FISHERY MANAGEMENT PLAN 2018-2021

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1. Introduction

The Kyle of Sutherland fish populations represent an important economic, cultural and ecological resource. An independent economic survey commissioned in 2007 concluded that recreational angling in the Kyle district contributes £3.73m annually and employs 86 full time equivalent posts. Historically, salmon netting was an important contributor to the local economy and other fisheries also operated commercially, for example eel trapping. Salmon also contribute to the local economy due to the presence of the visitor attraction at Shin Falls where salmon can be viewed leaping an obstacle. A number of watercourses in the district have international designations as special areas of conservation (SAC's), primarily due to the presence of species such as Atlantic salmon and freshwater pearl mussels.

The following plan has been jointly prepared by the Kyle of Sutherland District Salmon Fishery Board (KSDSFB) and Kyle of Sutherland Fisheries Trust (KSFT). For simplicity both organisations are collectively known as Kyle Fisheries although they are distinct entities. The following plan identifies a number of issues that potentially impact on the fish populations within the fishery district and where appropriate suggests remedial actions that may be taken in respect of these issues. Additionally issues such as monitoring and research requirements are also considered.

Fishery management plans have been previously produced for the period 2008-2012, and 2015-2018 but are now due to be updated. This plan therefore represents the third iteration of the planning process for the Kyle of Sutherland district as a whole. Historically, plans had been formulated for individual rivers on an ad hoc basis. This plan covers the period 2018 to 2021. A time span of three years has been selected again in order to give Kyle Fisheries more flexibility in its aims for managing the district. The plan has been published following a review of the 2015-2018 management plan.

2. Aims and Objectives

The overall aim of this fisheries management plan is to provide a framework for the protection and enhancement of fish populations within the Kyle of Sutherland district and to ensure that the exploitation of such populations by either commercial or recreational fisheries is undertaken in a sustainable manner. The plan relates to all native and naturally occurring fish species within district area, with a particular focus on salmon, trout and sea trout due to their economic importance. Other species, such as European eels and freshwater pearl mussels, which have a high conservation value are also considered in the plan where appropriate. Although this plan guides the work undertaken at Kyle Fisheries for the next 3 years, short annual reviews can ensure that Kyle fisheries remains adaptable in order to cope with changing circumstances and unforeseen events.

The lifespan of this plan is intended to be three years; commencing on the 1st May 2018 and ending 1st May 2021. The success of the management plan will be evaluated on an annual basis with a full review undertaken at the end of the three year planning period.

These objectives relate to the contribution that the plan is making to key life stages of fish and their contribution to local socio-economics, as outlined below:

- Maintain or enhance the density and distribution of juvenile fish populations, and develop an increased number of electrofishing sites across the district for monitoring this.
- Maximise the number of salmon and sea trout smolts exiting rivers within the district.
- As far as is practicable the stabilisation or enhancement of the number of resident or returning adult fish.
- An increased consideration of outreach and education.
- An increase in the socio-economic value of fisheries within the district.

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These objectives will be achieved through information gathering, the assessment of the key pressures on particular fish populations and the delivery of priority actions required for mitigating such pressures. At all stages of plan delivery an evidence based approach will be adopted. It is envisaged that the framework provided by the plan will be flexible as before and will evolve during the timescale covered. The planning process is likely to be iterative in nature with an assessment of the success and failures of the present plan being incorporated into future planning cycles. The plan will incorporate a number of important activities undertaken by Kyle Fisheries which include the provision of education activities and the promotion of the various fisheries available within the district.

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3. Current Fisheries Management Structure

3.1. Kyle of Sutherland District Salmon Fishery Board

KSDSFB is the statutory body responsible for the protection and enhancement of salmon and sea trout fisheries in the district. It takes its remit from the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 which states that a District Salmon Fishery Board may do such acts, execute such works and incur such expenses as may appear expedient for:

- The protection or improvement of the fisheries within their district;
- The increase of salmon (and sea trout); or
- The stocking of the waters of the district with salmon (and sea trout).

KSDSFB finances its work by levying a rate on the salmon fishery owners in the district. This fishery assessment is assessed at such uniform rate as is determined for all fisheries in the district by the board and shall be exigible according to the valuation of a fishery as entered onto the valuation roll. Elected representatives of those salmon fishery owners provide the core of the membership of the Board, together with representatives of salmon anglers, salmon netsmen and other parties who may have an interest in salmon stocks or fisheries in the district. Board members are all volunteers and are non-remunerated for their time and effort. The primary function of KSDSFB in the district is the policing of the relevant fisheries legislation largely in relation to salmon and sea trout and to this end a team of water bailiffs is employed. Additional project work, if considered to be of benefit to salmon and/or sea trout, is undertaken usually in conjunction with KSFT.

3.2. Kyle of Sutherland Fisheries Trust

KSFT is an environmental charity which was established in 2000 but became fully functional in 2003. Initially the remit of the Trust extended only to salmon but this has subsequently been amended to encompass all fish species native to the catchment. Core activities of KSFT include the collection of data on fish stocks within the area as well as the physical characteristics of the catchment. The gathering of this data facilitates the provision of informed advice to KSDSFB and other relevant agencies. KSFT has a history of undertaking scientific research projects into key issues such as salmon genetics as well as commissioning reports on issues such as the economic value of the fisheries in the area. KSFT also engages in outreach and education.

3.3. Others

Fisheries within the district are managed on a day to day basis by a number of proprietors, proprietorial groupings, river managers, ghillies and collective organisations such as angling associations. Each of the main rivers in the area that support a fishery (i.e. Carron, Cassley, Oykel, Shin and Evelix) have functioning proprietors groups which in turn are represented on KSDSFB. Most of the lochs, rivers and the estuary area (Kyle of Sutherland) in the district is managed to a greater or lesser extent. A number of other organisations play an important role in the management of the fisheries in the area. These include governmental organisation such as Marine Scotland Science (MSS) and Forestry Commission Scotland (FCS), executive non-departmental public bodies such as Scottish Natural Heritage (SNH) and Scottish Environment Protection Agency (SEPA) as well as commercial companies such as SSE. Kyle Fisheries liaises closely with such organisations on both a formal and non-formal basis.

4. The Kyle of Sutherland District

The previous Kyle of Sutherland management plan identified that the Kyle of Sutherland district drains circa 163,647 hectares and encompasses circa 46miles of tidal zone, 70 miles of principle river, 61 freshwater lochs and lochans and numerous small watercourses. The catchment is particularly complex in nature with specific issues raised by the tidal Kyle of Sutherland. Whilst all of it is tidal in nature, a salinity gradient exists which results in a considerable section of the Kyle being entirely freshwater.

For the purpose of this management plan, the district has been split into distinct management units. This has been done to better highlight particular issues relevant to individual areas and also largely reflects the proprietorial group management structure as outlined in section 3.3. It should be noted that the management units are somewhat arbitrary in nature and may not accurately reflect the biological complexity of the fish populations present. For example, genetic research has highlighted that a number of distinct salmon populations exist within the district and it is likely that as more powerful genetic techniques are developed understanding of the population structure of the fish species present in the district will increase. Where appropriate information is currently available relating to population structure then management will be undertaken based on biological units; where information is lacking a precautionary stance will be adopted e.g. any salmon stocking that is undertaken will assume population structuring is likely to exist even if no evidence is currently available in relation to the nature of that structure. It should also be noted that a number of issues, e.g. climate change and illegal fishing activity, are generic across the whole catchment.

For the purpose of management the Kyle of Sutherland district is split up into 6 different units, as each area has their own characteristics and needs which will require tailored management actions. The six management units can be seen below.

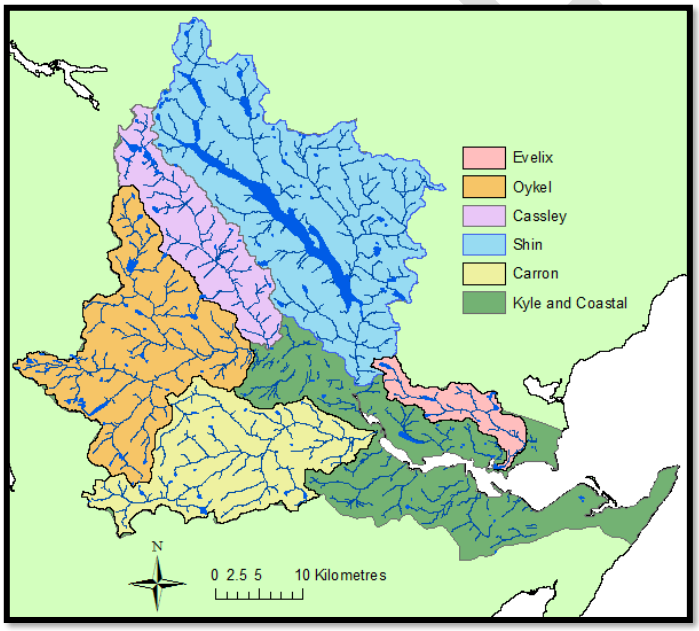

Figure 1. Kyle of Sutherland Management units.

4.1. Hydrology

SEPA gauging stations currently operate at number of locations within the catchment: Shin at Inveran; Carron at Sgodachail; Cassley at Rosehall; Oykel at Bailey Bridge; Oykel at Easter Turnaig;

and at Loch Ailsh (Oykel system). It would appear that stations have typically operated over different time frames. Examination of the National River Flow Archive data holdings suggests that long term data sets are available for the Carron (1974-2016), Cassley (1979-2016), Oykel at Easter Turnaig (1977-2016) and Shin (1981-2011). The Loch Alish station has data available from 2006-2016. The National River Flow Archive also has data for the Shin at Lairg for the period 1953-1957 which presumably relates to the construction of the hydro-electric schemes in that area.

4.2. Water quality

Sampling of water quality within the catchment is undertaken by SEPA on a regular basis. Typically water quality is of a high standard. However, pollution incidents do occur on occasions and Kyle Fisheries remains vigilant in ensuring that any incidents are reported and addressed.

4.3. Land use

Land use within the catchment is typified by sporting estates in the upland areas, often utilised for deer stalking, and extensive areas of commercial forestry. Native tree forests are also important in some areas and, for example, Amat Estate which is situated within the Carron catchment maintains an important remnant of the Caledonian Forest. Rough grazing is also available for both cattle and sheep. Arable farming is largely restricted to more coastal areas. The largest conurbations in the area are Dornoch, Ardgay, Bonar Bridge, Edderton, Tain, Rosehall and Lairg although much of the catchment is sparsely populated.

5. Fish species present within the Kyle of Sutherland District and fishery performance

5.1. Atlantic Salmon (*Salmo salar*)

Atlantic salmon are listed on Appendix III of the Bern Convention and Annex II and V of the EC Habitats & Species Directive. The multi-sea-winter component of the Atlantic salmon population is included in the UK Biodiversity Action Plan (UKBAP) Priority Species List. There is extensive UK legislation in place in order to protect the species. Economically salmon are the dominant species within the district and have supported both commercial and recreational fisheries for many years. In the independent economic survey previously noted, £3.5m of the £3.7m income resulting from fisheries in the area was estimated to be derived from salmon based expenditure.

5.1.1. Distribution

The current distribution of juvenile salmon within the fishery district is likely to be broadly similar to historical distributions except for a number of notable exceptions. The exceptions are largely the

result of hydro-electric developments, e.g. the upper reaches of parts of the Carron, or the construction of other potential barriers such as dams and bridge culverts. The presence of adult spawning salmon is inferred from the presence of juvenile salmon.

5.2.2. Fishery performance

A number of sources of information are available in respect of the abundance and exploitation of salmon. Catch records are available for some individual river beats from estate records and extensive records of the net fisheries within the district are also available in some instances. The most comprehensive data set that is available is the 1952-2017 rod and net catch records held by Marine Scotland Science (MSS). Additionally some fish counter data is available from two locations within the area, namely Duchally Dam on the River Cassley and Shin Diversion Dam on the River Shin. Both fish counters are owned and operated by SSE. There is also a fish counter on the river Evelix, owned and operated by Skibo estate.

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5.2.3. Net catches

For hundreds of years the Kyle region has supported important net and trap fisheries both in the inner tidal areas of the Kyle of Sutherland district and in the surrounding coastal communities. Various methods such as yairs, net and coble and bag nets have been used to catch salmon. In the nineteenth century the combined catch of the various types of commercial fisheries could be in excess of 30,000 salmon and grilse per annum. Until relatively recent times commercial catches could be in excess of 10,000 per annum. Many of the most productive netting operations operated in the Bonar Bridge area and have been the subject of buyouts in order that their operation be discontinued. However, a number of netting stations have still operated, particularly coastal bag nets in the Portmahomack area, albeit with fishing effort considerably reduced compared to historical levels. Typically, netting stations operating tend to do so for a short period in the summer months. For the last year that full figures are available from Marine Scotland (2017) no salmon were reported caught within the Kyle of Sutherland District by nets. There is currently a Scotland-wide ban on killing wild salmon outside estuary limits in force from 2016-2018. Prohibition of netting within estuary limits has also taken place in the district as part of the salmon conservation regulations introduced by MSS. An annual assessment is made by MSS to ascertain if a harvestable surplus of salmon is available for rod and line and net fisheries.

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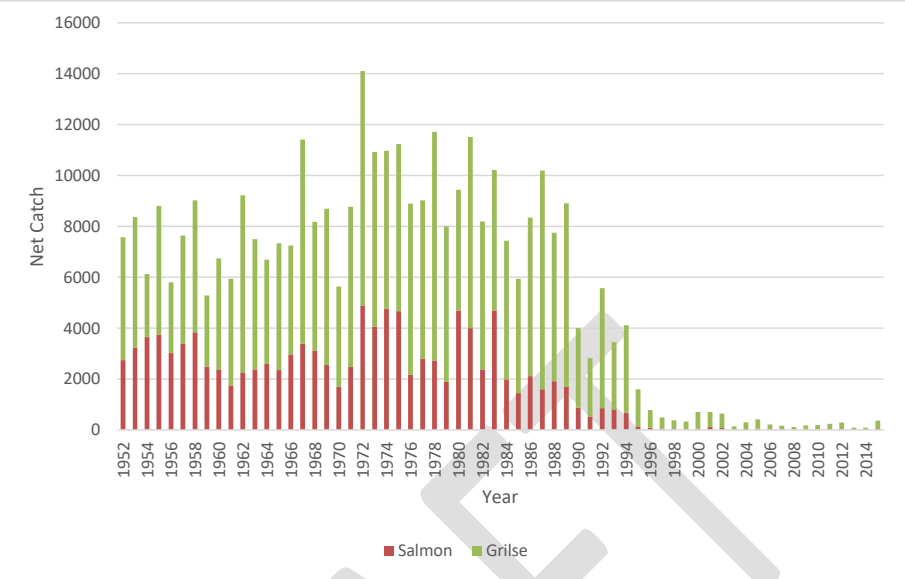

Figure 2. Combined fixed engine and net and coble catches.

5.2.4. Rod catches

Annual rod catches (salmon and grilse combined) over the period 1952-2017 as collected by MSS are presented in **Figure 3** below. The mean rod catch for the Kyle catchment within that period is 2,739. The lowest rod catch recorded in that period was 1031 in 1954 whereas the highest was 4,613 in 1995. Due to the way that the catch statistics have been compiled by MSS it is not possible to separate out the catches for individual rivers within the catchment in a satisfactory manner. As such, catch statistics are presented for the district as a whole. Kyle Fisheries does have access to records from individual rivers and beats within the catchment which can be utilised as and when required for more detailed analyses, however.

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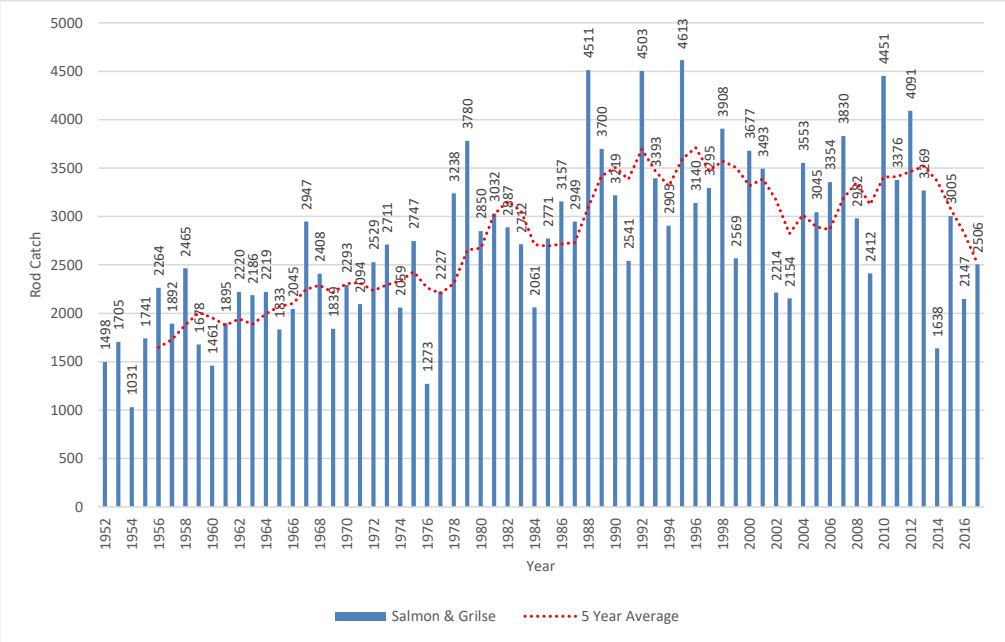

Figure 3. Total Salmon & Grilse rod and line catches.

Examination of the rod catch figures would suggest that rod catches over the time period have been fairly consistent. However, it should be noted that no effort statistics are available for the rod fishery to assess if effort has altered over time. Additional compounding factors in relation to using rod catch data as a proxy for overall abundance include the reduction in effort in the commercial salmon fishery and the widespread adoption of catch and release during the latter part of the time series which may mean that individual fish are captured – and thus counted as part of the total catch – on more than one occasion. Additionally, as the catches are aggregated as a whole for the district, declines in abundance in some rivers may be masked by increases in others. A similar scenario may also apply to various stock components within each river system.

MSS data is split into salmon (classed as a fish that has spent two or more winters at sea) and grilse (classed as a fish that has spent a single winter at sea) components. In the absence of detailed scale reading analyses the demarcation points in respect of weight, length etc. between salmon and grilse may be somewhat arbitrary in nature. Kyle Fisheries continues to undertake a scale reading programme of rod caught fish, to obtain a better understanding of the various stock components and their size and age structure. However, grilse and salmon catches as described by MSS data are illustrated in **Figure 4** below. It would appear that there has been a general trend for increasing grilse catches within the second half of the period for which official figures have been available although there has been considerable variance in annual catches. It is not known whether this is as a

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result of a general increase in abundance of grilse or whether the decrease in exploitation by the commercial sector in the region has facilitated increases in the number of grilse available for exploitation by the rod fishery, or some combination of the two factors.

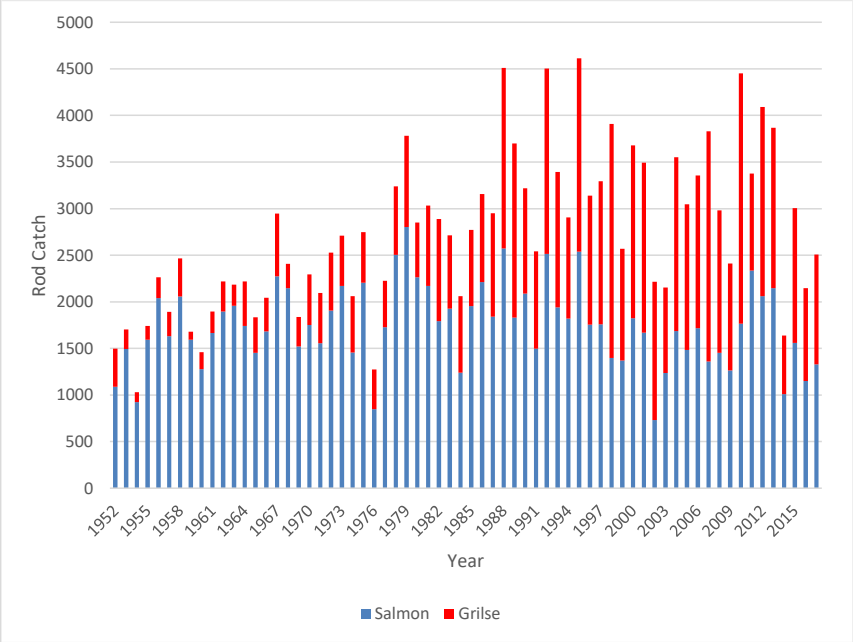

Figure 4. Salmon and Grilse components of rod and line catches.

Salmon enter the Kyle of Sutherland rivers from the sea over the bulk of the calendar year. The variation in run timing displayed by individual fish is likely to result from a combination of genetic and environmental factors although the precise mechanisms underlying this are relatively poorly understood. This variation is important economically as well as ecologically as it gives rise to a relatively long rod salmon fishing season (January 11th – September 30th) which in turn helps to support full time employment and the viability of fisheries and ancillary businesses such as hotels. There is a perception that the earliest running component of the overall salmon stock complex in the Kyle district is disproportionally important economically given that it supports the tourist sector at a time when visitor numbers would otherwise be at a low ebb. Evidence suggests that within Scotland, and indeed elsewhere, there have been considerable temporal shifts in abundance of salmon probably as a result of natural cycles. For illustrative purposes the MSS rod catch data has been split up into three component parts: spring (January-May); summer (June-August); and autumn (September, plus October in 1954, 1986, 2008, 2009 and 2010). Although somewhat arbitrary in nature (river entry date may predate capture date by an unknown amount) these time periods correspond to those utilised for the NASCO rod catch assessment tool in assessing the health of individual components of the overall stock complex within the Kyle of Sutherland district. **Figure 5.**

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below delineates the catches for each of the components in question. Examination of the catches suggests that the proportion of the overall catch derived from the summer and autumn time periods has increased compared to the spring. However, as effort data is not collected as part of the statistics it is not known how effort may have altered in relation to exploitation of the spring, summer and autumn stock components over the time series. Equally it is not known if the concurrent decline in netting effort during the time series may have disproportionally affected the numbers of fish available to the rod fishery at different times of year.

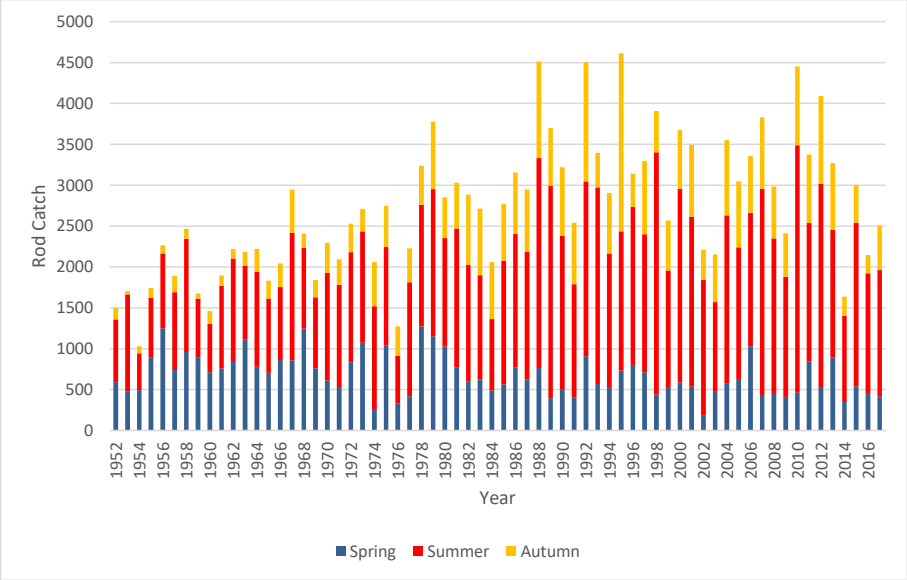

Figure 5. Seasonal salmon catch components.

5.2.5. Fish counter data

Fish counter data is currently available from two locations within the district, one on the Shin system and one on the Cassley system. The counters are of the resistivity type and are owned and managed by SSE. Both are housed within fish passes in dams. However a third counter on the Evelix system is now in operation also. In contrast to the SSE counters, the Evelix counter utilises infrared technology and is located in a fish pass in the lowermost reaches of the river. The counter is privately owned but is hoped that data will be made available to Kyle Fisheries for interpretation and to assist in the management of the River Evelix..[will update when I do get the counter data from SSE]

5.2. Brown/Sea Trout (*Salmo trutta*)

Trout in both juvenile and adult form are widely distributed within the Kyle of Sutherland catchment.

Brown trout (*Salmon trutta*) are a United Kingdom Biodiversity Action Plan (UKBAP) species and therefore deemed to be of national importance. Both brown trout and sea trout maintain important fisheries in the area and are particularly important for local angling clubs and a number of hotels. The independent economic survey undertaken in 2007 identified that 2,959 angler days resulted annually from the trout fishery in the district with associated expenditure of over £182,000.

5.2.1. Distribution

Brown trout and sea trout are the most widely distributed fish in the Kyle district. It is present in all of the management units in both rivers, lochs and estuary areas.

5.2.2. Fishery performance

The Kyle of Sutherland district has supported both brown trout and sea trout fisheries for a considerable amount of time. In respect of sea trout, Marine Scotland catch figures are available from 1952 onwards (see **Figure 5**). Official catch returns for the 2013 season are included in the chart for illustrative purposes due to the fact that that the catch figure will likely be revised upwards in the future due to an issue with a catch return from a major sea trout fishery. It should be noted that finnock (immature sea trout) catch statistics were only collected from 2004 onwards and that data for sea trout returned as against sea trout retained is only available from 1994 onwards. As with salmon rod catch data, effort metrics associated with the sea trout fishery have not been collected and an unknown factor relates to the level of recaptures of sea trout that have previously been released by anglers.

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A number of significant fisheries exist in lochs in the district. In particular Loch Shin supports a renowned fishery which provides income to Lairg AC and Overscaig Hotel. A number of lochs are significant contributors to the overall fishings provided by Oykel Bridge Hotel and Loch Eye is a noted brown trout fishery in the southern part of the catchment. At present information regarding catches etc. is not available for analyses. It is recognised by Kyle Fisheries that this is a significant barrier to the successful management of the resource. It is likely that some information exists in the form of angling association and hotel records but at present no attempt has been made to access this information. Some scale analyses of trout captured in Loch Shin has recently become available via the Moray Firth Trout Initiative.

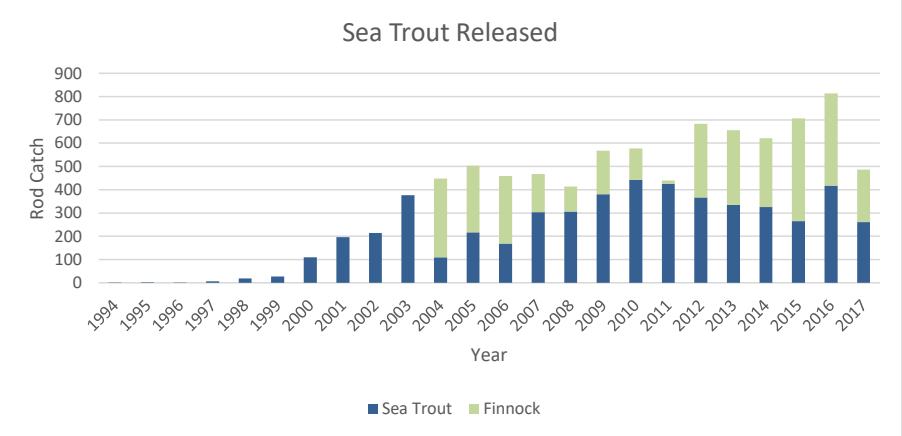

Figure 6. Sea Trout and Finnock numbers caught on rod and line in the Kyle of Sutherland District which were subsequently released.

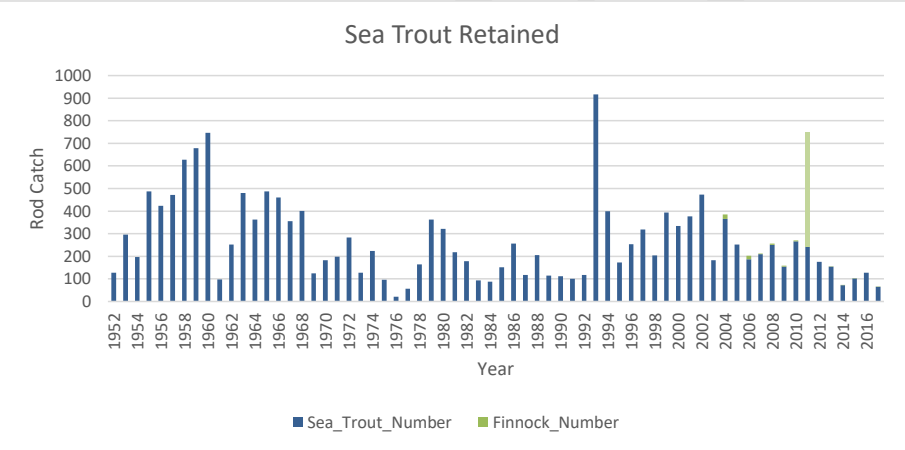

Figure 7. Numbers of Sea Trout and Finnock caught on rod and line within the Kyle of Sutherland District which were retained.

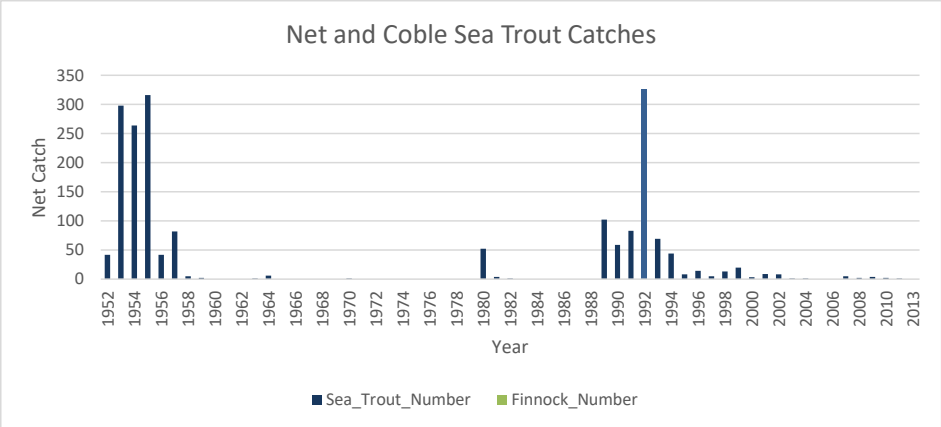

Figure 8. Sea Trout and Finnock numbers caught by net and coble within the Kyle of Sutherland District.

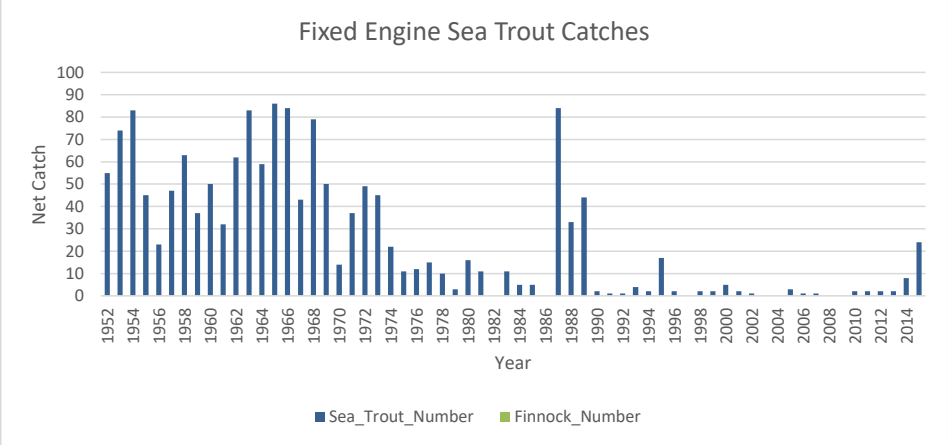

Figure 9. Sea Trout and Finnock numbers caught by fixed engine net fishery within the Kyle of Sutherland District.

5.3. European Eel (*Anguilla Anguilla*)

Reports suggest that the number of elvers (young eels) migrating into European rivers has fallen to less than 5% of 1980s levels. The exact reason for its decline is not known, but it is likely to be a combination of factors including climate change, overfishing, habitat loss and obstruction of waterways. This widespread decline has led the European Commission to develop an Eel Recovery Plan (Council Regulation No 1100/2007). This aims to return European eel stocks to sustainable levels. Each Member State is required to establish national Eel Management Plans, with an Eel Management Plan for Scotland developed by Marine Scotland Science in 2008. The European eel was also added to the UKBAP Priority Species List in 2007. In 2011, the species was listed as Critically Endangered on the International Union for the Conservation of Nature (IUCN) Red List.

Within the Kyle district eels are known to be present, particularly in the lower reaches of the rivers and in the Kyle of Sutherland itself. Historically eel fisheries have existed both for yellow/silver eels (usually in the Kyle itself) and elvers on the rivers flowing into the Kyle. Due to the decline in eel numbers and introduction of new legislation no fisheries for eels are currently prosecuted.

Figure 10. Eel caught during an electrofishing survey on a SFCC course in Inverness.

5.3.1. Distribution

Within the Kyle of Sutherland District information on Eel distribution within the SFCC database is somewhat fragmented. A distribution map could be perhaps produced if paper records were reviewed.

5.3.2. Fishery performance

Fishing for European Eel is prohibited without a licence from Scottish Ministers under the the Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008. No information is available to Kyle Fisheries in relation to the historical performance of the eel fishery.

5.4. Arctic Charr (*Salvelinus alpinus*)

The majority of Arctic charr populations in Scotland occupy still waters and are not found to occupy rivers, although there are exceptions to this. Currently, Arctic charr are a conservation feature in five Sites of Special Scientific Interest (SSSI) and are present in a number of water bodies protected for other purposes, either under the Natura 2000 network or the National Nature Reserve series. The conservation value of Arctic charr within the UK has been further recognised by their addition to the UKBAP Priority Species List in 2007. This considers them as 'threatened or declining in range' due to such factors as global warming, land use changes and species introductions. A register of waters in which charr are known to be present or for which historical information exists regarding their presence is maintained by Glasgow University and is periodically updated.

Figure 11. Arctic Charr caught in rotary screw trap on the River Merkland.

5.4.1. Distribution

Charr are known to populate the Loch Shin, Loch a' Ghriama and Loch Merkland catchment in particular. On occasion charr are captured in the rotary screw trap operated by Kyle Fisheries at the exit of Loch Ghriama into Loch Shin. Other lochs for which historical evidence exists for the presence of charr populations are Loch Fiag, Loch Mor, Crom Loch, Loch Sruban Mora and Loch a' Bhith.

5.4.2. Fishery performance

No fishery specifically targets charr within the Kyle District although the Overscaig Hotel reports that charr occasionally feature in catches of anglers primarily targeting trout.

5.5. Lampreys (*Agnathans*)

The lampreys belong to an ancient order of vertebrates, the Agnathans or 'jawless fishes'. The skeletons of lampreys are of strong flexible cartilage and it is not comprised of bone. A round, sucker-like disc surrounds the mouth which, in adults, carries rasping teeth. Most, but not all, species of lamprey are parasitic on other fish.

Figure 12. Juvenile brook lamprey caught on the Tutim burn in 2018..

Three lamprey species present in UK: brook lamprey (*Lampetra planeri*), river lamprey (*Lampretra fluviatilis*) and sea lamprey (*Petromyzon marinus*). All three species are afforded protection within conservation legislation:

- Brook Lamprey Annex II of the EU Habitats Directive Appendix III of the Bern Convention.
- River Lamprey Annexes II and V of the EU Habitats Directive Appendix III of the Bern Convention and are on the UKBAP Priority List.
- Sea Lamprey Annex II of the EU Habitats Directive Appendix III of the Bern Convention and are on the UKBAP Priority List.

All three species of lamprey spawn in fresh waters. After hatching, the young elongated larvae, known as ammocoetes, swim or are washed downstream by the current to areas of sandy silt in still water where they burrow and spend the next few years in tunnels (Maitland, 2003). The standard methodology for sampling lamprey species involves assessment of populations of these ammocoetes.

5.5.1. Distribution

It is likely that all three species of lamprey are present within the Kyle district. Anecdotal evidence suggests that adult lampreys are frequently seen in the district. Only one record for lampreys exist

within the Kyle of Sutherland district, in 2018 one was caught in the Tutim burn in the Oykel catchment. However, it would appear that no surveys targeted specifically at lampreys have been undertaken which would account for the lack of records.

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5.5.2. Fishery performance

No fishery prosecuted within this district.

5.6. Minnows (*Phoxinus phoxinus*)

The minnow (*Phoxinus phoxinus*) is the smallest member of the cyprinid family. It is a slender fish with brown and greenish barred back and sides, giving the appearance of a black stripe along the flank. It is found in shoals in lochs, small burns and fast rivers.

Minnows are believed to be an invasive non-native species (native to England and Wales but not to parts of Scotland) that compete with salmonids for food and space and feed on salmonid eggs and fry. It is thought that they were originally introduced after being used as live bait and then discarded into water bodies. The use of live vertebrates as bait was prohibited by the Aquaculture and Fisheries (Scotland) Act 2007.

Figure 13. A shoal of minnows caught during an electrofishing survey in the Spey catchment. Notice the distinct red colour of the cock minnow ready to spawn.

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5.6.1. Distribution

Minnows are likely to be widely distributed within the catchment. However, Examination of the SFCC electro-fishing database suggests that little information is currently held on minnow distribution by

Kyle Fisheries. However, it is likely that some information is held on paper records and has not been transferred to records held in electronic format.

5.6.2. Fishery performance

No fishery prosecuted within this district.

5.7. Three spined stickleback (*Gasterosteus aculeatus*)

The three-spined stickleback is the smallest of all British freshwater fish. It is easily recognisable by the three large spines on its back, well developed pectoral fins and the ventral fins reduced to spines.

In the sea it is confined to coastal waters. In freshwater, it prefers to live in small streams but also occurs in a variety of habitats including lakes, lochs and large rivers. It inhabits shallow vegetated areas, usually over mud or sand. Juveniles move to the sea (anadromous populations) or to deeper, larger water bodies such as lochs (freshwater populations) in July-August, forming large feeding schools. They feed on worms, crustaceans, larvae and adult aquatic insects, drowned aerial insects, and small fishes. Eggs are found in nests constructed from plant material.

Figure 14. Three-spined stickleback.

5.7.1. Distribution

Three-spined sticklebacks are present in the Kyle district, particularly in the Kyle of Sutherland itself. Examination of the SFCC electro-fishing database suggests that little information is currently held on stickleback distribution by Kyle Fisheries. However, it is likely that some information is held on paper records and has not been transferred to records held in electronic format.

5.7.2. Fishery performance

Three-spined sticklebacks are not targeted by sport anglers or commercial fishermen.

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5.8. Stone loach (*Barbatula barbatula*)

The stone loach is a small fish believed to have been introduced to the catchment by anglers in a similar manner to minnows. Stone loach are believed to be an invasive non-native species that compete with salmonids for food and space and feed on salmonid eggs and fry. It is thought that they were originally introduced after being used as live bait and then discarded into water bodies. The use of live vertebrates as bait was prohibited by the Aquaculture and Fisheries (Scotland) Act 2007.

Figure 15. Stone Loach caught on the River Tirry.

5.8.1. Distribution

At present stone loach are believed to be restricted to the Shin catchment upstream of Lairg Dam. However it is possible that they have spread to other parts of the Shin catchment – and potentially beyond – without being detected in electro-fishing surveys. eDNA could be used in future to detect the presence of stone loach.

5.8.2. Fishery Performance

No fishery for stone loach is prosecuted.

6. Identification of factors potentially limiting fish production.

In order to meet the aims and objectives of the plan, it is necessary to first identify factors that have the potential to limit the populations of species of importance within the district. After these have been identified, measures to prevent or mitigate any harm may be devised.

Atlantic Salmon is arguably the species of the greatest economic value within the Kyle of Sutherland watercourses, due to the revenue generated by the angling industry. Although anglers do come for sea trout and brown trout, Salmon is the primary target species. Atlantic Salmon is also a contributing factor to the Oykel SAC….

6.1. Hydrological issues.

Several of the factors which may limit fish production affect the hydrology of water courses within the district. These are outlined below.

6.1.1. Water abstraction and impoundment.

Water impoundment and abstraction is a significant issue in the district. Scottish Water impounds or abstracts water in a number of locations within the catchment, particularly the Evelix and coastal burns. Domestic water supplies also have the potential to reduce flows on burns, particularly during drought conditions although this is likely to have limited impact in most cases.

6.1.2. Hydro schemes.

Large scale hydro-electric schemes have been a feature of the Kyle of Sutherland area for many years. Several large dams were built in the 1950's. The effect that these schemes have on salmon stocks has been debated over the years. The presence of hydro installations and dams on a river system has the potential to be detrimental to fish populations in a number of ways. The potential impacts of large scale hydro schemes include:

- Lack of access for migratory fish to historically available habitat.
- Alterations to hydrological regimes.
- Changes in water chemistry and nutrient status.
- Lack of sediment transfer.
- The creation of 'pinch points' for the predation of both migrating juveniles and adults.
- The transfer of water between rivers which may alter migration patterns and may also transfer juvenile fish between catchments.

Small scale hydro power schemes have become increasingly popular over the last decade. One of the main environmental challenges associated with these developments relates to both upstream and downstream fish passage. The presence of several small generating stations on the same river may also introduce cumulative impacts.

6.1.3. Effect of man-made obstructions.

Dams, weirs, road culverts, bridge aprons and other constructions can reduce the available habitat for many fish species; particularly those adopting an anadromous or catadromous life history.

6.2. Predation.

Predation of salmon and sea trout by a number of different species is a common occurrence across Scotland, but also completely natural. However the impact that increasing numbers of predators, both migratory and resident, has on fish at the population level is poorly defined. Predation pressures may well be exacerbated by the presence of structures such as dams etc. which can create 'pinch points'. Of particular concern is predation on migratory fish during stages of their life cycle after which density dependent compensation for losses is likely to be exhausted e.g. salmon and sea trout smolts and returning adults.

6.2.1. Piscivorous birds.

Significant numbers of goosanders, mergansers, herons and cormorants frequent the Kyle District. These birds predate on a wide range of fish species, with juvenile salmon and trout forming a major component of their diet. Sawbills are known to take advantage of 'pinch points' or 'bottlenecks' during smolt migrations.

Cormorants will take larger prey items than sawbills including adult trout and even small grilse. They are also known to cause damage to larger fish that they attack but are too large to swallow.

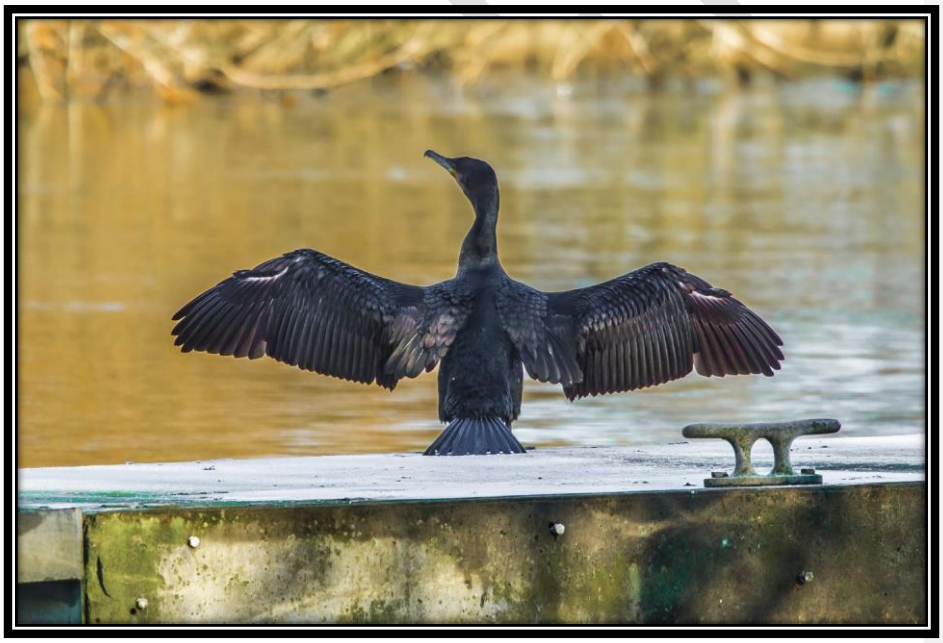

Figure 16. A typical cormorant.

Scottish Natural Heritage provides licenses for the shooting of fish-eating birds on an annual basis. This is done in cases where it is shown that the fish may cause significant damage to the fishery or

where significant damage is likely to occur.

Figure 17. Bird damaged smolt caught on the River Fiag.

6.2.2. Predatory fish.

Of particular concern in respect of salmon and sea trout juvenile predation in the Kyle of Sutherland area are large trout, and a range of sea species such as cod and bass which predate on smolts. The interactions between such species are presently poorly understood.

6.2.3. Seals.

The Moray Firth supports populations of grey seals (*Halichoerus grypus*), common or harbour seals (*Phoca vitulina*) and salmon. The interaction between these well-known and protected species causes a conservation and economic dilemma. Although salmon are likely to form a small part of the seal's overall diet their impacts on salmon stocks has the potential to be significant, particularly at migratory pinch points or 'bottle necks'.

Historically there was a great deal of conflict between various interests regarding how to best to manage seals in order to protect salmon. In the early 1990's both the number of salmon returning to rivers in the area (particularly the 'spring' component) and harbour seals declined significantly. Given the presence of SACs for both species in the area and obligations to ensure 'favourable status' of the key interest features, local district salmon fishery boards, the Scottish Executive, Scottish Natural Heritage and other stakeholders negotiated the Moray Firth Seal Management Plan (MFSMP) in 2005. This aimed to restore the favourable conservation status of seal and salmon SACs whilst reducing the shooting of harbour seals and seal predation on salmon.

The MFSMP has led to a greater understanding of seal biology amongst fishery managers and raised awareness of the competing needs of seals, salmon and their importance to the local economy of the Moray Firth. The experience gained also fed into The Marine (Scotland) Act 2010 which was introduced on 31 January 2011. This states that any fishery or fish farm in Scotland that requires to manage seals at any time of year, to prevent serious damage to fisheries or fish farms or to protect the health and welfare of farmed fish, will need an annual Seal Management Licence.

6.3. Invasive Non-Native species.

The Kyle of Sutherland has not experienced levels of invasive plant species that has been witnessed in many other Scottish catchments However, the catchment does contain a number of species that are not native to the Highlands of Scotland. This may increase levels of predation (e.g. mink), competition for food and habitat (e.g. minnows and stone loach) or reduce the quality of available habitat (e.g. Japanese knotweed and Himalayan balsam). There may even be interactions between INNS and salmon and sea trout in the marine environment.

6.3.1. Pink Salmon.

Pink salmon, *Oncorhynchus gorbuscha,* have occasionally been recorded in Scottish rivers. The species is native to the pacific, found on the west coast of North America and Canada, and on the east coasts of Korea and Japan. In 1956 it was introduced by the Russians to rivers on the Barents sea and White seas. Since then, this population has increased as has its distribution, gradually moving further south. Small occasional sightings have been recorded in Scottish rivers, however in 2017 across Scotland larger numbers were seen than before, 70 across Scotland by August. Marine Scotland Science conducted research in collaboration with DSFB's in regards to the egg viability of pink salmon in Scottish rivers such as the Spey and the Ness. It was noted that pink salmon fry hatched from these eggs. Pink Salmon are different from their Atlantic cousins in that they are a biannual species, and every odd year is a strong year class for them. Therefore, we would expect to see more pink salmon in 2019 and 2021. Pink salmon go straight to sea upon hatching and do not spend time in rivers like Atlantic salmon do, therefore competition effects between the juvenile stages of these species would be expected to be low. However, competition between the adults at sea would be of more concern and the interactions between the two species at sea are not known.

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Figure 18. Pink Salmon caught on the River Spey in 2017.

6.3.2. American Mink.

American mink (*Neovison vison*) are a member of the mustelid family whose other members include weasel, otter and badger. They were brought to the UK in the early 20th Century to be bred on farms for their fur. The first farm opened in Scotland in 1938 and in the same year they were recorded in the wild. American mink continued to escape or were intentionally released. The last fur farm closed in the UK in 1993 and in 2003 the industry was made illegal.

Figure 19. American mink.

Since their introduction America mink have been shown to have negative effects on a broad range of wildlife species of both conservation and economic value including fish species. They are classed as opportunistic, generalist predators able to switch between prey sources when one food source becomes scarce. Because of their high metabolic rate, American mink have to eat approximately one third of their body weight every day to sustain themselves.

Mink are known to be widely distributed further south than the Kyle of Sutherland catchment and small numbers have been observed and, on occasion captured, within the catchment. Kyle Fisheries was a key partner of the Scottish Mink Initiative (now the Scottish Invasive Species Initiative) which aimed to secure multiple adjacent river catchments as areas free of breeding American mink, thus protecting native wildlife such as water voles and ground nesting birds, as well as economically important populations of fish and game birds.

This Initiative is highly collaborative in nature and has input from numerous fishery trusts and boards, SNH, Forestry Commission Scotland, Scottish Wildlife Trust, University of Aberdeen and Oxford University in addition to gamekeepers and members of the public. The aims of the new SISI initiative also include invasive plants as well as mink.

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6.3.3. Invasive plant species

Of particular concern in the Kyle of Sutherland district is Japanese knotweed and Himalayan balsam. Giant hogweed (a large toxic plant which causes severe burns and poses a serious health concern) has not yet been noted in the district. All of these plants are key priorities of the Scottish Invasive Species Initiative, alongside American mink. Knotweed and balsam are fast growing tall plants which reduce sunlight and space available for other plants. In the winter these plants die off, and can leave river banks exposed which facilitates erosion. The seeds from Himalayan balsam can remain viable for 2 years which makes a long term eradication programme necessary. Seed pods burst upon being touched and the seeds can be carried downstream, which makes this plant very easy to spread. Japanese knotweed is a form of controlled waste and if removed mechanically needs to be disposed of at a licensed landfill site. Alternatively chemical control needs to span 3 to 4 seasons, which also makes managing this invasive a long term activity.

6.3.4. Species not yet present

In addition to the non-native species already present, a number of species not currently present in the catchment pose significant risks to the terrestrial and aquatic ecology. A biosecurity plan is in place in order to mitigate the possible risks of introductions, such as *Gyrodactalus salaris,* as much as possible. However the biosecurity plan will be updated within the lifespan of this management plan. Eradication /control programmes are in place for a number of non-native plant species although control is lacking in some areas.

6.4. Interactions with Aquaculture

Escapees from fish farms can interact with the wild population in a number of ways. Escapees can breed directly with the wild population, and this introgression reduces the fitness of the wild population. It is unknown whether natural selection can purge unfit domestic genes before the introgression causes population numbers to decrease. Escapees can also compete for space and resources with the wild populations of salmon, sea trout, brown trout and arctic charr.

6.5. Forestry

Large areas of the Kyle of Sutherland catchment contain commercial and non-commercial forestry. Forestry may have both positive and negative impacts on fish production. Negative impacts are likely to include silt inputs, altered hydrological regimes, acidification and over-shading of watercourses. Positive impacts include the provision of shade, nutrient inputs via leaf litter and increased inputs of terrestrial insects. Projects aimed at increasing levels of native riparian tree cover and improve forestry practices have been undertaken in recent years and it is expected that additional projects will be developed in future years.

6.6. Pollution

Diffuse and point-source pollution occurs in various locations within the catchment although overall water quality appears to be good.

6.7. Climate change

An emerging and episodic influence on fish production is the apparent increase in severe weather conditions, particularly flood episodes. There is an increased probability of redd washout etc. as a result of this factor. Linked to this are increased numbers of proposals for hard engineering, gravel removal etc. in respect of flood defence schemes all of which have the potential to damage fish stocks. Rising temperatures in small unshaded burns can also raise to lethal temperatures during heatwaves, killing fish. It is also possible that climate change is influencing marine survival of fish such as sea trout and salmon although the exact mechanisms for this are currently poorly understood. It is also possible that climate change has the potential to facilitate colonization by new species such as pink salmon. In addition to potential direct conflict such as competition for resources, these new species may also bring to native species.

6.8. Agriculture/land use

Agricultural practices are likely to have lowered the quality of habitat in many lowland areas via pollution, increased sediment inputs and inappropriate physical alterations to watercourses. However, effects of this appear to be restricted to a few isolated areas. Historical land drainage in upland areas may have altered hydrological regimes. In addition, a large number of new wind farm developments have the potential to impact on water courses if proper care is not taken.

6.9. Illegal activities

Illegal fishing has the potential to reduce the amount of fish available for legitimate fishing and may also reduce the number of adult fish available for spawning. In addition, historically there have been mass poisoning events which have killed a large number of fish and had a large impact on stakeholders. Water bailiffs patrol the catchment using a variety of different methods to try and reduce the impact of illegal activities.

7. Evaluation of actions in the previous fishery management plan.

7.1. District-wide actions

Limiting Factor	Location	Action Proposed	Action Carried Out (Y/N/P)	Action Ongoing?	Desired Outcome Achieved?	Comments
Abstraction and Impoundment	District wide	Develop Protocols for responding to applications for hydro-electric installations.	Y	N	Yes	Extended to developments such as wind farms etc.
Predation	District wide	Maintain piscivorous bird counts to support annual management license applications.	Y	Y	Yes	
Predation	District wide	Submit annual application for bird license to SNH in partnership with Moray Firth Predator Group.	Y	Y	Yes	
Predation	District wide	Review, maintain and implement Moray Firth Seal Management plan.	Y	Y	Yes	
Invasive Non Native Species	District wide	Maintain participation in Scottish Mink Initiative.	Y	Y	Yes	Now superseded by Scottish Invasive Species Initiative (SISI)
Invasive Non Native Species	District wide	Maintain high levels of awareness and encourage the development of preventative biosecurity measures for anglers and other river users.	Y	Y	Yes	Updated Plans required.
Illegal Fishing	District wide	Develop and implement a strategy for the effective policing of the Kyle district.	Y	Y	Yes	
Forestry	District wide	Continue to influence forestry design plans when consulted.	Y	Y	Yes	
Pollution	District wide	Maintain vigilance and report incidences to SEPA.	Y	Y	Yes	

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7.2. Carron Catchment

Limiting Factor	Location	Action Proposed	Action Carried Out (Y/N/P)	Action Ongoing ?	Desired Outcome Achieved?	Comments
Abstraction and Impoundment	Diebidale	Apply for funding for scoping/remedial action. Develop plan for restoration of fish population to upper reaches of Diebidale burn.	Y	N	Yes	Although scoping was carried out, remedial action is now required.
Abstraction and Impoundment	Glen Beag	Continue to liaise with SEPA and SSE to ensure that all practical actions are being undertaken to mitigate for losses as far as possible.	Y	Y	Yes	New actions being developed as part of new fishery management plan.
Abstraction and Impoundment	Glen Beag	Assess feasibility of installation of fish counter upstream of Glencalvie falls to better understand utilization of habitat upstream.	Y	N	Yes	Report completed. Various options for fish enumeration are available.
Abstraction and Impoundment	Glencalvie Falls	Develop protocols for annual assessment of Glencalvie Falls and ad hoc assessments when required.	Y	Y	Yes	Regular checks carried out by bailiffs and river workers.
Invasive Non Native Species	Braelangwell Gruinards	Continue, if required, to support river workers in controlling remnant populations of Japanese knotweed.	Y	Y	Yes	Believed to be under control.
Agriculture & Land Use	Braelangwell	Assess if restoration action could be eligible for Water Environment Fund.	Y	N	No	Not eligible for funding.
Climate Change	Carron	Investigate potential network of temperature monitoring probes for long term monitoring.	Y	Y	Yes	Continuation of monitoring and analysis of data is required. Investigate alternative avenues for collection and sharing of data.
Agriculture & Land Use	Carron	Assess hill drainage and other land uses for possible remedial action.	Y	Y	Yes	Bulk of drained areas appears to have had remedial action undertaken. If required support will be provided to proprietors seeking to undertake improvements.

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7.3. Cassley Catchment

Limiting Factor	Location	Action Proposed	Action Carried Out (Y/N/P)	Action Ongoing?	Desired Outcome Achieved?	Comments
Abstraction and Impoundment	Duchally	Assess distribution and abundance of juvenile salmon population downstream of Duchally Dam. Consider investigation into status of sediment.	P	Y	Partial	Better understanding of distribution achieved, but more electrofishing required.
Climate Change	Cassley	Investigate potential network of temperature monitoring probes for long term monitoring	N	N	N	Consideration for next iteration of fishery management plan. Potential use of new tools being developed by MSS.
Agriculture & Land Use	Cassley	Assess hill drainage and other land uses for possible remedial action.	Y	Y	Partial	Some drained areas identified on google earth. Some discussions with land owners.

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7.4. Oykel Catchment

Limiting Factor	Location	Action Proposed	Action Carried Out (Y/N/P)	Action Ongoing?	Desired Outcome Achieved?	Comments
Invasive Non Native Species	Lower Oykel	Continue, if required, to support river workers in controlling remnant populations of Himalayan balsam.	Y	Y	Yes	Will remain vigilant.
Forestry	Upper Oykel	Improve riparian habitat, increase native trees in riparian corridor hydrology and remove commercial trees from areas where they have been inappropriately sited	Y	Y	Yes	Achieved as part of PIP project. Will continue on.
Climate Change	Oykel	Utilise existing network of temperature probes and increase coverage of network.	Y	Y	Yes	Temperature network enhanced by collaboration with Scotland River Temperature Monitoring Network.
Agriculture/Land Use	Oykel	Assess hill drainage and other land uses for possible remedial action.	Y	Y	Partial	Some areas identified on google earth. Some remedial work has been undertaken as part of PIP project, however lacking fine detail in regards to hill drainage.

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7.5. Shin Catchment

Limiting Factor	Location	Action Proposed	Action Carried out (Y/N/P)	Action Ongoing ?	Desired Outcome Achieved?	Comments
Abstraction and Impoundment	Loch Shin	Continue with trials to assess passage rates of Tirry and Fiag smolts and potential remedial action	Y	N	Yes	Trap and Truck now identified as most effective remedial action.
Abstraction and Impoundment	Loch Shin	Continue to liaise with SEPA and SSE to ensure that all practical actions are being undertaken to mitigate for the presence of dams.	Y	Y	Partial	Discussions ongoing.
Abstraction and Impoundment	Shin	Assess efficacy of maintaining a hatchery operation to mitigate for SSE activities.	P	Y	Partial	Hatchery not currently being operated. Hatchery use will be assessed on a regular basis.
Abstraction and Impoundment	Grudie	Assess costs of trap removal against trap replacement	P	Y	Partial	Costs of repair currently being evaluated.
Abstraction and Impoundment	Grudie	Liaise with SSE about screening dewatered section of Grudie.	Y	N	No	SSE unwilling to consider screening.
Aquaculture	Loch Shin & Merkland	Continue to report suspected escapes to Marine Scotland Science. Continue to develop genetic screening of wild fish populations for potential introgression.	Y	Y	No	Suspected escapes still occurring. Work being undertaken to examine introgression.
Aquaculture	Loch Shin & Merkland	Improve knowledge base of trout and charr in Loch Shin.	P	Y	Partial	Scale samples read by Bryce White.

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Invasive Non Native Species	River Tirry	Continue to monitor the spread of stone loach in the catchment.	P	Y	Partial	More electrofishing on river Tirry being undertaken.

7.6. Evelix Catchment

Limiting Factor	Location	Action Proposed	Action Carried Out (Y/N/P)	Action Ongoing ?	Desired Outcome Achieved?	Comments
Invasive Non Native Species	Evelix	Develop plan for the control of Himalayan balsam within the catchment.	N	N	No	Development of plan for next iteration of FMP.
Forestry	Evelix	Improve riparian habitat, increase native trees in riparian corridor hydrology and remove commercial trees from areas where they have been inappropriately sited	P	Y	Partial	Consultation responses submitted to forestry design plans
Abstraction and Impoundment	Evelix tributary	Assess if alternative arrangements could be made to reduce abstraction and restore original course of burn.	N	N	No	Not considered to be an issue by PIP project habitat assessors.
Illegal Fishing	Evelix	Increase dissemination of information to proprietors and anglers.	Y	Y	Yes	
Pollution	Lower Evelix	Investigate current status of water quality and sampling regime.	Y	N	No	Discussions held with SEPA.

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7.7. Coastal Catchment

Limiting Factor	Location	Action Proposed	Action Carried Out (Y/N/P)	Action Ongoing?	Desired Outcome Achieved?	Comments
Invasive Non Native Species	Coastal	Develop plan for the control of non-natives within the catchment.	N	Y	N	Will consider in next iteration of FMP
Abstraction and Impoundment	Spinningdale Burn	Fit appropriate screen to lade entrance.	N	Y	N	Would require funding.
Agriculture & Land Use	Loch Eye	Assess if burns would benefit from habitat improvement.	P	N	N	SEPA WEF unlikely to fund.

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8. Current and future management actions.

8.1. District-wide actions

Location	Proposed Management Action	Potential Partner Organisations	Link to Research Objectives?	Continuous or Time Limited Action
District Wide	Maintain piscivorous bird counts to support annual management license applications. Consider increasing frequency of counts and altering counting methodology.	River Workers, SNH, Tain Field Club	8.3	Continuous
District Wide	Submit annual application for bird license to SNH in partnership with Moray Firth Predator Group.	SNH		Continuous
District Wide	Review, maintain and implement Moray Firth Seal Management plan.			Continuous
District Wide	Maintain participation in Scottish Invasive Species Initiative.	Cromarty Firth Fisheries Trust		Continuous
District Wide	Maintain awareness of pink salmon. Continue collecting information on sightings/catches, and collect carcasses to take samples from where possible.	FMS, MSS	8.12	Continuous
District Wide	Raise awareness of Skunk Cabbage, seen in other districts, and assist with removal if required.	SISI		Continuous
District Wide	Continue to implement the strategy for effective policing of the district.			Continuous
District Wide	Consider joint patrols with bailiffs from neighbouring fishery boards.	Cromarty Firth Fishery Board,		Continuous
District Wide	Continue to influence forestry design plans when consulted.	Forestry Commission		Continuous
District Wide	Maintain vigilance and report incidences to SEPA			Continuous
District Wide	Update fish distribution maps.			Time limited

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8.2. Carron Catchment

Issue Category	Location	Proposed Management Action	Potential Partner Organisations	Link to Research Objectives?	Continuous or Time Limited Action
Abstraction and Impoundment	Diebidale	Continue to liaise with dam owner and SEPA to facilitate remedial action.	Landowner, SEPA		Time Limited
Abstraction and Impoundment	Glean Beag	Plan and undertake adult salmon tracking on Carron system with particular attention to obstacle passage and fish movements in Glean Beag. Undertaken in support of potential compensation flow changes.	SSE, Landowners		Time Limited
Abstraction and Impoundment	Glean Beag and Carron	Consider use of genetic techniques to enumerate salmon populations in Carron, particularly in Glean Beag	SSE, Academic Partners	8.6	Time Limited
Invasive Non Native Species	Braelandwell, Gruinards	Continue, if required, to support river workers in controlling remnant populations of Japanese knotweed.	River workers, SISI		Continuous
Climate Change	Carron	Continue monitoring the temperature network. Explore other avenues of data collection and sharing.	River workers' SRTMN		Continuous

8.3. Cassley Catchment

Issue Category	Location	Proposed Management action	Potential Partner Organisations	Link to Research objectives?	Continuous or Time Limited Action
Abstraction and Impoundment	Duchally	Conduct more electrofishing surveys to examine the distribution and abundance of juvenile Atlantic salmon.			Continuous
Abstraction and Impoundment	Duchally	Consider carrying out investigations into smolt passage at Duchally Dam	SSE, SEPA		Time Limited
Climate Change	Cassely	Explore options for a temperature monitoring network,			Continuous

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		and how this could feed into tools being used by MSS.			
Agriculture and land use	Cassely	Continue discussions with land owners in regards to remedial action for hill drainage.			Continuous

8.4. Oykel Catchment

Issue Category	Location	Proposed Management action	Potential Partner Organisations	Link to Research Objectives?	Continuous or Time Limited Action
Invasive Non Native Species	Lower Oykel	Continue, if required, to support river workers in controlling remnant populations of Himalayan balsam.	River workers, SISI		Continuous
Agriculture and land use	Upper Oykel	Continue enhancement of riparian habitat that began with the PIP project.	Land owners		Continuous
Climate Change	Oykel	Continue use of network of temperature probes. Use this network to inform tree planting activities.			Continuous
Agriculture/Land Use	Oykel	Continue to encourage and facilitate hill drainage remediation.	SNH		Continuous

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8.5. Shin Catchment

Issue Category	Location	Proposed Management Action	Potential Partner Organisations	Link to Research Objectives?	Continuous or Time Limited
Abstraction and Impoundment	River Tirry	The River Tirry rotary screw trap has been identified as losing circa 70% of smolts. Liaise with SEPA and SSE about other avenues to explore in order to capture a higher percentage of smolts.	SSE, SEPA, FMS		Continuous
Abstraction and Impoundment	Grudie	Finalise costs of repairing trap for short term scientific work.		8.2	Time Limited
Abstraction and Impoundment	Grudie	Maintain hatchery so that it can be used if necessary.		8.2	Continuous
Abstraction and Impoundment	Shin	Consider use of instream works to improve spawning gravels in upper reaches of the Shin.	CBEC, SSE		Time Limited
Aquaculture	Loch Shin	Continue sampling of fish believed to be of a farmed origin. Supply MSS with genetic material to inform their introgression project. Continue introgression project with UHI to quantify levels of introgression in the population, but look for other project partners if necessary.	MSS		Continuous
Invasive Non Native Species	River Tirry	Remain vigilant for stone loach during electrofishing surveys on the River Tirry. Consider targeted surveys for stone loach.			Continuous

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8.6. Evelix Catchment

Issue Category	Location	Proposed Management action	Potential Partner Organisations	Link to Research Objectives?	Continuous or Time Incontinuous Action
Invasive Non Native Species	Evelix	Develop plan for the control of Himalayan balsam within the catchment.	SNH		Time Limited
Abstraction and Impoundment	Evelix	Liaise with Skibo estate about use of the data from the fish counter installed.		8.15	Continuous

8.7. Coastal Catchment

Issue Category	Location	Proposed Management action	Potential Partner Organisations	Link to Research Objectives?	Continuous or Timed Action
Invasive Non Native Species	Coastal	Develop plan for the control of non-natives within the catchment. Examine the possibility of liaising with other organisations.	SNH, Tain Field Club		Time Limited
Abstraction and Impoundment	Spinningdale Burn	Explore costings and options for funding to fit an appropriate screen to the entrance of the lade.			Incontinuous

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9. Scientific Managment Research Objectives

9.1. Introduction

Scientific work undertaken within the catchment feeds into management decisions intended to protect and/or enhance the fishery. As such, questions must be asked in order to guide scientific research to investigate topics that are of the most concern to management. With information addressing concerns management can decide upon the most appropriate actions to take. Many of the objectives below would require significant funding in order to be brought to fruition. However, the objectives provide a framework of research requirements that can be used to identify possible funding streams.

9.2. Grudie Wolf trap

9.2.1. Wolf Trap Efficacy

Rotary screw traps have been deployed by Kyle Fisheries for various projects, primarily for mitigation measures in order to transport smolts below Lairg Dam. From mark recapture trials we have estimates of the smolt runs on the Tirry and Fiag, although there is a great difference in the efficiency of the traps between the two sites. Another common type of trap which is less utilized due to the initial installation being expensive is a Wolf (total capture) trap. However, it would appear that not much work has been done to assess the capture efficiency of a Wolf trap.

The Grudie burn would be the ideal site for this experiment, due to the already existing Wolf trap which would require, requires repairs to be operational, and the fact that the burn is free of brown trout as it has historically been treated with rotenone. Predation from birds would also be limited due to the burn not being ideal habitat for sawbills, and therefore predation should not have a large impact on studies competed on this burn.

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9.2.2. Contribution of hatchery fish to the fishery

One of the key questions with any hatchery operation is how many of the hatchery fish return from sea and are caught on rod and line by anglers. There are various methods of assessing this, by fin clipping, coded wire tagging, PIT tagging or marking fish in some way. However, with some tags there may be issues with tag failure or failure to detect a tag. Taking genetic samples from bloodstock and juvenile hatchery fish, and then comparing with samples taken from rod caught fish (DNA could be extracted from scale samples, or a clip of the caudal fin). In this manner, rod caught fish may be assigned as being wold or hatchery reared, and thereby the contribution of the hatchery fish to the fishery could be assessed.

9.2.3. Assessment of hatchery practises in maintaining genetic diversity

Best practise for hatchery operations involves mixing several batches eggs from a single hen fish with the milt of several cock fish. This maintains the genetic diversity of the fish being released into the wild, which enhances the ability of the hatchery population to adapt to a changing environment, or even cope with extreme events (such as heatwaves).

If the hatchery is in operation, then a "best practice" approach of crosses can be compared with an older approach of fertilizing an entire clutch of eggs with milt from one male salmon. It may be possible to then quantify how much variation is present in "best practice" fry compared to older methods. An academic project partner would be ideal to keep the costs of this work down, perhaps offering as an honours or MSc project.

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9.3. Sawbills and Piscivorous Birds

9.3.1. Gut content analysis

Piscivorous birds are perceived to be a threat to Atlantic Salmon stocks, particularly smolts. However data on sawbill exploitation of smolts is rather sparse which makes it difficult to assess the actual impact these predators have on salmon stocks as a whole, rather than fish numbers in localised areas. In order to assess such an impact, multiple pieces of information are required. Largely this is how many fish are eaten per day of different species. Once this is estimated it can be used in conjunction with sawbill counts to extrapolate a broad estimate of how many fish may be eaten per time period. However this approach may be simplistic as there is likely to be temporal, individual and spatial variation in how much these birds eat, and their prey selection. Nevertheless, where possible the carcasses of piscivorous birds shot under license should be recovered for gut content analysis. Although very few birds are shot, it would be prudent to collect this information to draw upon in the future. Later work could feed this information into a model predicting the impacts of sawbill predation on the salmon stocks of various theoretical sizes, be this work undertaken by Kyle Fisheries or an external body.

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9.3.2. Telemetry

One of the large issue with any efforts to quantify the impact of sawbills on salmonid populations is that it is poorly understood how sedentary the birds may or may not be. A potential project to address this knowledge gap would be to attempt to track the movements of some of these birds. Such a project would likely take place in collaboration with other stakeholders, such as Science and Advice for Scottish Agriculture and SNH.

9.3.3. Effectiveness of scaring with lasers

High powered lasers are being used more often now for scaring birds within an agricultural setting. Bird species such as Canada geese, pigeons, starlings, seagulls, crows, house sparrows are dispersed with this tool. Examining the effectiveness of such a laser for scaring sawbills would be of a great advantage, especially during the smolt run. Not only have lasers proven to be highly effective in other species, the laser is less of a problem to other nearby people or animals than a gas gun.

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Informal discussions have been had with GWCT about the possibility of the loan of a laser for a study examining this, and there may be a window of opportunity in winter. This would be when the wintering populations of sawbills will be within the district, therefore there should be enough birds to test the laser on. If successful, this could be a valuable tool in the management of sawbills.

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9.4. Sediment Fingerprinting

Sediment deposition can affect survival of fish on rivers. It has been shown not only the amount of sediment but also the source of sediment are both independently important in determining the fitness and mortality of alevins. In addition, excessive sediment deposition has the potential to smother freshwater pearl mussels. This is a particular concern in the River Oykel which is a SAC for freshwater pearl mussels. In cases where sediment has been deposited in rivers, "sediment fingerprinting" is a technique which can determine the likely land use the sediment originated from, and therefore direct efforts if remedial action is required. Work is also ongoing to refine this technique to give a geographical source location of the sediment rather than just a land use. There have been instances of sediment deposition in the Kyle of Sutherland catchment where this technique could prove useful, this may be explored with academic partners.

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9.5. Applications of a drone for aerial imaging.

Unmanned Aerial Vehicles (UAV) are becoming increasingly popular in fisheries management for a wide variety of applications. These range from doing redd counts where water is clear enough, monitoring silt deposition into burns, mapping areas of river bank to monitor bank erosion over time. When Giant Hogweed is flowering, a drone can be used to map the area covered, and the same can be used for other invasive plant species if the camera resolution is high enough. Work in the Moray Firth is being carried out to count seabirds using UAV's, with a view to creating software that counts and identifies species automatically. Kyle Fisheries could consider using UAV's to assist with sawbill counts. Other fisheries trusts also utilise drones for enforcements, and this could be investigated. Using a drone for professional work such as site monitoring will require a staff member to obtain a PfCO license.

9.6. Genetics.

Genetics projects can give us insights into many aspects of ecology and variance or similarity between populations. Developments of Single Nucleotide Polymorphisms (SNP's) allows for more powerful investigations to be undertaken than microsatellite loci have previously allowed. Kyle Fisheries has to outsource genetics work due to the equipment required and has close links with the Rivers and Lochs Institute based in inverness, which has been a project partner in the past for genetics projects.

9.6.1. Genetic techniques of assessing breeding population.

Marine Scotland Science and others have recently investigated the possibility of using genetic sampling to reconstruct population size. This might be a possible way to assess populations in the

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catchment. If trialled within the Evelix this could be compared against estimates from the fish counter data when it becomes available. The technique may then be utilized on other river systems.

9.6.2. Assessment of diversity between juvenile salmon caught in the Kyle and in neighbouring rivers.

Possible use for stable isotope analysis. Are fish in the Kyle adapted to salinity? Do they have a higher salinity tolerance, is there phenotypic or genotypic divergence? Do juvenile fish spend some time in the Kyle and then go back to their rivers?

9.6.3. Investigate potential applications of eDNA.

Environmental DNA (eDNA) is a recent tool which has been developed in order to discern the presence or absence of species from samples taken from the environment. Currently being used to detect American Signal Crayfish and pink salmon in rivers and lochs, it has potential applications for other species also. It could be used to investigate the presence or absence of Atlantic salmon above ostensibly impassable barriers in cases where sightings have been reported, in conjunction with other techniques such as electrofishing. In addition, it could be used to monitor the presence of pink salmon in rivers over the coming years.

9.6.4. Archiving genetic material.

Genetic material can be extracted in a non-lethal manner from tissue samples (fin clips) and scale samples. Kyle Fisheries has scale samples from previous years, as well as genetic samples from smolts and broodstock. Archiving this material and creating an inventory system would create an invaluable source of material that could be utilized in future years by Kyle Fisheries as a historical baseline. In addition to collating and archiving pre-existing samples, a strategy to bolt on collection of new genetic samples to other work may be devised. For example, obtaining genetic or scale samples from electrofishing surveys, or from smolt trapping. The methods of long-term tissue storage, or "biobanking" would need to be investigated.

9.7. Electrofishing GRTS sites.

Beginning in 2018, Marine Scotland are trialling a scheme of randomly selected electrofishing sites with the overall goal of using this information on juvenile populations to feed into designation of the conservation limits alongside the rod catch assessments. In 2018 funding is available for fishery boards across Scotland to participate in the national plan. The proposed plan covers 9 years work in total, however a review will take place after the first year in 2018. It will be at least two years before this work feeds into how the conservation regulations are determined.

9.8. Scale reading.

In managing the fish stocks, we need to understand the age structure in order to feed into management decisions. To this end, we will continue collecting scales from rod caught fish as well as parr caught during electrofishing surveys. Collection of scales from anglers and ghillies will be encouraged and any necessary training provided. Scale packets will be provided also. Reading can be

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paid for, but a move towards in-house reading will be attempted. In addition, scales will be stored and a database of scales created. Although there may not be attempts to re-examine the ages of fish scales read, retaining them could provide valuable material for any future genetic studies. In addition, uploading scale photographs to the website may provide an opportunity for those involved in scale sampling to have a look at the scales they took, and to have a go at reading them.

9.9. Tracking and Tagging.

Tracking and tagging of salmon can provide several useful sets of information. If salmon are netted and tagged in the Kyle at Bonar Bridge or the lower reaches of rivers, they can be tracked as they travel up to spawning areas. This can identify the areas utilised for spawning and the ability of fish to pass barriers on their upstream migration, but also can give information on migration timing and how long it takes fish to travel up rivers. It can also give information on how many fish "drop out" of the Kyle system, if they are only entering the system to nose into a river.

In addition, the Moray Firth tracking project coordinated by the Atlantic Salmon Trust seeks to track smolts as they go to see, in order to determine where fish mortality is taking place. They intend to do this by fitting acoustic tags to fish, and have two arrays of receivers in the Moray Firth (a possible third in the Dornoch firth). If manageable, Kyle Fisheries is scheduled to participate in this project with smolts from the Oykel and Shin.

9.10. Develop an education/outreach programme.

In order for the fisheries sector and as a whole to be sustainable, we need to educate the younger generation and inspire them to get involved. Not only this, but outreach with other age ranges and audiences who do not currently have an interest in fisheries or conservation. Education and outreach are two separate activities. Education would involve working with local schools on projects such as hatchery visits, salmon in the classroom or scale reading. Outreach would involve hosting events, or, collaborating with local nature and biodiversity groups for events such as electrofishing demonstrations.

9.11. Investigate kelt reconditioning.

Kelt reconditioning is recovering salmon which have spawned, and rearing them on to be broodstock for hatchery operations. The advantage of using kelts for broodstock is that they have already contributed to wild egg numbers, and otherwise would likely die. If kelts are kept in reserve as broodstock, this reduces the number of wild salmon taken in future.

In the case of the river Tirry, kelts captured from the nearby river Fiag could potentially be used as broodstock to plant into the Tirry. Or, the chemical profile of the river Tirry could be used as a basis for selecting a similar river from which to take broodstock if this river was to be stocked again.

9.12. Monitoring pink salmon.

Pink salmon appeared across Scottish rivers in their largest recorded numbers in 2017. In the freshwater habitat, work done by Marine Scotland Science and DSFB's shows that pink salmon eggs

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will hatch in conditions found in Scottish rivers. Due to a difference in the life cycle of pink salmon and Atlantic salmon, it is not expected that there will be competition between the juvenile stages of the two species. However, there may be competition at sea and the presence of pink salmon should be closely monitored as this may be the start of colonization.

Juvenile pink salmon are easily differentiated from Atlantic salmon by the absence of parr marks. Therefore, any pink salmon found in electrofishing surveys late in the year can be retained for genetic analysis. Similarly, carcasses of adults can be retained for the same purpose.

Due to potential conflicts at sea, Kyle fisheries can undertake work in years when pink salmon are observed with a mind to informing future studies. One such example would be capturing pink salmon smolts to assess their size. If they are large enough to fit acoustic tags then a collaborative approach similar to the Moray Firth tracking project could investigate their migration routes, and whether they overlap with Atlantic salmon.

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9.13. Exploitation rate.

Previous work has examined the recapture rate of Atlantic salmon caught on rod and line, which was found to be very low at circa 3-4%. To build upon this, future work would ideally examine the proportion of wild fish caught on rod and line as a fraction of the overall population (the exploitation rate). Research shows that once fish have been caught using a certain type of gear they are less likely to be caught on that type of gear again. This would be done in such a manner as netting would take place at Bonar Bridge, and these fish would be tagged. Floy tags would work well for this purpose as they're easily identifiable by anglers and ghillies and do not require any special equipment to read. The percentage of Floy tagged salmon caught by the rod fishery cumulatively on the 4 rivers would then give the exploitation rate, which would allow the overall salmon population to be estimated from the rod catches. Ideally, this would be done over a number of years with nettings undertaken regularly through the year in order to identify any temporal variation in the exploitation rate. Initially radio tracking would likely be used in conjunction with Floy tags in order to ascertain the percentage of salmon caught in nets at Bonar Bridge that dropped downstream and left the catchment. In the absence of a network of fish counters in the lower reaches of rivers, this appears the most feasible method along with genetics of enumerating overall adult abundance and detecting trends in this abundance.

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9.14. Evelix smolts.

The presence of the Vaki fish counter on the Evelix system presents a unique opportunity to compare numbers of returning salmon and grilse with numbers of migrating smolts. A smolt trap on the Evelix would allow for the collection of genetic samples and for the entire smolt run to be estimated, if a capture efficiency for the trap was generated. This technique could be used in conjunction with a genetic assessment of the breeding population and the fish counter data, in order to investigate how the estimates from these different techniques would be. Over a long time period, these actions would allow a stock recruitment curve to be generated.