately 280,000 m^2. Almost 40% of this is in the reach downstream of Dalreavoch, and juvenile habitats in this part of the river were judged to be of good quality (Tables 15 and 16). The reach is typified by boulder and cobble dominated habitats that appear to provide excellent cover for parr. There are few shallow riffle habitats with smaller substrates of pebble and cobble, as a result of which only about 2% of the wetted area was classified as being exclusively fry habitat. Typical spawning riffles are rather scarce for the same reason, although it must be borne in mind that salmon and trout can and will spawn in pockets of suitable habitats that would not be picked up by extensive walkover surveys. Nevertheless, it is possible that spawning habitat might be limiting in this reach. Most of the reach is rather shallow, typically less than 0.6 m, and holding pools for adult fish are scarce. A number of croys and other modifications to the channel have been created, presumably in an attempt to create holding areas and increase angling opportunities. Many of these structures are old and some no longer appear effective. These old structures do not appear to cause significant problems and given the lack of pools may be of minor benefit.

Table 15 Distribution of habitat types in the upper River Brora management unit

Reach	Length (km)	Area of habitat (m²)						
		Fry	Mixed & deep juv.	Pool	Shallow glide	Deep glide	Bedrock and peat channel	Spawning (m²)
Balnacoil to Dalreavoch	6.9	2200	94400	2830	2150	0	260	142
Dalreavoch to Corrish	8.0	31440	66630	3920	1300	840	3690	1064
Corrish to Dalnessie	9.7	3820	11020	970	12500	42140	0	740
Dalnessie to falls	1.3	550	7510	1450	220	480	890	100
R. Brora above falls	3.8	3550	25660	1120	0	1430	2970	321
Tribs below Dalnessie	7.2	692	10246	159	648	0	1156	29
Allt nan Con Uisge	2.6	0	1925	1820	275	0	1065	23
A. Goblach & Crom Allt	12.7	2003	24875	351	0	1053	3119	214
Total	52.1	44255	242266	12620	17093	45943	13150	2633

The first ~0.7 km of river upstream of Dalreavoch has been substantially modified in recent years by the creation of a number of weirs and croys. This is likely to have been done to create angling opportunities. The structures have altered the morphology of the river, creating scouring downstream and backing up water behind. Upstream of the modified section as far as Corrish the river is mostly shallow with a moderate gradient. Substrates are largely of pebble, cobble and boulder. There are extensive areas well-suited to salmon and trout fry. Spawning habitat is plentiful and appears of good quality. Well over a third of the spawning habitat recorded in the upper Brora area is in this reach and it is interspersed with good quality juvenile habitats. Due to the preponderance of small substrates the proportion of parr habitat is less than in the reaches below Dalreavoch, but substantial areas are present and these are mainly of good quality. Given its mix of habitats and the juxtaposition of spawning and fry habitats, the reach between Dalreavoch and Corrish is likely to be an important area for spawning and recruitment of juvenile salmon. One potential limitation is the lack of deep holding water, as long reaches lack pools or deep glides where adults might hold up prior to spawning.

The nature of the River Brora changes greatly around Corrish and the reach between Corrish and Dalnessie has an extremely low average gradient. The meandering channel has a largely sandy substrate, and much of river is deep and canal-like with almost imperceptibly slow flow during periods of low water. This reach offers plenty of deep cover for adult salmonids, but provides little habitat for juveniles. Towards the upper part of this section there are frequent shallow riffles between the glide sections. These provide spawning opportunities, as evidenced by the presence of numerous fry during May habitat surveys. However although abundant, the quality of the spawning habitat in this reach is poor, with small grainsize substrate and a large proportion of sand. Furthermore, other than in the short riffle sections, rearing habitat for juveniles is sparse and the slow flowing glides are likely to be particularly unsuited to maintaining good densities of young salmon. A few hundred meters downstream of Dalnessie, near the confluence of Feith Buidhe (NC 635 148), the character of the river changes again, reverting to good quality mixed juvenile habitat with substrates predominantly of boulder, cobble and pebble.

Upstream of Dalnessie much of the River Brora appears very well-suited to juvenile salmon and trout. The gradient is mainly moderate with mixed flow types of riffle, run and glide. Instream cover in most reaches was judged to be good or moderate. In total, around 37,000 m² or 81% of the 46,000 m^2 of wetted habitat in the reach between Dalnessie and the confluence of Allt Gobhlach and An Crom Allt was classified as mixed juvenile or fry habitat. However, only 22% of this is downstream of the waterfall (NC 628 161) above Dalnessie and therefore regularly accessible to salmon. The remainder is widely held to be important to sea trout, but further information on sea trout access over the Dalnessie waterfall would be useful to confirm this.

Table 16 Quality of juvenile salmon habitat, upper River Brora management unit

Reach	Fry habitat quality (% of total)			Parr habitat quality (% of total)			Total fry habitat (m^2)	Total parr habitat (m^2)
	Good	Mod.	Poor	Good	Mod.	Poor		
Balnacoil to Dalreavoch	77.9	22.1	0.0	71.8	28.2	0.0	2200	94400
Dalreavoch to Corrish	97.0	1.9	1.1	88.8	10.4	0.8	31440	66630
Corrish to Dalnessie	79.6	8.5	11.9	33.6	66.4	0.0	3820	11020
Dalnessie to falls	100.0	0.0	0.0	100.0	0.0	0.0	550	7510
R. Brora above falls	97.4	2.6	0.0	94.3	5.7	0.0	3550	25660
Tribs below Dalnessie	43.7	46.4	9.9	13.3	36.5	50.2	692	10246
Allt nan Con Uisge	0.0	0.0	100.0	0.0	0.0	100.0	0	1925
A. Goblach & Crom Allt	13.1	86.9	0.0	47.2	52.8	0.0	2003	24875
ALL REACHES	79.1	18.7	2.1	72.4	24.4	3.3	44255	242266

6.5.3.2 Tributary streams

The accessible or potentially accessible reaches of all the larger tributary and headwater streams were included in the walkover survey. Data are summarised in Table 17 below. A number of the tributary streams appear to provide suitable spawning and rearing habitat for juvenile trout and, perhaps to a lesser extent, salmon.

Headwater tributary Allt Gobhlach has a rock ramp a short distance upstream of the confluence with An Crom Allt which may be impassable to migratory fish, although this is not confirmed. The river upstream of this obstacle offers extensive areas of good fry and parr habitat, especially in the lower reaches, as well as 7.2% of the spawning habitat recorded in the upper River Brora. An Crom Allt is steeper and less stable then Allt Gobhlach, with moderate quality fry and parr habitat, and spawning opportunities restricted to the lower reaches (shown in the accompanying photograph). There is a substantial rock ramp at NC 647 198, which may be impassable to sea trout but this is uncertain.

Downstream of Dalnessie Falls, Allt nan Con-uisge is a very low gradient, slow flowing stream of deep glides, pools and short reaches of shallow run and riffle. It provides very limited and poor quality habitat for fry and is largely unsuitable for salmon parr. The deep glides and pools hold trout parr. The substrate is largely peat, and the stream lacks spawning habitat.

The tributaries between Dalnessie and Corrish offer short- to moderate- length reaches (0.3 to 1.6 km) of generally good mixed juvenile salmonid habitat. Spawning substrates are available in Allt na h-Innse Mor, Allt Coire Chaorachaidh, Allt a Mhuilt, and Allt an Eisg (Craigton), and these may play an important role in maintaining salmonid populations in this reach of the River Brora given the lack of good juvenile and spawning habitat in the main river.

Between Corrish and Braegrudie the Allt an Fearna holds good fry habitat and spawning substrates suitable for trout. Downstream of Braegrudie the majority of the mapped tributaries are very small or inaccessible to fish from the River Brora. The exceptions are Allt an Tuirc and Tormore Burn which offer short reaches of stable mixed juvenile habitat, but lack spawning substrates

Table 17 Tributary and headwater streams, upper River Brora unit, accessible length and wetted area

Watercourse	Upstream limit	Accessible length (km)	Accessible area (m^2)	Comment
Tormore Burn	NC 78846 10732	0.2	90	Good trout fry and parr habitat. Little spawning substrate.
Allt an Tuirc	NC 79106 09110	0.6	1152	Stable boulder substrate. Lacks spawning.
Allt an Fearna	NC 71516 10851	0.9	1580	Good fry habitat, less cover for parr. Spawning habitat available. Fry and parr both seen
Corrish Burn	NC 69166 11197	0.1	325	Short accessible reach of mixed juvenile habitat before impassable obstacles.
Allt an Eisg (Craigton)	NC 69217 12639	1.1	1785	Not clear if this burn is accessible beyond the obstacles just upstream of the confluence.
Allt a Mhuilt	NC 6844 1379	1.6	2400	Good mixed juvenile habitat interspersed with peat channel sections. Some spawning.
Allt Coire Chaorachidh	NC 67341 12643	0.3	435	Small shallow stream with mixed juvenile habitat and spawning.
Allt na h-Innse Mor	NC 66065 14418	1.6	2880	Good mixed juvenile habitat. Numerous obstacles, upstream limit not certain.
Allt an Eisg (Dalnessie)	NC 64168 15419	0.8	1650	Good cover, excellent parr habitat. No spawning
Allt nan Con-uisge	NC 61107 17000	2.6	5085	Alternating peat channel, deep peat pools, and shallow mixed juvenile habitat.
An Crom Allt & tribs.	NC 65652 20440	5.1	12374	Some good spawning habitat in lower reaches. Moderate quality juvenile habitat.
Allt Gobhlach & tribs.	NC 60262 22548	7.6	23676	May be inaccessible from R. Brora due to rock ramp. Good rearing habitats, particularly in lower reaches.

6.5.4 Banks and riparian habitats

6.5.4.1 River Brora

From Balnacoil to Dalreavoch the riverbanks are largely stable and well vegetated. Riparian tree cover is present along approximately 45% of the left bank and 31% of the right (south) bank. There are some areas of localised erosion, particularly of the left bank around Point (survey section BA2) where the channel is active and braiding. In the main, erosion is not impacting significantly on stream habitats in this reach. Grazing pressure on the bank-tops is mainly light to moderate. Much of the riverbank downstream of Torseiller is fenced off from livestock. However, further upstream there are long sections where the banks are unfenced or where stock fences are ineffective. Grazing pressure by sheep was judged to be intense in two survey sections between Scibercross and Dalreavoch.

From Dalreavoch to Braegrudie the River Brora has fairly stable, well-vegetated banks and bank-faces. Approximately 30% of both banks have riparian tree cover, but almost all of this is in the lower half of the reach. Where present, the tree-cover may be of considerable value as the river throughout this long reach is shallow. Therefore shade cast by foliage could play a valuable role in maintaining lower water temperatures during hot summer weather. However the considerable width of the river in some stretches means that the shading effect does not extend

across the entire width of the river. Gorse is plentiful in some reaches near Braegrudie and this probably helps stabilise the riverbanks, but does not provide shade to the wider channel. Erosion is taking place in some parts of the reach but mainly at a moderate pace which supplies useful material to the river rather than being damaging. Grazing takes place along much of the reach, but its impact was classified as mainly light to moderate. The left bank is largely unfenced other than for a reach near Braegrudie.

Table 18 Summary data for riparian zone, upper River Brora management unit

Reach	Riparian trees or shrubs (% of bank length)		Erosion & collapse (% of bank length)		Intense grazing (% of bank length)	
	Left	Right	Left	Right	Left	Right
Balnacoil to Dalreavoch	45.7	31.1	10.3	10.3	26.6	20.4
Dalreavoch to Braegrudie	60.9*	51.8*	4.7	4.7	0.0	0.0
Braegrudie to Corrish	1.9	2.3	14.5	14.5	0.0	0.0
Corrish to Dalnessie	0.0	0.0	46.3	46.3	78.0	73.6
Dalnessie to falls	0.7	0.0	23.2	23.2	0.0	0.0
R. Brora above falls	0.0	0.0	25.2	25.2	78.5	78.5
Tribs. below Dalnessie	4.6	4.6	2.4	2.4	32.8	32.8
Allt nan Con Uisge	0.0	0.0	2.4	2.4	0.0	0.0
A. Goblach & Crom Allt	0.0	0.0	13.7	13.7	16.5	16.5

*much gorse rather than trees, providing little shade

The reach from Braegrudie to Corrish includes a variety of riparian habitats. For the first 1.5 km upstream of Braegrudie the banks are steeply sloping and comprise stable boulder covered by turf or bedrock. There is one short gorge like reach, approximately 0.5 km upstream of Braegrudie. Further upstream the river valley broadens out to a flat valley floor, and the banks are mainly low and composed of cobble, boulder and pebble. Exposed side and point bars are present in some reaches and there is a little erosion, although it is not rapid. Other than in the short gorge section, trees are almost absent from the riverbanks upstream of Braegrudie and riparian vegetation is typically composed of grasses, sedges and some heather. There is no canopy cover or shade. A deer fence enclosing an area of native woodland planting runs roughly parallel to the left bank along much of the reach between Braegrudie and Dail na Feusaig, and has the effect of funnelling herbivores onto the riverbank. The woodland planting is well back from the river and will not provide shade, bank stabilisation or leaf-fall to the river as the trees mature. There is no fence on the right bank so grazers have access to both riverbanks.

From Corrish to Dalnessie the river is meandering and very slow-flowing, passing through marsh, moorland and rough pasture. This section is extremely low-gradient, and the floor of the entire valley is a flood plain, dissipating energy and absorbing water during large spates. The bank-tops are vegetated with grass, herbs and soft rush, while bank faces are largely bare and trees are completely absent. The very slow flow and lack of shade through this section make it vulnerable to elevated water temperatures in hot summers. Grazing by both sheep and deer is moderate to intense, with the intensity increasing substantially between Craigton and Dalnessie. Erosion is substantial and approximately 50% of the bank faces were recorded as either eroding or collapsing. The banks are composed largely of alluvial deposits of sand and gravel and these can undercut rapidly, causing overlying turf to slump into the river. Where the bank top is not too high above the water, the undercuts provide some overhead cover for fish.

Trampling of the banks by deer and sheep appears to be a significant factor contributing to bank erosion and input of silt and sand to the river. Trampling was particularly apparent in areas where shallow water and low banks make the river easy to cross. Trampling by deer is also significant in areas where instream vegetation can be browsed from the banks. Sheep make 'sheep rubs' in the exposed earth of the bank faces for shelter, increasing erosion and precipitating the collapse of the bank top in these areas. Areas used for river crossing tend to be shallow riffles which are also used for spawning, and trampling and the associated input of silt to these areas could potentially be an issue for egg and alevin survival. Redd counts and electric fishing surveys would be a useful means of assessing the importance of these areas for spawning and the survival of fry spawned here.

From just downstream of Dalnessie (near Cnocan) to the confluence of Allt Gobhlach and An Crom Allt, the river flows through rough pasture and open moorland. Trees and scrub are largely absent, so the river receives little or no shade. Grazing by sheep and deer is moderate to intense, and often focuses on the areas immediately adjacent to the river where the better soil allows the growth of more attractive grass and herbs. Quite substantial amounts of erosion are occurring through this reach, both downstream and upstream of the waterfall, with significant input of material to the river.

6.5.4.2 Tributary streams

The tributary streams downstream of Dalnessie are varied and the riparian zones generally reflect those on adjacent reaches of the River Brora. Moderate to intense grazing pressure was recorded in the accessible reaches of Allt an Eisg (Craigton), Allt a Mhuilt, Allt na h-Innse Mòr and Allt an Eisg (Dalnessie). The lower reaches of Allt Coire Chaorachaidh at Craigton are ungrazed, providing benefits to this productive little stream.

Allt nan Con-uisge flows mainly through low-lying boggy ground with no riparian trees. There is some grazing by deer and reaches with dry firm banks show some trampling and erosion, but the majority of the watercourse has low, wet banks and shows relatively low herbivore impact.

The two main headwaters of the River Brora, An Crom Allt and Allt Gobhlach drain blanket bog and open moorland, and much of the surrounding land is covered in deep peat. There is an impressive section of bank erosion in the lower reaches of Allt Gobhlach close to its confluence with An Crom Allt, and some substantial areas of eroding terrace on the lower reaches of An Crom Allt although these are now becoming vegetated. Substantial peat erosion and hagging was noted in the upper reaches of An Crom Allt around the Allt Preas a' Chracinn confluence. This might contribute to siltation risks to spawning areas further downstream and may also have an impact on instream invertebrate abundance. Grazing along the two main headwater streams was judged to be moderate, but appeared to be concentrated on the stream banks due to the good forage available here. Trees and shrubs are lacking throughout and shade to the stream is limited to that provided by the bank faces and tops.

6.6 Black Water

6.6.1 Catchment

The Black Water rises on the western slopes of Ben Armine. Its headwaters are formed by the Allt na Seilich Bige and the Allt na Seilich Mòire coming together some 8 km upstream of Ben Armine Lodge to form the Abhainn Srath na Seilge, an 8 to 10 m wide river with a substrate of large boulders and a gradient of 2.5%. The Abhainn Srath na Seilge flows roughly south and then south-east down a steep-sided valley; its name changes name to the Black Water in the reach upstream of Ben Armine Lodge. In these upper reaches, the river flows through a landscape of blanket bog and patchy heather moorland.

Downstream of Ben Armine Lodge the Black Water continues to flow in a south-easterly direction all the way to the confluence with the River Skinsdale. From Ben Armine Lodge to Dalbreck the river is stony with much bedrock, often quite constricted between bedrock banks. Wet widths in this reach are between 9 and 12 m. From Dalbreck to the Skinsdale confluence the valley broadens out substantially and here the river is broader (18-21 m wet width), shallower and lower gradient (0.6%), with a substrate of cobble and pebble. Heather moorland is the dominant land cover in this reach, apart from a large area of conifer plantation on the left bank of the river between Dalbreck and the Skinsdale confluence.

From the Skinsdale confluence to Achaness Falls the river continues very broad and shallow, with a wet width of 20-29 m and a gradient of 0.6%. Substrates are mainly cobble and pebble, although there are some reaches of bedrock. From Achaness to the confluence with the River Brora at Balnacoil the character of the river changes substantially, becoming deeply entrenched between bedrock banks with sections of steep-sided gorge. The gradient increases to 1.3%. Wet width varies between 16 and 24m in the upper half of the section, but broadens in the lower half (22 to 32 m) where the river is still constricted by steep bedrock banks but becomes somewhat less gorge-like in character. Substrates through this reach are predominantly bedrock and boulder. Surrounding land cover is heather moorland, with conifer plantation towards the downstream end of the right bank.

Significant tributaries of the Black Water include the headwater streams Allt na Seilich Bige and the Allt na Seilich Mòire, Allt Coire an Fhaicnich, the substantial Coirefrois Burn and the Allt a

Mhuilinn Dubh. The River Skinsdale is a tributary of the Black Water, but due to its size and importance for salmon production is considered as a separate management unit.

6.6.2 Obstacles to migration

The first obstacle encountered by upstream migrants is 500 m upstream of the River Brora confluence. This is a straight jump up a 1.5 m high waterfall and is passable for salmon and sea trout. There are several further rapids and small waterfalls through the lower reaches of the river, parts of which flow in a gorge. These are all passable to salmon and sea trout.

Achaness Falls at NC 7908 1452, some 4 km upstream from River Brora, is the most substantial obstacle encountered by salmonids migrating up the Black Water. It is thought to be a temperature barrier, potentially restricting access in the early months of the year; but is passable by both salmon and sea trout when conditions are right. Upstream, the Black Water appears accessible to migratory fish as far as the waterfalls and rapids at NC 662 222 on the Abhainn Srath na Seilge (the upper Black Water) near Green Face. This section of river appears to act as a barrier to upstream migration and no salmon were found further upstream during electric fishing surveys in 2003 or 2018.

The walkover survey of Coirefrois Burn suggested that this substantial watercourse is accessible for approximately 7.1 km. A complex waterfall at NC 6907 1617 seems likely to be impassable to salmon or sea trout although this has not been confirmed. The obstacle is a complex cascade with an estimated height of 2.8 m and a total length of approximately 6 m. The steps and ledges provide several wetted channels but none seem likely to become passable on a high flow. However, confidence in this assessment is low. It is not known how much potentially suitable habitat is present further upstream. Brief electric fishing surveys upstream of the fall in July 2020 found trout fry and parr but no salmon, however further surveys extending through a greater reach of the watercourse would be useful to confirm this result.

Allt an Eoin, a tributary of the Coirefrois Burn, is accessible for approximately 600 m until a rock ramp at NC 7113 1493 prevents further upstream movement.

The Allt a' Mhuillin Duibh seems likely to be accessible for approximately 1.6 km. A rock ramp with an estimated height of 2 m at NC 7510 1470 seems likely to prevent further migration, although this is unconfirmed.

A number of other flow dependent obstacles were identified and these are listed in Appendix 15.4.

6.6.3 Instream habitats

6.6.3.1 Black Water and Abhainn Srath na Seilge

The Black Water has quite a different character from the River Brora. Much of the reach from the confluence with the River Brora at Balnacoil to Achaness Falls is characterised by moderate to fast current speed and coarse substrates. It is a large river with a typical wet width of over 20 m in its lower reaches. The first of a series of rapids is encountered approximately 0.5 km upstream of Balnacoil and from here to Achaness Falls much of the river flows in gorge-like terrain with a significant amount of bedrock riverbed (Table 16). These bedrock habitats are largely unsuitable for salmonid or other fish but are interspersed with reaches that are dominated by boulder and gravel, which provide good fish cover and pockets of potential spawning habitat. Deep holding pools for adults are present throughout the lower reaches of the Black Water and these provide valuable refuges for upstream migrants as well as offering angling opportunities.

The gorge-like habitat ends abruptly immediately upstream from the Achaness Falls and the river opens out in a broad, flat-bottomed strath. Here the river is wider and shallower than in reaches further downstream and bedrock is largely absent. From here to Gobernuisgach at the River Skinsdale confluence substrate is dominated by boulder, cobble and gravel. There are large expanses of juvenile habitat, most of which was judged to be of moderate quality. The riverbed is stable and depth is typically 25 to 60 cm. Spawning habitat is sparse. The Long Pool, a short distance downstream of the Skinsdale confluence provides resting habitat for adult salmon.

The reach between the Skinsdale confluence and Dalbreck (near the confluence of the Coirefrois Burn) is broad and meandering with a low gradient. Flow types are characterised by riffle and glide sequences and deep holding water for adult fish is plentiful in pools and glides. Substrate grain size is small, with much pebble and gravel in the riffle areas at the tails of glides and pools. These provide little cover for juveniles but spawning habitat is plentiful and appears of good quality. It is highly probable this reach is a significant spawning area for Black Water

salmon, and high fry densities were recorded in the area during the 2018 electric fishing survey. Habitat suited mainly to salmon fry is also quite plentiful in this reach. Good habitat suited largely to fry is quite patchily distributed in the Black Water, and this reach provides over 60% of that recorded in the Black Water area (Tables 19 and 20).

Table 19 Distribution of habitat types in the Black Water management unit

Reach	Length (km)	Area of habitat (m²)						
		Fry	Mixed & deep juv.	Pool	Shallow glide	Deep glide	Bedrock and peat channel	Spawning (m²)
Balnacoil - Achaness	4.3	0	34,840	26,940	0	0	32,000	0
Achaness – Skinsdale	3.3	1,800	59,630	8,920	0	0	7,600	200
Skinsdale - Dalbreck	3.4	14,700	31,020	9,930	1,590	6,620	510	970
Dalbreck - Armine FB	7.4	2,810	47,800	8,050	0	220	18,730	242
Armine FB - waterfalls	3.8	0	26,610	1,270	0	0	5,320	55
Inaccessible headwaters	9.0	2,440	43,280	7,325	0	2,240	2,735	505
Coirefrois & tribs	11.6	658	41,287	1,135	187	8,901	4,255	149
Other lower tributaries	11.7	480	40,116	1452	0	0	9,877	512
Total	54.4	**22,888**	**324,583**	**65,021**	**1,777**	**17,981**	**81,027**	**2,633**

Table 20 Quality of juvenile salmon habitat in each part of the Black Water management unit

Reach	Fry habitat quality (% of total)			Parr habitat quality (% of total)			Total fry habitat* (m^2)	Total parr habitat (m^2)
	Good	Mod.	Poor	Good	Mod.	Poor		
Balnacoil - Achaness	0.0	41.5	58.5	16.9	48.9	34.2	10,450	34,840
Achaness – Skinsdale	27.5	72.5	0.0	43.2	56.8	0.0	35,660	59,630
Skinsdale - Dalbreck	71.9	28.1	0.0	46.7	48.8	4.5	41,840	31,020
Dalbreck – Armine FB	36.1	41.6	22.3	52.3	44.7	3.0	43,870	47,800
Armine FB - waterfalls	0.0	100.0	0.00	55.5	44.5	0.0	25,950	26,610
Inaccessible headwaters	55.2	19.7	25.1	67.8	32.2	0.0	44,125	43,280
Coirefrois & tribs	25.9	70.9	3.2	25.8	72.6	1.5	41,945	41,287
Other lower tributaries	78.5	21.5	0.00	54.4	36.2	9.5	40,596	40,116
ALL REACHES	43.2	46.9	10.0	45.5	48.6	5.9	284,436	324,583

*Includes mixed juvenile as this is suitable for fry as well as parr

The average gradient between Dalbreck and the footbridge above Ben Armine Lodge is approximately 1.3%. The first 4 km of river upstream of Dalbreck is entrenched between steep banks and in places is scoured to bedrock. However, this reach also provides extensive patches of rearing and spawning habitat and there are some deep and secure holding pools for adults. Further upstream towards Ben Armine Lodge the river provides much juvenile rearing habitat for salmonid fry and parr, mostly of moderate to good quality. Spawning habitat, although not abundant, is widespread and well distributed in relation to rearing habitats.

In addition to the 243 m^2 of typical spawning habitat recorded during the walkover it is likely that there are further small pockets of usable habitat that went unrecorded. Substrates of a suitable size for spawning are widespread and flow types varied, making for a high degree of habitat variety. Habitat suited mainly to fry is sparse but edges and shallow areas amongst the mixed juvenile habitat provide plenty of space suited to younger juveniles. The streambed through most of this reach is moderately stable and instream cover for juvenile salmon is largely good throughout.

The character of the river changes somewhat approximately 1 km upstream of Ben Armine Lodge. In particular the riverbed and banks appear less stable as the channel cuts through glacial deposits and old river terraces. The gradient is steeper than in the reaches further downstream, with an average of 3.2% between the old footbridge and the waterfalls. Substrates are dominated by boulder and cobble, with unstable patches of sand and gravel. Clearly differentiated areas of spawning habitat are sparse amongst the mixed substrates, but some spawning opportunities are present. However, due to the dynamic nature of the river, redd washout is likely to be a concern during spates. To the west of Green Face the river channel becomes more entrenched, running in a narrow v-shaped valley. Bedrock becomes more

prevalent and the gradient steeper until the waterfalls at NC 662 222 are encountered, marking the upstream limit of migration for salmon.

Approximately 9 km of watercourse were surveyed upstream of the waterfalls. While salmon have been shown to be absent from these reaches during two electric fishing surveys (See section 7) it is not known if they are also inaccessible to sea trout, which will sometimes ascend difficult, complex obstacles that are barrier to salmon. These headwater reaches have a moderate gradient and provide large areas of potential rearing habitat, representing approximately 13% of the juvenile habitat and over 20% of the potential spawning habitat in the Black Water area. Over a quarter (26%) of the 'good' fry habitat in the Black Water is upstream of the Srath na Seilge falls, and all of the parr habitats in this part of the system were judged to be of moderate or good quality (Table 17). Without doubt, the headwaters have substantial potential for smolt production if fish were to have access to them. Allt na Seilich Moire in particular provides excellent spawning opportunities, as does its tributary Allt an Inne Mhoire.

6.6.3.2 Coirefrois Burn

The Coirefrois Burn flows west to east, draining the low hills (~400 m) between Srath na Seilge and the upper River Brora. The catchment area is approximately 24 km^2 and it is a substantial stream with a wet width of 8 to 10 m in its lower reaches. The gradient in the lower 4 km, downstream of the Allt an Eoin confluence (NC 716 152) is moderate or low. Long reaches of stable mixed juvenile habitat alternate with deep pools and deep glides. Stream gradient increases upstream of the old Coirefrois village, and the channel becomes more constricted within the v-shaped valley of Claise an Daimh. However, juvenile habitat quality remains good or moderate all the way up to the waterfall at NC 6907 1617.

Approximately 80% of the surveyed area of Coirefrois Burn was classified as productive juvenile habitat, and the stream provides approximately 12% of the juvenile habitat in the Black Water survey area. Although habitat suited exclusively or mainly to fry is scarce in Coirefrois Burn, many of the mixed juvenile habitats include areas that are well suited to fry. Almost 20% of fry and mixed juvenile habitats in the Black Water system that were classified as 'good' for fry are in the Coirefrois Burn (Tables 19 and 20). In addition, approximately 150 m^2 of spawning habitat were recorded in the stream. Much of this is either in the lower reach around Dalbreck, or in the reaches immediately upstream and downstream of the Allt nan Eoin confluence. The spawning habitats that were recorded were judged to be of moderate or good quality. Some of the potential spawning areas in the lower reaches had minor impacts from silt/peat fragments but is seems likely that much of this might be winnowed out during redd creation. Overall, Coirefrois Burn is likely to be a significant producer of smolts to the Black Water and Brora fisheries.

Allt nan Eoin is a small stream and accessible only for about 800 m until waterfalls are encountered. However stable spawning habitats suited to trout and salmon are present in the lower reaches.

6.6.3.3 Other tributary streams

A number of other smaller streams flow into the Black Water in addition to those described above. In the headwaters an unnamed tributary of the Allt na Seilich Bige holds some unstable mixed juvenile habitat but offers no spawning substrate, however the small Allt an Inne Mhòir, a tributary of the Allt na Seilich Mòire, holds a substantial 90 m² of spawning habitat. The small Allt Dubh Ceann na Creige, a tributary of the Abhainn Srath na Seilge, offers rather poor habitat and little spawning substrate. It is not known if these streams are accessible to sea trout, but they are thought to be inaccessible to salmon.

Just upstream of Ben Armine Lodge the moderately-sized Allt Coire a' Mhile is a 4 m wide stream with an unstable substrate of boulder and cobble. There is little accumulation of spawning-sized sediments apart from small patches in the tails of pools, however lots of fry were seen at the time of the survey, suggesting these areas are used successfully. The stream flows through a conifer plantation, and fallen trees in this section are causing blockages/debris dams at various points.

Downstream of Ben Armine Lodge, the Allt Coire an Fhaicnich is a significant tributary with an accessible length of 4.9 km and wet widths of 1 to 5 m. The lower reaches of this stream are shallow mixed juvenile habitat, changing upstream to glide with patches of fry habitat. Spawning substrates are found throughout, totalling 59 m². Iron flocs, and heavy peat deposits over the substrate, were noted in the upper reaches.

The Allt an Lòin Earraich is a low gradient stream flowing into the Black Water from the north. It holds alternating shallow mixed juvenile and deep glide habitats and averages 3.5 m width. It is very stable, except for a short steep braided section which provides plentiful small substrate. 62 m² of spawning habitat was recorded in this stream, and fry were numerous in these areas at the time of the survey.

Table 21 Tributaries and headwater streams, Black Water, accessible length and wetted area

Watercourse	Upstream limit	Accessible length (km)	Accessible area (m^2)	Comment
A. na Seilich Bige tributary	NC 67590 26311	0.7	660	Shallow and unstable. Substrate of unsorted angular boulder/cobble/pebble. No spawning.
Allt an Inne Mhoire	NC 68070 24716	0.6	480	Braided stream. Substrate of pebble with gravel, cobble and sand; lots of spawning suitable for trout.
A. Dubh Ceann na Creige	NC 67269 20891	1.2	1,180	Small burn with rather immobile substrate of boulder, cobble and a little gravel. Little spawning.
Allt Coire a' Mhile	NC 70193 20505	1.5	6,120	Unstable. Cobble-dominated at lower end, bouldery higher up. Good cover. Little spawning.
A. Coire an Fhaicnich	NC 69617 17570	4.9	14,500	Mixed juvenile habitat in lower reaches, changing to glide in upper reaches. Some good spawning throughout.
Allt an Loin Earraich	NC 73334 18843	3.1	10,710	Alternating shallow mixed juvenile and deep glide habitats. Low gradient. Good spawning.
A. a Mhuillin Duibh	NC 74634 13993	2.6	7,753	Broad shallow stream with stable cobble and small angular boulder substrate. Some poor spawning in lower section.
Long Pool Burn	NC 77430 16144	0.4	585	Small stream with substrate of angular cobble and boulder. Lacks spawning.

Allt a Mhuillin Duibh is a 3 m wide stream flowing into the Black Water from the south at Pollie. It is mostly very shallow mixed juvenile habitat with a substrate of stable cobble and small angular boulder which provides little opportunity for spawning. At the time of survey, a dense growth of algae was noted, trapping peat fragments.

Long Pool Burn is a small shallow stream entering the Black Water from the north just downstream of the Skinsdale confluence. It holds a mix of run and step-pool habitat with a substrate of angular cobble and boulder. No spawning habitat was recorded during a survey of the lower reaches.

6.6.4 Banks and riparian habitats

6.6.4.1 Black Water and Abhainn Srath na Seilge

The banks of the Black Water between Balnacoil and the Achaness falls include long reaches of bedrock. Parts of this section are gorge-like and therefore the banks are very stable, providing little or no sediment input to the channel. Away from the gorge sections, the banks are a mix of boulder and bedrock overlain with turf and again are very stable. Downstream of the waterfall at Balnacoil the banks are open and grassy, allowing angler access. Upstream of the waterfall they become steeper and are clad in bracken and scrub with some scattered broadleaf trees. The more gorge-like reaches downstream of Achaness Falls are more heavily wooded. Overall, approximately 30% of each bank has some riparian tree cover (Table 22). Grazing intensity is mainly light with some short reaches of moderately intense grazing in the lower reaches only.

Upstream of Achaness Falls there is almost no tree cover anywhere along the mainstem of the Black Water. The banks of the lower reaches are grazed by sheep and deer and although in most places grazing intensity is only moderate the presence of grazers undoubtedly inhibits the regeneration of tree or scrub cover. Remnant mature alders along the left bank of Long Pool suggest that the banks along this reach probably supported riparian woodland in the past, and mixed-age woodland on the island at the head of Long Pool indicates that riparian trees grow well and can regenerate naturally here in areas inaccessible to herbivores.

The reaches between the Skinsdale confluence and Dalbreck appear to be quite heavily grazed compared with other reaches, and large numbers of deer were observed descending to the grassland in this area in the evening. Substantial amounts of erosion and collapse are present in this reach and while these are natural process along a meandering floodplain the rate of change may be increased by lack of scrub or tree roots to help bind banks.

Table 22 Summary data for riparian zone, Black Water management unit

Reach	Riparian trees or shrubs (% of bank length)		Erosion & collapse (% of bank length)		Intense grazing (% of bank length)	
	Left	Right	Left	Right	Left	Right
Balnacoil - Achaness	32.0	30.8	2.0	2.0	0.0	0.0
Achaness – Skinsdale	0.5	0.0	2.9	2.1	0.0	0.0
Skinsdale - Dalbreck	0.0	0.0	29.3	21.7	0.0	0.0
Dalbreck – Armine FB	0.0	0.0	6.5	13.3	24.7	24.7
Armine FB - waterfalls	0.0	0.0	31.1	31.1	36.1	36.1
Inaccessible headwaters	0.0	0.0	39.5	39.1	34.0	34.0
Coirefrois & tribs	0.3	0.3	2.2	0.6	10.9	10.9
Other lower tributaries	1.3	1.3	15.8	15.8	13.1	13.1

The first few km upstream of Dalbreck are rather entrenched and the banks are mainly very stable boulder or bedrock. One or two trees cling to the steeper areas of bank that are inaccessible to grazers, but these are too infrequent to provide shade or significant leaf-fall to the river. As the channel opens out downstream of Ben Armine Lodge some short sections of bank erosion are present, but these do not equate to more than 10% of bank length in most survey sections and do not negatively impact habitat quality.

From the lodge upstream the river channel is more mobile and the proportion of eroding and collapsing bank increases. The river appears to have a flashy nature and where it encounters old river terraces or glacial deposits these rapidly become undercut and prone to collapse. The reach around the confluence with Alltan Dubh Ceann a Creige (NC 680 207) is particularly dynamic with approximately 60% erosion and collapse along each bank. Large deposits of boulder, cobble and pebble were unvegetated at the time of survey suggesting recent large-scale change in this area. Further upstream to the west of Green Face, where the channel is more entrenched, the banks are mainly stable turf-cover boulder or bedrock. Tree cover is entirely lacking and the banks are mainly grassy other than in the first 1 km upstream of the footbridge where there are some reaches lined with gorse. There is some gullying and erosion of peat in the riparian area and in the lower reaches of tributaries.

From Green Face upstream to Caochan na Luibe and the old (now defunct) footbridge, the channel continues quite entrenched in a steep-sided valley, with stable turf-covered bedrock and boulder banks. Once at the old footbridge however the valley broadens, and the channel between here and the bothy at the confluence of the Allt na Seiliche Moire and Allt na Seiliche Bige is dynamic and meandering. The banks are turf over peat and unstable glacial deposits, eroding readily on bends. The eroded hard material is redeposited as point- and side-bars, while peat input to the watercourse here is a cause of siltation.

The Allt na Seiliche Bige is a very dynamic and unstable stream. It is entrenched in places with stable boulder and bedrock banks, but away from these sections the banks are loose glacial deposits or peat, and erosion in some sections is severe (up to 50% of bank length). Deer use the riverbanks intensively for grazing and shelter, trampling open peat faces and exacerbating erosion. The surrounding peatland is heavily hagged and gullied, funnelling rainwater directly to the river rather than absorbing it, which will increase the severity of spates and speed up the natural processes of erosion which would be expected in headwater streams such as this. These gullies also deliver large quantities of peat fragments into the watercourse.

Allt na Seiliche Moire is a typical headwater stream with active bank erosion and deposition where it is not constrained by bedrock or boulder banks. Erosion amounting to 30-50% of bank

length was recorded in most survey sections. Banks away from stable bedrock sections are either peat or glacial deposits, or both. As in Allt na Seiliche Bige, trampling and hagging resulting from deer grazing and use of peat faces for shelter exacerbates peat erosion and instream siltation. Gullying and hagging of the surrounding peatland is severe.

There are no trees along any of the headwater described above. The stream banks throughout all reaches from Dalbreck to the headwaters are unfenced.

6.6.4.2 Coirefrois Burn

The lower reaches of the Coirefrois Burn around Dalbreck flow though intensively grazed rough pasture. The banks are low to the water and as the channel is broad and the gradient moderate there is little or no erosion of the banks, which are stable boulder and cobble covered in turf. The 4.9 km of stream between NC 741 158 and NC 701 156 flows through woodland grant scheme. Tthe wooded area is within a deer fence, however, a broad buffer zone has been left unplanted beside the river, so riparian trees are lacking. Nevertheless the banks are well vegetated and as a result of the reduced grazing pressure heather and other tall herbs provide some good cover alongside the banks. Unfortunately the channel lacks any other canopy cover, and as the stream is rather slow flowing and shallow it is likely that summer water temperatures may become very high. The stream banks themselves are very stable and there is no significant erosion or collapse along the reaches within the woodland scheme. In July 2020 it was noted that the watergates on the deer fenced area are damaged, and deer now have access to this area. Impacts of browsing and trampling are beginning to be visible in some areas.

Upstream of the woodland scheme towards the old Coirefrois village the river is more dynamic and there are some substantial areas of erosion as well as some braiding of the channel. These are unlikely to constitute a problem and may be an important source of sediments for the maintenance of juvenile and spawning habitats in the reaches further downstream. Further small areas of erosion are present through Clais an Daimh, but here the banks are mainly stable boulder covered in turf.

6.6.4.3 Other tributary streams

Allt Coire an Fhaicnich flows through moorland on glacial deposits in its lower reaches, changing to blanket bog on deep peat towards the headwaters. Banks are unstable and eroding close to the confluence with the Black Water, but much of the watercourse above this reach has low stable turf banks with little erosion. Towards the upper reaches erosion increases, with high eroding peat banks feeding peat fragments to the watercourse. Use of this area by deer for grazing and shelter was intense at the time of the habitat survey.

Allt an Loin Earraich has mainly low stable banks with undercuts providing good cover for fish. A short middle section has a long, eroded peat bank face with exposed roots of old pines; trampling by deer is evident here. Upstream is a braided section through a marshy area with low, wet banks, followed by a short relatively steep section cutting through glacial deposits in which substantial erosion is occurring and producing useful material for the watercourse downstream. Above this the channel becomes fairly stable again with low turf and boulder banks.

Allt Coire a' Mhile is a steep mobile stream through glacial deposits of loose boulder/cobble/pebble/gravel/sand, which are very unstable and easily eroded. There is some overhead cover along the banks from undercuts and boulders. The lower reaches pass through a conifer plantation. Despite this there is little shade, as the stream is almost north-south in alignment and thus benefits little from the riparian trees. The mobile nature of the watercourse through the plantation means that conifers extend right up the water's edge in places although they may not have been planted that way originally, and some trees have fallen across the stream.

Allt a' Mhuilinn Duibh has low stable banks throughout the reach accessible to migratory salmonids.

6.7 River Skinsdale

6.7.1 Catchment

The River Skinsdale's headwaters are the Allt an Ealaidh and Allt Coir' an Eas, which drain the east side of Ben Armine, and the Allt a' Choire Bhuidhe and Allt Preas a' Chamraig draining the low hills that separate the Skinsdale and Helmsdale catchments. Most of the River Skinsdale catchment is blanket bog with some areas of heather moorland and rough pasture on the drier ground. In the lower reaches around Muiemore there are some larger areas of rough grassland and heather moor. Except for a small block of conifers set well back from the river near Muimore, trees are absent. The river is typically broad and shallow and in its lower reaches, below the Garvary Burn confluence, it has a typical wet width of between 15 and 20 m. Further upstream towards Cnocan, width is closer to 10 m. Although it is no longer fished, Ordnance Survey data show several named pools in the reaches downstream of Cnocan indicating that it has a history as a fishery.

Significant tributaries of the Skinsdale are the headwater streams Allt an Ealaidh, Allt Coir' an Eas, Allt a' Choire Bhuidhe and Allt Preas a' Chamraig, along with the Garvary Burn and its tributaries Allt Crithinn, Allt Garbh Beag and Allt a' Ghorm-Loch. Smaller tributaries which may be important for trout include Allt Acha' Mhòir, Allt Meadhonach and Allt Blàrach.

6.7.2 Obstacles to migration

There are no major obstacles on the River Skinsdale itself, and both Pollie Falls (NC 762 180) and Muimore Falls (NC 755 191) appear easily passable by salmon and sea trout. Based on these findings it would seem that salmon and sea trout have access well into the headwaters including the full length of Allt an Ealaidh. Allt Coir' an Eas, Allt a' Choire Bhuidhe and Allt Preas a' Chamraig are also accessible along much of their length.

A waterfall at NC 737 216 probably restricts salmonid access to the lower 4 km of Garvary Burn. These lower reaches include much the better salmon habitat. Its tributary Allt Garbh Beag is

probably accessible for around 2.5 km, as far as a waterfall at NC 727 208. No impassable obstacles were recorded on the other main tributary, Allt Crithinn, which is thought to be used by spawning salmon (J. McMorran pers. comm.).

Overall, an estimated 39 km of the 42 km of stream surveyed in the Skinsdale sub-catchment during 2018 was judged likely to be accessible to salmon and/or sea trout. It should, of course, be kept in mind that to reach these habitats fish must first ascend two substantial waterfalls in the lower reaches of the Black Water, but these are known to be passable to sea trout and salmon when water levels and temperatures are suitable.

6.7.3 Instream habitat

Instream habitats in the River Skinsdale sub-catchment are largely stable throughout all watercourses encompassed by the 2018 walkover survey, including the headwater streams and the Garvary Burn. Substrates are uncompacted and instream cover is good in the mainstem of the river and moderate to good in the headwaters such as Allt an Ealaidh and in the Garvary Burn. Stability is promoted by relatively low gradient and the non-entrenched nature of channels.

There are substantial expanses of good quality spawning habitat in the River Skinsdale catchment, with an estimated total area of over 2,200 m^2 recorded during the 2018 walkover survey. This represents an estimated 24% of the spawning habitat recorded in the River Brora catchment, underscoring the probable importance of the River Skinsdale and its tributaries to the maintenance of the Brora fisheries. The vast majority of the available spawning habitat was considered to be stable and unlikely to wash out during spate events.

Spawning habitats are widely dispersed through the sub-catchment, but over 50% of the total is in the River Skinsdale itself, between Two Stones (just upstream of the Garvary Burn confluence) and the Allt an Ealaidh confluence. This part of the river is likely to be of great importance for spawning salmon. There are further good quality spawning habitats in the lower river around Muimore, where the channel meanders through a flood plain.

The Allt an Ealaidh, despite its small size, accounts for a further 16% of the spawning habitat in the sub-catchment. Electric fishing data suggest that salmon ascend this stream almost to Gorm-loch Beag. No data are available or fish populations in Allt Coir an Eas. The other headwater streams included in the survey, Allt Choire Bhuidhe and Preas a' Chamraig, provide relatively little spawning habitat and seem unlikely to be attractive to salmon, although they have not been surveyed by electric fishing. These smaller streams may be used by spawning sea trout, where they have access.

Table 23 Distribution of habitat types in the River Skinsdale management unit

Reach	Length (km)	Area of habitat (m²)						
		Fry	Mixed & deep juv.	Pool	Shallow glide	Deep glide	Bedrock and peat channel	Spawning (m²)
Black Water confluence - Two Stones	7.3	11,840	84,390	5,240	0	2,160	14,220	345
Two Stones – A. an Ealaidh	9.3	16,475	58,910	3,050	7,680	3,270	5,660	1,206
Garvary Burn & tributaries	11.8	1,944	23,348	1,916	2,768	3,660	1,590	284
A. an Ealaidh & A. Coir an Eas	9.3	2209	22,076	1,169	1,624	3,373	865	424
Choire Bhuidhe/ Preas a'Chamraig	4.6	1,037	3,230	46	1,426	1,845	0	21
Total	42.3	33,505	191,954	11,421	13,498	14,308	22,335	2,280

The total estimated wetted area in the surveyed reaches of the River Skinsdale sub-catchment was approximately 287,000 m^2 of which approximately 225,000 or 78% was classified as juvenile salmonid habitat. In total, an estimated 24% of salmon fry habitat and 21% of salmon parr habitat in the surveyed reaches of the Brora catchment are in the River Skinsdale and its tributaries, again underscoring the value of this part of the catchment to fish production.

Good quality, largely stable fry and parr habitats are distributed throughout the mainstem of the River Skinsdale from the confluence with the Black Water at Gobernuisgach all the way to the headwaters. Throughout these reaches the river is typified by moderate to low gradient and substrates of cobble, pebble and boulder. Productive juvenile habitats, mainly of good quality, continue up Allt an Ealaidh which, as noted above, is accessible to migratory fish, perhaps all the way to Gorm-loch Beag.

All of the juvenile habitats recorded in the Skinsdale mainstem were classified as either of good or moderate quality (Table 24). Where habitat quality was not classed as good this was mainly due to small substrate size resulting in a lack of cover for larger salmon and trout parr in some reaches. A lack of overhead cover for trout alongside the riverbanks was also a feature of most reaches on the mainstem of the river.

The Allt an Ealaidh, despite its small size, provides an estimated 10.3% of the good fry habitat and 11.3% of the good parr habitat in the Skinsdale sub-catchment. None of the juvenile habitat in the Allt an Ealaidh was classified as poor quality. Garvary Burn also provides substantial areas of moderate and good quality fry and parr habitat. The better quality habitats for salmon in this tributary are in the lower, accessible reaches of the Garvary Burn.

Table 24 Quality of juvenile salmon habitat, River Skinsdale management unit

Reach	Fry habitat quality (% of total)			Parr habitat quality (% of total)			Total fry habitat (m^2)	Total parr habitat (m^2)
	Good	Mod.	Poor	Good	Mod.	Poor		
Gobernuisgach - Two Stones	87.8	12.2	0.0	81.0	19.0	0.0	11,840	84,390
Two Stones – A. an Ealaidh	79.6	20.4	0.0	52.0	48.0	0.0	16,475	58,910
Garvary Burn	45.7	38.1	16.2	36.2	42.3	21.5	1,944	23,348
A. an Ealaidh & A. Coir an Eas	67.8	32.2	0.0	62.3	37.7	0.0	2,209	22,076
Choire Bhuidhe/ Preas a'Chamraig	0.0	0.0	100.0	0.0	0.0	100.0	1,037	3,230

The great majority of juvenile habitat classified as being of poor quality was in the Garvary Burn and its tributaries or in the Allt a Choire Bhuidhe/Allt Preas a' Chamraig headwater area. However the total area of these poor quality habitats is low, as these streams are relatively small. Poor quality sections made up only 4% of the total area of fry habitat in the River Skinsdale sub-catchment. Poor quality parr habitat made up a similar proportion. The factor resulting in the downgrading of habitat quality assessments in these reaches was primarily deposition of eroded peat over the streambed. Due to the size of the affected streams such impacts may disproportionately affect trout, which are more reliant on small streams for spawning than are salmon.

Pool habitat suited to adult salmon is most prevalent in the lower reaches of the river. Pool habitat makes up an estimated 3% of the wetted area between Two Stones and the Allt and an Ealaidh confluence, where spawning habitat is most abundant. Not all pools in this reach provide deep, secure holding water for adult salmon. This may have implications for the uptake of spawning opportunities.

6.7.4 Banks and riparian habitats

There is a substantial amount of bank erosion occurring throughout the River Skindsale from its confluence with the Black Water right up to the headwaters (Table 25). The banks in many parts of the mainstem are deposited river sediment and are easily eroded. As much of the River Skinsdale is low gradient, meandering and mobile, there is substantial erosion occurring on the outside of many of the bends with deposition on the inside. The most substantial areas of bank instability are in the lower Garvary Burn, the River Skinsdale downstream of the Garvary Burn confluence, and in some of the smaller headwaters streams including some parts of Allt an Ealaidh.

Table 25 Summary data for riparian zone, Skinsdale management unit

Reach	Riparian trees or shrubs (% of bank length)		Erosion & collapse (% of bank length)		Intense grazing (% of bank length)	
	Left	Right	Left	Right	Left	Right
Gobernuisgach - Two Stones	0.0	0.0	40.6	44.2	0.0	0.0
Two Stones – A. an Ealaidh	0.0	0.0	22.6	24.5	60.5	60.5
Garvary Burn	0.0	0.0	16.4	16.4	16.4	16.4
A. an Ealaidh & A. Coir an Eas	0.0	0.0	14.7	16.5	41.4	41.4
Choire Bhuidhe/ Preas a'Chamraig	0.0	0.0	6.7	6.7	69.0	69.0

Large areas of active erosion and deposition are present in the lower reaches of the River Skinsdale, especially in sections SA3 to SA6 around Muiemore and Lubeag. These are associated with a low gradient, meandering channel where the river flows through a floodplain. There is some braiding of the channel. The banks are of cobble and pebble overlain with turf. These banks are friable and prone to slumping as they undercut, so erosion is quite rapid on the outside of the larger bends and there are large depositional point bars on the insides.

Some erosion is also occurring on the River Skinsdale upstream of the Garvary Burn confluence, but the channel here is less active and the rate of erosion appears lower. The most active areas of change in this section are in the reaches around Cnocan, where the river again has an actively meandering channel with some braiding. These reaches are associated with some excellent spawning areas and it is likely that the supply of material from bank to channel supports the maintenance of these habitats. While erosion and deposition are a natural feature of meandering channels it may in some areas lead to the channel becoming gradually wider and shallower. This may be a concern in relation to water temperature, particularly as the River Skinsdale is treeless and lacking shade.

In the headwaters, although grazing pressure was generally assessed as moderate, deer activity tends to be concentrated along the river banks where grazing is good and the ground offers easy travel and some shelter. This exacerbates erosion in heavily-used areas and increases the input of silt and peat fragments to the river. This was particularly evident in the headwater streams including Allt Preas a' Chamraig, where the riverbed in the lower gradient areas was densely coated in eroded peat. Hags and erosion gullies were evident in many places in this part of the catchment, particularly in the areas where the deep peat slopes towards the stream channel. Slumping of peat into the headwater streams was also a feature of these deep peat headwater reaches.

During the course of developing the current management plan concerns were expressed about the levels of bank erosion on the River Skinsdale. Due to the friable nature of the riverbanks in the meandering reaches around Muiemore and, to a lesser extent Cnocan, there undoubtedly are places where erosion is quite rapid. This is a natural process but is likely to be exacerbated by climate change, which is known to be resulting in a higher frequency of large spate events. It is these events that are likely to result in the most rapid changes to riverbanks. The impression formed during the walkover survey was that current levels of bank erosion are not a significant concern. Indeed, it must be remembered that these erosional process are essential for supplying the gravels, pebbles and cobbles to the channel that form fish habitats and without which the riverbed would become scoured and armoured. However, if erosion should result in widening and shallowing of the channel this would be a concern and it seems possible that this process is underway in some parts of the river. Any such change would be expected to a) exacerbate increased summer water temperatures to the potential detriment of salmon and trout, and b) reduce carrying capacity for older juveniles and therefore smolt production.

7 ABUNDANCE AND DISTRIBUTION OF JUVENILE SALMON AND TROUT

7.1 Data sets and methods

7.1.1 Available data sets

Data have been collated from ten electric fishing surveys (Table 26). Further data have been collected on an annual basis by the Brora District Salmon Fisheries Board but these are not currently accessible. The most wide ranging and recent data are from two Government sponsored surveys conducted during 2018 and 2019 as part of the National Electrofishing Programme for Scotland (NEPS). These two surveys left some significant gaps, including on the lower River Brora, lower Black Water and Coirefrois Burn. A survey by Waterside Ecology in July 2020 filled some of these gaps. The data from 2018 to 2020 form much the basis for stock assessment within this section of the Management Plan.

Table 26 Juvenile survey data from Brora catchment

Year	Reference	Sites (n)	Reaches covered	Comment
1999	Unknown	17	R. Brora, Black Water, Skinsdale, several tributaries	Summary data available in Carnie (2003). Original unseen.
2001	West Galloway Fisheries Trust (2001)	9	R. Brora near Dalnessie, Allt Gobhlach, An Crom-Allt (upstream of Dalnessie)	Conducted to estimate potential smolt output from upper R. Brora above Dalnessie
2003	Carnie (2003)	17	R. Brora, Black Water, selected tributaries	No River Skinsdale data due to access restrictions
2006	Era & CHA (2006)	6	Coirefrois Burn	Conducted on behalf of SNH
2010	Waterside Ecology (2010)	6	Scottarie Burn	Survey for Kilbraur Wind Farm Environmental Statement (E.S.).
2012	Waterside Ecology (2012)	15	R. Brora above L. Brora, lower Black Water, Allt Ach'a Bhathaich	Survey for proposed Balnacoil Wind Farm E.S.
2018	NEPS 2018	14	R. Brora above Black Water confluence, Allt Coire Chaorachaidh Black Water, R. Skinsdale,	National Electrofishing Programme for Scotland 2018
2019	NEPS 2019	17	R. Brora above Black Water confluence, Black Water, R. Skinsdale,	National Electrofishing Programme for Scotland 2019
2019	Waterside Ecology (2019)	10	Allt Ach'a Bhathaich, Allt Smeorail, Oldtown Burn	Baseline survey Gordonbush wind farm monitoring
2020	Waterside Ecology	31	Lower R. Brora, upper R. Brora, lower Black Water, Coirefrois Burn, Allt Coire an Fhaichnich, Allt an Ealaidh	Funded by Brora DSFB in support of management planning

7.1.2 Marine Scotland Science surveys 2018 and 2019

Electric fishing surveys were carried out in sixteen locations in the Brora River catchment in 2018. Fourteen of the locations were generated by Marine Scotland as part of the NEPS surveys. These sites are allocated randomly through the accessible reaches, omitting mainstem rivers judged too large for quantitative survey. A further two areas were fished to add data on presence/absence above potentially impassable waterfalls. In total eight sites were fished on the Upper River Brora, five on the Black Water and three on the River Skinsdale. There were no sites on the Middle or Lower River Brora downstream of Balnacoil.

The NEPS was also conducted during 2019, when seventeen sites were surveyed. Sites were again allocated randomly, with the exception of four where repeat sampling was undertaken at sites included in the 2018 survey. In total nine sites were surveyed on the upper River Brora, five on the River Skinsdale, two on the Black Water and one on the Coirefrois Burn.

Some of the sites were sampled using fully quantitative techniques and others using single run electric fishing. For ease of comparison, all of the densities given in the following sections are presented as single run minimum densities i.e. the number of fish caught in the first electric fishing run through the site divided by the wetted area of the site. Data are presented as number of fish per 100 square meters (fish.100 m^{-2}).

The classification provided by Godfrey (2006) is used to describe fish abundance in a regional context. The classification is based on large data sets held by Scottish Fisheries Co-ordination Centre (SFCC). The quintile ranges of salmon and trout densities (Appendix 15.2) allow for comparison of fishery performance against regional reference data. 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 streams of various widths, but as the reference data set was small we have used the absolute classification, which is based on data from all reference streams and sites.

7.1.3 Waterside Ecology 2020

The NEPS surveys of 2018 and 2019 were invaluable in providing up to date assessments of juvenile stocks but left some substantial gaps in knowledge of the current distribution and abundance of juvenile salmon. The Brora DSFB commissioned Waterside Ecology to conduct 5 days of electric fishing during July 2020 to fill some of these gaps. Priority areas identified were: Lower River Brora (sea to Loch Brora), Middle River Brora (Loch Brora to Balnacoil), Black Water below R. Skinsdale confluence, upper Skinsdale (Allt an Ealaidh), River Brora between Braegrudie and Craigton, River Brora near Dalnessie, and Coirefrois Burn. In the event, time did not permit surveys around Dalnessie but a series of semi-quantitative surveys were conducted in all other areas.

Due to their large size, the lower reaches of the River Brora and Black Water could not be surveyed using standard SFCC methods. Instead, 'patches' of wadeable habitat were fished. These extended as far out into the channel as was deemed safe in order to minimise any edge effect (juveniles are sometimes to be found at highest density close to the riverbank). Other watercourses were fished across the full channel width.

7.2 Lower River Brora (sea to Loch Brora)

7.2.1 Salmon

No electric fishing surveys were carried out in the Lower River Brora in the 2018 or 2019 NEPS surveys. However, a number of sites were surveyed by Waterside Ecology in 2020. Data from this and other surveys in this part of the catchment are summarised in Table 27 below.

The 2003 survey (Carnie 2003) included a single site on the River Brora downstream of the loch and recorded densities of 29.0 salmon fry and 9.3 salmon parr per 100 m^2. These densities are classified as good and fair respectively. The recent survey in 2020, which covered the length of the lower river, found densities of fry ranging from 5.2 to 65 per 100 m^2. The average density across the survey sites was 34.8 fry per 100 m^2, which is classified as excellent. Parr densities were similarly variable but parr were well distributed and the average density of 10.9 per 100 m^2 is classified as good. The presence of such healthy densities of fry and parr suggests that a significant amount of spawning takes place in the lower river and this is backed up by regular observations of spawning activity (M. Livings, pers. comm.). Given its large size, it is apparent

from these data that the Lower River Brora contributes significantly to smolt production from the system.

Table 27 Juvenile salmon densities Lower River Brora

Watercourse	Year	East	North	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Lower River Brora	2003	287300	904400	29.0	9.3	Good	Fair
Lower River Brora	2020	289519	903884	53.6	1.8	Excellent	Very poor
Lower River Brora	2020	288754	903662	65.0	7.5	Excellent	Fair
Lower River Brora	2020	287613	904293	32.7	22.4	Excellent	Excellent
Lower River Brora	2020	288253	903788	50.0	14.7	Excellent	Good
Lower River Brora	2020	287525	904288	15.0	0.0	Good	-
Lower River Brora	2020	286476	904909	22.0	28.0	Good	Excellent
Lower River Brora	2020	286347	904988	5.2	1.7	Very poor	Very poor

7.2.2 Trout

No trout fry or parr were recorded in the Lower River Brora in either 2003 or 2020.

7.3 Middle River Brora (Loch Brora to Balnacoil, including Loch Brora tributaries

7.3.1 Salmon

No electric fishing surveys were carried out in the Middle River Brora in 2018 or 2019 NEPS surveys. However, a number of sites were surveyed by Waterside Ecology in 2020. Data from this and other surveys in this part of the catchment are summarised in Table 28 below.

Table 28 Juvenile salmon densities lower River Brora and tributaries

Watercourse	Year	East	North	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Loch to Balnacoil	2003	280800	910900	3.2	8.3	Very poor	Fair
Loch to Balnacoil	2014	281967	910595	42.6*	3.5*	Excellent	Poor
Loch to Balnacoil	2014	280958	910907	36.9*	15.8*	Excellent	Good
Loch to Balnacoil	2020	282038	910573	17.9*	0.0*	Good	-
Loch to Balnacoil	2020	280967	910909	36.6*	2.3*	Excellent	Poor
Carrol Burn	1999	unknown	unknown	10	23	Poor	Excellent
Oldtown Burn	1999	unknown	unknown	121	40	Excellent	Excellent
Oldtown Burn	2003	285300	908650	121.1	10.5	Excellent	Good
Oldtown Burn	2019	285266	908627	7.9	20.3	Poor	Excellent
Allt Smeorail	1999	unknown	unknown	96	39	Excellent	Excellent
Allt Smeorail	2014	284383	909575	7.4	9.2	Poor	Fair
Allt Smeorail	2019	284383	909575	26.1	51.3	Good	Excellent
Ascoile Burn	1999	unknown	unknown	1	5	Very poor	Poor
Ascoile Burn	2003	282500	911000	3.2	8.3	Very poor	Fair
Ascoile Burn	2010	282425	910857	27.5	10.6	Good	Good
Ascoile Burn	2014	282434	910854	56.9	16.8	Excellent	Good
Ascoile Burn	2019	282434	910854	30.4	20.2	Excellent	Excellent
Scottarie Burn	1999	unknown	unknown	0	5	-	Poor
Scottarie Burn	2010	282610	909980	37.6	23.1	Excellent	Excellent

*average of two to three patches of representative habitat at one location on mainstem River Brora

Data are rather sparse from the reach of the River Brora between Loch Brora and Balnacoil. Two areas were surveyed in 2014 and again in 2020. Such data as are available indicate that fry densities in suitable habitats can be high. This is consistent with the abundance of spawning opportunities in this reach. During the 2014 survey, good parr densities were found in the better habitats close to Balnacoil, where cobble substrates are predominant. Parr were very scarce in 2020.

The data from the smaller streams that have been surveyed suggest these can be very productive and that they often support high juvenile salmon densities. Due to the very restricted wetted accessible areas, these small streams can be stocked to capacity by very few spawning salmon. Nevertheless taken together they might contribute substantial numbers of smolts to the system. Some of the fry from these burns may migrate downstream into the River Brora or Loch Brora to grow on as parr. There are few data on salmon parr densities in Scottish lochs but their contribution to smolt production can be significant and the potential of Loch Brora as rearing habitat should not be overlooked.

Some of the smaller streams have been surveyed on more than one occasion. Data from e.g. Ascoile Burn and Oldtown (Hatchery) Burn suggest that there may be substantial year-to-year variation in the uptake by salmon of spawning opportunities in these streams.

7.3.2 Trout

Juvenile trout densities are provided below. The data suggest that trout fry and parr are scarce in the River Brora and none were recorded at any of the mainstem sites downstream of Balnacoil during the survey in 2020.

Table 29 Juvenile trout densities lower River Brora and tributaries

Watercourse	Year	East	North	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
Loch to Balnacoil	2003	280800	910900	0.6**	0**	Very poor	-
Loch to Balnacoil	2014	281967	910595	0**	0**	-	-
Loch to Balnacoil	2014	280958	910907	0**	0**	-	-
Loch to Balnacoil	2020	282038	910573	0**	0**	-	-
Loch to Balnacoil	2020	280967	910909	0**	0**	-	-
Carrol Burn	1999	unknown	unknown	11	4	Excellent	Fair
Oldtown Burn	1999	unknown	unknown	17	2	Excellent	Poor
Oldtown Burn	2003	285300	908650	28.9	21.0	Excellent	Excellent
Oldtown Burn	2019	285266	908627	35.0	3.4	Excellent	Fair
Allt Smeorail	1999	unknown	unknown	37	0	Excellent	-
Allt Smeorail	2014	284383	909575	12.1	0.9	Excellent	Very poor
Allt Smeorail	2019	284383	909575	9.3	12.1	Good	Excellent
Ascoile Burn	1999	unknown	unknown	1	0	Very poor	-
Ascoile Burn	2003	282500	911000	11.5	7.1	Excellent	Good
Ascoile Burn	2010	282425	910857	24.8	0.9	Excellent	Very poor
Ascoile Burn	2014	282434	910854	9.2	1.8	Good	Poor
Ascoile Burn	2019	282434	910854	16.6	3.7	Excellent	Fair
Scottarie Burn	1999	unknown	unknown	21	1	Excellent	Very poor
Scottarie Burn	2010	282610	909980	14.5	7.2	Excellent	Good

* Seven sites were surveyed as per Table 24. No trout were caught.
**average of two to three patches of representative habitat at one location on mainstem River Brora

In contrast, trout fry densities in many of the tributary streams during recent surveys have classified as excellent by regional standards. This pattern is quite typical of trout in larger catchments and underscores the importance of smaller watercourses to this species. Where access is possible including the lower sites on Ascoile Burn, Scottarie Burn, Allt Smeorail and Oldtown Burn it is highly probable that there is a large migratory component in the trout population.

Fry densities at many of the tributary sites greatly exceed parr densities and parr density classifications were often poor. It is probable that many juvenile trout drop out of the smaller streams as they grow, due to competition for space. This downstream migration can commence almost any time after hatching, but in larger streams it often occurs toward the end of the first growing season. It is likely that many of the juvenile trout in the streams listed below grow on in Loch Brora, or in parts of the river that are inaccessible to electric fishing by wading. As result, parr are unlikely to be as scarce as survey data might suggest.

7.4 Upper River Brora (Balnacoil to headwaters)

7.4.1 Salmon

These reaches were subject to a considerable amount of survey effort in both NEPS surveys, with seven quantitative surveys sites in 2018 and nine in 2019 (Tables 30 and 31). Two sites around Dalreavoch were sampled in both years. A qualitative survey was conducted upstream of the Dalnessie waterfall during 2018. Waterside Ecology surveyed five sites in the Braegrudie to Craigton area during 2020. This reach includes substantial areas of good quality juvenile habitat but few data had been collected during the NEPS surveys.

Salmon fry densities during 2018 were good at three sites and excellent at four. Parr density classifications were more variable and ranged from poor to excellent. The average density of fry over the seven quantitative sites during 2018 was 29.1 per 100 m^2. This density is at the upper limit of the good classification suggesting good spawning success in 2017 and healthy recruitment of young salmon during 2018. Average parr density was 12.1 per 100 m^2, also classified as good. The habitat through much of the surveyed reaches of the river is excellent, but spawning habitat is sparse downstream of Dalreavoch and thus the good to excellent fry densities in these reaches are rather unexpected. Unsurprisingly the highest fry densities in this sub-catchment during 2018 were recorded just above Dalreavoch, close to an area of good quality spawning habitat.

Table 30 Single run minimum salmon densities, upper River Brora, NEPS 2018

Site	Site code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Above Dalnessie Falls	NA	262804	916191	present	0.0	Present	-
Above Dalnessie Falls	NA	263414	917220	present	0.0	Present	-
Dalnessie A	0736	262800	915998	24.9	4.0	Good	Poor
Allt Coire Chaorachaidh	0864	267463	912755	33.9	15.6	Excellent	Good
Dalreavoch	0726	274519	908458	38.6	13.3	Excellent	Good
Dalreavoch lower	0730	276105	909453	18.3	7.0	Good	Fair
Sciberscross A	0854	278261	909651	36.7	16.3	Excellent	Excellent
Tormore	0734	278727	910369	30.1	12.2	Excellent	Good
Torseiller A	0858	279243	910575	22.0	16.3	Good	Excellent

The 2019 data were less encouraging. High parr densities were recorded at several sites, but parr were absent at two sites close to Dalnessie. Salmon fry were also reported as absent at the same two sites as well as a site approximately 3 km downstream of Dalnsessie where parr were plentiful. The data suggest that recruitment was poor during 2019.

Table 31 Single run minimum salmon densities, upper River Brora, NEPS 2019

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Dalnessie B	0780	262935	915631	0.0	0.0	-	-
2.5 km below Dalnessie	0776	265049	914078	0.0	0.0	-	-
3 km below Dalnessie	0748	265471	913819	0.0	18.2	-	Excellent
Braegrudie	0742	273013	909212	1.4	1.4	Very poor	Very poor
Dalreavoch upper	0894	274151	908467	4.4	9.9	Very poor	Good
Dalreavoch*	0726	274519	908458	10.4	15.2	Fair	Good
Dalreavoch lower*	0730	276105	909453	13.2	14.2	Fair	Good
Sciberscross B	0774	277732	909618	4.6	4.6	Very poor	Poor
Torseiller B	0778	279612	910724	2.3	8.5	Very poor	Fair

*sites repeat surveyed 2018 and 2019

The 2020 survey of the reach from Braegrudie to Craigton found good or excellent densities of salmon fry at all sites except the most upstream, at Craigton (Table 32). Salmon parr densities ranged from poor to good at most mainstem sites, again with the exception of Craigton where they were very poor. The results at Craigton reflect the habitat, with a slow flow over a bed of sand. Fry and parr at this site were taken from the cover of weed-beds. The habitat is typical of the reach and the presence of small numbers of fry in such poor quality habitat might be seen as a reflection of generally healthy recruitment in 2020. The rather variable parr density across the 2020 survey sites may reflect apparently poor recruitment noted in 2019.

Table 32 Single run minimum salmon densities, upper Braegrudie to Craigton, Waterside Ecology 2020

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
0.5 km below Braegrudie	BU1	272409	909499	35.0	7.0	Excellent	Fair
By Grumbie Rock	BU2	270932	910548	17.4	4.3	Good	Poor
3.5 km above Braegrudie	BU3a	269496	911090	51.2	5.6	Excellent	Poor
3.6 km above Braegrudie	BU3b	269465	911126	28.0	9.8	Good	Good
Craigton	BU4	267909	912591	8.0	0.7	Poor	Very poor
Allt an Eisg	BU5	268610	912187	95.2	38.1	Excellent	Excellent

No quantitative surveys have been carried out upstream of Dalnessie Falls in recent years, but qualitative surveys during 2018 confirmed the presence of salmon fry above the falls, albeit in very small numbers. It thus appears that the falls are passable to salmon under certain conditions. Previous surveys and anecdotal reports suggest that salmon are usually absent upstream of the falls, but current data indicate they may occasionally be passable. No salmon parr could be found upstream of the falls, so successful ascent of the falls by salmon may be a rare event.

Overall, the electric fishing data suggest that the upper River Brora is well stocked and that the better quality habitats are capable of sustaining high densities of salmon fry and, where habitats are suitable, parr.

7.4.2 Trout

Trout were generally scarce in the surveyed sites during the 2018 survey (Table 33). A notable exception was Allt Coire Chaorachaidh, a small stream flowing into the main River Brora near Craigton. Here both fry and parr densities were classified as excellent. This is consistent with trout preferring tributary streams as spawning and juvenile habitat, and suggests that further such streams should be surveyed throughout the catchment if any useful assessment of trout populations is to be made. Although scarce, trout fry were present at all mainstem sites on the upper river during 2018 with the exception Dalnessie A, which is upstream of the weir but below the waterfall. Trout parr were also very widespread, absent at only one site. Parr densities were classified mainly as very poor, with the highest mainstem density at Dalnessie A. As fry and parr are very widespread and the river is large, trout production from the upper River Brora is likely to be substantial. Trout fry and parr were recorded above Dalnessie Falls and the impression gained during the non-quantitative survey was that numbers were quite high.

Table 33 Single run minimum trout densities, upper River Brora (above Balnacoil), NEPS 2018

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
Above Dalnessie Falls	NA	262804	916191	Present	Present	Present	Present
Above Dalnessie Falls	NA	263414	917220	Present	Present	Present	Present
Dalnessie A	0736	262800	915998	0.0	4.0	-	Fair
Allt Coire Chaorachaidh	0864	267463	912755	23.5	9.1	Excellent	Excellent
Dalreavoch	0726	274519	908458	0.6	0.0	Very poor	-
Dalreavoch lower	0730	276105	909453	0.7	0.7	Very poor	Very poor
Sciberscross A	0854	278261	909651	0.7	0.7	Very poor	Very poor
Tormore	0734	278727	910369	0.0	0.7	-	Very poor
Torseiller A	0858	279243	910575	0.0	0.6	-	Very poor

Very few trout were recorded during the 2019 NEPS survey (Table 34). Fry were absent at eight of the nine sites and parr at seven, including the two repeat sites where fry and/or parr were present during 2018. There are no clear causal factors for the lack of trout reported from these reaches in the 2019 survey. Trout were also very scarce during the Braegrudie to Craigton survey in 2020 (Table 35). The exception was in the tributary Allt an Eisg (Craigton), where fry density was good.

Table 34 Single run minimum trout densities, upper River Brora (above Balnacoil), NEPS 2019

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
Dalnessie B	0780	262935	915631	0.0	0.0	-	-
2.5 km below Dalnessie	0776	265049	914078	0.0	0.0	-	-
3 km below Dalnessie	0748	265471	913819	0.0	0.0	-	-
Braegrudie	0742	273013	909212	0.0	0.0	-	-
Dalreavoch upper	0894	274151	908467	0.0	0.0	-	-
Dalreavoch*	0726	274519	908458	0.0	0.0	-	-
Dalreavoch lower*	0730	276105	909453	0.0	0.0	-	-
Sciberscross B	0774	277732	909618	1.8	1.8	Poor	Poor
Torseiller B	0778	279612	910724	0.0	0.8	-	Very poor

*sites repeat surveyed 2018 and 2019

Table 35 Single run minimum salmon densities, upper Braegrudie to Craigton, Waterside Ecology 2020

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
0.5 km below Braegrudie	BU1	272409	909499	0.0	1.0	-	Very poor
By Grumbie Rock	BU2	270932	910548	0.0	0.0	-	-
3.5 km above Braegrudie	BU3a	269496	911090	0.0	0.0	-	-
3.6 km above Braegrudie	BU3b	269465	911126	0.0	0.0	-	-
Craigton	BU4	267909	912591	2.0	3.3	Poor	Fair
Allt an Eisg (Craigton)	BU5	268610	912187	9.5	0.0	Good	-

Some historic data from the upper River Brora are available from 2001 and 2003 (Carnie 2003). In 2001 relatively high densities of trout fry and parr were found in the River Brora, Allt Gobhlach and An Crom-Allt upstream of Dalnessie in reaches that are believed to be accessible to sea trout. The 2003 survey found that trout fry were present at five of six sites in the upper River Brora area. Densities were very poor at all mainstem sites, but fry were abundant in the lower reaches of Allt a' Mhuilt, the only tributary included in the survey. Trout parr were patchily distributed and present at low density at all sites. The 2003 survey was concentrated on reaches downstream of Dalnessie.

In general the electric fishing data for trout reinforce the perception that densities in the mainstem of the river are generally low, with much of the spawning and fry production arising from tributary streams and in the headwaters.

7.5 Black Water

7.5.1 Salmon

Four quantitative sites were surveyed in the Black Water during the 2018 NEPS survey and a further presence/absence survey was carried out immediately upstream of the Srath na Seilge falls at NC 662 222. The latter appeared to confirm that these cascades are impassable to salmon. The next site downstream was near Green Face, approximately 2.5 km downstream of the falls. Salmon parr densities at this site were excellent and fair numbers of fry were present.

Table 36 Single run minimum salmon densities, Black Water, NEPS 2018

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Srath na Seilge*	NA	266251	922595	0	0	-	-
Green Face	0768	267600	921303	16.3	17.1	Good	Excellent
Ben Armine - Upper	0761	270260	919361	133.5	14.4	Excellent	Good
Ben Armine - Lower	0857	270958	918819	45.5	8.7	Excellent	Fair
Pollie	0765	275310	915942	56.4	2.6	Excellent	Poor

*upstream of natural obstacle at NC 662 222

The other three quantitative sites in the 2018 survey were in the middle reaches of the Black Water between the River Skinsdale confluence and Ben Armine Lodge. Spawning habitats are present close to all of these sites and salmon fry densities at all three were classified as excellent. The upper Ben Armine Lodge site had extraordinarily high fry densities with 133.5 fry recorded per 100 m² as the single run minimum density. Parr densities were good and moderate at the two sites near Ben Armine Lodge, but very poor at Pollie; this reflects the nature

of the habitat at this site, which has small substrate, shallow flow and a lack of suitable cover for parr.

Only three sites on the Black Water were included in the 2019 NEPS survey. The most upstream of these (0777) was approximately 4 km downstream of Ben Armine Lodge. Fry density was only fair, but parr were present at a good density. The lower site was at Gobernuisgach, just upstream of the confluence with the River Skinsdale. Salmon fry were scarce and no parr were caught. This reach is predominantly riffle glide sequences with small substrates, and instream cover for fish is lacking. The lack of parr and low fry density is most likely a reflection of habitat, but more fry might have been expected given the abundance of spawning habitat in the vicinity.

Table 37 Single run minimum salmon densities, Black Water, NEPS 2019

Site/watercourse	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
4 km ds Ben Armine	0777	273616	917027	13.9	9.6	Fair	Good
Gobernuisgach	0897	276689	915776	5.4	0.0	Poor	-
Coirefrois Burn	0749	271359	915241	19.5	11.4	Good	Good

One site was surveyed in the Coirefrois Burn during 2019, approximately 4.5 km upstream of its confluence with the Black Water. Densities of fry and parr were both classified as good. Due to the relative lack of data on this substantial stream Waterside Ecology surveyed six sites in July 2020 (Table 38). The average density of salmon fry was 31.8 per 100m^2, classified as excellent. Average parr density was 22.8 per 100m^2, also classified as excellent. Parr density at CB2, which is located upstream of the old Coirefrois settlement and is likely to be close to the upstream migratory limit for salmon, was exceptional. Past data from Coirefrois burn are available from a survey conducted for Scottish Natural Heritage in 2006, when average densities across six sites were 17.4 fry and 15.2 parr per 100m^2. These densities are broadly comparable to those from more recent surveys.

Table 38 Single run minimum salmon densities, Black Water, Waterside Ecology 2020

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Lower Black Water	BW1	280189	911908	56.3	13.8	Excellent	Good
Lower Black Water	BW2	278913	914653	37.8	13.5	Excellent	Good
Lower Black Water	BW3	277615	915691	27.1	12.1	Good	Good
Coirefrois B. (above falls)	CB1	269011	916110	0.0	0.0	-	-
Coirefrois Burn	CB2	269629	916193	35.8	45.3	Excellent	Excellent
Coirefrois Burn	CB3	270472	915302	23.6	14.5	Good	Good
Coirefrois Burn	CB4	271379	915272	59.6	8.8	Excellent	Fair
Coirefrois Burn	CB5	272480	915303	27.4	16.1	Good	Good
Coirefrois Burn	CB6	273967	915611	12.3	29.2	Fair	Excellent
Allt Coire an Fhaichnich	ACF1	272034	917233	0.0	6.1	-	Poor

The 2020 survey included three sites on the Black Water between Balnacoil and the River Skinsdale confluence. This reach was omitted from the NEPS surveys. Fry and parr densities at all sites were good or excellent (Table 38). Two sites were surveyed in the same reaches during 2013 (Waterside Ecology 2013). Fry densities at both sites were excellent while parr densities were at the upper end of the 'good' classification; results that are very consistent with

the more recent survey. The river in this reach is broad and these data show that it is likely to produce significant numbers of smolts annually.

The 2003 Carnie survey included a number of sites on Black Water (Table 39) and is worth reproducing for comparative purposes. The data from three sites on the mainstem of the Black Water suggest that recent juvenile densities compare very favourably with those previously reported. Data from the single site on Coirefrois Burn are comparable with those reported in 2006 and 2019. The Carnie survey also shows that salmon parr densities in the lower reaches of A. a' Mhuillin Dubh were high in 2003.

Table 39 Single run minimum salmon densities, Black Water, Carnie (2003)

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
A. a' Mhuillin Dubh	BW1	275150	915200	22.4	34.5	Good	Excellent
Coirefrois Burn	BW3	274400	915900	11.2	10.6	Fair	Good
Black Water, Dalbreck	BW3a	274500	916050	6.8	9.4	Poor	Fair
Black Water Ben Armine	BW4	270300	919300	25.8	8.7	Good	Fair
Green face	BW6	266400	921800	3	4.5	Very poor	Poor
Srath na Seilge*	BW7	265700	923700	0	0	-	-
Srath na Seilge*	BW8	266500	924600	0	0	-	-

*upstream of natural obstacle

Overall, the juvenile survey data underscore the importance of the Black Water for salmon production. The habitat survey shows that it provides large areas of suitable juvenile habitats. Consecutive electric fishing surveys demonstrate that these habitats are generally well stocked with young salmon. The Coirefrois Burn is clearly a valuable stream for production of salmon with good to excellent parr densities consistently recorded in suitable reaches.

7.5.2 Trout

Trout fry were scarce or absent in the three lower sites (Pollie to Ben Armine Lodge) during the 2018 NEPS survey (Table 40). However parr density at the upper Ben Armine site was good. Further upstream near Green Face, fry and parr densities were both classified as good. Qualitative fishing upstream of the waterfalls suggested that trout fry and parr were quite plentiful, but densities were not calculated. The waterfalls appear to be impassable for salmon, but it is not known whether sea trout can access the reaches upstream. Although the data set is small it does seem to suggest that trout densities may be higher in the upper accessible reaches than they are further downstream.

Three sites were surveyed during the 2019 NEPS survey (Table 41). No trout fry were recorded at any of the survey sites and parr were absent from two of the three.

Table 40 Single run minimum trout densities, Black Water, NEPS 2018

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
Srath na Seilge*	NA	266251	922595	present	present	Present	Present
Green Face	0768	267600	921303	5.4	6.2	Good	Good
Ben Armine - Upper	0761	270260	919361	0.0	5.7	-	Good
Ben Armine - Lower	0857	270958	918819	1.2	1.9	Very poor	Poor
Pollie	0765	275310	915942	0.0	0.0	-	-

*upstream of natural obstacle

Table 41 Single run minimum trout densities, Black Water, NEPS 2019

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
4 km ds Ben Armine	0777	273616	917027	0.0	4.3	-	Fair
Coirefrois Burn	0749	271359	915241	0.0	0.0	-	-
Gobernuisgach	0897	276689	915776	0.0	0.0	-	-

Similar findings were recorded during the 2020 survey of the lower Black Water (Table 42), with juvenile trout absent from fish samples at all three sites downstream of the Skinsdale confluence. While it is improbable that no juvenile trout inhabit these reaches, it is clear that their numbers and density are very low.

Perhaps more surprisingly, juvenile trout were also found to be scarce in Coirefrois Burn. The gentle gradient through much of this stream suggests it may be well suited to trout fry and parr. In fact trout fry were absent at half the sites and where present their densities were low. Trout parr were slightly more abundant, with fair densities recorded at the two most upstream sites.

Table 42 Single run minimum trout densities, Black Water, Waterside Ecology 2020

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
Lower Black Water	BW1	280189	911908	0.0	0.0	-	-
Lower Black Water	BW2	278913	914653	0.0	0.0	-	-
Lower Black Water	BW3	277615	915691	0.0	0.0	-	-
Coirefrois B. (above falls)	CB1	269011	916110	Present	Present	NA	NA
Coirefrois Burn	CB2	269629	916193	0.0	3.8	-	Fair
Coirefrois Burn	CB3	270472	915302	0.0	3.6	-	Fair
Coirefrois Burn	CB4	271379	915272	1.8	0.0	Poor	-
Coirefrois Burn	CB5	272480	915303	0.0	1.6	-	Poor
Coirefrois Burn	CB6	273967	915611	1.5	1.5	Very poor	Poor
Allt Coire an Fhaichnich	ACF1	272034	917233	27.3	36.4	Excellent	Excellent

Carnie's 2003 survey data are reproduced below. This survey also found that trout fry and parr were patchily distributed in the Black Water catchment. In common with the NEPS survey of 2018 fry and parr were more abundant upstream near Green Face than they were lower down the river. Perhaps surprisingly the numbers in the Allt a' Mhuillin Dubh were poor. This small stream appears well suited to spawning trout in its lower reaches.

Table 43 Single run minimum trout densities, Black Water, Carnie (2003)

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
A. a' Mhuillin Dubh	BW1	275150	915200	0	1.7	-	Poor
Coirefrois Burn	BW3	274400	915900	0	1.4	-	Poor
Black Water, Dalbreck	BW3a	274500	916050	0	0.4	-	Very poor
Black Water Ben Armine	BW4	270300	919300	1.5	0.8	Very poor	Very poor
Green face	BW6	266400	921800	5.2	3	Good	Fair
Srath na Seilge*	BW7	265700	923700	Present	Present	Present	Present
Srath na Seilge*	BW8	266500	924600	0.8	2.5	Very poor	Poor

*upstream of natural obstacle at NC 662 222

Overall the data suggest that juvenile trout numbers through the mainstem of the Black Water are low, particularly downstream of the Skinsdale confluence. There are indications that trout abundance may increase towards the upper reaches around Green Face. Trout are scarce in Coirefrois Burn, despite its apparent suitability. Further electric fishing surveys of the headwaters and tributary streams of the Black Water would be useful to better understand the trout population in this part of the catchment. It would also be of interest to collate data on sea trout catches from game books for the Black Water and other rivers in order to obtain an objective picture of trout production at catchment scale. Observations of sea trout presence by keepers and others should be collated and formalised.

7.6 River Skinsdale

7.6.1 Salmon

Three sites were surveyed in the River Skinsdale during 2018 NEPS survey, one in the lower river downstream of the Garvary Burn confluence and two in the mid-section near Cnocan. There is good spawning habitat close to all three sites. Salmon fry densities were ranked 'excellent' near Cnocan, with very high densities (79.2 fry per 100 m²) at the upper site. However densities were ranked only as fair at the lower site near Muiemore. The Muiemore site has very little cover due to small substrate size and was not typical juvenile salmon habitat; the low density of fry may reflect this.

Parr densities were good at the lower Cnocan site but very poor at the top site (0853), where substrates were dominated by pebble and small cobbles providing little cover for parr. Parr density at the Muiemore site was ranked as fair. Most of the parr captured at this site came from beneath overhanging banks and other features providing cover. Observations suggest that in reaches with very little riverbed cover parr may be present, but will move away from surveyors into patches of cover, which can lead to densities being under-estimated.

Table 44 Single run minimum salmon densities, Skinsdale, NEPS 2018

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Cnocan upper	0853	277305	922248	79.2	1.7	Excellent	Very Poor
Cnocan lower	0729	276765	921038	39.7	16.2	Excellent	Good
Muiemore A	0733	275320	918356	12.9	6.9	Fair	Fair

The 2019 NEPS survey repeated two of the above sites, Cnocan upper and Cnocan lower. Salmon fry numbers at both sites during this survey were substantially lower than those recorded during 2018. However, salmon parr numbers at the upper Cnocan repeat site where up significantly on 2018 results, while parr numbers at the lower Cnocan repeat site were similar in both year of survey. Further downstream near Muimore fry densities were again low, but excellent parr densities were reported. No salmon fry were recorded at the most upstream site, which is approximately 6 km above Cnocan.

Table 45 Single run minimum salmon densities, Skinsdale, NEPS 2019

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
6 km above Cnocan	0771	274555	925191	0.0	7.3	Absent	Fair
Cnocan upper	0853	277296	922248	20.1	12.8	Good	Good

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
Cnocan lower	0729	276742	921050	8.7	17.5	Poor	Excellent
Muiemore B	0745	276246	917530	2.0	22.7	Very poor	Excellent

Waterside Ecology surveyed four sites in the Allt an Ealaidh in the headwaters of River Skinsdale in 2020 (Table 46). The survey extended from the confluence with Allt Preas a' Chamraig to approximately 1 km downstream of Gorm-loch Beag where the channel is less than 2 m wide. Juvenile salmon were found throughout and the presence of fry at the uppermost sites demonstrates that salmon spawn well into the headwaters of the river.

Table 46 Single run minimum trout densities, upper Skinsdale, Waterside Ecology, 2020

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Salmon 0+	Salmon 1++	Salmon 0+	Salmon 1++
A. an Ealaidh lower	AE1	274270	926238	38.2	26.5	Excellent	Excellent
A. an Ealaidh	AE2	273079	926768	8.6	18.5	Poor	Excellent
Allt an Ealaidh	AE3	272088	927285	21.3	8.5	Good	Fair
Allt an Ealaidh upper	AE4	270917	927979	22.1	0.0	Good	-

The data collected between 2018 and 2020 suggest that the River Skinsdale is capable of supporting high densities of salmon fry and parr, but that substantial year to year variation occurs. The 2020 survey demonstrated that salmon spawn well into some headwater streams, almost to Gorm-loch Beag on Allt an Ealaidh. Additional data on the typical upstream limit of salmon distribution in tributaries and headwaters including the Garvary Burn and Allt Coire an Eas sub-catchments would be useful. The River Skinsdale was not included in the 2003 survey (Carnie 2003) and no other wide ranging electric fishing surveys have taken place in this part of the catchment, so no historical data are available for comparison.

7.6.2 Trout

Juvenile trout were absent at two of the three sites on the River Skinsdale during the 2018 NEPS survey (Table 47). Single fry and parr were captured at the lower of the two survey sites near Cnocan.

No trout fry were recorded during the 2019 survey, which covered four sites (Table 48), but small numbers of trout parr were present at two. There is no lack of suitable spawning habitat for trout in the mainstem of the River Skinsdale but the data seem to suggest it is little used. There are few small tributaries flowing into the Skinsdale in the lower and middle reaches, and if smaller streams are the preferred spawning habitat for trout in the Brora catchment it is possible that relatively few trout breed in this section of the river. The Waterside Ecology survey of 2020 found that trout were present at headwater sites (Table 49), which is consistent with a preference for smaller streams. Additional data on trout distribution and abundance in headwaters and smaller tributaries would be valuable.

Table 47 Single run minimum trout densities, Skinsdale, NEPS 2018

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
Cnocan upper	0853	277305	922248	0.0	0.0	-	-
Cnocan lower	0729	276765	921038	0.9	0.9	Poor	Moderate
Muiemore A	0733	275320	918356	0.0	0.0	-	-

Table 48 Single run minimum trout densities, Skinsdale, NEPS 2019

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
6 km above Cnocan	0771	274555	925191	0.0	0.9	-	Very poor
Cnocan upper	0853	277296	922248	0.0	0.0	-	-
Cnocan lower	0729	276742	921050	0.0	0.0	-	-
Muiemore B	0745	276246	917530	0.0	2.0	-	Poor

Table 49 Single run minimum trout densities, upper Skinsdale, Waterside Ecology, 2020

Site	Code	Easting	Northing	Density per 100 m²		Density classification	
				Trout 0+	Trout 1++	Trout 0+	Trout 1++
A. an Ealaidh lower	AE1	274270	926238	1.5	5.9	Very poor	Good
A. an Ealaidh	AE2	273079	926768	2.5	3.7	Poor	Fair
Allt an Ealaidh	AE3	272088	927285	2.1	6.4	Poor	Good
Allt an Ealaidh upper	AE4	270917	927979	22.1	0.0	Excellent	-

7.7 Synopsis of juvenile stock status, River Brora catchment

7.7.1 Salmon

Data collected between 2018 and 2020 suggest that juvenile salmon are currently well distributed throughout the catchment of the River Brora including, where access is possible, the headwaters (Figure 14). Salmon fry densities in the larger watercourses were mainly classified as good or excellent during the 2018 NEPS survey, and where lower densities were encountered this was often a reflection of habitat at individual survey sites rather than an indication of poor recruitment over extended reaches. Parr densities were similarly healthy, and also typically classified as good to excellent by regional standards. Fry densities during 2019 were lower in most parts of the catchment. While the average density across all sites in 2018 was 42 fry per 100 m^2 (excellent) in 2019 it fell to 6.4 per 100 m^2 (poor). Care must be taken interpreting these data as sites and survey teams were different in the two years, and all data are single run i.e. not fully quantitative. The 2020 survey focussed on areas not covered by previous surveys, but was wide ranging. Average fry density across all sites in 2020 was 30.7 per 100 m^2 (excellent). Average parr densities per 100 m^2 across all sites during recent surveys were 9.5 in 2018, 9.8 in 2019 and 11.6 in 2020. Although the data should be treated with caution for the reasons mentioned above, the parr data may suggest that smolt output is likely to fluctuate less than the fry data might suggest.

The assessment of the NEPS data collected in 2018 concluded that salmon fry and parr densities in the Brora (and neighbouring Helmsdale) both exceeded the predicted benchmark values (Malcolm et al. 2019). Indeed, the Brora and Helmsdale area had some of the highest densities of salmon parr and fry recorded in any part of Scotland. This clearly demonstrates the productive potential of riverine habitats in the Brora catchment. At the time of wring (November 2020) no assessments of the 2019 NEPS survey had yet been published.

The brief review provided above has concentrated solely on juvenile densities and has not presented a breakdown of parr numbers by year class. Nevertheless, it was apparent during surveys that parr aged 1+ and 2+ were likely to be present at some sites. The task of classifying

parr samples by age would be worth carrying out when time permits as this may help in identify different stock components. Furthermore, residence time in the river is one of the factors that will influence smolt output.

7.7.2 Trout

A consistent feature of all survey data collected to date has been the scarcity of juvenile trout at survey sites in the larger watercourses. Although few sites have been surveyed in tributary streams the available data point to a high degree of spatial segregation between spawning trout and salmon. High densities of trout fry have been identified only from tributary streams and upper headwaters, and it is likely that these are of the utmost value to trout populations, including the sea trout stock component.

Outside of the tributaries, there is some evidence from the upper River Brora, upper Black Water, and Allt an Ealaidh (Skinsdale) that trout numbers are highest in the headwater reaches. Further surveys of tributary streams and the headwaters of all three main sub-catchments would be very useful in gaining a more accurate picture of trout populations and spawning distribution in the catchment.

Figure 15. Distribution and densities of salmon fry and parr, 2018 to 2020

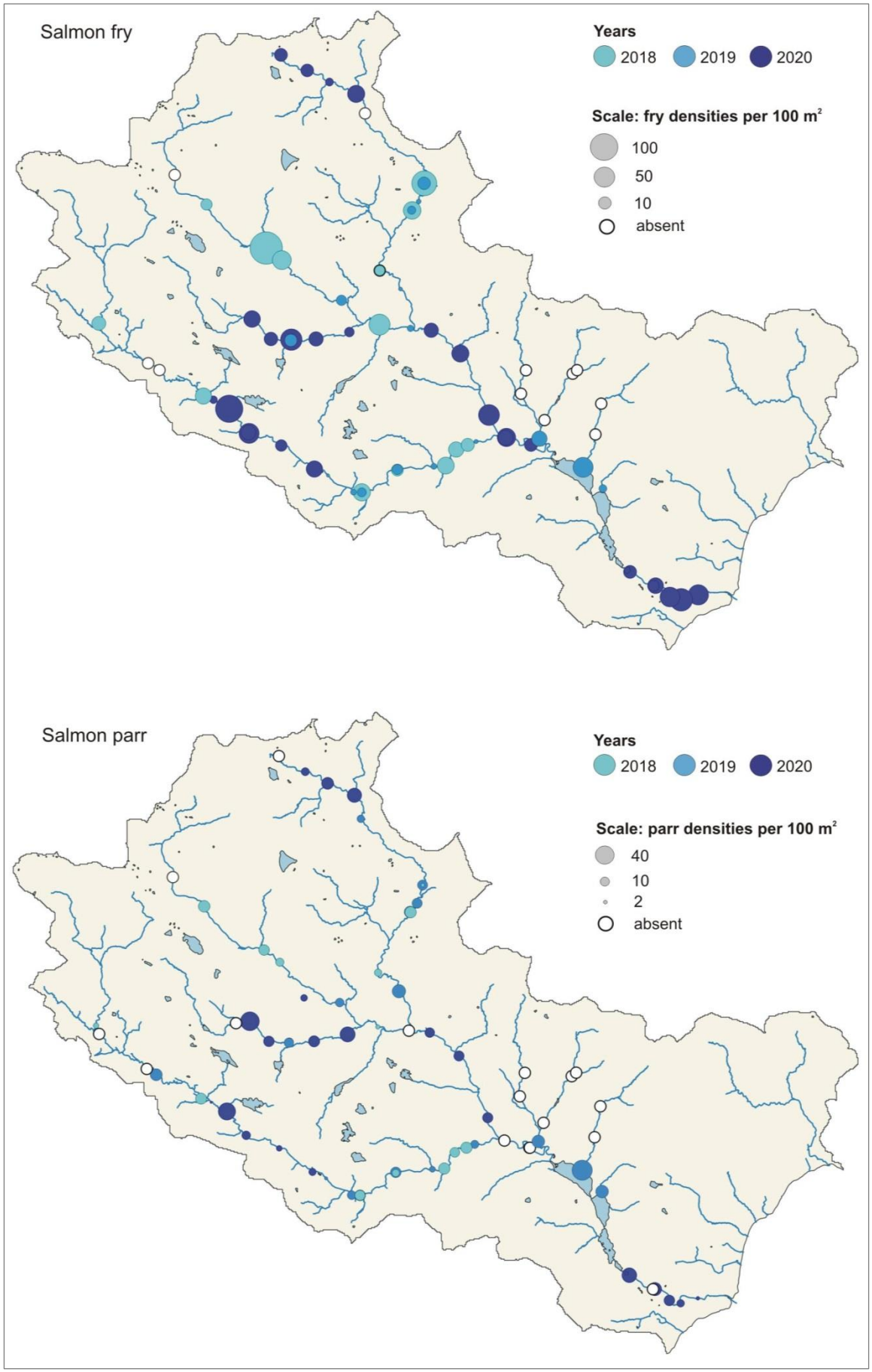
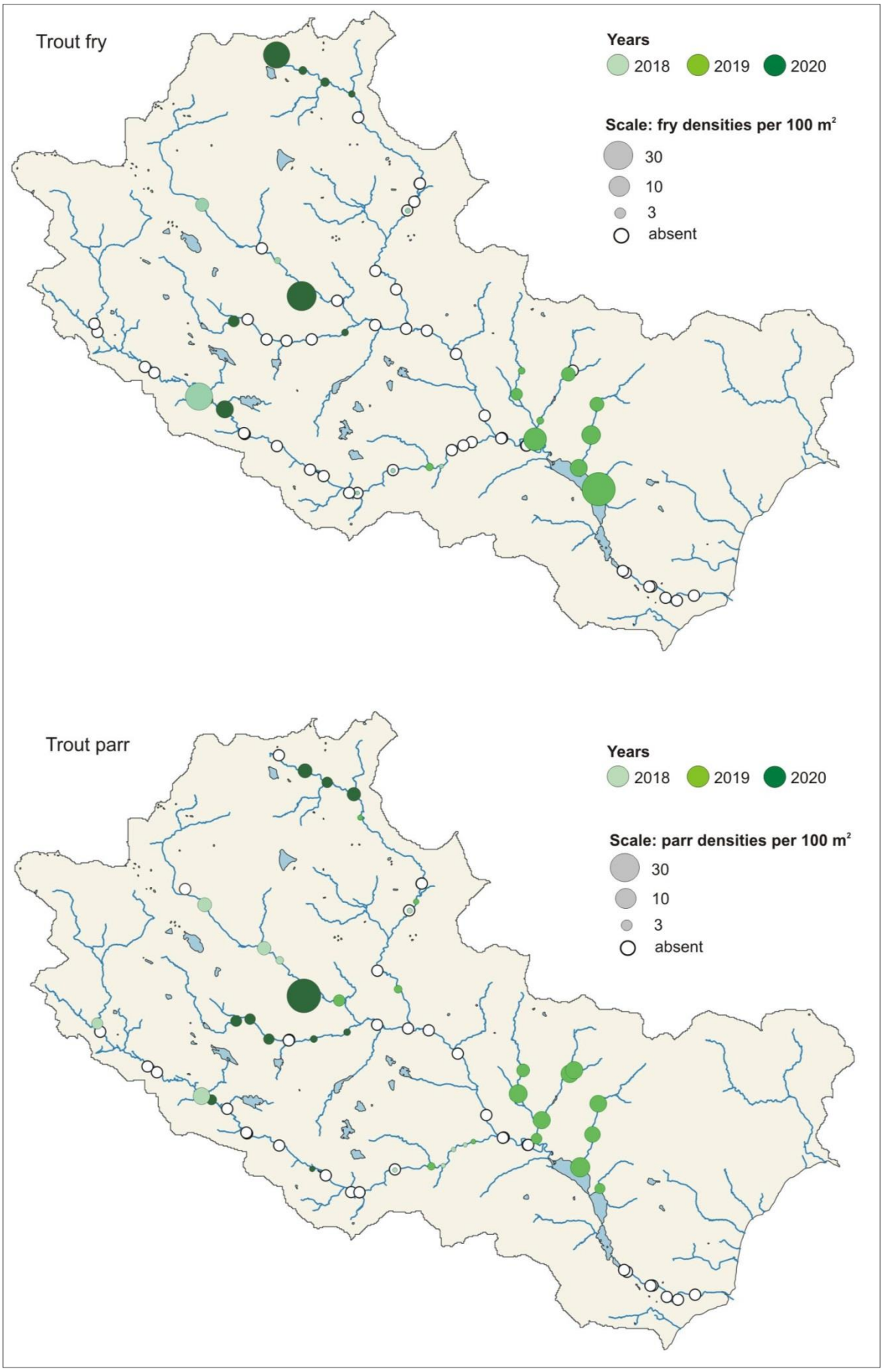


Figure 16. Distribution and densities of trout fry and parr, 2018 to 2020



8 FISHERIES ON THE RIVER BRORA

8.1 Salmon

8.1.1 Rod catches and run timing

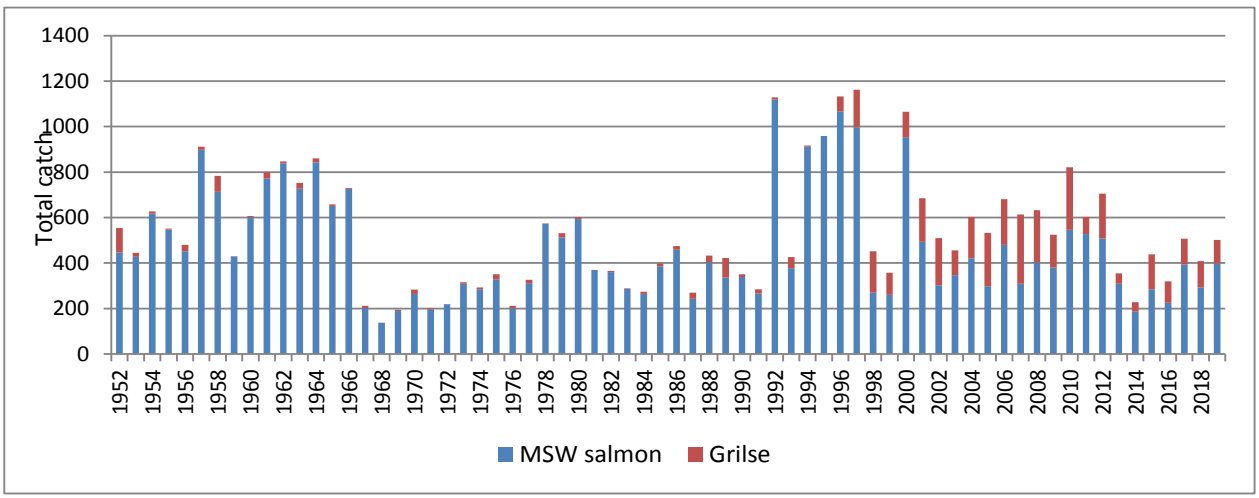
The River Brora has a long history as a salmon fishery. Stoddart (1853) noted that it provided excellent spring fishing when water levels were suitable. He also noted the occasional presence of very large salmon, including one of thirty pounds weight taken in 1850. Calderwood (1921) referred to the Brora as an "excellent little river" with the best fishing in the lower reaches between Loch Brora and the sea. He suggested that the rod catch of spring fish in the river varied from 300 to 450 fish, mostly in the 8 lb to 10 lb size range. The annual catch between 1900 and 1920 was given by Calderwood as ranging from 148 to 434 salmon per year (Table 46). Mills and Graesser (1981) considered the River Brora to be one of the best salmon rivers in Sutherland, with angling catches of up to 800 salmon annually.

Table 50 Salmon rod catches 1900 to 1920 (from Calderwood 1923)

Year	Salmon (n)	Year	Salmon (n)	Year	Salmon (n)
1900	434	1907	222	1914	152
1901	331	1908	315	1915	294
1902	348	1909	417	1916	348
1903	449	1910	248	1917	148
1904	348	1911	395	1918	431
1905	382	1912	392	1919	432
1906	330	1913	371	1920	152

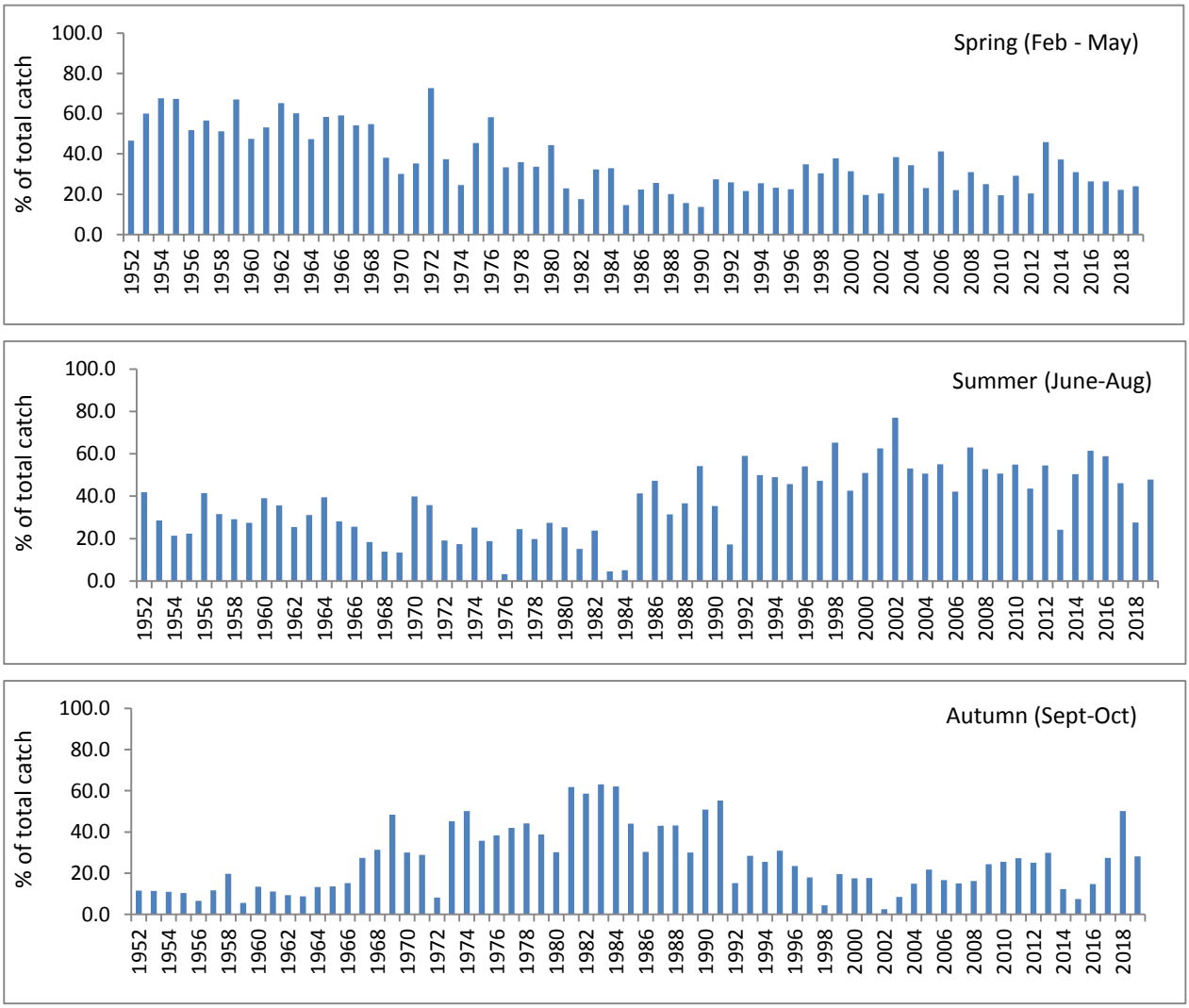
Since 1952 rod catches of salmon and grilse have been collated for the Brora and Fleet Fishery District within the Catch Statistics for Scottish Rivers, published by Scottish Government. These data are reproduced in Figure 17. A striking aspect of the data is the predominance of multi-sea winter salmon in the reported rod catch. In each decade from the 1950s to the 1980s salmon made up at least 95% of the reported rod catch, with few grilse reported. Since then, the proportion of rod caught fish reported as grilse has increased; ranging from 11% in the 1990s to 32% in the decade between 2000 and 2010. In the last decade, from 2010 to 2019, grilse made up 24% of the reported catch but numbers appear to have declined compared to the previous decade. The highest proportion of grilse recorded to date was in 2007, when they made up a reported 50% of the rod catch.

Figure 17. Total annual rod catches of salmon and grilse, 1952 to 2019



There is strong evidence in the rod catch data of a change in run timing of Atlantic salmon in the River Brora catchment. The proportion of the total catch of salmon and grilse captured in the spring period (February to May inclusive) has shifted substantially across the years for which data are currently available (Figure 18). Until the late 1960s spring fish usually made up over 50% of the annual rod catch. This changed through the 1970s and 1980s when late running autumn fish became more prevalent in the catch data, with a corresponding decline in the proportion of spring fish. This period of shift from early to late running coincided with an overall reduction in the total rod catch of salmon. The last 30 to 40 years has seen summer fish make a larger proportion of the catch, coinciding with an increase in the proportion of grilse being reported.

Figure 18. Trends in rod catches of salmon and grilse in spring, summer and autumn, 1952 to 2019



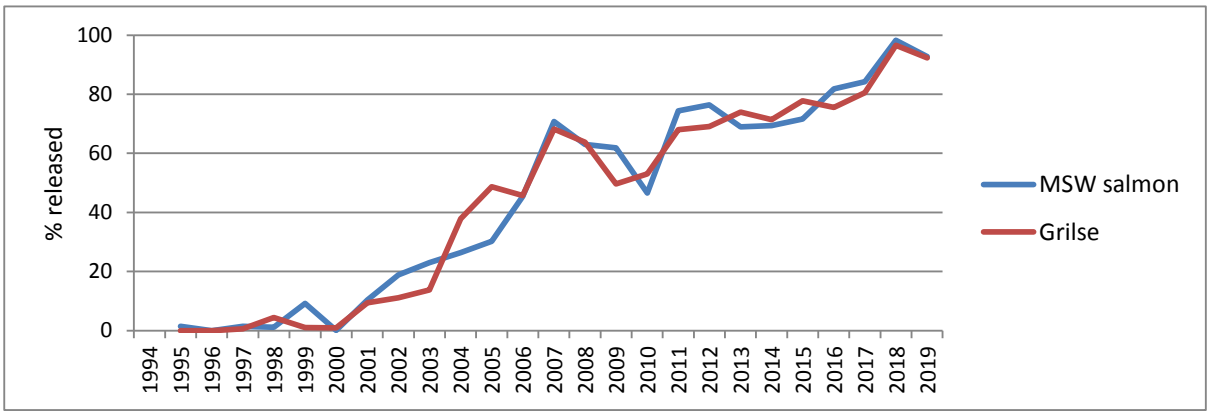
8.1.2 Catch and release

The number of salmon and grilse released after capture has been recorded in the official statistics since 1994. Since then there has been a steady increase in the proportion of salmon and grilse that are released (Figure 18). Trends for the release of the two stock components have followed very similar trajectories and in recent years over 80% of salmon and grilse have

been released alive. Catch and release is strongly encouraged by the Brora DSFB and is mandatory in many circumstances (see section 8.1.3.2).

Numerous studies have shown that released fish have excellent rates of survival if handled carefully. The Board's stated policy of attaining 85% release is therefore likely to make a significant contribution to ensuring the sustainability of stocks and fisheries.

Figure 19. Percent of salmon and grilse released following capture, Brora and Fleet, 1994 to 2019



8.1.3 Conservation

8.1.3.1 Conservation of Salmon (Scotland) Regulations 2016

The Conservation of Salmon (Scotland) Regulations 2016 outlined for the first time a system under which the killing of Atlantic salmon in inland waters is managed on an annual basis by categorising the conservation status of their stocks. Conservation status is defined based on the likelihood of a river's salmon stock meeting its conservation limit. The conservation limit is, in effect, the estimated number of adult salmon required to ensure that egg deposition is sufficient to maintain stock levels. The conservation status of each river's stock is defined by the probability of the stock meeting its conservation limit (CL) over a 5-year period. Stocks are allocated to one of three grades, each with its own recommended management actions (Table 50).

The most recent assessment of the River Brora by Marine Scotland Science classified it as a Category 1 river. The average chance of the conservation limit being met was estimated to be 89.3% during the 5-year period between 2014 and 2018[11].

Table 51 River grading definitions (Conservation of Salmon (Scotland) Regulations 2016)

Category	Probability of Meeting CL	Advice
1	At least 80%	Exploitation is sustainable therefore no additional management action is currently required. This recognises the effectiveness of existing non-statutory local management interventions.
2	60-80%	Management action is necessary to reduce exploitation: catch and release should be promoted strongly in the first instance. The need for mandatory catch and release will be reviewed annually.
3	Less than 60%	Exploitation is unsustainable therefore management actions required to reduce exploitation for 1 year i.e. mandatory catch and release (all methods).

[11] https://scotland.shinyapps.io/sg-salmon-conservation/

8.1.3.2 Brora DSFB Conservation Policy

The Brora DSFB Conservation Policy for 2020 is set out below. The policy is reviewed annually to reflect the Board's wish to preserve stocks and to ensure compliance with the Conservation of Salmon (Scotland) Regulations 2016.

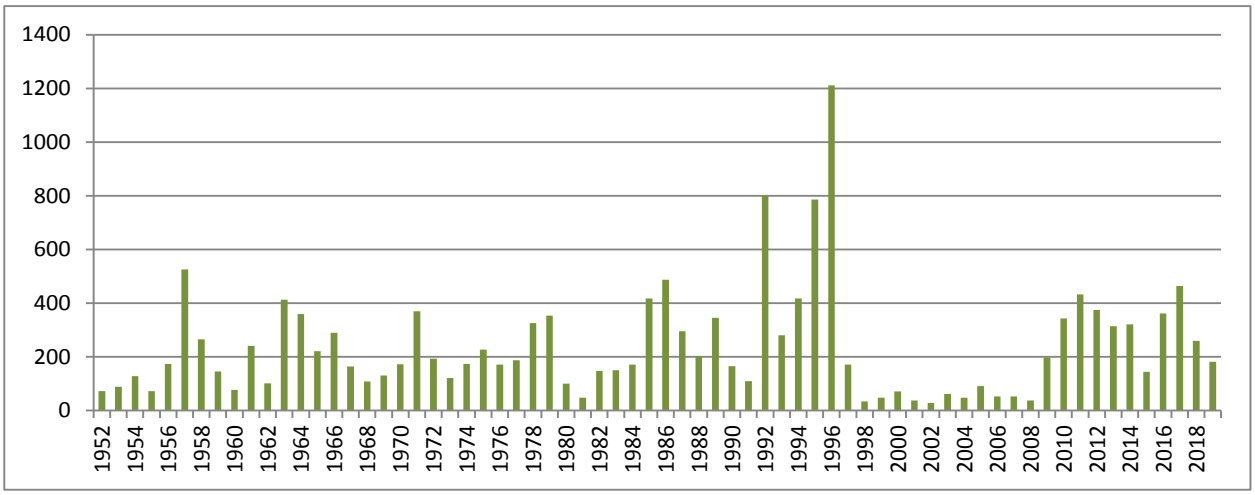
- All salmon and grilse to be released prior to 1st April (100% catch and release regardless of injury).
- Weekly lets on the river may keep one salmon or grilse per rod per week.
- Angling Club season ticket holders on the loch may retain one salmon or grilse per week up to a maximum of two in the season.
- Angling Club weekly ticket holders may retain one salmon or grilse per season.
- If tenants or ticket holders are fishing for less than a full week all fish are to be returned.
- It is an aim of the Board to achieve a 85% catch and release rate and we would encourage anyone fishing to better that where possible, for the long term benefit of fish stocks.
- All fish over 30 inches or 75 cm (about 10 lbs) are to be released.
- All hen fish are to be returned, in order to maximise future stocks.

8.2 Sea trout

8.2.1 Rod catches

Up until the early 1990s the annual catch of sea trout typically fluctuated between 150 and 300 fish (Figure 19). The early 1990s saw a dramatic increase in sea trout catches with almost 800 caught in 1992 and 1995. The peak catch of 1211 was in 1996. This was followed by a collapse in catches to less than 60 fish per year throughout the late 1990s and 2000s. Numbers began to increase in 2009 and recent data suggest that the rod catch has returned to historic levels.

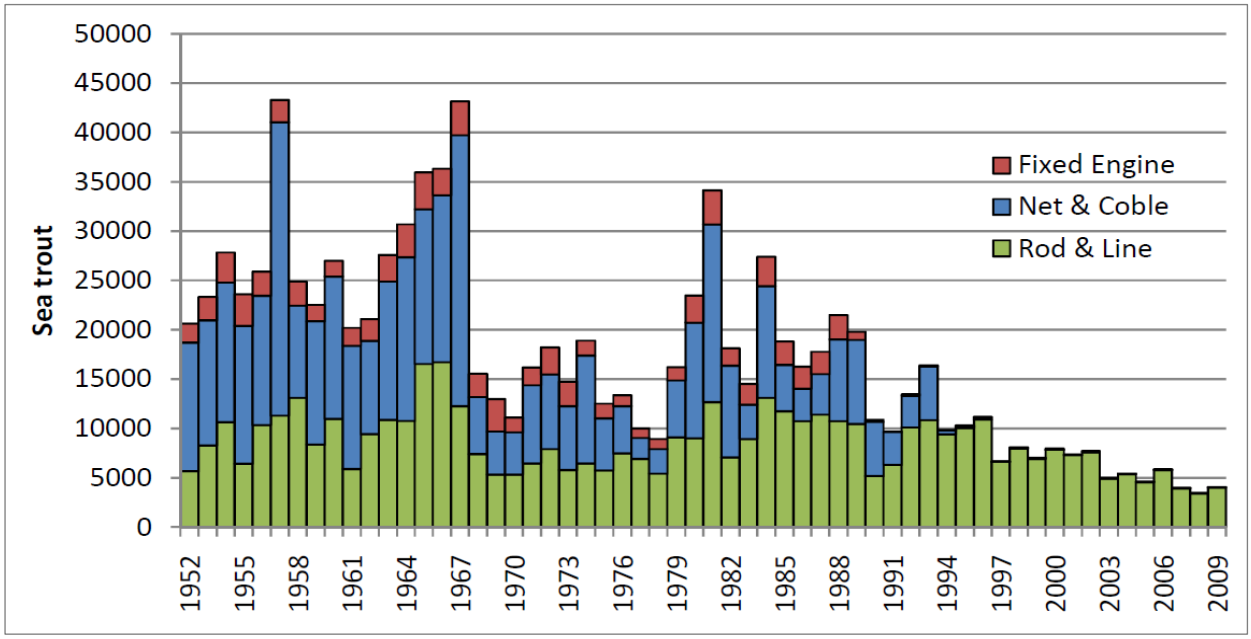
Figure 20. Rod catch of sea trout, Brora and Fleet, 1952 to 2019



It is not clear how the rod catch reflects actual numbers of sea trout. Netting effort has undoubtedly declined in North Region, and has ceased in recent years. The fact that catches are relatively low in recent years despite cessation of netting may suggest that sea trout abundance is not at historic levels. This is consistent with wider regional data from the Moray

Firth area. The Moray Firth Sea Trout Project[12] compiled catch data from Marine Scotland for the period 1952 to 2010. These data show a decline in regional rod catch despite the near-total cessation of commercial netting (Figure 21).

Figure 21. Sea trout catches Moray Firth region, 1952 to 2010



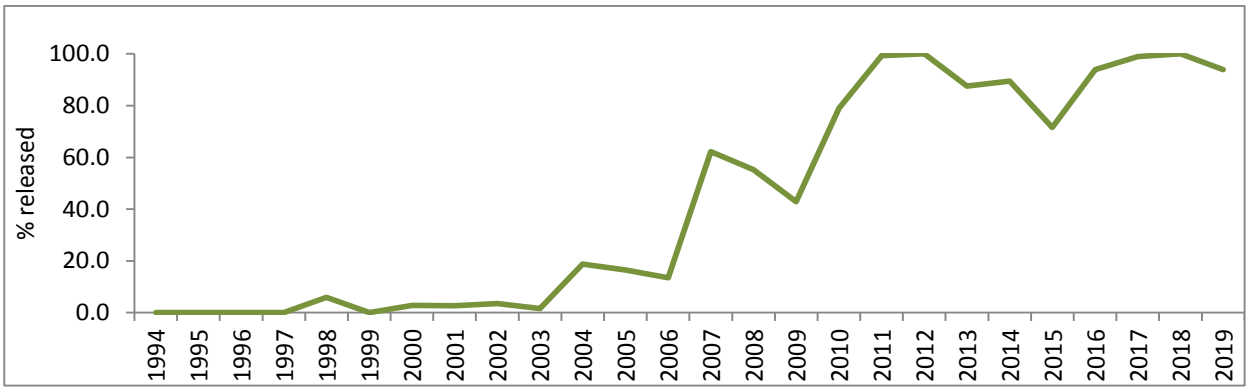
No weights are given for sea trout in the Scottish catch statistics for Brora and Fleet. In many parts of western Scotland where sea trout numbers have declined there has been a corresponding decrease in fish weight. This has been due to a decrease in longevity as well as, in part, growth rate. Sea trout can survive to spawn several times and the number of eggs deposited by a female is proportional to fish weight - larger females producing more eggs. Data on the size and age composition of sea trout might be a valuable addition to monitoring of this component of the rod fishery. It is possible that some data may exist in the game books for individual fisheries and these provide a starting point for any future investigation of sea trout stocks structure. As noted by Carnie (2002), the high catches reported in some years suggest the catchment has (or had) a substantial productive capacity for trout and it is unclear if this potential is currently being realised.

8.2.2 Catch and release

Before 1998 the catch data suggest that all sea trout captured were retained. Whether this was in fact the case is uncertain, but in all probability the majority of fish would have been kept for consumption. Since the apparent stock collapse of sea trout during the late 1990s there has been a steady increase in the proportion of sea trout released following capture (Figure 22). Almost all sea trout and finnock reported in the rod catch are now released.

[12] https://www.speyfisheryboard.com/wp-content/uploads/2014/12/MFSTP-Final-Report.pdf

Figure 22. Percent of sea trout and finnock released following capture, Brora and Fleet, 1994 to 2019



8.2.3 Brora DSFB Conservation Policy

The Brora DSFB Conservation Policy for sea trout reflects the understanding of the value of larger sea trout to the breeding population. It is set out below.

- Sea trout over 1½ lbs are particularly valuable and should be released. Only sea trout under 1½ lbs (about 15 inches) can be retained and it would be preferable to kill only smaller fish.
- It is an aim of the Board to achieve a 85% catch and release rate and we would encourage anyone fishing to better that where possible, for the long term benefit of fish stocks.
- Weekly lets on the river may retain a maximum of two sea trout per rod per week.
- Angling Club season ticket holders may retain up to a maximum of two per season.
- Angling club week ticket holders may retain one sea trout in the season.
- If anglers are fishing for less than a full week all sea trout should be returned.

8.3 Stocking

The Brora fishery has a long history of hatchery use for the production of juvenile salmon and Carnie (2002) provides an interesting history of salmon stocking in the river going back to the 1800s. In this early period the river received juvenile salmon from stocks including Brora, Helmsdale, Thurso and even the River Rhine. The present hatchery was used between the mid-1980s and the early 2000s. There has been no stocking in recent years although the hatchery remains functional and is subject to basic routine maintenance.

8.4 Fishing season

The fishing season for salmon and sea trout on the River Brora extends from 1st February to 15th October inclusive. The fishing season for resident brown trout is from 15th March to 6th October inclusive.

9 THREATS AND PRESSURES

9.1 Marine mortality

9.1.1 Salmon

It is widely recognised that the marine survival of Atlantic salmon is currently low and, based on return rates of smolts to adults from monitored rivers, has been in decline since the mid- to late 1980s. Until recently abundance declined most severely for the multi-sea-winter stock components, but in recent years rapid declines in grilse abundance have also been noted in some rivers while numbers of multi-sea winter fish have stabilised. There are now growing concerns over the decline in the numbers of grilse returning throughout Scotland.

There is much evidence that spawning stock is related to recruitment in freshwater, but that the effect of variation in spawner numbers is to some degree ameliorated by density-dependent changes in the growth and survival of juveniles. Put simply, if fewer adults spawn, a higher proportion of each of their progeny may survive to go to sea. A critical feature of marine survival is that it shows no such compensatory relationship with smolt abundance. Survival rates at sea cannot be predicted from estimates of the numbers of smolts going to sea; the same proportion is likely to die before returning regardless of numbers. However, all being equal, the more smolts that go the sea the more adults will return. Common patterns of decline across the range of Atlantic salmon suggest that very broad-scale factors are impacting abundance and that these act throughout the time that salmon spend at sea. The declines in abundance seen in recent decades are almost certainly driven by large scale climate changes in the North Atlantic, which in turn affect food availability and growth. Sea temperature change may also impact on predation as well as being a direct threat. The precise mechanisms by which these large scale environmental factors impact salmon survival are not well understood but their reality is not in doubt and they are the subject of considerable research effort throughout the north Atlantic region.

Data from rivers monitored by Marine Scotland Science suggest that return rates to the coast were as a high as 25% for east coast salmon in past decades. More recent published percentage survival data indicate a 10 year average survival of around 6% to home waters[13]. The figure for multi-sea winter fish is smaller, with a 10 year average of around 5.3%. These figures make depressing reading for fisheries managers and can leave them feeling helpless. What they do, however, is reinforce the importance of protecting and enhancing the freshwater environment in order that smolt production can be sustained or even improved.

A number of recent initiatives have sought to tackle poor salmon survival at sea. These include the closure of interceptory, mixed-stock coastal fisheries including bag nets. It is likely that the closure of these fisheries has benefitted the River Brora salmon stocks.

9.1.2 Sea trout

Sea trout marine survival has received less research effort in recent decades than has been targeted at salmon, particularly in eastern Scotland where the relationship between salmon farming and sea trout declines has been less of an issue than in western Scotland. The knowledge gaps are large and even apparently simple metrics such as survival, marine residence time and return rates are poorly known. Due to the species' flexible life history these parameters may vary greatly between rivers. It is known that many post-smolt sea trout remain

[13] https://jncc.gov.uk/jncc-assets/Art17/S1106-SC-Habitats-Directive-Art17-2019.pdf

at sea during the summer and return to freshwater to over-winter (as finnock). However, this pattern is not consistent and some can remain at sea until they later return to freshwater to spawn as full adults. Studies suggest that some sea trout populations undertake long-distance marine migrations to feed; for instance many tagged sea trout from the River Tweed are caught on the Frisian coast of Netherlands and along the East Anglian coast. However it is thought that most populations from further north in Scotland are likely to remain within 80 km of their river of origin.

It has been suggested that climate change may have resulted in some of the sea trout's favoured prey – sprats, sandeels and juvenile herring – moving northwards due to climatic factors. If so, this may impact on their survival both due to a relative paucity of local feeding as well as to the risks of undertaking longer migrations in search of food. Declines of coastal fish stocks such as herring and sprat through overfishing also may have had a significant impact on sea trout, which feed heavily on the juveniles of these species. Greater understanding of the use of marine habitat by sea trout in the northeast of Scotland would clearly be of value in understanding how stocks in the River Brora might best be protected. Until such knowledge exists, it is likely that any efforts to minimise the impact of a) commercial exploitation of food species and b) predation, may be worthwhile on a precautionary basis.

9.2 Potential freshwater factors

9.2.1 Exploitation and management

In recent years the River Brora DSFB has been successful in ensuring high levels of catch and release, usually exceeding the self-imposed target of 85% release for both salon and sea trout. This and the Category 1 classification from Marine Scotland Science suggest that legal angling is currently unlikely to represent a threat to stocks.

It is always difficult to ascertain the level of illegal fishing, including netting. The latter can be exceptionally damaging. The Water Bailiffs conduct regular patrols and work with Police Scotland to minimise the potential impact of illegal exploitation of fish stocks.

9.2.2 Water quality, flows and abstraction

As noted in earlier chapters the River Brora has a largely natural flow regime. Due to its topography, which is less steep than many comparably sized Highland rivers, it has seen relatively little development of small-scale hydropower. Such small-scale schemes can undoubtedly be developed in a manner that is sympathetic to fish, but a watching brief on their development is needed to ensure that where developments are proposed they include appropriate mitigations. The development of schemes on the smaller steeper streams seems likely to present a greater risk to sea trout than to salmon, due to the relative distribution of the two species.

SEPA data suggest that water quality in the catchment is good and few threats were noted during the extensive walkover survey. No significant issues relating to either point source or diffuse pollution were noted during the survey, with the exception of siltation due to peat erosion in some headwater streams.

The transfer of water away from the upper River Brora at Dalnessie is the single large-scale abstraction from the catchment. The reduction in discharge in the river may have some potential to reduce production but as abstraction ceases at low flow any impact, if present, is likely to be

slight. Similarly the weir seems unlikely to have more than a localised impact on morphology and sediment transport on the upper River Brora. Most of the substrate that collects behind the weir is sand (A. Stephen pers. comm.) rather than cobble, pebble and gravel that might make a positive contribution to spawning habitats. Assessment of any wider impact of the altered flow regime on stream morphology is beyond the scope of the current document, but the presence of good numbers of juvenile salmon throughout the downstream reaches suggest any effect on juvenile densities may be small. The weir overtops in spates so flushing flows, which may be important in maintain the quality of spawning habitats by mobilising smaller sediments, continue to take place. There may be some potential for reduced flow to exacerbate high summer water temperatures, although it is unlikely that abstraction would take place during the prolonged periods of hot dry weather when temperatures are most likely to be critical. Although current data suggest that juvenile stocks downstream of Dalnessie remain in good health, Mills and Graesser (1981) contended that the reduced flows impede migration of sea trout and salmon into the depleted reaches. The basis for this is uncertain and without tracking of adults might be difficult to ascertain objectively.

9.2.3 Access and obstacles to migration

The 2018 walkover survey data suggest that man-made obstacles to migration do not significantly impact on any of the larger watercourses. The survey did not include all smaller streams, which may be of substantial value to sea trout production. These smaller watercourses are more likely to suffer from installation of non-fish-friendly culverts, bridge aprons or other barriers than are larger watercourses, where greater care is likely to be taken with instream works. It would be useful to compile a 'live' database of potential or actual obstacles where these are encountered by bailiffs, anglers or interested members of the public.

Additional information may be useful in relation to some of the natural barriers that have been identified. For instance, the 2018 electric fishing survey found salmon fry upstream of the waterfall near Dalnessie in a reach that had previously been thought inaccessible to salmon.

9.2.4 River engineering works

Engineering works in rivers, streams and lochs can cause damage to the water environment. This in turn can affect populations of invertebrates, fish and other biota. Poorly designed engineering works can cause erosion and scouring of riverbeds and damage to riverbanks, or may block fish access to spawning areas. Natural river processes including sediment transport may be disrupted, to the detriment of spawning habitats. Direct removal of river sediments, e.g. for track construction, can greatly damage spawning areas. At its most extreme, river engineering in parts of Scotland and Ireland has involved dredging and straightening channels resulting in gross deterioration of habitat quality for flora and fauna.

Most of the Brora catchment has avoided the worst excesses of engineering. The most extensively engineered reaches are in the lower river, downstream of Loch Brora, where extensive work has taken place over many decades to a) improve opportunities for angling and b) minimise riverbank erosion. Further engineering, mainly for fisheries purposes, has taken place in past years in the reaches around Balnacoil and, more recently, Dalreavoch.

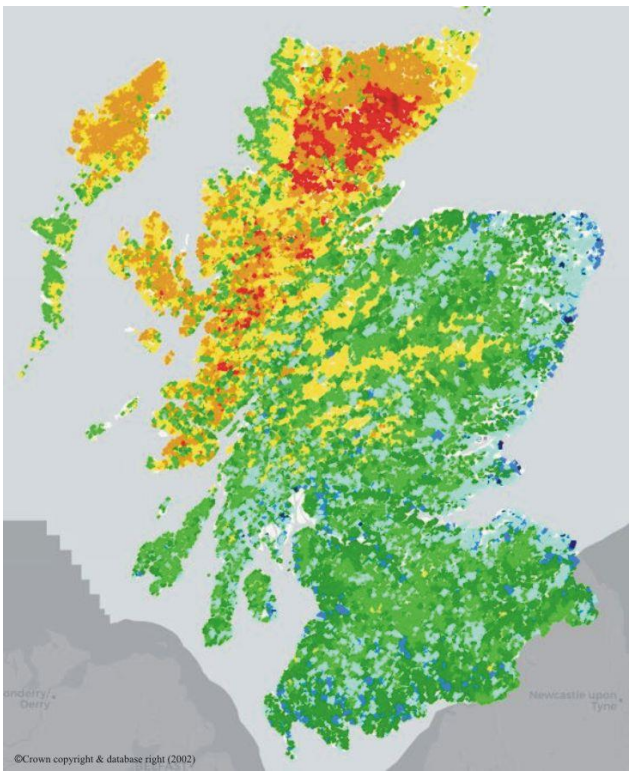
The effects of engineering on the lower River Brora are discussed by Moir (2019). As pointed out by Moir, some of the impacts of built structures may have been to the detriment of riverine habitats for fish. However, it is important to recognise that the revenues from angling are themselves of the utmost importance in protecting and promoting fish populations, so a balanced approach is required if considering future change. The needs of other stakeholders, including farmers, must also be considered. Moir (2019) suggests that a long term aim for the lower river might be to gradually reinstate natural river processes by prioritised modification and / or removal of some engineered structures. It would clearly be essential to ensure that such works were done in a manner that did not impact on the financial sustainability of the fisheries.

Engineering in the water environment is now covered by the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR). These and their amendments apply to all engineering, building or other works in inland surface waters (including wetlands) and works in the vicinity of inland surface waters where those works pose a risk of significant adverse impact. Any work carried out without the appropriate authorisation under the regulations is an offense.

9.2.5 Climate change

Since the last century, as concentrations of greenhouse gases in the atmosphere have increased, the atmosphere and oceans have warmed, snow and ice in polar areas have reduced and the sea level has risen. Observed national changes in land temperature in Scotland have been seen an average rise of around 1°C in recent decades. In the same period, rainfall over Scotland has increased by around 13% compared to the average for the early decades of the 20th century. These changes have implications for aquatic habitats and species, including salmonid and other fish.

Figure 23. Climate sensitivity of Scottish Rivers



9.2.5.1 Summer water temperatures

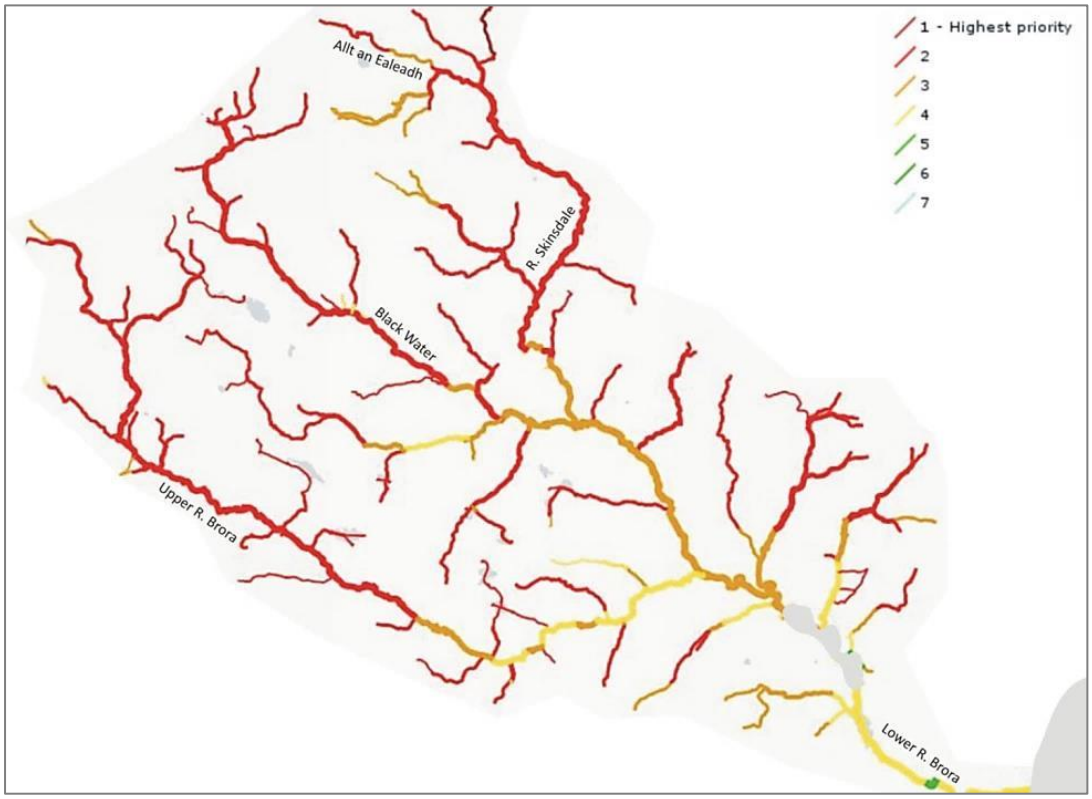
Atlantic salmon and brown trout are cold-water adapted species and may experience stress, loss of growth and increased mortality at higher water temperatures. Brown trout are relatively more sensitive to high water temperature than salmon in that they exhibit stress and loss of growth at lower temperatures. Optimal water temperatures for salmon and trout growth are 16 °C and 13.5 °C respectively. Corresponding maximum temperatures for growth are 22.5 °C and 19.5 °C for salmon and trout respectively. Juvenile salmon experience thermal stress, stop feeding and seek thermal refuges if temperatures rise

above 23 °C. Given these sensitivities there is widespread concern that rising river temperatures in the summer months may represent a threat to Scotland's salmonid populations.

In order to investigate temperature effects on freshwaters the Scotland River Temperature Monitoring Network (SRTMN[14]) was established in 2013 - a collaboration between Marine Scotland Science, District Salmon Fisheries Boards, Fisheries Trusts and the University of Birmingham. The data are publicly available and a suite of management tools has been developed based around the data. The map above shows the relative sensitivity to temperature increase of rivers across Scotland based on data from the national monitoring network. Perhaps surprisingly given the climate, it is the rivers of parts of northern and western Scotland where sensitivity is highest and management action most pressing.

The temperature monitoring network includes several locations within the River Brora catchment, although data are not currently available from all locations in all years. The early summer of 2018, during which the habitat walkover survey took place, was hot and dry. Temperature monitoring data[15] from the Black Water near Achaness found that mean daily water temperature during 2018 exceeded the optimum for juvenile salmon growth for 63 days, and exceeded the temperature at which they experience significant thermal stress for 20 days. The maximum temperature that was recorded on the Black Water in 2018 was 27 °C. Modelling data available at the SRTMN show that much of the upper catchment of the River Brora is at high risk from increased summer temperatures and that management action to address this issue is a high priority (Figure 24). Northern areas of Scotland have experienced drier summertime conditions since 1961, and reduced water levels in the summer period will undoubtedly exacerbate the effect of increased air temperature and radiated heat.

Figure 24. Temperature threat level and priority for action R. Brora catchment (SRTMN)



[14] http://marine.gov.scot/information/scotland-river-temperature-monitoring-network-srtmn-predictions-river-temperature-and
[15] https://scotland.shinyapps.io/sg-srtmn-data/

9.2.5.2 Winter water temperatures and water levels

Data on past changes in precipitation and river flow show an upward trend in winter precipitation since 1961, with an increase of almost 70% in northern Scotland[16]. For the same period, the data show that Scotland, as a whole, became 20% wetter. Predicted changes in future years for northern Scotland include:

- Milder and wetter autumns and winters, and
- Increased frequency and intensity of extreme precipitation events.

Both of these have implications for salmonid fish. Salmonid egg development rate is linked to water temperatures; higher water temperatures lead to earlier hatching dates, which can expose alevins and young fry to displacement and increased mortality in late winter spates.

Spate events also have the capacity to change instream habitats, destabilising riverbeds and banks. In extreme cases, this can lead to significant degradation of key habitats including those used for spawning. Spates can also impact directly on eggs through redd washout. As was noted in section 4.3.1, the River Brora catchment lacks large headwater lochs that would buffer the rapidity and amplitude of extreme spate events. This may make parts of the catchment vulnerable during periods of intense rainfall. Actions to slow runoff, such as restoring peatlands, promoting native woodlands and blocking old drainage channels may help adaptation to some of the predicted changes in rainfall patterns. It is worth noting in this context that in the 1950s the Hill Farm Improvement Scheme attempted to drain extensive parts of the Black Water and upper Brora catchments, via the creation of 150 miles of ditches and drains. This is likely to have increased the rate of runoff in parts of the catchment (Mills & Graesser 1981).

9.3 Land use and riparian management

9.3.1 Livestock and deer

The upland areas of the catchment, including the vast majority of the upper Brora, Black Water and Skinsdale, are maintained as deer forest. Stalking is an important source of revenue for these estates and a provider of local jobs. It is apparent in some parts of the catchment that trampling by deer is having an impact on streams by exacerbating erosion of peat as well as by suppressing riparian vegetation. Deer in peatland areas use the riparian corridors relatively intensively compared with their use of wider peatland habitats, due to the richer vegetation. In the River Brora catchment impacts from trampling and grazing are widespread and visible at both a localised and landscape scale. The potential effects of these impacts on stream ecology are substantial and are considered further in the following sections. Reducing impacts from grazing and trampling presents a substantial challenge to fisheries interests, as optimal management for stream health can have significant implications for deer management.

Sheep can have broadly similar impacts to deer, through suppression of vegetation and trampling, which can lead to erosion or compaction of soils. Current impacts from sheep in the Brora catchment are less widespread than those from deer, but are significant along parts of the River Brora upstream of Balnacoil. Few parts of the hill ground or the headwater areas are currently grazed by sheep[17].

[16] https://www2.gov.scot/Publications/2019/02/6294/362868
[17] http://esutherlanddmg.deer-management.co.uk/wp-content/uploads/2016/04/6.-ESDMG-Sheep-Distribution-Map-1.pdf

9.3.2 Peat erosion

Peat erosion is linked to a number of factors including climate change, trampling by deer and livestock, and muirburn. Where the naturally-occurring vegetation is removed or damaged, the peat below is exposed to the erosive effects of wind, sun and rain, and to oxidation through exposure to the air. Oxidation releases stored carbon into the atmosphere, while drying and fragmentation by sun and wind produce fine particles which are washed away by rain, exposing new peat faces to the elements. Once exposed, peat faces can be slow to revegetate, especially where they continue to be disturbed by animals. Often the bare peat faces prograde gradually to form extensive systems of hags and gullies. Close to streams, they can effectively form a network of channels delivering water and eroded peat fragments from the surrounding area into the watercourse. In headwater areas in the Brora system, the input of fragmented peat to streams in this manner can be high. During the low flow period in spring and early summer of 2018 a number of the smaller watercourses were significantly impacted by deposition of peat across the streambed. This was clearly linked to the desiccation and erosion of peat. In some of the slower flowing watercourses the impact was very clear, peat deposits almost obscuring other substrates. Even in riffle habitats, it was apparent that there were excessive deposits of peat within the substrate matrix, potentially reducing water flow through the gravels and pebbles.

The effects of peat erosion on streams are beginning to be better understood. Recent research (e.g. Brown et al. 2019; shows that it can result in changes to invertebrate populations, reducing both numbers and biomass of insects. The impact on Ephemeroptera and Plecoptera (mayflies and stoneflies) may be severe as these groups are generally intolerant of sedimentation. Both groups are important food sources for juvenile and adult salmonids. Direct impacts on fish can be expected through clogging of spawning habitats, reducing egg survival.

As noted above, the effects of climate change in northern Scotland are expected to be hotter, drier summers and wetter winters. This is expected to increase the rate and severity of desiccation and erosion of peatland habitats, leading to an increased yield of sediments into streams to the detriment of fish and other aquatic life. In the River Brora catchment this may be a particularly serious threat to sea trout, as data suggest they are highly reliant on the smaller streams where peat trampling and erosion are having the greatest impact.

Healthy peatlands absorb and store rainwater, releasing it slowly over extended time periods. This natural buffering capacity protects against the damaging impacts of spates and summer droughts, reducing the frequency and severity of floods and summer low water events. Peatland which is degraded through gullying, hagging and erosion sheds water before it has time to be absorbed, with significant negative consequences for watercourses.

9.3.3 Muirburn

Rotational vegetation burning is practised widely in upland Scotland to boost production of recreational game birds or to manage grazing areas. The level of burning practiced in the Brora catchment is uncertain but probably slight, and impacts were not recorded during the walkover survey of streams. It is however worth noting that burning can affect stream fauna as a result of changes in water quality including sedimentation, nutrient runoff, increased acidity or leaching of potentially toxic metals such as aluminium. It also has potential to damage riparian vegetation such as heather and shrubs, which provide overhead cover for young trout as well as shade in smaller streams. The Muirburn Code[18] specifically recommends that buffer zones should be left along watercourses to minimise sediment runoff, bank erosion and changes to water quality. Recommended width of buffer zones is 2 m for stream less than 2 m width and 5 m for streams over 2m or for lochs and lochans.

9.3.4 Loss of riparian trees and shrubs

There is no doubt that land use over at least two centuries has greatly altered the abundance and distribution of woodland and scrub habitats in the Brora catchment. Browsing by deer, sheep and cattle persistently prevents the establishment of young trees, while over time existing mature trees age and die, causing a gradual attrition of woodland in all but the most inaccessible areas such as islands in lochs and rivers. Historically woodland would have been found in the river valleys where the soil is suitable, often lining the river banks for long reaches. This would have created useful shade, stabilised banks against erosion, and provided nutrients to the watercourse through leaf-fall; fallen trees and branches would have altered flow on a small scale and created valuable micro-habitats for fish and their invertebrate prey.

[18] http://muirburncode.org.uk/muirburn-code-jul20/

Little natural woodland remains in the catchment and the loss of riparian trees and shrubs in particular has left watercourses very vulnerable to high summer water temperatures and to bank erosion during spates. This is of particular concern in the Black Water and Skinsdale sub-catchments where little or no riparian woodland remains.

Most of the remaining riparian trees are now restricted to the Lower River Brora, and a section of the Upper River Brora between Balnacoil and Dalreavoch. However due to grazing pressure and lack of adequate fencing there is little or no regeneration and some trees are now senescent. Mature riparian woodland is a very valuable resource which takes many years to create; protection and maintenance of existing riparian woodland is a management priority.

9.3.5 Over-shading and woodland encroachment

Over-shading by shrubs and trees can reduce stream productivity. This was not identified as a problem during the walkover survey. If present at all, it is most likely to be an issue on smaller streams that have not been surveyed.

Woodland encroachment onto floodplains has been implicated as a potential contributor to erosion and scouring, as the trees might concentrate increased flow in the river channel. Woodland encroachment is not an issue in the Brora catchment and lack of shade is a far greater threat. Nonetheless care should be taken and appropriate expert advice sought if planting programmes on floodplains are to be taken forward.

9.4 Predation

Fish predators are a natural a part of freshwater and marine ecosystems. As such, predator control for fisheries management is a controversial subject and needs to be handled in a sensitive and responsible manner. Furthermore, many or most piscivorous birds and mammals have some degree of statutory protection and cannot be killed or removed without appropriate licenses. Predation is most likely to be a significant issue in areas where 'bottlenecks' are encountered by fish. For instance, adult fish waiting in estuaries during low river levels may be vulnerable to seals while smolts accumulating near low-water barriers on their downstream migration may be easy targets for sawbill ducks or predatory fish species.

Recent research conducted by the Atlantic Salmon Trust suggests that mortality of downstream-migrating salmon smolts may exceed 50%. The causes are not known, but it is likely that predation plays a part. Loss of smolts or adult fish are generally likely to be of more concern in relation to fisheries than loss of younger age classes, as no compensatory changes in survival

will occur i.e. loss of smolts or adults is likely to have a direct impact on numbers of spawning fish.

The Moray Firth Seal Management Plan (Butler et al. 2008) provides a local mechanism by which the needs of salmon, seals, fisheries and wildlife tourism might be balanced. The Plan fed into the Marine (Scotland) Act 2010 which seeks balance seal conservation with sustainable fisheries and aquaculture. Under the Act it is an offence to kill or injure a seal except under licence or for welfare reasons, outlawing unregulated seal shooting that was permitted under previous legislation.

Sawbill ducks (mergansers and goosanders) and cormorants are specialist fish eaters and most likely to impact on stocks during smolt migration. In order to prevent serious damage to fisheries, SNH can grant a license for shooting a small number of these birds and for scaring activities such as the use of gas guns and blank cartridges. Applications for such a license generally have to be supported by objective information relating to bird numbers and potential damage caused. Obtaining sufficient data (counts of birds) to obtain a license can be time consuming and expensive in man-hours. An option to reduce losses, gaining in popularity, is 'smolt shepherding', where predator hot-spots are identified and non-lethal scaring techniques are put in place to reduce smolt losses.

Predation in the marine environment is likely to be outside the control of the Brora DSFB and as it is poorly understood it is not considered further in relation to management.

9.5 Alien species

9.5.1 Gyrodactylus salaris

Gyrodactylus salaris (Gs) is a small parasite (0.5mm in length) infecting the skin, gills and fins of fish. It can cause serious damage to Atlantic salmon parr and has been responsible for significant mortalities (up to 98%) of wild Atlantic salmon populations in Norway. Gs is a listed disease that must be reported under Schedule 1 of the Aquatic Animal Health (Scotland) Regulations 2009. The U.K. is currently recognised as being free from Gs although evidence exists to suggest that our Atlantic salmon populations are highly susceptible to both infection and mortality. Once introduced it may be impossible to eradicate Gs and preventing its introduction is a national and local priority.

9.5.2 Signal crayfish

North American signal crayfish were introduced to the UK for aquaculture. They have since spread in the wild and are now widely distributed in England and southern Scotland. The nearest records to the Brora catchment are near Inverness. Signal crayfish can cause damage to habitats by burrowing in riverbanks. They have a very varied diet but this includes fish eggs, small fish, other crustaceans and vegetation. They can be damaging to fish populations and fisheries. It is important that steps are taken to minimise the chance of their introduction.

9.5.3 American mink

Mink colonised large parts of Scotland after escaping from fur farms. Mink are a relatively generalised predator and as well as having had huge impacts on species such as water voles and terns they can be a significant predator of juvenile salmonid fish in small streams. Mink are currently rare in the far north of Scotland, including east Sutherland. Limiting their spread by eradicating colonists is a realistic objective. This is done by using mink monitoring rafts to

establish if mink are present in an area; once detected, mink are trapped and dispatched. Support is available from the Scottish Invasive Species Initiative[19].

9.5.4 Perch, minnows and other non-native fish

Introductions of non-native fish have been controlled by legislation since 2008. However, it seems likely that at least one non-native species (perch) has already been introduced. Such introductions not only carry risks from ecological interactions between native and non-native species but may also carry substantial disease risk. Fish farming and other fish movements are one of the primary routes for introduction of diseases and parasites to freshwater systems.

Perch have recently been reported from Loch Brora. Perch diet is mainly invertebrates including insect larvae and crustaceans. Small fish do however forma a part of the diet and perch may prey on salmonid fry as well as on minnows and sticklebacks. Whether they represent a substantial threat to juvenile trout or salmon is uncertain but the addition of a non-native fish-predator to the loch is unlikely to be beneficial. Once established, it is unlikely that perch can be effectively controlled let alone eradicated.

Minnows are not native to the north of Scotland but are now widespread and they have been recorded in several locations in east Sutherland. They have not, it seems, been recorded in the River Brora catchment. No records can be found on the National Biodiversity Network atlas and they have not been reported in electric fishing surveys. In nutrient poor waters minnows can compete strongly with trout and may lead to declines in populations of trout fry. Minnows are usually introduced by anglers using them as live-bait for trout. The use of live minnows as bait is prohibited under Section 4 of the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Section 33(A) of the Act makes it an offence to introduce, or to be in possession of live minnows with the intention of introducing them into inland waters.

9.5.5 Invasive plants

While not a direct threat to fish or fisheries invasive plant species such as Japanese knotweed, Himalayan balsam and rhododendron can substantially alter vegetation structure and can become dominant along riverbanks once they become established. It is always better and easier to remove these species before they have a chance to spread and become a serious problem.

9.5.6 Diseases

Many diseases can affect wild salmon and sea trout. Advice on disease issues can be sought from the Fish Health Inspectorate at Marine Scotland Science. The Inspectorate's main objective is to prevent the introduction and spread of listed and emerging fish and shellfish diseases in Scotland. Advice should be sought from the Inspectorate where disease outbreaks are identified or suspected.

[19] https://www.invasivespecies.scot/

10 ASSESSMENTS AND MANAGEMENT IMPLICATIONS

In the interests of continuity with the previous Fisheries Management Plan a current assessment of the strengths, weaknesses, opportunities and threats to each management unit are described below along with management implication relating to these. This chapter is intended to link the findings of surveys and assessments of potential threats to the management proposals which follow, providing a rationale for proposed actions and activities.

Some issues are generic and operate across more than one management unit. To enable the sections relating to the different management units to be read and used in isolation from the rest of the management plan, there is inevitably some repetition between these sections.

The marine environment is largely omitted from this section of the Management Plan, but marine survival is recognised as an over-arching issue and is considered within the subsequent management proposals, albeit those actions to address marine issues are largely outside the control of the Fisheries Board.

10.1 Lower River Brora management unit (sea to Loch Brora outflow)

Strengths

- Excellent angling opportunities;
- Substantial accessible extent of juvenile salmonid habitat, and frequent holding pools for adult fish;
- Mixed riparian vegetation and some tree cover.

Weaknesses

- The lower river lacks sediment transport.
- There are few extensive areas of spawning habitat.
- The productivity of the Lower River Brora as a salmon river is heavily reliant on upper sub-catchments to provide smolts and returning runs of adult fish;

Threats

- Sediment starvation may have long-term consequences for availability and quality of spawning and juvenile habitats.
- Potential for predation of smolts by piscivorous birds during downstream migration
- Seal predation on salmon and sea trout in the river mouth
- Illegal exploitation
- Productivity of angling is threatened by any negative upstream impacts including in the headwater areas outside of the control of lower river riparian owners.

Opportunities

- Use of fisheries-generated revenues to promote wider catchment management initiatives;
- Increased woodland on south bank of lower river to maximise shade and in the long-term provide large wood features in-channel.
- Develop long-term strategy to reinstate natural river processes.

The Lower River Brora holds a good mix of juvenile habitat and holding areas for adults. Engineering works over many years have stabilised the river to provide angling opportunities and maintain a single unchanging course, reducing erosion and the input of material to the watercourse. At present juvenile numbers are good but the lack of sediment transport is a risk to the long-term availability of adequate spawning habitat. A shift to a more natural, process-based

regime is likely to be beneficial in the long-term but, as pointed out by Moir (2019) would require that the river be given more space to move laterally. Such an ambitious change of management strategy is beyond the scope of this Plan but serious consideration should be given to identifying reaches where benefits might accrue without unacceptable impacts on other stakeholders.

10.2 Middle River Brora management unit (Loch Brora to Balnacoil, including loch tributaries)

Strengths

- Excellent angling opportunities;
- Moderate extent of juvenile salmonid habitat, and frequent holding pools for adult fish;
- Good spawning habitat near Balnacoil;
- Productive tributaries around Loch Brora with spawning habitat and good densities of both salmon and trout;

Weaknesses

- No riparian trees on the main river to stabilise banks or provide shade;
- Impacts from trampling and erosion of the banks by livestock between the loch and Balnacoil, and on some tributaries where livestock have access.

Threats

- Potential impacts of perch on juvenile salmonids in Loch Brora;
- Potential for predation of smolts by piscivorous birds during downstream migration;
- Illegal exploitation;
- Productivity of angling is threatened by any negative upstream impacts including in the headwater areas outside of the control of lower river riparian owners.

Opportunities

- Use of fisheries-generated revenues to promote wider catchment management initiatives;
- Promote regeneration of willow in some areas such as the lower reaches of Ascoile Burn;
- Reduce grazing impacts on lower reaches of tributaries, as these can be highly productive;

The Middle River Brora encompasses three distinct sections with very different management requirements: the River Brora from the loch to Balnacoil, the loch itself, and the tributary burns that run into the loch and the river.

Loch Brora provides a large area of habitat for fish. It seems likely that juvenile trout, and probably also salmon, utilise the loch as a rearing area.

The reach between the loch and Balnacoil is a natural floodplain. It provides some good quality grazing and is likely to be valued for this purpose. However, this has led to long-term loss and degradation of vegetation along the riverbanks. Consideration might be given to restoring habitat within one of the narrow meander bends, where it may be feasible to exclude grazers and plant willow. Realistically, fisheries benefit would be minimal but it would locally enhance habitat and act as an accessible demonstration project. Perhaps of greater benefit would be a phased programme of livestock exclusion from the banks of smaller tributaries of the loch and River Brora. Electric fishing shows that these can be highly productive but some reaches are becoming degraded. Redd counting followed by summer fry surveys in the reach below Balnacoil may help identify whether habitat degradation is affecting egg or alevin survival.

10.3 Upper River Brora management unit (Balnacoil to headwaters)

Strengths

- Large accessible extent of good quality juvenile habitat from Balnacoil to Corrish and between Cnocan and Dalnessie Falls
- Excellent spawning habitat at Dalreavoch and Braegrudie
- Largely stable
- Good densities of salmon fry and parr
- Little exploitation of spawning stock upstream of Dalreavoch
- Good extent of mature riparian woodland in the lower reaches from Craggiemore to Balnacoil, corresponding to lower predicted maximum summer water temperatures for this reach (level 4)

Weaknesses

- Lack of deep water refuges for adult fish between Balnacoil and Braegrudie, and lack of spawning habitat between Balnacoil and Dalreavoch
- Lack of riparian trees upstream of Craggiemore
- High levels of deer and livestock grazing between Craigton and the Allt Gobhlach/An Crom Allt confluence result in loss of vegetation, bank trampling and increased erosion.
- Between Craigton and Cnocan, shallow riffle areas used for spawning are also used as crossing points by sheep, deer and cattle
- Large areas of good juvenile habitat and spawning habitat upstream of Dalnessie Falls are extremely challenging to access.
- Headwater areas suffer from peat deposition over the substrate, due to erosion of peat bank faces and riparian peatlands.
- Headwater areas are owned by stalking and/or farming estates with no economic interest in fisheries on the lower catchment.
- Loss of water at Dalnessie due to abstraction.

Threats

- Entire sub-catchment upstream of Braegrudie has been identified as being vulnerable to high summer water temperatures (level 2 throughout)
- Habitat damage and mortality of ova and alevins in spawning areas due to siltation and/or trampling by deer and livestock
- Stress, loss of growth or mortality of juvenile fish in hot summers
- Shallowing and widening of channel, increasing vulnerability to high summer temperatures
- Loss of bankside fish cover, increasing vulnerability to predation
- Predation of smolts by piscivorous birds during downstream migration

Opportunities

- The orientation of the Upper Brora, combined with suitable soil-types, makes it a good candidate for establishment of riverine woodland to provide shade and stabilise eroding banks
- Management of valuable existing riparian woodland to exclude grazers and encourage regeneration would ensure it does not degrade over time

- The presence of existing recent WGS enclosures close to the river may offer the potential to extend fenced areas across the river, allowing the development of new riverine woodland at lower cost than would be the case for complete new fenced exclosures.
- There is a possibility that small alterations to the pool below Dalnessie Falls might ease the jump for upstream-migrating salmon, increasing access to good areas of habitat upstream.
- East Sutherland Deer Management Group aim to reduce deer densities to a target of 8 per square kilometre for the Northwest Group (includes Dalnessie).

The Upper Brora holds large areas of good quality juvenile and spawning habitat for salmonids, however habitat on this sub-catchment is quite unevenly distributed. The reach from Balnacoil to Dalreavoch is almost entirely mixed juvenile habitat, well-suited to parr in particular, but lacks both holding pools for adult fish and significant extents of spawning habitat. There are some modifications of varying ages through this reach intended to create pools for angling, some of which are still effective; these have created very few visible downstream impacts. This reach is probably very important to the productivity of the river as it has extensive riparian woodland, particularly along the southern bank of the river where trees are most useful for providing shade; as a result the reach has been identified as one of the least vulnerable sections of the catchment to high summer water temperatures. High densities of salmon fry and parr in 2018 indicate that despite only small scattered areas of spawning habitat the reach has the capacity to be very productive. A high management priority for this reach is the maintenance of the existing riparian woodland and extending it further where opportunity exists.

The reach from Dalreavoch to Corrish holds extensive areas of juvenile habitat as well as large areas of excellent spawning habitat. Holding pools are limited to the reach above Braegrudie. The section of river by Dalreavoch Lodge has been extensively modified with weirs and croys, some of which have created downstream scours and localised erosion issues. There are no data on the habitat in this reach prior to the modification works and it is therefore difficult to assess what damage may have been caused to instream habitats; however extensive juvenile and spawning habitats remain nearby, and the modifications have created some useful pool habitat, so from a fish habitat point of view their removal/alteration is relatively low priority.

Dalreavoch to Craggiemore has relatively well-wooded banks, but upstream of Craggiemore there is very little riparian woodland. Grazing is light to moderate and banks are relatively stable. Good juvenile habitat and excellent spawning give this reach the potential to be the most productive section of the upper River Brora.

Management priorities for the Dalreavoch to Corrish reach are to explore opportunities to extend and maintain the woodland around Craggie, and to establish new riparian woodland between Craggiemore and Corrish. A recent Woodland Grant Scheme to the north of the river between Braegrudie and Corrish offers the potential to extend the fencing across the river to allow planting on the south bank, while requiring only just over half the new fencing that would be necessary for a complete new block on the south bank. An assessment, and if necessary modification or removal, of some of the weirs and croys which are affecting bank stability near Dalreavoch Lodge may be worth considering, but is a low priority.

From Corrish to just downstream of Dalnessie the river is slow meandering glide, with short reaches of relatively poor-quality spawning substrate, and offers relatively poor habitat for juvenile salmonids. However electric fishing results indicate that spawning takes places, and that both salmon and trout fry and parr are present throughout the reach. The reach is a flood-

plain and as such may not be suitable for typical woodland creation schemes. Nevertheless it is likely that it would, in the past, have supported riparian trees such as willow and alder. There is a Woodland Grant Scheme on the hill slope to the south of the river between Corrish and Craigton, but this does not extend up to the riverbanks. A small enclosure with some native trees exists on the lower part of Allt an Eisg near Cnocan, possibly established in response to Carnie's recommendations in the 2002 management plan, but it has been opened up to allow livestock access and is ineffective at present.

Management concerns in this reach are centred around grazing and trampling by both deer and livestock, which tends to be concentrated on the river margins and shallow crossing points. Options that might be explored include fencing of potentially vulnerable reaches to protect the banks (particularly spawning areas), or a reduction of livestock stocking densities. Another possibility is investigation of the potential for small plantations of riparian willow, along with willow spiling to stabilise and protect bank faces. Any such work should focus on spawning areas. Establishing such plantations may be challenging but would be an interesting experiment and potentially of local benefit. WGS or smaller plantations might be established on the hill slopes along some of the tributary streams, as was suggested by Carnie in the 2002 management plan.

From Dalnessie to the An Crom Allt/Allt Gobhlach confluence the river offers good mixed juvenile habitat and good spawning. Dalnessie Falls is a very challenging obstacle which is reputedly passable for sea trout and which electric fishing in 2018 demonstrated to be passable for salmon; however it is unlikely that many fish make it upstream of the falls. The most significant management issue in this area, much like downstream of Dalnessie, is the impact of livestock and deer on bank stability; efforts to reduce stocking densities would be very worthwhile. There may be possibilities for excluding livestock from sections of the banks and creating small areas of woodland in this upper reach, as demonstrated by an existing fenced area at Dail na Ceardaich which supports a good growth of young trees; or perhaps even a larger WGS plantation (soils are potentially suitable between Cnocan and Dalnessie Falls where the orientation is suitable for maximum shading effect, and around Dail na Ceardaich where riparian planting could be focused around the large s-bend to maximise shading); however fences would have to be located with care to minimise the chances of repeated damage by spates.

Alterations to the pool at the bottom of the left side of Dalnessie Falls (looking downstream) could allow the water to back up to a greater depth, simplifying the jump for migrating salmon. Salmon are now known to access the river above the falls, but modifications to ease access might open up the good habitat upstream to greater numbers of fish. This could have relevance for spring salmon in particular which tend to be headwater spawners. As noted above (Table 12) some 12% of spawning habitat in the Upper River Brora is upstream of the falls and there are extensive areas of moderate and good quality juvenile salmon habitats. Action to ease the falls is not recommended unless the use by sea trout of the reaches upstream is better understood, as increasing salmon densities could pose a risk to trout stocks.

Headwater streams Allt Gobhlach and An Crom Allt hold some good habitat, although the habitat in Allt Gobhlach may not be accessible due to falls just upstream of the confluence. Here management concerns centre around deer trampling and hagging impacts on peatland and the resultant input of peat fragments to the watercourses. Inclusion of these headwater areas in

either a local or wider-scale peatland restoration project would be very worthwhile and should be explored.

10.4 Black Water management unit

Strengths

- Good angling opportunities.
- Substantial accessible extent of juvenile salmonid habitat and good holding pools for adult fish.
- Widespread spawning opportunities including large areas between Achaness and Dalbreck.
- Good juvenile densities including highest recorded densities of salmon fry in the catchment.
- Productive tributaries including Coirefrois Burn.
- Channel orientation maximises benefits of shade where present and provides opportunities for woodland enhancement.
- Demonstrated willingness of estates to engage with peatland restoration and woodland creation schemes.

Weaknesses

- Much of the river upstream of Ben Armine Lodge, through currently productive, is unstable.
- Reaches upstream of Dalbreck have been identified as being vulnerable to high summer water temperatures (levels 1 and 2).
- Virtually no riparian trees on mainstem upstream of Achaness.
- Headwaters suffer from peat deposition over the substrate, resulting from erosion of peat bank faces.

Threats

- Stress, loss of growth and potential mortality of fish in hot summers.
- Deer grazing and trampling is intense in headwater areas leading to peat erosion.
- Peat fragments damaging spawning substrates in headwaters.
- Peat erosion impacts on invertebrates in headwater tributaries, potentially resulting in reduced food availability for juvenile salmonids.
- Destabilisation of riverbed by floods due to changing rainfall patterns and high runoff rates.

Opportunities

- Make use of currently available grants for peatland restoration in headwaters, possibly in collaboration with neighbouring estates to restore a larger area.
- Riparian tree-planting along the southern bank of the Black Water. Exact areas would depend on fencing practicalities. Soils in this area may be suitable for a wider-scale WGS scheme.
- The opportunity exists to infill-plant with trees right up to the watercourse in the existing WGS enclosure on the Coirefrois Burn, along with a commitment to remove/shoot the deer now in the enclosure and repair and maintain the water gates. This could be a relatively low-cost, high impact intervention.
- East Sutherland Deer Management Group target to reduce deer densities to 8 per square kilometre in headwaters

The Black Water holds a good mix of juvenile salmonid habitats, adult holding pools and spawning areas. It is higher gradient than the River Skinsdale and the upper River Brora, and as a result is quite mobile and unstable in its upper reaches, with extensive erosion. It is important to note that although mobile substrates can provide as much cover as stable ones, the movement of the substrate during spates can cause a number of problems for fish in these reaches. Unstable spawning substrate is at risk of being scoured out before eggs have hatched or young alevins have fully developed and become mobile. Unstable substrates have also been demonstrated to have significant negative impacts on the density of invertebrates in the periods following spates (Cobb *et al,* 1992), and although populations usually recover, these dips in food supply are likely to have consequences for juvenile salmonids in unstable reaches. Thus although much of the instream habitat in the upper Black Water is categorised as 'good' on the basis of the degree of cover provided, its instability means that it is potentially less reliable as a nursery habitat than reaches with a more stable substrate.

The river is quite entrenched between hard banks from Balnacoil to Achaness and from Dalbreck to just downstream of Ben Armine Lodge, so despite its high energy mobile nature, the banks in these reaches are quite stable and the river has not spread out to become broad and shallow as it has done in the neighbouring Skinsdale sub-catchment, or in the reaches with banks composed of loose glacial and alluvial deposits such as the section around Pollie.

It has several substantial tributaries which vary considerably in nature, from high gradient and unstable (eg Allt na Seiliche Bige, Allt Coire a Mhile) to stable and low-gradient (eg Coirefrois Burn, Allt Coire an Fhaicnich).

Electric fishing data found the highest recorded densities of salmon fry in the entire catchment on the Black Water close to Ben Armine Lodge, and good densities have been recorded throughout the main river as far up as the Abhainn Srath na Seilge falls and on Coirefrois Burn. Only trout have been found in the headwaters; it is not known if trout can ascend the falls or if populations in the headwaters are resident.

Management concerns in the Black Water centre around protecting juvenile salmonids from damaging high summer water temperatures, managing the impacts of peat erosion on headwater fish habitats and water quality, and managing riverbank and bed erosion to protect juvenile fish habitat in the upper Black Water/Abhainn Srath na Seilge and tributaries.

Trampling, hagging and gullying of peat in the Black Water headwaters appeared quite severe during walkover surveys of the river. Measures to restore peatland habitat in these areas could have multiple benefits, reducing input of peat fragments to watercourses and also reducing the rate of water run-off and restoring the capacity of the peatland to hold and store water, which in turn can reduce the severity of spates and consequent erosion, and also buffer against periods of extreme drought in hot summers.

A small peatland restoration project is already underway on Ben Armine estate at Green Face, and funding is available for further projects, either estate by estate or at a wider catchment-level scale.

Summer water temperatures are likely to be a concern in the Black Water, particularly upstream of Dalbreck. Broad-scale soil maps of the sub-catchment show that the right bank of the Black Water (the southern/south-western side) from the Alltan Dubh Ceann na Creige upstream of Ben Armine Lodge right down to Balnacoil, has broad deposits of alluvium and glacial material, much of which may be suitable for tree-planting. The existence of trees along a short stretch of the left

bank downstream of Long Pool, on the island in the nearby rapids where they are protected from deer, as well as around Ben Armine Lodge, indicates that trees can grow well in these reaches. While it is very probably undesirable from an estate point of view to attempt to create riparian woodland along this entire length of watercourse, selection of some areas for woodland creation either on the right (south) bank or crossing the river and taking in both banks would be very worthwhile.

Examples which would be worth considering for their value in creating shade, should this be compatible with estate priorities and feasible from a practical (mainly fencing) point of view, include:

- Ben Armine Lodge NC 718 179 to NC 688 197, taking in both banks, with the intention of increasing bank stability as well as providing shade (this area is rather unstable so appropriate advice should be sought regarding feasibility);
- A WGS taking in the right bank of the Black Water and the lower reaches of the Allt Coire an Fhaicnich;
- Restoration of fencing and water gates, plus removal/shooting of deer in the existing Coirefrois WGS, followed by infill planting up to the river banks;
- Establishment of either riparian planting or a more extensive WGS in at least part of the reach from Dalbreck to Achaness, focussing tree-planting on the south bank of the Black Water.

The headwaters have only extremely narrow strips of till/alluvium along the banks making tree-planting impractical. Both the headwaters and the reach from Balnacoil to Achaness are oriented largely north-south making tree-planting in these reaches less effective in terms of creating shade.

10.5 River Skinsdale management unit

Strengths

- Large accessible extent of excellent juvenile habitat.
- Plentiful good-quality spawning, well-distributed through the river and in proximity to good juvenile habitat.
- Stable.
- Good densities of salmon fry and parr throughout.
- Has been an unfished ‘sanctuary’ for some years.
- Not used for livestock.
- East Sutherland Deer Management Group commitment to reduce deer densities to below 8 per square kilometre.

Weaknesses

- Deep water refuges for adult fish are very infrequent upstream of Cnocan.
- Much of the river is very shallow.
- Majority of the sub-catchment has been identified as being vulnerable to high summer water temperatures (levels 1 and 2).
- No riparian trees.

- Upper reaches suffer from peat deposition over the substrate, resulting from erosion of peat bank faces (Skinsdale Peatlands SSSI assessed as in Unfavourable condition due to deer trampling).
- Deer grazing and trampling, intense in much of headwaters .
- Deep peat in much of the surrounding landscape mitigates against standard WGS tree-planting schemes as a grant-funded means of generating shade to reduce water temperatures.
- Headwater areas are owned by stalking estates with no economic interest in fisheries on the lower catchment.

Threats

- Mortality of juvenile fish in hot summers
- Peat fragments damaging spawning substrates, especially in Allt an Ealaidh
- Peat erosion impacts on invertebrates in headwater tributaries, resulting in reduced food availability for juvenile salmonids.
- Smolt predation by piscivorous birds such as sawbills

Opportunities

- Make use of currently available grants for peatland restoration in headwaters, tied in to current evaluation of Skinsdale Peatlands SSSI as being in unfavourable condition due to deer trampling.
- Targeted tree-planting to create shade is may be feasible in the lower reaches where orientation and soils are suitable,

Data from the 2018 habitat survey and recent electric fishing surveys highlight the importance of the River Skinsdale as a spawning and rearing area for salmon, with extensive reaches of good quality juvenile habitat and plentiful, well-distributed spawning areas. Densities of fry and parr are good throughout the accessible reaches. Deeper-water holding areas for adult fish are available throughout the lower river, but are less frequent upstream of Cnocan where the river tends to be wide, shallow and low-gradient. At present, the river remains unfished and is effectively a ‘sanctuary’.

Concerns on the Skinsdale sub-catchment centre around two issues: protecting juvenile salmonids from dangerous summer water temperatures and managing the impacts of peat erosion on headwater fish habitats and water quality. The majority of the sub-catchment upstream of Pollie Falls has been identified by Marine Scotland as being at risk from high summer water temperatures; these reaches also tend to be broad, shallow and slow-flowing, and hold the bulk of the good quality juvenile and spawning habitats. At the time of the habitat survey in 2018, hagging and trampling of peat and the consequent deposition of peat fragments in the watercourses was observed to be most severe in the headwater tributaries, of which Allt an Ealaidh in particular holds high quality juvenile and spawning habitat. Hagging was also noted in the Garvary Burn and its tributaries.

The fact that the Skinsdale Peatlands is an SSSI and forms a part of the Caithness and Sutherland Peatlands SAC, and that it has been found to be in unfavourable condition due to trampling, makes it a very good candidate for peatland restoration. Grant funding is currently available for such schemes and this should be looked into with some urgency to ensure the opportunity is not missed. As well as reducing negative impacts of peat erosion on the watercourses, the increased capacity of undamaged peatland to absorb and hold water and to

slow run-off rates increases the ability of the landscape to buffer against the effects of prolonged droughts or heavy downpours.

Tackling the issue of summer water temperatures is very challenging. The only tool in the fishery manager's kit for managing water temperatures is tree-planting to create shade. However much of the Skinsdale is oriented south-north, which makes it difficult to create effective shade, and furthermore the vast majority of the Skinsdale sub-catchment is deep peat, which is unsuitable for woodland.

Alluvial soils and/or glacial till/morainic deposits are found along much of the river banks, from the Black Water confluence to Bad na h-Earba (NC 754 246) forming riparian strips capable of supporting woodland, but there is no easy means of protecting such long narrow riparian woodlands from the inevitable deer damage. Grant funding for riparian fencing is not currently available, and even were it to become so, the challenge would be to locate areas in which fences could be erected without the risk of them accumulating debris during spates, effectively creating dams which are then pulled down under the pressure of high water.

If fences are established in suitable reaches, it remains likely that water-gates and small sections of fencing would be quite regularly damaged during spates, and manpower and resources to enable frequent checking and restoration work would have to be factored in to any planned scheme. Potentially suitable reaches for riparian tree-planting in which river orientation would maximise the effectiveness of shading would be Pollie Falls to Muiemore, and the sheilings to Bad na h-Earba.

Watercourse orientation on the mainstem upstream of Bad na h-Earba, on the Allt an Ealaidh and on the Garvary Burn make them theoretically suitable for tree-planting to create shade, however here suitable soils become very scarce indeed, and in many places peat extends almost up to the edge of the watercourses, making these reaches very probably unsuitable for riparian trees.

A third area of management concern is smolt predation. Smolts originating in remote headwater areas such as the Skinsdale have a long way to travel before reaching the sea and are at risk of predation from piscivorous birds such as sawbills during their migration downstream, particularly in broad shallow reaches. No data are available at present on the densities of piscivorous birds or on their impact on smolt output.

11 MANAGEMENT ACTION PLAN, STRATEGY

The River Brora is a productive and healthy system. The survey results and analyses presented above show that it has extensive high quality juvenile salmonid habitat from the sea to the headwaters, and electrofishing surveys have found juvenile salmon densities equal to those in the best rivers in the country. The challenge is to maintain this high-quality system and to develop means of protecting and buffering it against future changes.

In a healthy system such as the River Brora, the most significant pressures on migratory fish and the maintenance of a productive fishery are in-river losses of migrating smolts, poor marine survival and climate change. The last two of these are global-scale issues outwith local fishery managers' control, but efforts to reduce in-river loss of juvenile fish and smolts, and thus maximise smolt output, offer the most promising strategy to ensure a reliable supply of returning adult fish to the fishery. A number of actions are proposed in the following tables to improve and protect habitat and stocks on a local scale, including targeted management actions to help protect smolts during migration and increase egg to smolt survival.

In order to protect the fishery effectively over the long term, measures must be put in place with some urgency to build resilience into the Brora system to enable fish stocks and habitat to withstand the effects of climate change, most notably increasingly high summer water temperatures and a greater frequency and intensity of spates, the effects of which are already apparent. As a result there is a strong emphasis in this management plan on catchment-wide landuse and on the maintenance and restoration of habitats in both the riparian zone and the wider catchment, with the objective of building a resilient system able to support healthy fish populations and withstand unpredictable conditions to come.

In short, the Brora's fish populations currently seem to be in rude good health; as a result management does not have to focus on firefighting to preserve stocks in the short term. The job of the Brora fisheries managers today is to take the long view, much like visionary Victorian gardeners designing borders and planting slow-maturing trees with an eye to creating something permanent and important that would outlast them. The focus of management in the Brora catchment should be to leave future generations of anglers, land-owners, visitors and locals with a robust, productive fishery supported by the intelligent, integrated management of its beautiful setting.

12 MANAGEMENT TABLES

Proposed management actions are set out in the tables below. A 'traffic light' system has been used to assign priority levels to each proposed action. All actions proposed in the plan are considered worthy of implementation; but some need to be tackled with a degree of urgency to prevent deterioration or damage, to take advantage of currently available grant streams, or simply to maintain and build momentum in the management of the River Brora catchment. These are flagged in red. Actions that are important but less urgent are flagged in amber, while those that could be kept 'on the back burner' until time and resources allow are flagged in yellow. A number of actions are ongoing, and are flagged in green.

Priority	High	Moderate	Low	Ongoing

12.1 Habitat management – catchment-wide actions

Actions proposed below would benefit from a coordinated approach across multiple estates, and rolling programmes of works carried out over several years. Such broad-scale and long-term projects could be very significant in building resilience against the growing pressures from climate change, which are projected to include more frequent extreme rainfall events and spates, summer droughts, and high summer water temperatures.

Issue	Location	Notes & comments	Proposed actions	Potential partner organisations	Priority
Degradation of peatlands: • Severe hagging in many headwater areas • Skinsdale Peatlands SSSI in Unfavourable condition	Upper Skinsdale catchment, upper Black Water catchment, upper Brora catchment (encompassing Ben Armine, Loch Choire, Borrobol, Dalnessie and Balnacoil estates)	Peatland degradation has serious consequences for rivers including siltation of instream habitats, reductions in invertebrate populations and reduced ability of the landscape to absorb rainwater and release it gradually over a long period. The broader the scale of the restoration work the greater the expected long-term the benefits to the Brora catchment.	• Identify which landowners are potentially prepared to engage in restoration initiatives. • Make contact with Peatland Action and local SNH office for guidance and support.	Relevant estates Peatland Action SNH	
			• Subject to advice from Peatland officers, engage services of peatland specialist to assess the state of peatlands in headwater area		
			• Develop and submit grant application for peatland restoration programme		
Lack of riparian trees and scrub: • Lack of shade in areas vulnerable to high summer water temperatures • Bank erosion	Catchment-wide, especially upstream of Loch Brora. Locations where greatest benefits to fisheries would accrue are shown on Figure 25. These areas need to be refined to account for wider land management needs and environmental conditions	Woodland planting for shade creation will be most effective on southern or south-eastern/south-western banks. Woodland cannot usually be established without fencing which is costly. At present grant funding is not available for narrow riparian planting schemes, but WGS funding can be used to plant wider areas which include watercourses. Smaller localised projects making use of existing opportunities are considered in section 12.2	• Initial engagement with landowners and representatives to identify reaches where riparian woodland creation would potentially align with estate management objectives.	All estates Woodland Trust FLS	**Initial meetings commenced 2020**
			• Involve woodland specialist in refining target areas.		
			• Prepare riparian woodland creation plan based on above. • Seek grant or other funding as appropriate.		
			• Small trial plots can be a useful first step where larger-scale projects are not feasible/acceptable, or in areas where trees have been absent for many years.		
Grazing impacts on the riparian zone: • Damage to banks and instream habitats • Contribution to peatland	Catchment-wide upstream of Loch Brora Localised priority areas are listed in section 12.2.	Grazing by sheep, cattle and deer is often heaviest along the banks of rivers and streams. In heavily-graved areas trampling, bank erosion and siltation can damage instream habitats, in addition to the damage caused by loss of woodland. Spawning areas are	• Initial engagement with landowners and managers to identify reaches where reductions in grazing pressure would potentially align with estate management objectives. • Exclusion of grazers or reduction in grazing pressure to protect key areas.	Estates ESDMG Tenant farmers and shepherds Stalking tenants	

Issue	Location	Notes & comments	Proposed actions	Potential partner organisations	Priority
degradation and riparian deforestation • Prevention of regeneration		particularly vulnerable.			
WGS review	NA	WGS will be reviewed in the near future. Linear riparian planting does not fit current scheme but has been highlighted as a potential priority for future.	• Lobby for inclusion of riparian planting as a priority for future iterations of WGS.	FMS SFCC MSPs	

12.2 Habitat management – localised actions

Actions proposed here are small- to moderate-scale, targeted actions to address localised issues, and most can be undertaken by individual estates. While this type of project would not be likely to meet the criteria for the major grant schemes, some proposals may be suitable for support by local community benefit trusts or similar bodies.

Issue	Location	Notes & comments	Proposed actions	Potential partner organisations	Priority
Channel and bank modifications	Lower R. Brora	Loss of natural river processes leading to gradual degradation of instream habitat (see Moir 2019). Long term risk to spawning and juvenile habitats.	• Any future creation or modification of wing weirs, croys or other structures should be based on assessment of habitat effects. • Long term planning to reinstate natural processes while not damaging fishery value.	Cadogan Estate Uppat Estate SEPA	
Lack of mainstem spawning habitat	Lower R. Brora	Availability of spawning habitat may limit production. Linked to sediment starvation (see above)	Watching brief including: • Regular monitoring of salmon fry populations. Persistent decline or lack of fry may suggest spawning becoming limiting. • Repeat survey of spawning habitat if declines observed in fry populations.		
Riparian vegetation management	Lower R. Brora	Bankside vegetation can increase productivity, while overhead cover from draped vegetation may provide refuges for juvenile salmonids.	• Minimise control of scrub and trees in areas where they do not restrict angler access. • Strategic tree planting, especially on south bank.	Landowners Tenants	
Degradation of existing mature riparian woodland	South bank of the River Brora from Balnacoil to Craggiemore	This is the only substantial wooded reach upstream of the loch, with identifiable benefits on Scotland River Temperature Monitoring Network (SRTMN). Much is unfenced and there is little regeneration.	• Exclude grazers from existing riparian woodlands. • Repair any existing stock exclosures.	Dunrobin Estate Tressady Estate Woodland Trust Tenant farmers and crofters	
Lack of riparian planting; deer impacts	Coirefrois Burn WGS	The existing woodland scheme did not plant the riparian zone, although it is within the fenced area. Watergates are damaged and deer currently have access to the area. This is a relatively simple and inexpensive way to create shade on quite a substantial reach with a high fishery and wider conservation	• Repair/maintain water gates and fences. • Deer management within existing WGS • Planting of riparian zone, particularly the south bank	Ben Armine Estate Woodland Trust Volunteers SNH	

Issue	Location	Notes & comments	Proposed actions	Potential partner organisations	Priority
		value.			
Bank erosion and collapse (exacerbated by grazing)	Middle R. Brora	Fine sediment inputs. Loss of bankside fish cover. Temperature effects.	Stock fencing, tree planting, willow spiling for bank stabilisation. • Initiate discussion with landowners and tenants • Explore possible funding opportunities	Dunrobin Estate Balnacoil Estate Gordonbush Estate SSE	
Loss of riparian vegetation	Scottarie Burn (lower) Ascoile Burn (lower)	Loss of riparian vegetation and potential for habitat degradation in currently productive streams.	• Initiate discussion with landowners and farmers. • Explore options for fencing stream margins to restrict livestock access.	Dunrobin Estate Balnacoil Estate Gordonbush Estate SSE	
Overgrazing of banks leading to erosion and bank collapse; trampling of spawning areas	Upper R. Brora Craigton to Dalnessie	Has led or will lead to: • Shallowing and widening of channel • Inputs of fine sediment • Trampling of spawning areas • Loss of bankside fish cover. Potential conflicts of interest with deer management and sheep farming.	• Identify optimal areas.in consultation with landowners and tenants • Targeted fencing to restrict livestock/deer access and promote regeneration of vegetation. • Where possible, combine with riparian tree planting targeting south and west banks to optimise shade.	Tressady Estate Dalnessie Estate	
	Upper R. Brora, headwaters above Dalnessie			Dalnessie Estate	
	Black Water, Amat to Dalbreck			Dalreavoch Estate, Balnacoil Estate	
Instream and bankside modifications	Balnacoil to Dalreavoch	Weirs and croys around Dalreavoch have mixed impact. The lowest at NC 75317 08805 is effective (pool creation) but has caused significant downstream erosion. Several further weirs upstream have no discernible effect either positive or negative.	• Watching brief. RBDSFB should be fully informed of any further proposed instream modifications. • Any future creation or modification of wing weirs, croys or other structures should be based on assessment of habitat effects. • Liaison with SEPA in relation to any associated CAR licenses.	Dalreavoch Estate Dunrobin Estate SEPA	
Rapid riverbank erosion	Black Water mainstem upstream of Ben Armine Lodge (sections BWc2 and BWc3)	This highly dynamic area appears much degraded, but may be an important source of substrates for maintaining downstream habitats.	• Periodic (3-yearly) inspection linked to electric fishing. • If habitat quality and fish numbers clearly decline commission hydro-morphologist to determine whether intervention is desirable or feasible.	Ben Armine Estate	

12.3 Stock protection

Issue	Location	Notes & comments	Proposed actions	Potential partner organisations	Priority
Illegal exploitation in river or loch	River Brora Loch Brora	Poaching, especially with net, potentially reduces spawning escapement.	• Maintain bailiff force and associated stock protection procedures to minimise illegal exploitation. • Appoint voluntary bailiffs if required.	Angling clubs	
Angling	River Brora Loch Brora	Reduction of spawning escapement.	• Maintain current conservation policy for salmon and sea trout.		
Coastal netting (legal)	Coasts	Not currently practiced	• Support current ban/moratorium on coastal netting by working with AST and Fisheries Management Scotland (FMS).	AST FMS	
Coastal netting (illegal)	Coasts	Loss of adult salmon and sea trout. Mixed stocks fisheries cannot be managed in relation to sub-populations.	• Board to liaise with Scottish Fisheries Protection Agency and neighbouring DSFBs.	Marine Scotland Cromarty DSFB Helmsdale DSFB	
Seal or other estuarine predation (adults)	Estuary and sea pool	Reduction of spawning escapement.	Watching brief only: • Promote staff and angler awareness of how to identify predator marks on rod caught fish. Record these to gauge and trends. • Investigate opportunities for control if problem identified (see Moray Firth Seal Management Plan).		
In-river avian predation (smolts/parr)	Potential bottlenecks for smolts at constrictions, pools, loch inflow and outflow or other areas where smolts may congregate in numbers.	Impacts on: i) smolt run ii) pre-smolt density. Likely to be a priority during smolt migration.	• Any potential bottlenecks where birds may congregate should be identified and options for scaring investigated (smolt shepherding).	Estates & keepers MFPMG[20]	
			• Counts of piscivorous birds using standardised procedures. If necessary, license for control may be obtainable but this would require objective data from counts.	FMS MSS	

[20] Moray Firth Predator Management Group – contact Roger Knight, Spey DSFB

12.4 Stock management

Issue	Location	Notes & comments	Proposed actions	Potential partner organisations	Priority
Angling	River Brora Loch Brora Black Water	Reduction of spawning escapement.	• Maintain current conservation policy for salmon and sea trout.		
Recording of angling effort	River Brora Loch Brora Black Water	MSS now request that all beats collect angling effort data. This is important information which combined with seasonal catch data allows estimates to be made of the annual run in the river.	• Ensure that effective systems are in place to record, collate and report angling effort data.	All estates with angling interests MSS	
Enhancement or mitigation stocking	NA	Not currently required. Electric fishing surveys demonstrate healthy stocks throughout catchment	• Maintain hatchery infrastructure in working order		

12.5 Marine mortality

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Poor understanding of causes of marine mortality	Marine	Lack of knowledge contributes to lack of management action.	• Support research into causes of marine mortality through e.g. NASCO and Atlantic Salmon Trust (AST).	NASCO AST	
Sandeel fisheries	Inshore waters	Sandeels support fish stocks including sea trout during their marine growth phase.	• Support initiatives to maintain and extend closures of sandeel fisheries.	FMS RSPB	

12.6 Alien species and biosecurity

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Biosecurity	All	Non-native species and introduced pathogens/diseases have potential to damage fish populations and habitats. As few invasive non-native species were recorded during habitat survey there is an opportunity to protect integrity of habitats and species assemblages.	• Develop and implement formal Biosecurity Plan for River Brora covering fish disease and non-native species. • Early intervention when invasive non-native species (INNS) are recorded in catchment. • Disease controls in relation to river users including anglers. See https://www.invasivespecies.scot/	MSS SISI SNH	
Mink	All with emphasis on lower catchment	Mink recorded in catchment and spreading in the N. Highlands. Can be effective fish predator in small streams.	• Establish mink monitoring and trapping. Advice and information at: See: https://www.invasivespecies.scot/	SISI Keepers volunteers	
Awareness	NA	Raise awareness among anglers and other catchments users of	• Raise awareness among river users of potential impacts of pathogens and INNS.	SISI	

12.7 Developments and industry

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Hydroelectric schemes	All	Potential to impact on abstracted watercourses and fish. Due to relatively low gradients many streams are unattractive to hydroelectric developers.	• Ensure that RBDSF maintains good working relationship with regulators (SEPA, THC) and that protocol is in place for effective response to consultation and applications.	SEPA THC SNH	
Wind farms	All areas, likely mainly to impact headwaters.	Developments have potential to alter water quality and exacerbate peat erosion. Potential negative impacts can be offset by collaborative restoration and conservation initiatives.	• Maintain good working relationship with regulators and developers. • Respond effectively to consultations and planning applications. • Where developments take place, promote positive habitat management and other initiatives to benefit river and fish e.g. habitat restoration.	THC Developers (e.g. SSE)	

12.8 Barriers to migration

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Natural obstacles	Dalnessie Falls @ NC 62815 16041	Traditionally believed to be passable for sea trout but not salmon, however salmon were found upstream in 2018. Large extents of good spawning and juvenile habitat are available upstream.	• Electric fishing targeting trout to assess importance of reach upstream of falls. • Consider pros and cons of easement (intervention in natural processes and potential impact on fish populations upstream). • If easing of falls is deemed appropriate, it may be possible to make minor alterations to the pool at the base of the left side of the falls to increase the depth and facilitate jumping.	Dalnessie Estate	
	Abhainn Srath na Seilge NC 6620 2223	Waterfall/cascade. Large expanses of good quality spawning in reaches upstream.	• Seek records of sea trout in upstream reaches (keepers, estate records) • Upstream survey (electric fishing/observations during spawning period) to identify whether falls are ever passable. • Consider pros and cons of easement (intervention in natural processes and potential impact on fish populations upstream).	Ben Armine Estate	
Debris dams	Allt Coire a' Mhile	Fallen trees and debris where this stream flows through conifer plantation east of Ben Armine Lodge. Passable at time of survey but potential for blockage. Limited spawning potential.	• Check and remove any woody debris that is blocking channel or damaging habitats	Ben Armine Estate	

12.9 Water quality and quantity

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Abstractions	Dalnessie Dam	0.32 m^3s^{-1} is released through Dalnessie Dam down the Brora. 21 periods of increased hands-off flow annually. Sediment management agreed with SEPA	Watching brief and ongoing communication with operator in relation to opportunities to improve or maintain: • Hand-off flows • Fish passage • Sediment management	SSE	

12.10 Information needs: fish populations

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Juvenile salmon distribution and abundance	Lower River Brora Upper River Skinsdale Coirefrois Burn	Knowledge of juvenile distribution and abundance has wide implications for management in relation to e.g. barriers, targeting of resources or enhancement stocking.	• Baseline completed 2020. These areas should now be incorporated into rolling plan for catchment monitoring.		Completed 2020
	Black Water upper	Limited data suggest falls and cascades in lower reaches of Abhainn Srath na Seilge NC 66 22 may be impassable to salmon.	• Electric fishing survey aimed at clarifying upstream migratory limits for salmon and sea trout.		
	Upper River Brora, Braegrudie –to Dalnessie	Spawning habitats are present but poor juxtaposition with juvenile habitats.	• Assess importance of spawning areas in low-gradient reach (timed/area fry surveys, redd counts).		
	Upstream of Dalnessie Falls	Salmon fry found upstream of falls 2018 but more data needed to identify severity of barrier.	• Identify presence and distribution of salmon via presence/absence surveys upstream of Dalnessie Falls every 2 years.		
Juvenile salmon, population trends	Larger watercourses	Trends in juvenile abundance can highlight problems in the catchment or at sea. They can also be used to monitor the efficacy of management actions such as habitat improvement.	• Develop rolling programme of monitoring, possibly using NEPS/MSS model. • Incorporate periodic monitoring of key headwater monitoring sites	MSS	
Juvenile salmon and trout populations in tributary streams	Accessible tributary streams	An understanding of the role of tributary streams in production of trout/sea trout and salmon will underpin appropriate management.	• Implement a tributary survey using electric fishing. This should be preceded by brief walkover habitat inspections to identify those streams offering the most suitable habitat (see Section 12.11 and Appendix 15.5).		
Salmon stock structuring (sub-populations)	All reaches	Spatial structuring of stocks may have significant implications for ensuring sustainability of sub-populations. E.g. where do early running fish spawn and how might their numbers be protected or enhanced?	• Develop and implement research on stock structure in catchment and how any identified sub-populations contribute to fisheries. Genetic analysis of tissue samples taken during NEPS surveys may provide a starting point for further work.	MSS	
Production from loch habitats	Loch Brora	The role of lochs for salmon production is uncertain but may be significant. With good spawning but limited juvenile habitat in the R. Brora below Balnacoil fry may	• Investigate potential sweep netting sites. If sufficient sites are available carry out semi-quantitative assessments of juvenile abundance around loch shores.		

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
		migrate to L. Brora.			
Sea trout spawning areas	All	Knowledge of sea trout distribution is poor and main spawning areas are uncertain.	• Formalise local knowledge through discussion with keepers and others. • Targeted surveys for juvenile trout.		
Characteristics of adult salmon and sea trout popualtions	All	There is a lack of data on size, distribution and run timing of adult salmon and sea and sea trout in different parts of the catchment. Such data may provide indications of stock structure and local population trends.	• Identify data sources (estate game books, catch returns from different parts of the catchment)	Estates	
			• If sufficient data are available, extract and interrogate to identify trends in fish size and run timing in management units.		

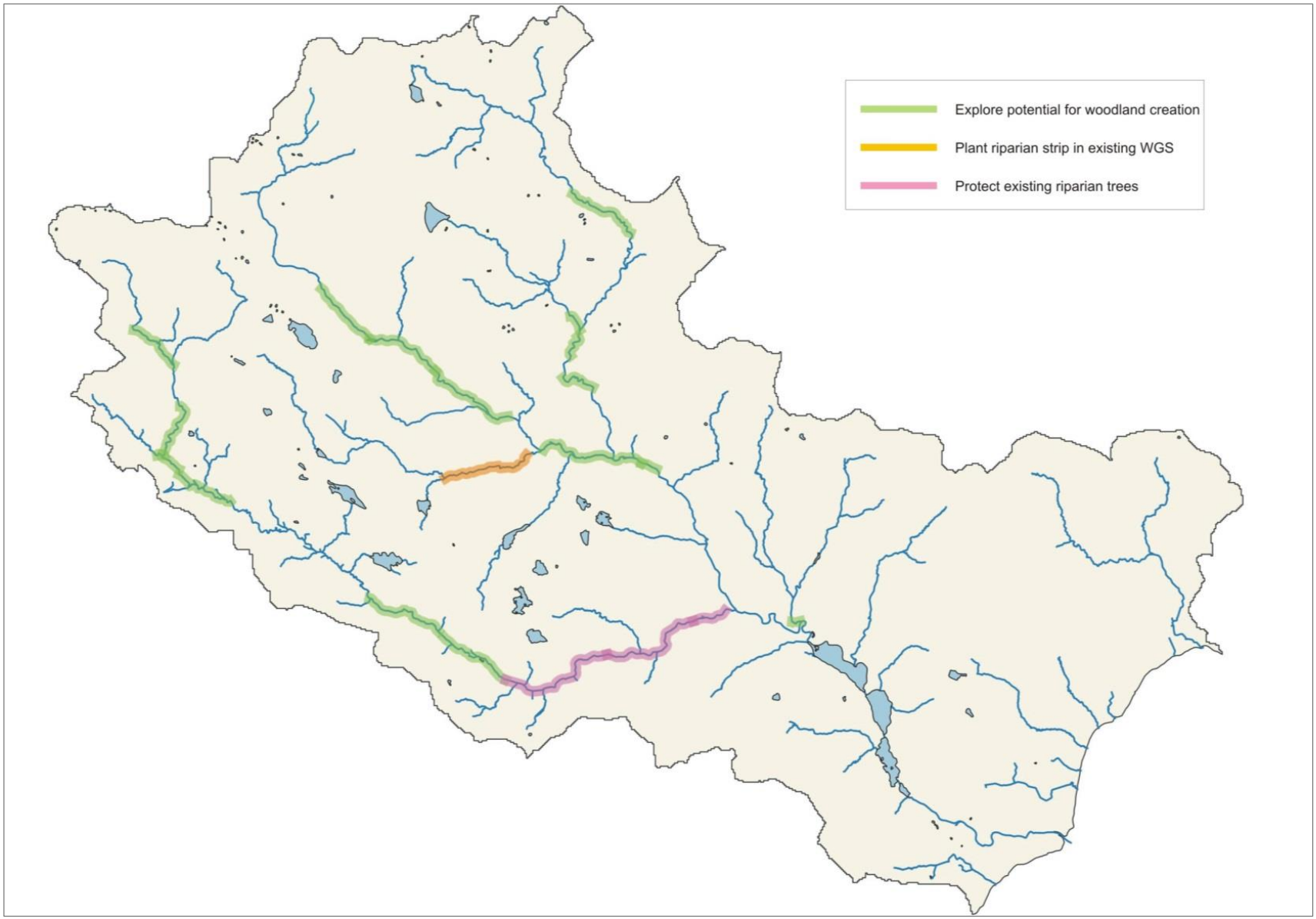
12.11 Information needs (stream habitats)

Issue	Location	Description	Proposed actions	Potential partner organisations	Priority
Limited information on habitat in smaller tributaries	Several small but accessible streams that were omitted from 2018 walkover	Data suggest smaller streams may be essential for maintaining sea trout populations, but many small watercourses remain un-surveyed. Lack of information restricts Board's ability to protect or enhance these watercourses.	Brief (qualitative) assessments of: • Accessible length (to 1st impassable barrier) • Wet width (typical wet width at 250 m intervals) • Typical habitat quality including presence/abundance of spawning habitat • A photographic record of typical habitats in each stream should be maintained.		
Aquatic invertebrate communities	Middle and upper catchment	Freshwater invertebrates are the main food source for salmonids. They are also important indicators of water quality, and can be useful in identifying areas that would benefit from restoration work or monitoring the impacts of such work.	• Expand invertebrate surveys across middle and upper catchment	Riverfly Partnership Buglife	

12.12 Implementation of Fisheries Management Plan

Issue	Description	Potential partner organisations	Priority
Implement FMP for River Brora	Identify appropriate management structure for implementation of Fisheries Management Plan. Initially, this could take the form of a Working Group reporting to River Brora District Salmon Fisheries Board.	SSE SNH SEPA	
Staff training	BDSFB staff should receive ongoing training to maintain or increase skills for delivery of required tasks in relation to management and information gathering.	SFCC MSS	
Liaison with SFCC	Ensure coordination with Moray Firth-wide, national and other programmes to maximise the Brora catchment's input to and benefit from fisheries initiatives.	SFCC MSS FMS AST	

Figure 25. Reaches where action to increase woodland coverage or protect existing woodlands should be considered.



13 IMPLEMENTATION AND REVIEW

13.1 Implementation

This document presents a range of proposals to secure the long-term health of the River Brora's freshwater habitats and fish populations. Taking forward the proposed initiatives and turning them into actions along the rivers and burns will require resources. In particular personnel and time will be needed to identify and develop partnerships with landowners and others, seek funding and initiate or carry out the proposed actions. It is beyond the scope of the current document to identify how this will be done. However, in the first instance we recommend that the BDSFB should set up a working group with responsibility for taking the plan forward and initiating the actions within it. In many parts of Scotland this role might be taken on by a Trust or Foundation. This is not a necessity, although it can open some funding doors and help attract partners. What is clear is that ongoing effort and time will be required over a period of many years to realise some or all of the required tasks.

13.2 Review

Although an early draft of this Plan was circulated for consultation we recommend early review of the current document. If, as is recommended, a Working Group is set up to take the Plan forward it is probable that practical constraints – resulting either from lack of resources or limitations imposed by other land-uses - will result in a shift of priorities and perhaps an increasing focus on a smaller number of priority 'projects'. Reviewing the document after a period of approximately 1 year may help ensure that a range of actions are taken forward and that the wide-ranging nature of proposed management opportunities does not result in inertia due to perceived overload. We recommend that this first review should take place December 2021.

The Plan should be formally reviewed annually thereafter, by the Working Group or those tasked with its implementation. Annual reviews need not result in a re-write, which might be a poor use of time, but any proposed changes or identified omissions should formally recorded so that they can be incorporated into later versions.

The Plan should be fully revised after a period five years, in December 2025. Progress, successes and failures should be identified so that these can guide the next iteration of the Plan.

14 REFERENCES

Addy, S. Cooksley, S., Dodd, N., Waylen, K., Stockan, J., Byg, A and Holstead, K. 2016. River Restoration and Biodiversity: Nature-based solutions for restoring rivers in the UK and Republic of Ireland. CREW reference: CRW2014/10

Brown, L.E., Johnston, K., Palmer, S.M., Wilkes, M. & Holden, J. 2013. River ecosystem response to prescribed vegetation burning on blanket peatland. PLoS One, 8 (11). e81023. ISSN 1932-6203

Brown, L.E., Aspray, K.L., Ledger, M.E., Mainstone, C., Palmer, S.M., Wilkes, M & Holden, J. 2018. Sediment deposition from eroding peatlands alters headwater invertebrate biodiversity. Global Change Biology, November 2018. https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcb.14516.

Calderwood, W.L. 1921. The Salmon Rivers of Scotland. Edward Arnold, London.

Carnie, C. 2002. Management Plan for the River Brora 2003 – 2008. The Carnie Consultancy, December 2002.

Carnie, C. 2003. Report on the electro-fishing survey of juveniles carried out in August 2003 with recommendations and additions to the Management Plan. The Carnie Consultancy, October 2003.

Cobb, D.G., Galloway, T.D. & Flannagan, J.F. 1992. Effects of Discharge and Substrate Stability on Density and Species Composition of Stream Insects. Canadian Journal of Fisheries and Aquatic Sciences 49(9): 1788-1795.

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

Hendry, K. & Cragg-Hine, D. 1997. Restoration of Riverine salmon habitats. Fisheries Technical Manual 4, Environment Agency, Bristol.

Lothian, A.J., Newton, M., Barry, J & Walters, M. 2018. Migration pathways, speed and mortality of Atlantic salmon (Salmo salar) smolts in a Scottish river and the near-shore coastal marine environment. Ecology of Freshwater Fish 27, 549-558.

Maitland, P.S. Scotland's Freshwater Fish: Ecology, Conservation & Folklore. Trafford Publishing.

Maitland, P.S. & Adams, C.E. 2018. Arctic Charr in the Lochs of Scotland: an Assessment of Distribution & Status. Fast Print Publishing. SBN-13: 978-1784564773

Malcolm, I.A., Millidine, K.J., Jackson, F.L., Glover, R.S. & Fryer, R.J. 2019. Assessing the status of Atlantic salmon (*Salmo salar*) from juvenile electrofishing data collected under the National Electrofishing Programme for Scotland (NEPS).

Mills, D. & Graesser, N. 1981. The Salmon Rivers of Scotland. Cassell Ltd., London.

Moir, H. 2019. The physical condition of the River Brora and options for sustainable management. Commissioned report to Brora District Salmon Fisheries Board, December 2019 (draft).

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

Stoddart, T. 1853. The Angler's Companion to the Rivers and Lochs of Scotland. 2nd Edition, Herebert Jenkins Ltd., London.

Tesch, F. W. 1977. The Eel, Biology and Management of Anguillid Eels. John Wiley and Sons, New York.

Waterside Ecology. 2013. Balnacoil Wind Farm, Fish and Fish Habitat Survey. Commissioned Report to Alba Ecology Ltd., March 2013.

Waterside Ecology. 2015. Gordonbush Wind Farm Extension: assessment of fish habitats and populations. Commissioned Report to SSE Renewables, March 2015.

Waterside Ecology. 2019. Gordonbush Wind Farm Extension: Baseline fish survey. Commissioned Report to SSE Renewables, November 2019.

Watt, J., Brown, L. & Seed, M. 2011. Fish Populations of the Scottarie Burn: Monitoring 2010. Commissioned report to Atmos Consulting, January 2011.

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

West Galloway Fisheries Trust. 2001. Estimate of Smolt Production From the Upper Brora. Report to Scottish & Sothern Energy, October 2001.

15 APPENDICES

15.1 Typical examples of habitat categories used in walkover survey

	**Fry** habitat Moderate to fast flow, shallow with pebble and cobble substrate. Often overlaps with spawning habitat.
	**Mixed juvenile** habitat. Good for fry but only moderate for parr. The better parr habitat is amongst the boulders towards the far bank. Fry are likely to be most abundant in the shallow pebble and cobble habitats.
	**Mixed juvenile** habitat. Dominated by boulders with depths of 20 to 45 cm. This area is good for salmon and trout parr but probably relatively poor for fry.

	**Deep juvenile** habitat. The river is between 0.4 and 0.7 m deep. There is good cover in boulder and cobble for parr and sufficient current for drift feeding. Moderate to good for salmon parr but probably poor for fry.
	**Shallow glide** Lack of cover for juvenile salmonids and densities in such habitat are typically very low unless cover present in vegeation.
	**Deep glide** Lack of juvenile cover. Can provide habitat for adult salmon and trout. Trout parr present where overhead cover available.

	**Pool** habitat. A holding pool with deep water and cover under rock ledges.
	**Pool** habitat. This pool is just over 1 m deep and provides little cover. It is unlikely to be suitable as a refuge area for prolonged periods during upstream migration.
	**Bedrock** Sheet bedrock provides no cover and generally supports very few or no juvenile fish. Deep pools on bedrock can provide resting areas for adults.

	**Peat channel** Simple channel incised in peat with no or few hard substrates. Unproductive for fish.
	**Spawning** Typical salmon spawning habitat at tail of glide where water breaks into riffle
	**Spawning** Sea trout and resident brown trout frequently spawn in minor watercourses

15.2 Salmonid density classification for North Region

	salmon 0+	salmon 1++	trout 0+	trout 1++
Percent zero density	24.0%	18.0%	12.0%	28.0%
Min	0.51	1.01	0.51	0.57
20th percentile	5.45	2.18	1.79	1.09
40th percentile	10.70	6.36	4.16	2.72
60th percentile	14.79	9.49	5.10	4.37
80th percentile	29.37	16.28	10.07	7.61
Max	67.36	27.66	98.49	14.73

Descriptive categories used in text

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

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

15.3 Habitat availability in tributary streams

Reach	Length (m)	Area of habitat (m²)						
		Fry	Mixed & deep juv.	Pool	Shallow glide	Deep glide	Bedrock and peat channel	Spawning (m²)
Oldtown Burn	670	0	1925	0	0	0	420	70
Ducharry Burn	600	0	900	0	0	0	0	20
Allt Coire Aghaisgaeig	160	0	320	0	0	0	0	1
Carrol Burn (incl. Allt a'Chairn)	2020	0	4440	169	0	0	200	47
Allt Smeorail	620	150	2530	620	0	0	0	59
Allt Ach'a Bhathaich	1000	140	2500	710	0	0	800	36
Scottarie Burn	830	0	830	0	0	0	0	unknown
Tormore Burn	230	0	540	0	0	0	150	1
Allt an Tuirc	640	0	1080	0	0	0	72	0
Allt an Fearna	880	540	990	0	0	0	54	15
Corrish Burn	130	0	175	25	0	0	125	0
Allt an Eisg (Craigton)	1050	0	1666	0	0	0	119	3
Allt a Mhuilt	1600	0	2250	0	0	0	150	0
Allt Coire Chaorachaidh	290	0	435	0	0	0	0	5
Allt na h-Innse Mor	1600	108	1746	90	648	0	288	5
Allt an Eisg (Dalnessie)	750	44	1364	44	0	0	198	0
Allt Gobhlach (upstream of falls)	5830	1317	14822	223	939	2307	0	153
Allt a'Bhaid Leathain	1810	520	3436	28	0	0	84	60
An Crom Allt	4280	166	8393	200	270	783	1428	17
Allt Preas a'Chraicinn	810	294	728	0	0	0	112	11
Seilich Bige upstream of falls	3970	0	10567	176	0	0	1392	95
Seilich Moire	3960	480	7509	111	0	0	1215	340
Allt a Mhuilinn Dhuibh	2595	280	6500	87.5	0	0	885	23
Allt Coire an Fhaicnich	4930	378	6992	542	187	5301	1100	59
Allt Coire a' Mhile	1530	0	4970	105	0	0	280	5
Allt an Loin Earraich	3060	0	24700	400	0	3600	1900	62
Coirefrois Burn	8200	2120	38000	7325	0	1600	2575	480
Allt an Eoin	800	320	5280	0	0	640	160	25
Allt an Ealaidh	5990	1778	15944	501	528	425	580	370
Allt a'Choire Bhuidhe	2120	168	2985	46	0	1235	0	12.5
Allt Preas a'Chamraig	2500	869	245	0	1426	610	0	8
Allt a'Choire Bhuidhe	3310	431	6132	668	1096	2948	285	53.5
Allt Coir' an Eas	5620	1536	15416	1164	2456	362	1240	214.5
Garvary Burn	1030	40	1900	0	120	0	0	11
Allt a Ghorm Loch Mhoir	1580	176	902	68	72	176	60	23
Allt Crithinn	3510	192	4830	684	120	3122	290	35
Allt Garbh Bheag	5990	1778	15944	501	528	425	580	370

15.4 Obstacles to migration

15.4.1 Middle R. Brora

NGR	Watercourse	Passable	Height (m)	Length (m)	Type
NC 85213 08966	Oldtown Burn	Unknown	1.5	6	Bedrock chute
NC 85240 08971	Oldtown Burn	S/F	3	4	Waterfall
NC 85298 09073	Oldtown Burn	No (U)	5	12	Waterfall
NC 85777 04667	Ducharry Burn	No (U)	2.6	3.2	Cascade
NC 84940 06560	Allt Coire Aghaisgaeig	No (U)	1.4	0.2	Waterfall
NC 84400 07173	Allt a'Chairn	No (U)	4	25	Bedrock ramp + weir
NC 84510 09730	Allt Smeorail	No (U)	7		Waterfall
NC 82429 10774	Allt Ach'a Bhathaich	S/F			Culvert
NC 82448 11059	Allt Ach'a Bhathaich	S/F			Boulder torrent
NC 82449 11109	Allt Ach'a Bhathaich	S/F	1.3		Bedrock fall
NC 82462 11185	Allt Ach'a Bhathaich	Unknown	3?		Series of waterfalls
NC 8222 0989	Scottarie Burn	S/F	2.5		Waterfall
NC 8216 0991	Scottarie Burn	No (U)	4		Waterfall

15.4.2 Upper R. Brora

NGR	Watercourse	Passable	Height (m)	Length (m)	Type
NC 78111 09220	Allt an Tuirc	S/F	1.6	1.5	Waterfall
NC 78105 09125	Allt an Tuirc	No(U)	4	6	Waterfall + rock ramp
NC 63181 15210	Upper R. Brora, Dalnessie Dam	Yes	3		Fish Pass
NC 71373 10407	Allt an Fearna	S/F	1		Waterfall
NC 71516 10851	Allt an Fearna	No (U)	3	3	Waterfall
NC 69166 11197	Corrish Burn	No (U)	2	2	Waterfall
NC 68645 12219	Allt an Eisg (Craigton)	Unknown	1.5	2.2	Waterfall
NC 68658 12229	Allt an Eisg (Craigton)	Unknown	1.2	2	Bedrock cascade
NC 68209 13298	Allt a Mhuilt	S/F	1.2	vertical	Waterfall
NC 67341 12643	Allt Coire Chaorachidh	No (U)	6	10	Ramp
NC 66457 13778	Allt na h-Innse Mor	No (U)	1.5/2	2.5/4	Bedrock ramps
NC 66065 14418	Allt na h-Innse Mor	No (U)	1.5	3	Rock steps
NC 64418 15779	Allt an Eisg (Dalnessie)	No (U)	2.5	7	Slab
NC 64307 15693	Allt an Eisg (Dalnessie)	No (U)	3	6	Slab
NC 64168 15419	Allt an Eisg (Dalnessie)	No (U)	2	3	Waterfall
NC 62815 16041	Upper R. Brora, Dalnessie Falls	S/F	4	3	Waterfall
NC 62781 18942	Allt Gobhlach	Unknown	2	5	Waterfall
NC 60821 21915	Allt Gobhlach	Unknown	0.8	2	Turf dam
NC 63015 18861	An Crom Allt	S/F	1	1.2	Waterfall
NC 64710 17843	An Crom Allt	No (U)	2.8	3.5	Waterfall
NC 64718 19843	An Crom Allt	Unknown	2	5	Rock ramp
NC 65227 20797	Allt Preas a'Chraicinn	S/F	0	1.5	Dry channel
NC 64880 21115	Allt Preas a'Chraicinn	No (U)	10 (2.5)	20	Waterfall

15.4.3 Black Water

NGR	Watercourse	Passable	Height (m)	Length (m)	Type
NC 8035 1146	Black Water	S/F	1.5 - 2		Waterfall
NC 8023 1156	Black Water	S/F			Rapid
NC 7942 1372	Black Water	S/F	1.8		Waterfall
NC 7937 1383	Black Water	S/F	1.5		Waterfall
NC 7924 1422	Black Water	S/F	1.5		Waterfall
NC 7921 1432	Black Water	S/F	1.5		Waterfall
NC 7908 1452	Black Water	S/F	2.5 - 3		Waterfall
NC 77480 15810	Long Pool Burn	S/F	1.5	4.5	Rock ramp
NC 77434 15887	Long Pool Burn	Unknown	1.6	2	Rock ramp
NC 77462 15915	Long Pool Burn	Unknown	0.6	0	Bridge apron
NC 77430 16144	Long Pool Burn	Unknown	2.5	3	Rock ramp/waterfall
NC 77206 15750	Black Water	S/F	1.5	0.6	Waterfall
NC 73211 16944	Black Water	S/F	1.4	1.4	Waterfall
NC 73003 17059	Black Water	S/F	1.5	1.8	Waterfall
NC 75102 14704	Allt a Mhuillin Duibh	No (U)	2.2	5	Rock ramp
NC 72369 17351	Allt Coire an Fhaicnich	S/F	5	2	Waterfall
NC 70193 20505	Allt Coire a' Mhile	No (U)	2.9	3	Waterfall
NC 67344 21551	Black Water	S/F	1	2	Waterfall rock ledge
NC 66199 22230	Abhainn Srath na Seilge	S/F	1.8	1	Waterfall
NC 66222 22400	Abhainn Srath na Seilge	S/F	5	25	Rapid
NC 66460 25025	Allt na Seilich Bige	Unknown	1.8	5	Bedrock chute
NC 67447 27043	Allt na Seilich Bige	Unknown	1.5	2	Stepped cascade
NC 67348 27351	Allt na Seilich Bige	No (U)	2.4	4	Waterfall
NC 67405 26052	Allt na Seilich Bige tributary	No (U/D)			Peat dam
NC 69069 16174	Coirefrois Burn	Unknown	2.8	6	Waterfall
NC 68900 16055	Coirefrois Burn	S/F	1.2	2	Rock ramp
NC 71417 15059	Allt an Eoin	Unknown	3	14	Rock ramp
NC 71132 14933	Allt an Eoin	No (U)	2.2	5	Rock ramp and waterfall

15.4.4 River Skinsdale

NGR	Watercourse	Passable	Height (m)	Length (m)	Type
NC 76182 17976	R. Skinsdale	S/F	2.7	3	Waterfall
NC 72975 26728	Allt Coir' an Eas	S/F	0.8	0.3	Sump/boulder choke
NC 72754 26488	Allt Coir' an Eas	S/F	1.2	0.4	Waterfall
NC 71462 25362	Allt Coir' an Eas	S/F	1.5	7	Rock ramp
NC 7127 2536	Allt Coir' an Eas	S/F		20	Dry channel
NC 73652 21570	Garvary Burn	Unknown	2.2	3.5	Waterfall
NC 74886 21289	Allt Crithinn	S/F	1.6	3	Stepped bedrock outcrop
NC 72714 20824	Allt Garbh Bheag	Unknown	1.9	1	Waterfall

15.5 Minor streams requiring trout habitat assessment

Watercourse	Management area	Priority	
		Medium	Low
Allt nam Ban	River Brora	x	
Dalvaich burn	River Brora		x
Allt Storral/Torsellier burn	River Brora	x	
Allt a Chlamhain	River Brora		x
Allt Siberscaig	River Brora	x	
Feith Ghlas	River Brora	x	
Mill Burn	River Brora	x	
Allt Reidh-Lochan	River Brora		x
Allt na Creige Moire	River Brora	x	
Grumby Burn	River Brora	x	
Craigton Burn	River Brora	x	
Allt Garbh	Black Water	x	
Achaness Burn	Black Water	x	
Allt Coire Ruairidh	Black Water	x	
Allt an Tuirc	River Skinsdale		x
Allt Glas	River Skinsdale	x	
Allt Achadh Mor	River Skinsdale	x	
Allt Meadhonach	River Skinsdale	x	
Allt Blarach	River Skinsdale		x

Brief (qualitative) assessments of the above streams would be worthwhile. As a minimum surveys should include:

- Determination of accessible length (to 1st impassable barrier)
- Wet width (typical wet width at 250 m intervals)
- Typical habitat quality including presence/abundance of spawning habitat

A photographic record of typical habitats in each stream should be obtained.