Awe Catchment
Fishery Management Plan




Summary; 2014 - 2019 (*DRAFT 1.1. -February 2014)*

Plan Summary

Introduction

The Awe catchment area is an important freshwater resource for both biodiversity and the rural economy in the region of Argyll and the Islands. The full recreational and economic potential of the river catchment is not currently being fully realised due to a range of factors affecting the productivity of both the freshwater and marine habitats. This Fishery Management Plan (FMP) seeks to identify and where possible address the factors causing a reduction in biodiversity, fish abundance and subsequent health of fish and fisheries.

Aims and objectives

The limited resources generated by an underperforming fishery dictate that some prioritisation of management activities is required to deliver best cost benefit. The priorities of the plan are focused on three main areas;

- **Fisheries** - conserve their diversity and improve their performance through sustainable means
- **Habitat & biodiversity** – maximise the use of naturally accessible habitat and improve habitat condition to achieve benefits a wide range of species.
- **Knowledge gaps** – undertake investigative work to better understand the fisheries resource and factors affecting productivity to inform future management.

Fishery Description and Analysis

The Awe catchment hosts a diverse range of freshwater habitats; streams, rivers and lochs with a mixture of native and introduced species, but fisheries are mostly concentrated on Atlantic salmon, brown trout and pike. The health of fish populations and the sustainability of fisheries required freshwater habitats are in optimal condition. The general trends in abundance of fish indicate a decline in native species with consequences for the performance of the fisheries. The human-derived pressures acting on freshwater habitats are many; forestry, agriculture and infrastructure development alongside the increasing development of renewable energy schemes. While some habitats are in good condition others are in less than good condition. Some other pressures are identified by regulators to have overriding socio-economic benefit so they are unlikely to be tackled completely but may be mitigated to benefit fisheries and biodiversity in the longer-term.

Management Actions

Existing fishery management bodies are required to cooperate and engage with other sectors to implement different elements of the plan and secure some of the required funding. The main activities include:

- **Protection of fish and habitat** – by managing exploitation of fish, consulting with developers and agencies, implementing biosecurity measures and building-in resilience of habitats to the effects of further climate change
- **Improving productivity of habitats** - by ensuring that all naturally available habitat is accessible to fish, improving the condition of the habitat by restoring bio-diverse riparian habitats and mitigating for renewable energy schemes.
- **Filling knowledge gaps** – by building-on previous research of fish population structures, their habitats and migration routes and the factors affecting abundance to inform future phases of the management plan.

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Cover Pictures: top left – *Salmon fishing on the River Orchy,* top right – *three age classes of juvenile salmon,* bottom right – *A view over Loch Awe and Ben Cruachan,* bottom left – *Catch & release of a summer grilse*

Acknowledgements
We thank the Loch Awe Improvement Association (LAIA), Awe District Rivers Improvement Association (ADRIA), and the Argyll District Salmon Fishery Board (ADSFB) for funding, guidance and facilitation of this plan.

1. INTRODUCTION

The Awe catchment is the largest and most diverse freshwater catchment area in Argyll and the Islands which sustains a variety of fish species and habitats that are an important part of the region's biodiversity. The full recreational and economic potential of a range of fishery opportunities for Atlantic salmon and brown (including sea-run) trout are not currently being fully realised due to a range of factors affecting the productivity of both the freshwater and marine habitats that are utilised in different life-phases of these species. This Fishery Management Plan (FMP) seeks to identify and where possible address the factors causing a reduction in fish abundance and subsequent catches of fisheries.

This fishery management plan (FMP) developed by Argyll Fisheries Trust (AFT) is one of a number of plans envisaged by the Argyll & the Islands Strategic Fishery Management Plan to improve the management and health of fisheries and optimise benefits to local biodiversity and economy. The plan refers to guidance from international (NASCO & ICES) and national policy makers as well as guidance from professional bodies (IFM), the wider fishery sector in Scotland (RAFTS) and species specific interest groups for Atlantic salmon, brown trout and coarse fish. A range of information has been collected at the local scale that has been collated to inform the management actions detailed in this plan. The management and improvement of the freshwater resources of Argyll are also influenced by the Water Framework Directive administered by the Scottish Environment Protection Agency (SEPA) through the development of River Basin Plans. There are also a range of other plans and policies that require engagement from fisheries interests to ensure the resource is conserved. These activities include aquaculture, forestry, farming, renewable energy, local development and biodiversity.

1.1 Management mission

This plan seeks to provide a flexible framework for adaptive management of the fishery resources of the Awe catchment area. The underlying drivers for improving management and regeneration of this unique and renewable fishery resource are many, but are principally to conserve and improve fish populations, their habitat and fisheries while defending it from factors that may further undermine its capacity to produce self-sustaining fish populations.

1.2 Management of the plan

It will be important to ensure that the recommended actions are effective and that the progress of the plan is assessed and adapted accordingly over time. Delivery of the wider benefits of the plan will require a broad ownership and participation by all interested parties. Therefore, the first draft of the plan is likely to be amended according to the level of input from stakeholders through consultation.

The plan seeks to engage and involve a wide range of interests operating at the local scale;

- **Fisheries interests** – Anglers, owner/managers, Loch Awe Improvement Association (LAIA), Awe District River Improvement Association and Argyll District Salmon Fishery Boards (ADSFB)
- **Land & water resource users** – Forestry Commission (FC), Argyll Agriculture Forum interests, Aquaculture companies and Renewable energy developers
- **Regulatory bodies** – Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH) and Argyll & Bute Council (A&BC)

2 AIMS AND OBJECTIVES; Priorities for management

The limited resources generated by an underperforming fishery dictate that some prioritisation of management activities is required to deliver best cost benefit. To deliver effective management and improvement of the resource over the long term, it is essential to employ a management strategy that delivers activities that tackle the causes of decline such as habitat degradation where initial investment in improvements are returned over a long period of time rather than treating the symptoms of decline (a lack of fish) through costly on-going repetitive activities such as stocking which are now known to damage wild fish populations (RAFTS, 2014).

2.1 Fisheries priorities

The **native species**; brown trout, its migratory form, the sea trout and Atlantic salmon are the most significant species that support **rod & line fisheries** in the catchment and therefore the priority is to conserve their diversity and improve their abundance through sustainable means. Maximising benefits and **avoiding activities that can cause harm** to other native species such as Arctic charr, European eel and lampreys is also a consideration for management. Managing the **exploitation of native species** is a priority to ensure the regeneration of young fish that represent the future of the fishery. It is therefore essential to tackle potential biological and ecological issues that may undermine the **production of young fish**.

Where present, introduced coarse fish species also support fisheries, but as a non-native species they have a lower priority in regard to biodiversity initiatives. Maintaining a biomass of large pike that is in balance with the other coarse fish such as roach and perch are both important to the fishery and a mechanism for **natural control of predators** and other non-native species that may compete for limited resources with native species. Management of bio security issues are also required to **prevent further introductions of invasive non-native species** (INNS).

2.2 Habitat & biodiversity priorities

The effective management of freshwater habitats are a common aspect for all fisheries in the catchment. Therefore, **maintaining and improving the productivity of key habitats** that produce young fish is a high priority for management. The reinstatement of connectivity in fragmented habitats by **removing or easing man-made barriers to fish migration** has the highest potential to contribute to recruitment of native species. Engaging and establishing a working relationship with significant water and land resource users that can generate **management activities at a catchment-scale** will be important to achieve improvements of sufficient scale to be of benefit to fisheries. A growing number of stakeholders such as the Forestry commission also have aims driven by the River Basin Plan to initiate measures to improve riparian habitats and control and eradicate non-native flora in key fish habitats. The **protection of habitats** against inappropriate development through the planning and consultation process is essential to maintaining productive habitats.

2.3 Knowledge gaps

Robust and up-to-date knowledge of the fishery resource is fundamental to informing the management strategy and the on-going process of decision making. While much information has already been obtained, gaps in our knowledge remain. Priorities for further investigation are related to **genetic structuring of populations** of fish, **effects of fisheries and other influences** on their abundance and how and where

further effects of **climate change** may undermine the suitability of habitats to support native species.

3. FISHERY DESCRIPTION AND ANALYSIS;

The Awe catchment hosts a diverse range of freshwater habitats and fisheries are mainly focused on Atlantic salmon in the Rivers Awe and Orchy, mixed trout and coarse fish in the larger lochs and resident brown trout in smaller hill lochs (Figure1).

3.1 Atlantic salmon

The fishery for salmon is based on two forms; larger salmon that spend more than one winter at sea (multi sea-winter) and the smaller salmon (grilse) that spend only one winter at sea which support a relatively long angling season (May through to October). Studies of Atlantic salmon genetics in the Awe catchment indicate that there are at least 6 or more distinct breeding populations present, each of which are likely to exhibit different life-history characteristics that have evolved to suit the local environment. The differences in 'genotypes' are likely to be reflected in the age, body size and run timing which are important in respect to the variation and length of the salmon fishing season. Understanding the complexity of salmon populations and how they are exploited by the fishery is a key requirement of conservation and effective management of the fishery.

A successful self-renewing fishery requires that a sufficient proportion of young salmon (smolts) that migrate to sea to feed, subsequently return to their home rivers to spawn the next generation. However, the survival of salmon at sea has changed; a decline of 66 % for 1 sea-winter salmon (grilse) and 81% for multi sea-winter salmon since the 1970's. These two groups of fish are thought to feed in different areas of the North Atlantic and may therefore be subject to different pressures. The relatively low number of salmon currently returning to the fishery requires that management is focused on conservation to ensure stocks are sufficiently healthy so that they are able to adapt to the on-going challenges occurring at all life-stages as a result of climate change.

Multi sea-winter salmon enter the fishery from spring and early summer while the more numerous one sea-winter grilse generally return from mid-summer through to autumn. Fish counter and fishery catch data show that there is a much higher exploitation of salmon (50-70 % of salmon are caught in the fishery) compared to grilse (10-20 %). These differences require that multi sea-winter salmon require a high level of protection until their numbers recover although there also appears to be more recent declines in grilse numbers that require review of fishery management policy.

Trends in stock abundance and salmon fishery performance

Unlike most fisheries in Scotland, a fish counter provides an accurate estimate of the number of salmon entering the catchment each year providing an opportunity to analyse trends and operate the fishery on the basis of real-time information. Since 1985 the salmon fishery catch has averaged 481 salmon per year with a similar number caught in the River Awe (243) and the River Orchy (239). On average, the catch has consisted of 46 % salmon and 54 % grilse. Trends in salmon and grilse catches have broadly followed the trends of the number of returning fish entering the fishery; decreasing from a peak of over 1,000 fish caught in 1989 to 140 fish in 1998 and increasing to over 600 fish in 2005 and 2007 before decreasing again to just over 200 fish in 2009 and over 400 fish in 2011 and 2012 (Figure 2).

Figure 1. Location of fisheries in the Awe catchment

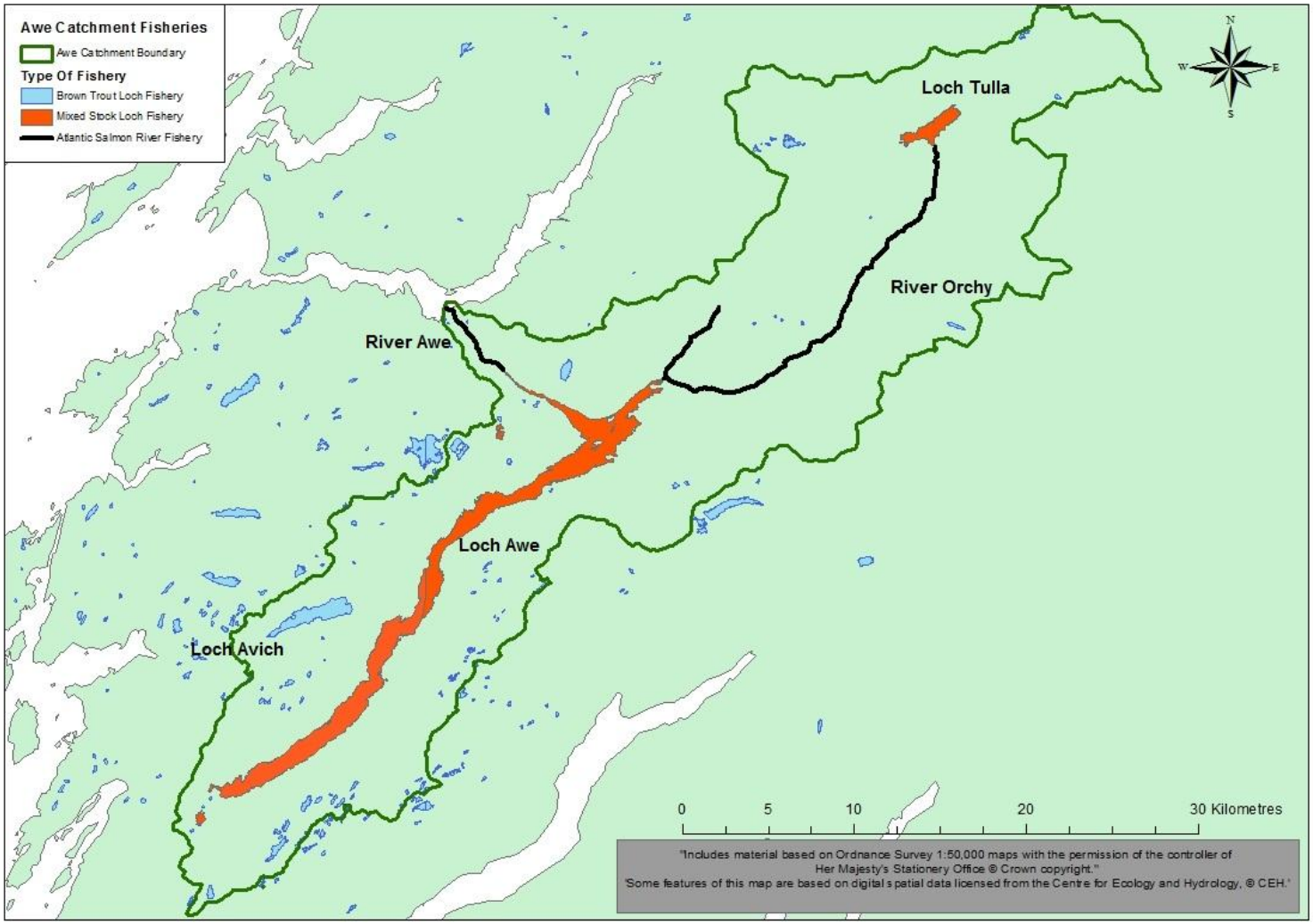
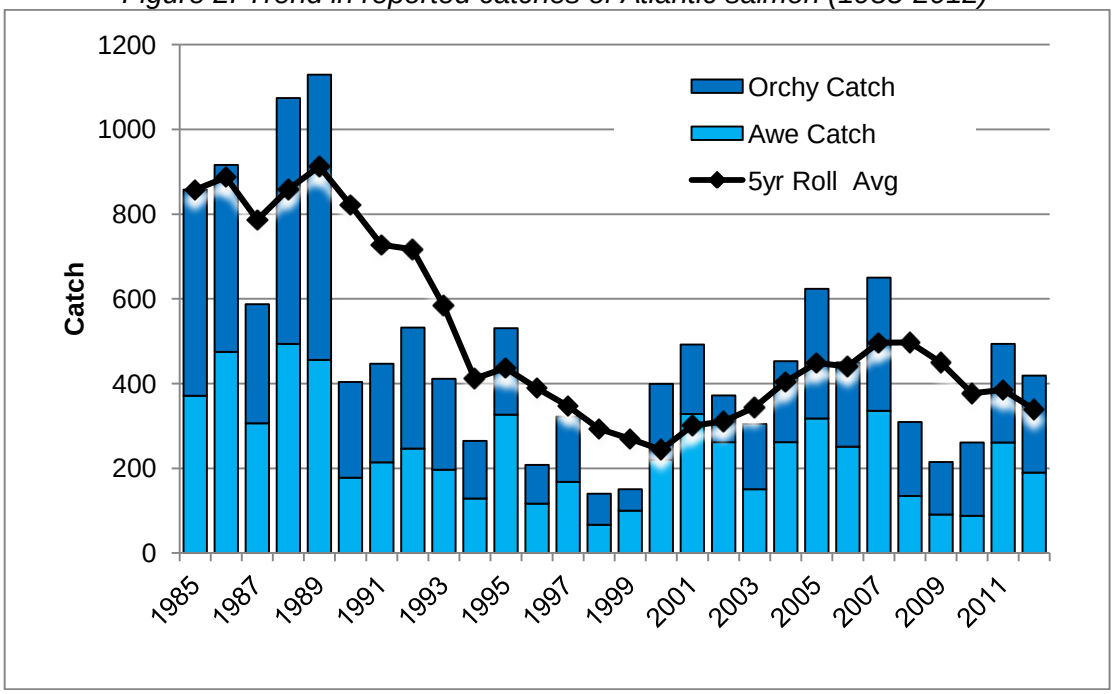


Figure 2. Trend in reported catches of Atlantic salmon (1985-2012)



Factors, other than the number of salmon returning, affecting the fishery catch are related to water flow. The regulated flow on the River Awe provide suitable flows for fishing throughout the season, while the Orchy fishery relies on natural rain-fed spate flows to provide optimal angling conditions and therefore angling opportunity may vary between and through each season.

These data suggest that some populations within the stock may be at risk of over exploitation by the fishery in years when the numbers of adults that return are low. However, since the introduction of catch and release angling practices in 1999 an average of 93 % of multi sea-winter salmon and 85 % of grilse caught have potentially been able to spawn after being released by the fishery (Figure 3).

Maintaining production of juvenile salmon

Continued operation of the fishery during periods when few salmon are returning to spawn requires that all or a high percentage of those salmon are able to spawn and subsequently maintain the production of smolts going to sea. The introduction of catch and release and improvement in the numbers of returning adults has seen similar number of eggs available for recruitment between 2000 and 2009 (average 4.3 million eggs) compared to that available in the 1960s, 70s and 80s despite fewer smolts returning as adults (Figure 4) due to the catch and release policy that reduce the loss of eggs in the fishery. However, a more recent decline in adult returns has meant that fewer eggs are available despite catch and release angling (average 2.6 million eggs). Ensuring that there are sufficient numbers of eggs to re-stock the available habitat is a fundamental goal of management which is currently being met by the adoption of the catch and release strategy by the fishery. To maximise the benefit of this approach, it is essential that as many of those juveniles are able to grow and survive so that smolt production from the catchment is maximised. Counter data show that even when relatively few adults return to spawn (e.g. 1998 and 1999), the large number of eggs carried by adults ensure that stocks can recover quickly given that the habitat remian productive. The fundamental restrictions on the production of smolts is the quantity and condition of freshwater habitat required to support young fish.

Catch & release angling has become established to conserve remaining stocks

juvenile numbers have been maintained by release of rod-caught salmon

There have been a number of previous attempts to increase fishery catches by operating hatcheries in the catchment, but none have been sufficiently successful to make a significant contribution to catches. More recent research has shown that the genetic complexity of populations, lack of natural selection in the hatchery environment and subsequent poor survival of stocked salmon are mainly responsible for this lack of success from operating hatcheries.

Stocking operation	Cause	Effect
Broodfish capture	Capture & use of fish from different breeding groups	Out-breeding depression – poor survival of progeny
	Capture / use of closely related fish	In-breeding depression – poor survival of progeny
	Removal of wild broodfish	Reduced wild production
Hatchery-rearing	Selection of genes suited to hatchery environment	Hatchery population differ to that found in the wild.
	changes to body shape / fin condition	Reduce fitness of population to survive in the wild
Post releases	Domestication & lack of natural selection	Poor survival of stocked compared to wild fish
	Hatchery fish spawn with wild fish	Reduce the genetic variation, fitness and adaptability within wild population
Management	Lack of post-stocking assessment – false interpretation of the contribution of the hatchery to the fishery	Poor use of limited time and resources Reduce investment in habitat protection and improvement

Where hatchery stocking to benefit fisheries has been succesful in returning significant numbers of fish caught by the rods and spawn in the wild, it has been shown to subsequently reduce genetic variation in the stock and undermine the natural capacity of wild populations of salmonid fish to adjust to changes in the environemnt with consequences for their long-term survival. On the basis of this overwhelming and comprehensive scientific information on the damaging effects of hatcheries and guidance from fishery management organisations (IFM & RAFTS), there has been no hatchery operated by the salmon fishery in recent years.

Figure 3. Estimates of salmon stock abundance, exploitation and catch & release in the fishery (1964-2012)

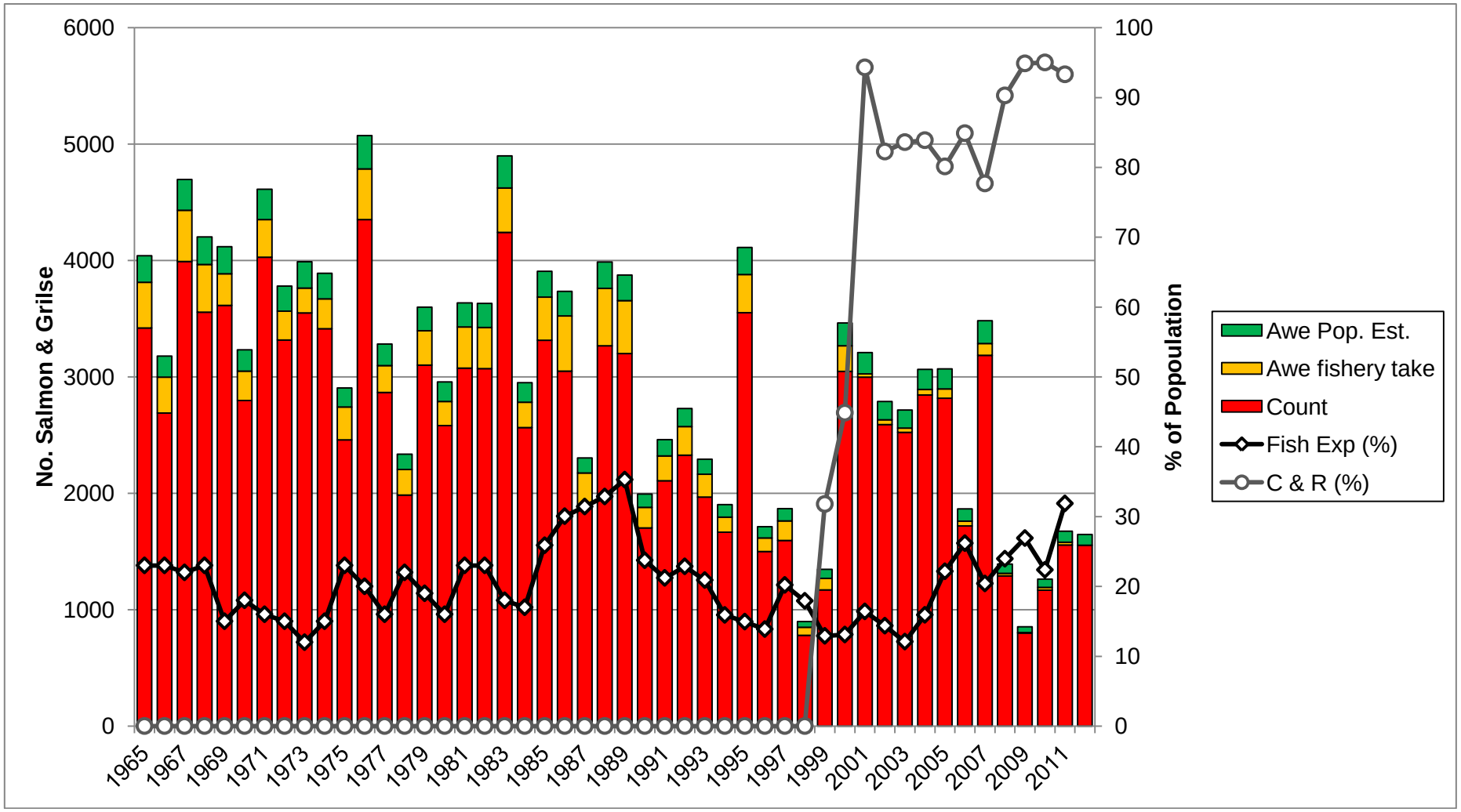
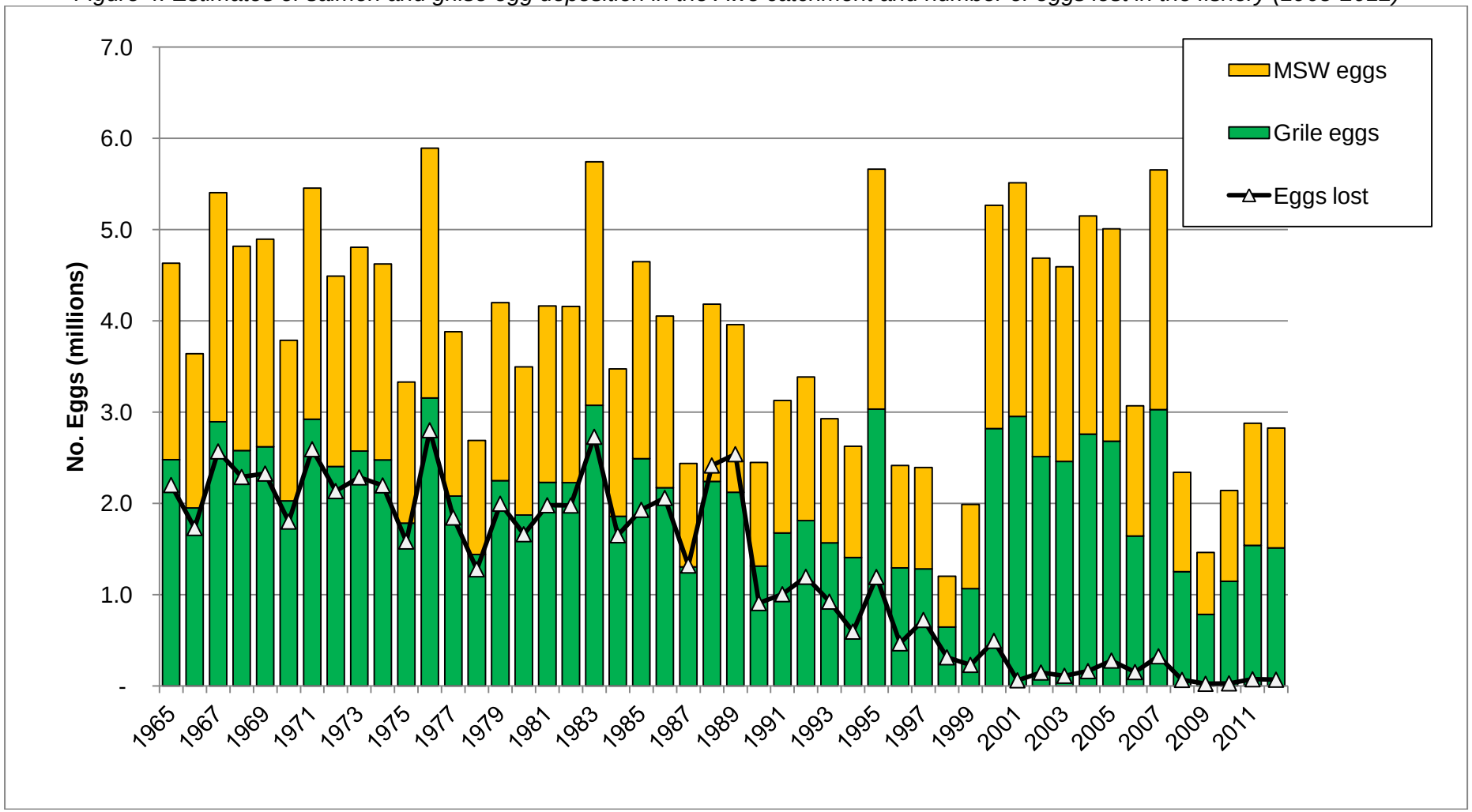


Figure 4. Estimates of salmon and grilse egg deposition in the Awe catchment and number of eggs lost in the fishery (1965-2012)



3.2 Brown trout

Although described as one species, the stock of brown trout in the Awe catchment displays a high degree of variation in resident and sea-run forms which is reflected in fisheries for sea trout, loch trout and ferox trout. Similarly to salmon, this stock appears to consist of multiple populations that reproduce in relative isolation to others. The main sub-components of relevance to the fishery are migratory sea trout that utilise marine habitat as well as freshwater habitats, resident trout which include forms that potentially have access to marine habitat but remain in fresh water; loch trout and Pisciverous 'ferox' trout as well as other trout populations that are isolated upstream of waterfalls, commonly known as 'hill loch' or burn trout.

3.2.1 Sea trout

Sea-run brown trout are usually part of the same population as resident trout, but some (mostly female) choose to migrate, similarly to salmon, to marine habitats as smolts. After smolting, sea trout are recognised as two life-stages; as young 'finnock', returning after only months at sea and as older mature sea trout that return to spawn in fresh water. Unlike most salmon, sea trout are thought to remain in coastal waters and may move between fresh and salt water to spawn and feed on numerous occasions.

Whilst currently sea trout are not a major feature of Awe fisheries, historical records indicate they were once much more numerous as one beat on the lower river is reported to have caught 571 and 963 sea trout in the years 1907 and 08 respectively. More recent records (1982 to 85) show that an average of 65 finnock (of less than 1lb in weight) and 10 larger sea trout averaging 2.4lbs were caught each year during this period. Since this time, catches have declined further with no fish reported caught in many returns in the 1990s and 2000s. Reasons for the decline in sea trout in the Awe catchment are not well understood, but reduced survival of post smolts in the local marine environment and increased productivity of freshwater habitats possibly linked to the development of aquaculture which may reduce tendencies of trout to migrate to sea may be at least partly responsible.

3.2.2 Resident brown trout

Fisheries for non-migratory trout are primarily based on Loch Awe which is a fishery of national recognition, providing a high number of anglers with accessible and affordable trout fishing under the Loch Awe Protection Order (1992). The characteristics of the brown trout fishery are formed by the variation in the two 'types' of trout present. A limited study on the genetic profile of loch trout in Loch Awe suggest that most trout are a relatively modern race (which may reproduce with sea-run trout) that rarely live longer than five years and reach a weight of one pound (0.4 kg). As a relatively less common predator of other fish 'ferox' trout are part of an ancestral form of trout that have potential to live longer (eleven years or more) and reach weights of more than 20 pounds (9 kg).

Loch trout fishery

The most significant trout fishery is founded on the most abundant 'modern' type of brown trout in Loch Awe and Loch Avich. Estimates of angling effort on Loch Awe are derived from hotel record books and more recently the number of permits sold by LAIA. Historically, records from 1887 until the 1980s, recorded angling effort was relatively low, although the number of trout anglers has been higher than that recorded in the 1950s through to the early 1990s. In recent years, more accurate records show that trout angling effort on Loch Awe was estimated to be approximately 9,000 angling days compared to an average of around 14,000 days per year between 1992 and 2009.

Ferox brown trout of Loch Awe currently hold the British rod caught record

Loch Awe brown trout support the most active and economically important fishery in Argyll

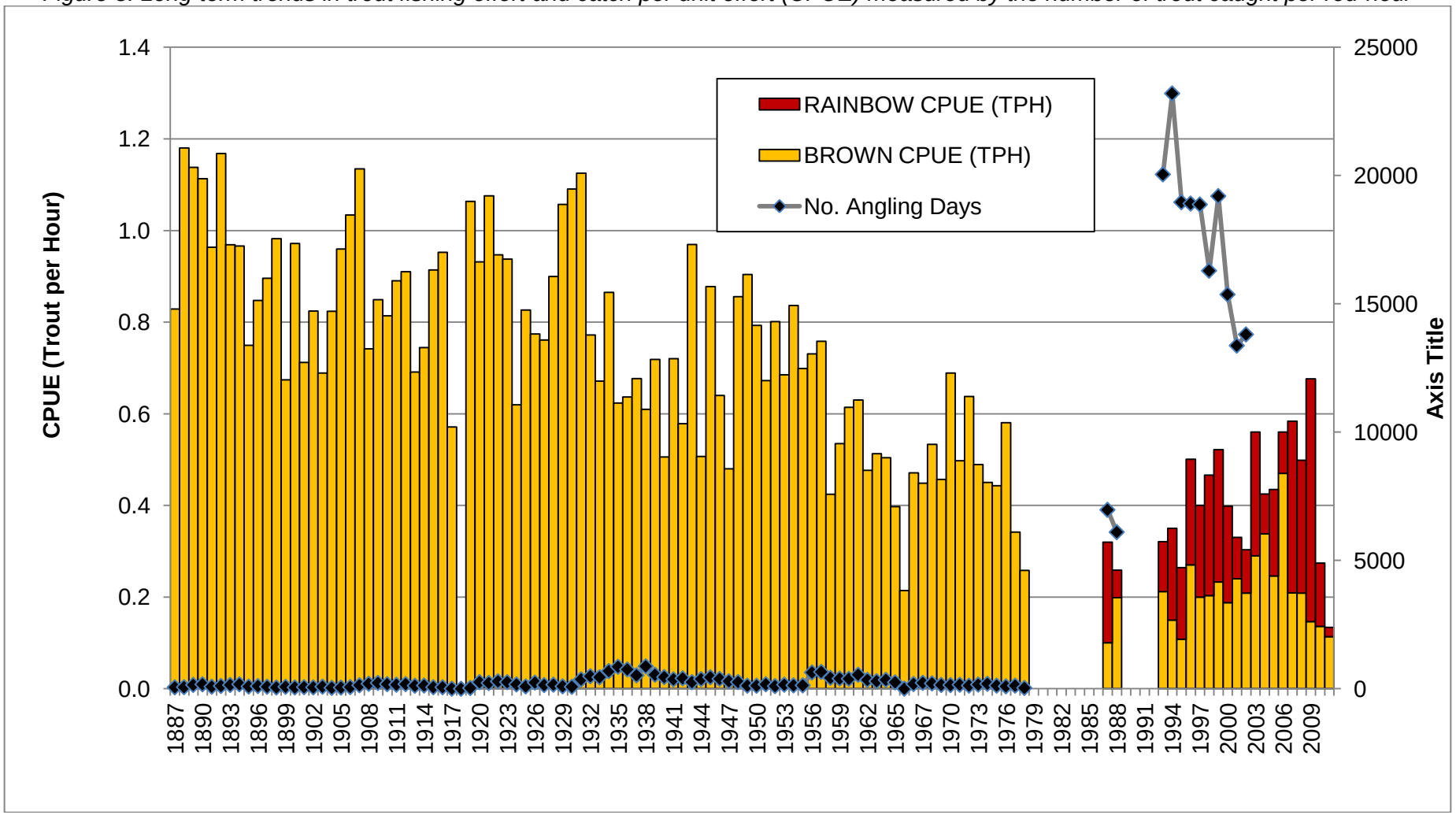
Estimates of the catch of brown trout on Loch Awe indicate that thousands of brown trout are caught each season and between 50 and 90% of these are now returned to the loch by anglers. Trends in catch per unit effort (no. of fish per rod per hour) indicate that despite the reduction in fishing effort and the increase in catch and release angling, the performance of the brown trout fishery has declined (Figure 5). The status of trout stock in Loch Awe and factors affecting catches are not fully understood and may be masked by the relatively small percentage of anglers making a catch return and varying numbers of escapee rainbow trout also caught in the fishery.

Evaluation of the status of the brown trout stock in Loch Awe is an important but difficult aspect of management. While there are issues affecting the spawning and nursery habitat in the many small tributary streams flowing into Loch Awe, fish surveys suggest that young trout are being recruited in relatively moderate numbers. Recent studies of the fish community in the loch suggest that new introduced species are competing for limited resources with native species, which may be a contributing factor in the decline in catches of brown trout. Rainbow trout that escape from fish farms on Loch Awe have also been caught in relatively large numbers since the 1980s. Studies suggest that escapees may also compete with brown trout for food, but most are usually caught by anglers relatively quickly after escaping into the loch. There is also potential for the transfer of diseases and other pathogens from the farm fish to the wild populations, but it is not well understood if this is a factor in the decline of the brown trout fishery.

Ferox trout

The fishery for 'ancestral' ferox type trout is much smaller compared to that of the 'modern' trout and less than 20 notable fish over 10 pounds in weight are reported each year reflecting the relatively low abundance of this predatory trout. Despite the smaller size of the fishery, this specialist fishery attracts a growing number of anglers. The increasing popularity of ferox fishery and the relatively few ferox inhabiting Loch Awe requires that the stock is maintained through catch and release techniques to ensure that the population is maintained at optimal abundance. The limiting factors acting on the ferox population are not well understood, but genetic information suggest that at least some of the population spawn in the river Awe which is regulated by a hydroelectric generation scheme. Ensuring that ferox are able to reach spawning habitat in the River Awe and that there are suitable flows to enable ferox (and salmon) to spawn and support healthy juvenile populations will be an important part of managing this unique fishery.

Figure 5. Long-term trends in trout fishing effort and catch per unit effort (CPUE) measured by the number of trout caught per rod-hour



Hill trout
Resident brown trout are found in many of the burns and lochs upstream of waterfall barriers. There are also over 100 other smaller lochs in the catchment, most of which provide habited for brown trout. This resource is likely to offer some potential to further develop sustainable fisheries, but exploitation of stocks and increasing development of renewable energy schemes requires information on fish populations and cooperation from land owners to improve access to anglers.

Rainbow trout
Escapee rainbow trout from fish farms in Loch Awe and Loch Etive attract a number of anglers to Loch Awe and the River Awe. The numbers of escapee fish caught by fisheries vary considerably each year depending on the size and frequency of escape events. Immediate reporting of catches of rainbow trout is essential to inform both farmers and regulators to ensure remedial actions are undertaken swiftly and subsequent effects on fisheries minimised.

3.3 Coarse fish

Although not native to Argyll, coarse fish such as pike, perch and roach are present in Loch Awe as a result of deliberate introductions. Other smaller lochs in the catchment such as Loch Ederline, Loch Leathan, Loch Tulla and Loch Tromlee also support pike and other coarse fish. Pike in particular are valued for their fishery potential, particularly on Loch Awe and attract anglers from all over the United Kingdom and abroad.

Pike, present since the 1840s, support fisheries, but require management to maintain balance in the fish community

Roach are a relatively new species introduced in the 1980s, but their affect on native species is not well understood

While there is relatively little catch return data for coarse fish, sales of LAIA coarse fishing permit have increased since 2003 indicating that the angling for coarse fish, particularly pike is becoming more popular. Pike, a predatory species, may be an important factor in managing coarse fish populations (such as the newly introduced roach) upon which pike mostly prey and therefore maintaining a healthy population of pike in balance with other coarse fish species can be beneficial for native species. Therefore, there is a common benefit to all fisheries to maintain the population of large pike through conservation-minded fishery rules and enforcement, particularly in the popular pike fishing areas in the catchment.

The pike fishery on Loch Awe is run by four different managers; the LAIA in much of Loch Awe, Ederline Estate (Loch Ederline), Torran Mhor (Ford Bay) and Kilchurn Bay. Permit sales from these fisheries are likely to show that there are 3,000 or so angling days fished for pike in the catchment each year. Maintaining common pike

fishery management practices in the catchment such as catch and release angling will be required to maintain the performance of the fishery.

The perch, roach and minnow in Loch Awe are less prominent in the fishery, but are caught accidentally by trout fisherman. There is concern that these species compete for limited habitat and food resources with native species, such as brown trout and Arctic charr and therefore the re-distribution of these species need to be controlled.

3.4 Fishery management structure

The fisheries of the Awe catchment are managed by a mixture of fishery interests, ranging from individual owners, angling clubs, organised groups of fishery owners and users in the LAIA and ADRIA committees. These local fishery interests also contribute to the wider management process through representation on Argyll District Salmon Fishery Board which has statutory powers and responsibilities for migratory fish and the Argyll Fisheries Trust (AFT). The activities of the ADSFB and ADRIA are restricted to the management of migratory fish under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003, while resident fish such as brown trout are managed under the protection order on Loch Awe. The AFT has interest in the management of all fish populations and their habitats.

Fisheries	Area	Management interests
Atlantic Salmon Sea trout	River Awe Loch Awe River Orchy	Argyll District Salmon Fisheries Board Awe District River Improvement Assoc.
Brown trout Coarse fish	Loch Awe	Loch Awe Improvement Association Ederline Estate (L. Ederline) Torran Mhor Farm (Ford) Kilchurn Bay
Hill-loch trout	East lochs West lochs Loch Avich	Ederline Estate Forestry Commission Ardchonnel Farm Blarghour Farm Ballemeanoch Farm Forestry Commission Loch Awe Improvement Association Oban & Lorne Angling club

3.5 Analysis of factors affecting fisheries

The management of a sustainable fishery requires an understanding of fish biology, ecology and the limitations of habitats and other pressures on the recruitment of target fish to the fishery. While there are natural and many man-induced pressures on freshwater habitats from use of land and water resources in the catchment there are also other pressures in the marine environment that affect migratory species; Atlantic salmon and sea trout. Additionally, further climate change is expected to influence both freshwater and marine habitats with some known and unknown consequences for fisheries.

3.5.1 Freshwater factors

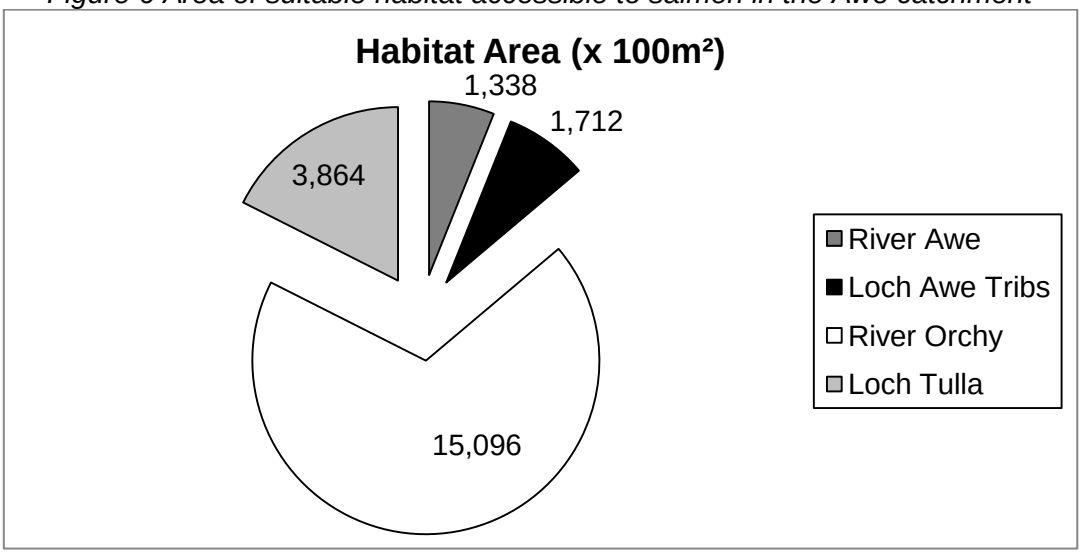
Natural limitations on the ability of the habitat to produce young fish are primarily due to accessibility and area of habitat available to spawning adults, the productivity of the underlying geology, the topography (gradient), hydrology (drainage) and resulting effects on geomorphology (river channel and bed substrates types).

Natural limitations on fish populations

The primary restriction to the recruitment of young fish to fisheries is the accessibility of young fish to spawning and nursery habitat which is restricted by topography of the landscape through high gradient, particularly waterfalls which fish cannot ascend. Habitat and fish surveys have identified areas of habitat that are (and are not) able to be utilised by fish targeted by fisheries, some of which may be accessed by fish only in years when there is sufficient flows during the spawning migrations in the autumn.

The area of stream habitat (Figure 6) suitable for spawning and nursery habitat available to salmon, which prefer larger streams (3 m width or more), is estimated at 220.1 hectares, described below in terms of 100 m² units which can be related to the production of smolts.

Figure 6 Area of suitable habitat accessible to salmon in the Awe catchment



Scottish derived theoretical estimates of smolt production of five per 100 m² suggest that the Awe catchment should produce some 110,000 smolts, but this is likely to vary depending on egg deposition and survival of each life-stage. Subsequently, at least 2.5 to 3 % of smolts are required to survive at sea and return to the catchment as adults so that spawning targets (2,750) and fishery targets (3,300) are reached. The counter data suggest that either the catchment is not producing the estimated number of smolts or that losses during migration through the catchment are significant or that marine survival is lower (e.g. between 1 and 2 %) than that needed to reach target values. Further investigation is required to ascertain if freshwater factors affecting the production of healthy smolts can be identified and remedied.

Similarly, brown trout have limited habitat area of their preferred habitats in tributary streams of loch and larger rivers. While many of the 180 or more tributaries of Loch Awe have been studied, less is known on the importance of tributaries of the River Orchy to trout in the Loch Awe fishery.

Human derived pressures

The pressures acting on freshwater habitats are likely to be the those that may be most influenced by fisheries management but there are many aspects of human activity in the catchment that impair freshwater habitats, Some of which are perceived by regulators to be of sufficient socio-economic benefit that they are therefore unlikely to be tackled completely but may be mitigated to benefit fisheries. While some environmental pressures are well documented, others are implicated but more information is required to be sure of their relevance.

Although the information generated from studies of fish and their habitats by Argyll Fisheries Trust and other workers is far from comprehensive, the existing data enable evaluation of the freshwater resources to be made. Other catchment-wide pressures affecting fisheries have been identified by SEPA in the Argyll Area Management Plan which may change as further information is acquired. Where the status of a waterbody is less than good, some wider RBP initiatives and resources may be available to assist in improvements. Where the status is already good any fishery-related improvements are less likely to attract outside funding.

Upper River Orchy

In the north of the catchment (Figure 7) much of the headwaters have a 'good' or 'high' ecological status with the exception of the Allt Dochard tributary of Loch Tulla (moderate) and the Allt Kinglass is classed as a heavily modified waterbody (HMWB) with bad ecological potential due to abstraction as shown below;

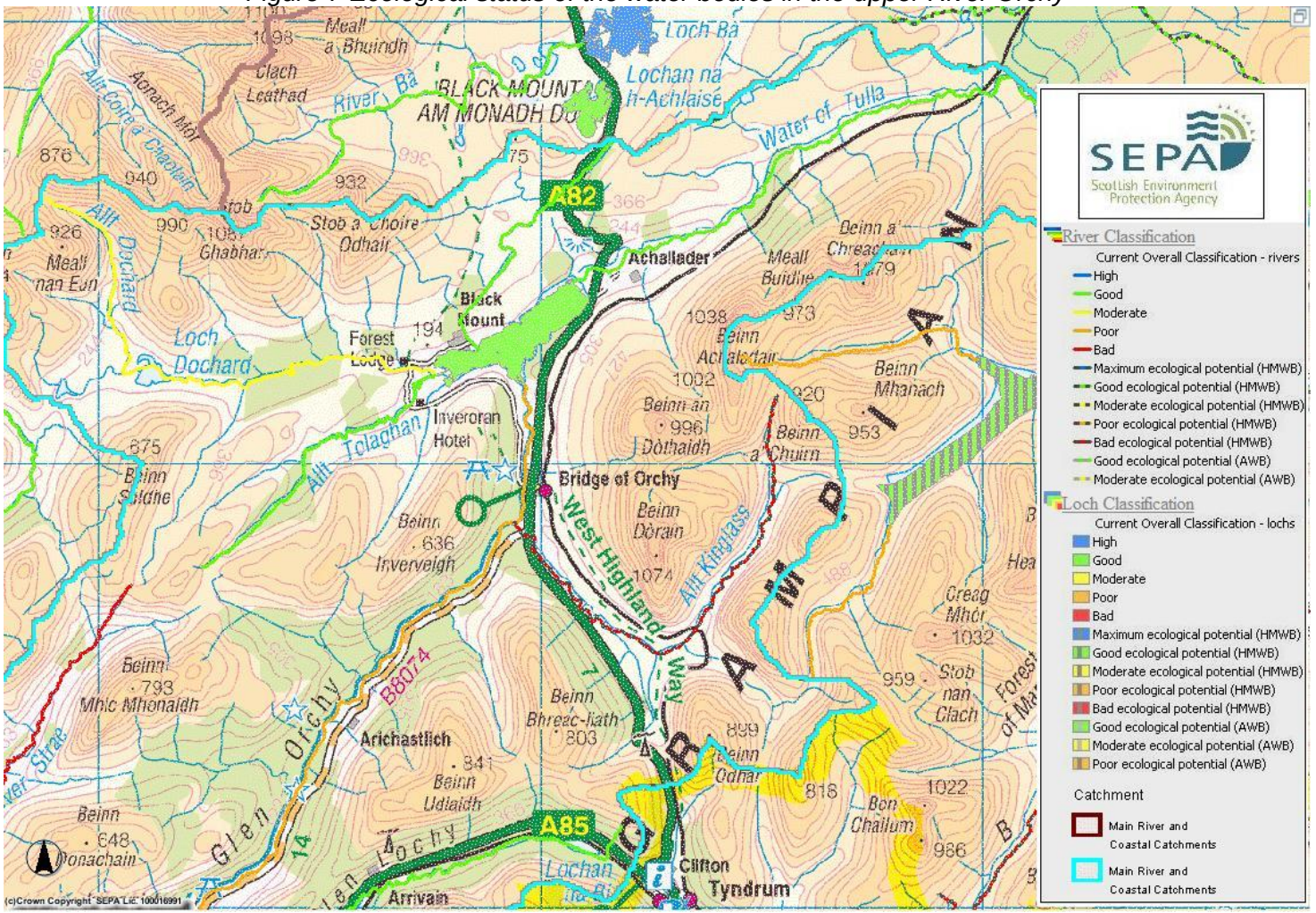
Waterbody	RBP Status	Pressures	Management aims
Water of Tulla Allt Tolaghan Abhainn Shira	Good Good Moderate	Base productivity, livestock & deer grazing Conifer plantations Lack of shading	Increase supply of food Improve riparian habitat Increase shading
Oother		Hatchery in-take dam	Restore fish passage
Loch Tulla	Good	Predation and competition from non-native fish (pike & perch)	Manage predators in balance with primary prey species
River Orchy mainstem	Moderate	Conifer plantation Deer grazing	Improve riparian habitat
Allt Kinglass (HMWB)	Bad ecological potential	Abstraction Base productivity, livestock & deer grazing	Asses effect of abstraction Increase supply of food Improve riparian habitat Increase shading

Lower River Orchy

The lower altitude areas of the catchments have more pressures (Figure 8) affecting their ecological status. The ecological status of the major tributaries to the north end of Loch Awe is mixed: River Orchy (poor) and its tributaries: River Strae (bad), River Lochy (good), Allt Mhoillie (good potential HMWB).

Waterbody	RBP Status	Pressures	Management aims
River Lochy	Good	Base productivity, livestock & deer grazing Conifer plantations Hydro development	Increase supply of food Improve riparian habitat Increase shading Asses effect of hydro
Allt Mhoillie	Good	Hydro development Base productivity, livestock & deer grazing	Assess effect of hydro Improve riparian habitat
River Orchy mainstem	Poor	Abstraction Conifer plantation Livestock & deer grazing	Assess effect of abstraction Increase supply of food Improve riparian habitat
River Strae (HMWB)	Bad ecological potential	Abstraction Base productivity, livestock & deer grazing	Assess effect of abstraction Increase supply of food Improve riparian habitat

Figure 7 Ecological status of the water bodies in the upper River Orchy



Loch Awe North

The north end of Loch Awe (Figure 8) is classed as a HMWB with moderate ecological potential due to abstraction and water treatment works, while the rest of the Loch is at moderate status despite the loch water level being controlled by the Awe barrage. Other large tributaries assessed to date such as the Teatle Water and Allt Beochlich on the north-east side of the loch and the Kilchrenan Burn on the west have good status, but the Inverinan and Cladich Rivers are HMWB with moderate and bad ecological potential due to abstraction of water respectively to the Clachan and Nant hydro schemes.

Waterbody	RBP Status	Pressures	Management aims
Kilchrenan B. Teatle Water Allt Beochlich	Good	livestock and deer grazing Conifer plantations	Increase supply of food Improve of riparian habitat
Loch Awe Inverinan Burn (HMWB)	Moderate potential	Abstraction Flow regulation Non-native species livestock and deer grazing Conifer plantations	Assess effect of abstraction Prevent introductions of INNS & new species Improve riparian habitat vegetation
Cladich River (HMWB)	Bad ecological potential	Abstraction Livestock & deer grazing Conifer plantations	Assess effect of flow regulation Improve riparian habitat

Loch Awe South

The southern end of the loch (Figure 9) has tributaries with good ecological status at Blarghour and the Kames River and the Clachan Dubh at Ford although the status of these may change with the development of hydroelectric generation schemes in future. The Abhainn Bhealaich at Braevallich on the east side of the loch is a HMWB with moderate ecological potential while the River Liever on the west side is currently at bad status. Only Loch Avich and the River Avich have high ecological status after being initially assessed.

Waterbody	RBP Status	Pressures	Management aims
Loch Avich River Avich	High	livestock & deer grazing Conifer plantations	Improve riparian habitat
Blarghour Kames R. Clachan-Dubh	Good	livestock & deer grazing Conifer plantations Abstraction / regulation	Improve riparian habitat Assess effect of flow regulation
Loch Awe (HMWB)	Moderate ecological potential	Abstraction / regulation Non-native species livestock & deer grazing Conifer plantations	Asses effect of regulation Prevent introductions / control INNS Improve riparian habitat
River Liever (HMWB)	Bad ecological potential	Deer grazing Conifer plantations Flow regulation	Improve riparian habitat Assess effect of hydro

Many of the smaller tributary streams in the catchment are yet to be assessed as part of the RBP process, but fish habitat surveys have found that many of these tributaries of the River Orchy and Loch Awe that are particularly important habitats for brown trout are also affected by re-alignment of stream channels to increase

Figure 8 Ecological status of water bodies in the lower River Orchy and North Loch Awe

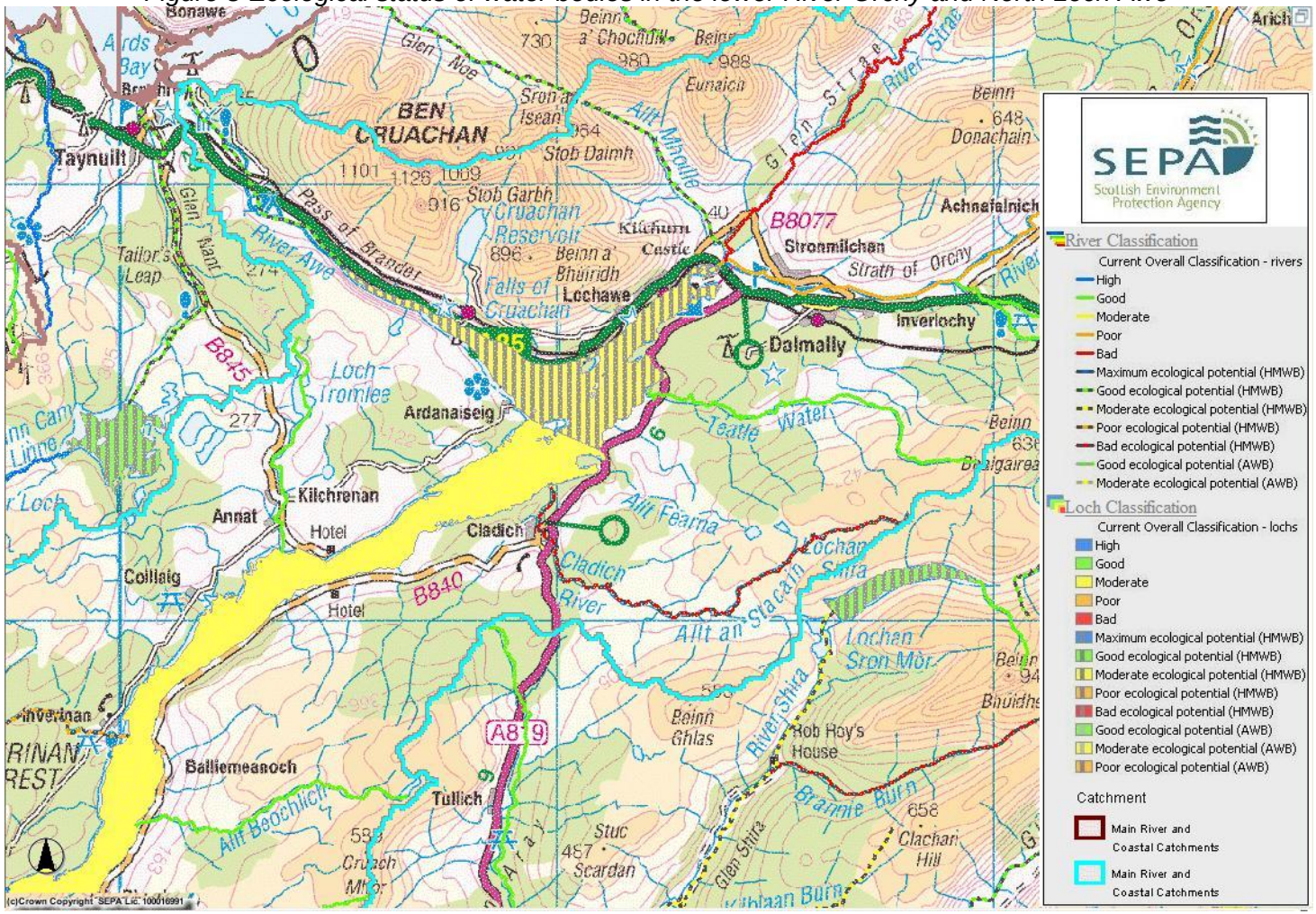
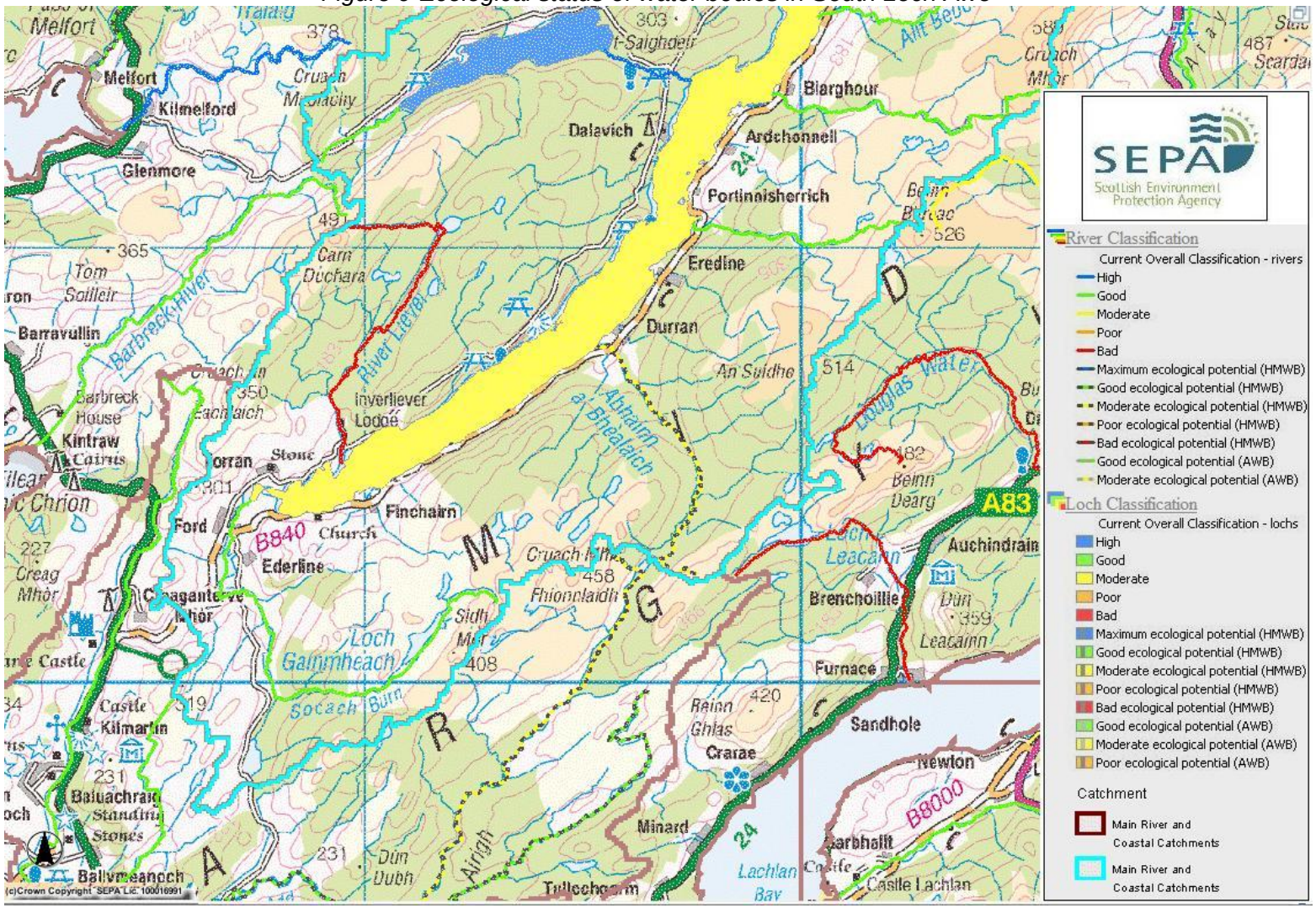


Figure 9 Ecological status of water bodies in South Loch Awe



drainage efficiency or diversions as a result of urban development and the road network.

River Awe
The River Awe is a HMWB at good ecological potential due to the flow regulation in relation to the Inverawe hydro scheme.

Waterbody	RBP Status	Pressures	Management aims
River Awe (HMWB)	Good potential	Abstraction Flow regulation Fish passage	Minimise impact of flow regulation and fish passage

There is an on-going study to assess recent measures to mitigate effects of loss of habitat and flow regulation which will inform future management.

Hill lochs and streams
The many hill lochs and streams upstream of waterfall barriers have not yet been evaluated as part of the RBP process. However, numerous sub catchments are being utilised for hydro-electric generation schemes and may also be affected by the infrastructure of wind farm developments.

Waterbody	RBP Status	Pressures	Management aims
Hill Lochs	-	livestock & deer grazing Conifer plantations Renewable energy development	Improve riparian habitat Minimise impact of level regulation
Hill Streams	-	livestock & deer grazing Conifer plantations Abstraction / regulation	Improve riparian habitat Assess effect of flow regulation

Climate change
As cold water species, the native salmonid species are most at risk of adverse effects of climate change, which with increasing average temperatures may have profound consequences for cold-blooded organisms. Warming of the environment may also better-suit invasive and other competing animals reducing availability of food and territories. Particular threats have been identified as a result of climate warming are related to the increase biological demands on hibernating fish over-winter (when food availability is limited) and increase stressors during hot summers with consequences for growth and survival. There are other consequences for migratory species that also utilise marine habitats during phases of their life-cycle.

Invasive non-native species (INNS)
There are a growing number of existing and potential threats to biodiversity, fish health and the productivity of fisheries. Recent work has been undertaken to raise awareness, identify, control and eradicate invasive non-native species (INNS), but further work needs to be done to protect habitats and fish populations.

3.5.2 Marine habitats (migratory salmonids)
The survival of migratory fish during the marine phase of their life-cycle has a dramatic and significant affect on the numbers of adult salmon and sea trout returning to support fisheries and recruit the next generation. While many of the factors influencing the wider marine environment are yet to be fully determined, there

is some evidence that implicates marine factors as affecting the performance of fisheries. The marine factors are summarised below.

Factor	Pressure	Impacts
Climate change	Reduced productivity of marine habitats	Reduced or highly variable growth and survival of migratory fish
Marine fisheries	By catch of post-smolt salmon in commercial fisheries	Reduced abundance of post-smolt salmon at sea
Aquaculture	Fish farm escapes Disease and parasite transfer	Loss of genetic fitness Reduced productivity Increased mortality over natural levels
Coastal net fisheries	Exploitation of mixed stocks	Reduced reproductive capacity of vulnerable stocks

There are other factors that are of concern to fishery interests, but are not well understood and therefore require investigation to assess their relative impact on the productivity of migratory species.

Factor	Pressure	Impacts
Benthic Fisheries	Loss of habitat diversity and productivity	Reduced growth & survival of migratory fish
Predation Seals & birds	Marine predators Aquaculture containment	Increased mortality over natural levels Escapee fish sustain predators in higher than natural numbers
Renewable Energy	Development of marine resources for tidal and wind energy	Direct mortality from turbines and sub-lethal impacts of migration disturbance

The marine-based factors that have potential to be influenced by local management are principally those that are present in inshore marine waters; aquaculture, coastal net fisheries, seal population management and the development of marine renewable energy schemes.

3.5.3 Assessing significance factors affecting productivity

The many factors affecting freshwater and local marine species and habitats have varying degrees of influence on the fishery performance. Independent of the significance of each factor and the consequences for fisheries, the ability of fishery managers to influence the responsible regulators and individuals or organisations active in the catchment and in-shore marine habitat varies considerably.

Identifying the most effective means of maintaining and increasing the influence of fisheries in a number of sectors is an important component of protecting and improving fisheries and is undertaken by a range of organisations at the national, regional and local levels. As a consequence of the varying ability of fisheries interests to influence other sectors, management activities may be prioritised accordingly but may not tackle the most significant factors affecting fishery catches.

Summary of the significance of factors affecting productivity

Factor	Pressure	Scale	Frequency	Significance	Responsible bodies	Ability to influence	Activities
Fisheries	Exploitation	Salmonids & pike	On-going	High	ADRIA LAIA	High	Monitor fisheries / counter Fishery rules (methods)
Bio-security	Alien species	Widespread	Increasing	High	SEPA SNH	Moderate	Prevention, control & eradication
Climate change	Temperature & flow	Widespread	On-going	High	None	Moderate	Restore riparian woodland Improve habitat
Hydro	Flow regulation	Localised	Increasing	Variable site specific	SSE SEPA	Moderate	Monitor fish / flows Improve habitat Consultation
Aquaculture	Escapes Sea lice Disease	Widespread	Occasional Bi-annual On-going	High	Fish farmers SEPA MSS	Low	Monitor fisheries Report escapes Monitor fish health
Agriculture	Riparian habitat	Widespread	On-going	Moderate	SEPA NFU	Moderate	Fencing Improve habitat
Forestry	Riparian habitat Drainage	Widespread	On-going	Moderate	FC SEPA	Moderate	Restore riparian native woodland Improve habitat
Infrastructure network	Morphology drainage	Widespread	On-going	Moderate	A&BC SEPA	Low	Improve habitat
Abstraction	Flow reduction	Localised	On-going	Moderate	SEPA SW	Low	Monitor fish Improve habitat
Wind farms	Road construction	Localised	Increasing	Moderate	SEPA Developer	Moderate	Monitor fish Consultation
Predation	Loss of stock	Localised	On-going	Moderate	SNH	Low	Ease / remove man-made obstacles
Water quality	Pollution	Localised	Occasional	Low	SEPA	Low	Monitor fish / inverts

4. Management Actions

The implementation of new initiatives as well as sustaining and improving existing activities are required to achieve the aims of the plan. Some of the individual actions recommended will fulfil more than one management objective and therefore are likely to be a priority over those that may have a lesser contribution. Each action prescribed is described with reference to the current status and the likely time-scale in which it will be established. Management bodies such as Argyll DSFB, ADRIA and LAIA are required to implement the fishery protection elements of the plan effectively utilising data and management advice from AFT. A detailed work programme is given in Section 5.

Some more recently developed activities are already underway and require on-going support while other new activities are not yet embedded into the work programme, The time-scale estimated for completion are represented as three categories;

1- Essential and achievable in the short term (1 to 5 years);
2- Essential in the short-term, but may take longer to accomplish (1-10 years);
3- Important, but will realistically take more time to complete (1-20 years).

For each of the Management actions prescribed, a number of activities are delivered as a combination of funding from fisheries and projects that also seek contribution from interested parties. The acronyms used in the tables are;

Fisheries management – ADSFB (Argyll District Salmon Fishery Board), AFT (Argyll Fisheries Trust), ADRIA (Awe District River Improvement Association), LAIA (Loch Awe Improvement Association)
Regulators – SNH (Scottish Natural Heritage), SEPA (Scottish Environment Protection Agency), A&BC (Argyll & Bute Council),
Resource users – FC (Forestry Commission), Agriculture (FDPs), Aquaculture (FMPs), Hydro operators (HO)
Funding sources – SSE (Scottish & Southern Electric Plc), EU (European Union), WEF (Water Environment Fund)

High priority actions
These actions are related to minimising damage to fisheries from new threats which have a potential to detrimentally affect fisheries; the new threats from bio-security issues, effects of further climate change, management of aquaculture and new development of hydroelectric and other renewable energy generation schemes.

Medium priority actions
These actions are related to reducing the effects of chronic and widespread damage to the resource and the use of land resources that impair the ability of the habitat that produce young fish: agriculture, forestry, urbanisation, infrastructure and wind farm development, abstraction for potable water supplies and various activities that can exacerbate predation on young fish (such as partial barriers).

Lower priority actions
These actions are related to activities, development and use of habitats that have little influence on the maintenance of aquatic environments or are monitored by other management bodies or agencies.

4.1 Protecting fish and habitats from new and existing threats

Given the wide range of pressures on freshwater resources in the catchment it is essential to defend remaining stock and key fish habitats against inappropriate development and other aspects of existing activities that have potential to impair fisheries.

4.1.1 Consultation and representation

The recent and on-going development of new renewable energy schemes and aquaculture facilities require that regulators and developers consult with the responsible body; Argyll District Salmon Fishery Board (ADSFB) so that potential effects of new development on the fishery are minimised. In addition, there are existing mechanisms for representation of fishery interests in other aspects of wider catchment management such as Forest Design Plans (FDPs), Area Advisory Groups (AAG) and hydro developments (SEPA/SSE). Contributing to the costs of these activities is a primary consideration for protecting fishery interests.

Consultation & representation	Developers	Regulators	Responsible Bodies	Funding sources
A. **New developments**; Support Argyll DSFB to minimise impacts on fisheries by consulting with developers and agencies.	Various	SEPA / SNH A&BC SEPA / SNH	 ADSFB	ADRIA / LAIA / ADSFB ADSFB ADRIA / LAIA
B. **Existing developments**; Identify and facilitate opportunities to improve management to benefit habitats & fisheries – Loch Linne FMA (Aquaculture) Forest Design Plans (Forestry)	FF, FC		ADSFB AFT	

4.1.2 Managing exploitation

Given the current poor survival of smolts at sea affecting salmon and other factors affecting brown trout it is essential to protect remaining stocks to ensure there are sufficient spawning adults that escape the fishery to maintain fish populations.

Managing exploitation of fisheries	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Fish counter / salmon catch analysis & reporting	SSE / ADRIA	ASFB	AFT	ADRIA / LAIA / ADSFB
B. Trout catch analysis & reporting	LAIA	SG	AFT	LAIA
C. Establish conservation limits for fisheries	AFT		AFT	ADRIA / LAIA
D. Produce guidance leaflet / training on effective C&R	MSS	ADSFB	AFT	ADRIA / LAIA / ADSFB
E. Manage bailiffing & wardening effort	ADRIA / LAIA	ADSFB	ADSFB	ADRIA/LAIA

4.1.3 Biosecurity

Existing and new threats from biosecurity issues such as the spread of Invasive Non-Native Species (INNS) and other fish pathogens have potential to further undermine fishery performance. Some control measures are underway and will need to be continued, but other preventative measures need to be undertaken.

Biosecurity	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Update data on INNS – Monitor fisheries / habitats	AFT	SEPA / SNH	ADSFB	SEPA
B. Develop new projects to control and eradicate INNs	AFT			SNH
C. Prevent introduction of INNS	Various			EU / WEF

4.1.4 Climate change

Further warming of the climate is forecast to bring change to key fish habitats and the distribution of species. Threats to cold water fish such as salmon, trout and char require that actions are undertaken in the short-term to achieve long-term goals. Ensuring key fish habitat is as future-proofed as possible will give native species a better chance of absorbing change.

Climate change	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Collect water temperature data & report	AFT		AFT	ADRIA / Other
B. Develop Riparian woodland planting schemes	AFT	FC/SNH	AFT	SRDP / WEF / EU
C. Increase refuge habitat (mitigate for flood/drought)	AFT	SEPA	AFT	ADRIA / LAIA

4.2 Improve productivity of fish habitats

Many of the activities related to habitat issues will require cooperation from a wide range of stakeholders and be guided by the development of catchment management plans as part of the River Basin Planning process. Similarly fishery restoration activities require a close working relationship with fishery interests and a willingness to implement best practice guidance developed by centres of expertise. Some activities are underway and will be complete in this phase of the plan.

4.2.1 Ensure all naturally available habitats are accessible to fish

While there are few man-made barriers to fish migration others may impair access to key spawning sites in trout habitats. Field surveys are required to establish where obstacles require work to ease fish passage and a monitoring programme is required to prevent build-up of debris that collect at culverts and other locations.

Fish access to habitats	Data supplier	Regulators	Responsible Bodies	Funding sources

A. Collect data on obstacles – Habitat /Fish surveys B. Ease / remove obstacles C. Assess outcomes – Fish surveys D. Remove debris dams– culvert/spawning surveys	AFT	SEPA FC / SNH ADSFB	ADSFB / AFT	A&BC / LAIA / ADRIA WEF / ADRIA / LAIA ADRIA / LAIA LAIA

4.2.2 Improve productivity of riparian and in-stream habitats

The productivity of many fish habitats are impaired by land use. Field surveys have already identified a number of issues that require intervention. Where improvement measures are implemented, information on the response of fish populations is required to inform future management activities.

Improve riparian & in-stream habitats	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Habitat surveys B. Mapping analysis C. Fencing / planting D. Re-meander & LWD placement E. Assess response– Fish surveys	AFT	SEPA FC/SNH	ADSFB/AFT	LAIA / ADRIA ADRIA / LAIA SRDP / ADRIA / LAIA LAIA / ADRIA LAIA / ADRIA

4.2.3 Improve productivity of heavily modified habitats

The productivity of many fish habitats that are heavily modified through flow abstraction and data need to be collected to inform any changes in compensation and freshet flows. Field surveys have already identified a number of issues that require intervention. Where improvement measures are implemented, information on the response of fish populations is required to inform future management activities.

Improve heavily modified habitats	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Habitat / Fish / Rredd surveys B. Flow / Ffish / Sspawning – Data analysis & consultation C. Habitat-based mitigation measures D. Awe barrage – Ffish tracking E. Assess response – Fish surveys	AFT/SSE	SEPA	ADSFB/AFT SSE SP SW	SSE / LAIA / ADRIA

4.3 Improve management of and revenue from fisheries

Developing the management structure and funding management activities will require cooperation between and modernisation of fisheries management bodies. Utilisation of multi-media communications will also improve information transfer to a wide range of interests that effect fishery performance.

4.3.1 Improving catchment-wide cooperation

It is important that management of fisheries reflect the mixed nature of the fish community and fisheries in the catchment. Combining resources of salmon, trout and coarse fish fisheries will better utilise limited resources.

Create and maintain awareness of fishery issues	Facilitators	Regulators	Responsible Bodies	Funding sources
A. Develop catchment-wide fishery management forum B. Create catchment-wide fisheries website	AFT / ADSFB ADRIA / LAIA	ADSFB	ADRIA / LAIA	LAIA / ADRIA Development project

4.3.2 Improve revenue from fisheries

It is important that access to fisheries are maximised and that all potential to secure revenue are realised. Combining resources of salmon, trout and coarse fish fisheries will provide a more cost-effective means of improving access to fisheries.

Increase revenue from fisheries	Facilitators	Regulators	Responsible Bodies	Funding sources
A. Create catchment-wide on-line fisheries permitting facility B. Develop fishery potential in trout hill lochs	AFT / ADSFB ADRIA / LAIA	ADSFB	ADRIA / LAIA	LAIA / ADRIA Development project

4.4 Improving Knowledge of the fishery resource

Collection and analysis of information on priority species across the catchment will be a key element of informing future phases of the plan. Many of these activities will be led by Argyll Fisheries Trust in partnership with a wide range of stakeholders where opportunities arise.

4.4.1 Identify population structures of salmon and trout

Initial genetic surveys of salmon and trout populations have shown that there are a number of breeding groups present in the catchment. It is not known if some populations are vulnerable to fisheries or specific developments or how they contribute to fisheries. Understanding the status, life-history how different populations contribute to fisheries is a fundamental goal of future fisheries management.

Identify genetic structuring & fishery exploitation	Data supplier	Regulators	Responsible Bodies	Funding sources

A. Atlantic salmon – Genetic & life-history analysis B. Brown / sea trout– Genetic & life-history analysis	AFT / RAFTS	ADSFB	ADRIA / LAIA	LAIA / ADRIA Development project

4.4.2 Investigate changes in stock status over time

Understanding mechanisms underlying changes and longer-term changes in abundance of fish populations targeted by fisheries is required to inform management. To complement studies of species response to habitat improvements information from a wider network of sites is required to compare changes against the general population. Other on-going investigation of marine parasites on migratory fish is required to understand the significance of aquaculture development on wild fish health.

Investigate changes in stock status over time	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Monitoring site network – electrofishing B. Assess survival of juvenile life stages – Field surveys C. Assess smolt production – smolt trapping D. Assess significance of sea lice – sea trout monitoring	AFT MSS ICES NASCO	ADSFB SEPA	ADRIA./.LAIA	LAIA./.ADRIA Development project

4.4.3 Investigate migration routes & habitat use

Existing and future development are likely to occur in both freshwater and inshore environments which have potential to affect specific habitats and migration routes. Identifying key habitats, migration routes and factors likely to affect fish will be an important area of investigation. However, these studies are expensive and will require outside support to be completed.

Identifying migration & routes habitat use	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Atlantic salmon – Tagging / tracking / genetic studies B. Sea trout– Tagging / tracking / genetic studies C. Ferox trout – Tagging / tracking / genetic studies D. Brown trout– Tagging / tracking / genetic studies	AFT / ADSFB ADRIA / LAIA	ADSFB	ADRIA / LAIA	LAIA / ADRIA Development project

4.5 Fund management activities and assess outcomes

To achieve the goals of management, it is essential to maintain sufficient fishery activity to raise funds for important management activities. The numerous work programmes required to tackle the many factors affecting the productivity of habitats require that funding from other sources will be required.

4.5.1 Attracting funding to fisheries

Attracting funding and maximising the benefits of the many activities prescribed will require cross-sector support. By engaging a wide range of stakeholders in partnership projects, it is more likely that the aims of the plan will be achieved.

Inform & fund activities	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Develop project and grant-based work programme B. Incorporate a wide range of benefits to attract funding C. Deliver work program to evaluate mitigation of developments D. Maintain fishery funding for management activities	AFT ADRIA / LAIA	ADRIA / LAIA	ADRIA / LAIA	LAIA / ADRIA Development project

4.5.2 Assess progress of the plan

It is essential that the plan remains as a working document and progress is reviewed on a regular basis and that new information informs the next phase of the plan.

Assess progress of the plan	Data supplier	Regulators	Responsible Bodies	Funding sources
A. Establish management group to assess progress B. Review data & amend activities accordingly C. Develop new phase of the plan before 2019	AFT / ADRIA / LAIA	ADSFB	ADRIA / LAIA	AFT / LAIA / ADRIA

5. Work programme

A number of work programmes have been identified that seek to combine management activities into work streams that may attract funding from within and outside of the fisheries sector. Some programmes are currently underway; while others wait opportunities to arise that can be begun once the funding becomes available.

5.1 Work programmes currently underway

Some of the work programmes identified have been initiated, but are yet to be completed.

5.1.1 River Awe Project

This project aims to investigate and inform management of the flow regulation and fish access on the River Awe in relation to the Inverawe hydro electric generation scheme. Project partners include AFT, ADRIA, ADSFB, SEPA and SSE. The initial start-up phase (baseline surveys) of the project has been funded by ADRIA and further work is being supported by SSE. The budget for this work in 2014-2015 is £5,000

Project Aims	Activity	Status	Duration	Outcomes
A. Establish baseline data on spawning habitat and juvenile fish populations	E-fish & redd count surveys Flow measurement	Complete	2011-12	Insufficient flow for spawning / egg incubation
B. Identify factors limiting recruitment of juveniles	Data analysis and reporting	Complete	2012-13	Inappropriate flows & impaired habitat identified
C. Inform and seek improvement in flow regime	Consultation	Underway	2013-15	Increase winter flows to improve spawning & egg survival
D. Improve accessibility and condition of spawning habitat.	Restore flow to marginal spawning sites	Underway	2012-15	Initial work appears beneficial Repeat concept at other sites
E. Assess response of fish populations to changes in flow regime	E-fish & redd count surveys. Counter analysis	Underway	2013-16	3-fold improvement in fry numbers at treatment sites (2013)

5.1.2 Lower River Orchy Project

This project aims to investigate the significant reduction in catches of salmon in the lower River Orchy and loch trout in north Loch Awe which utilise the lower River Orchy and its tributaries for spawning and juvenile recruitment. The initial data collection to inform the project is supported by ADRIA and LAIA, but other funding will also be required to complete habitat improvements.

Project Aims	Activity	Status	Duration	Outcomes
A. Establish baseline data on spawning habitat and juvenile fish populations	E-fish, habitat & redd count surveys	Underway	2013-14	Some habitat in sub-optimal condition
B. Identify factors limiting recruitment of juveniles	Data analysis and reporting	On-going	2014-15	Morphology and riparian habitat impair juvenile recruitment
C. Consult with land owners and fund habitat improvement measures	Consultation & project proposal	To be initiated	2014-16	
D. Restore access to tributaries and marginal spawning in main river	Remove obstacles (tribs.) and croys (main river)	Underway	2013-16	
E. Improve condition of riparian habitat improve resilience to climate change.	Fencing, coppicing & regenerate diverse vegetation structure	To be initiated	2014-17	
F. Assess response of fish populations to changes in flow regime	E-fish & redd count surveys. Counter analysis	To be initiated	2015-18	

5.1.3 Loch Awe tributaries habitat Project

In response to declines in the performance of the brown trout and salmon fishery, this project aims to restore access and improve habitat condition in the many tributary streams flowing into Loch Awe that are used for spawning and juvenile recruitment. Due to the large number of streams to be investigated, there is a longer-term approach the project. The initial data collection to inform the project is supported by LAIA and ADRIA, but other funding will also be required to complete habitat improvements.

Project Aims	Activity	Status	Duration	Outcomes
A. Collect new data on spawning habitat and juvenile fish populations	E-fish, habitat & redd count surveys	Underway	2013-14	Poor or no access to some streams. Some habitat in sub-optimal condition.
B. Compare new with baseline data and Identify factors limiting recruitment of juveniles	Data analysis and reporting	On-going	2014-16	Morphology and riparian habitat impair juvenile recruitment
C. Restore access to spawning habitat	Construct steps downstream of culverts. Replace ineffective culverts.	To be initiated	2014-17	
D. Consult with land owners and fund habitat improvement measures	Consultation & secure permissions and funding	Underway	2013-19	Eredine Forest Project
E. Improve condition of riparian habitat improve resilience to climate change.	Fencing, coppicing & regenerate diverse vegetation structure	Underway	2013-19	
F. Assess response of fish populations to changes in flow regime	E-fish & redd count surveys.	To be initiated	2015-20	

5.1.4 Renewable energy scheme monitoring programme

In response to the increasing use of water resources for medium-to-small scale hydroelectric generation and new roads and stream crossings associated with development of wind farms there is a need to inform management and monitor the effects on habitats and fish populations. While initial baseline data and monitoring of such schemes is usually funded by the developer, there will be a longer-term requirement to assess the on-going health of fish populations in affected habitats.

Renewable energy scheme	Activity (Funding)	Status	Duration	Outcomes
A. Ederline hydro scheme	E-fish surveys (developer)	Underway	2014-18	Inform management of scheme.
B. Inverliever hydro scheme	E-fish survey (developer)	Underway	2012-15	No significant change found in fish population (to date)
C. Kames hydro scheme	E-fish surveys (developer)	To be initiated	2015-17	
D. Braevallich hydro scheme	E-fish surveys (Fisheries)	To be initiated	2014	
E. Coire Alan hydro scheme (Allt Kinglass).	E-fish surveys (Fisheries)	To be initiated	2014	
F. Allt Moihle hydro scheme	E-fish surveys (Fisheries)	To be initiated	2014	
G. Tulla Water tributary hydro scheme	E-fish surveys (Fisheries)	To be initiated	2014	
H. Carraigh Gheal wind farm	E-fish & habitat surveys (Developer)	Underway	2013-2016	Some disturbance to habitat
I. River Lochy hydro scheme	E-fish surveys (Developer)	To be initiated	2015-2021	

5.1.5 Fish population investigation and monitoring programme

Although much has been learnt about the biology and ecology of the fish populations in the Awe catchment, it is desirable to improve our understanding and management of the fishery resource. Some of this work (e.g. genetic studies) will require significant resources to undertake which may be secured as opportunities arise as part of larger national projects in the future.

Programme aims	Activity (Funding)	Status	Duration	Outcomes
A. Provide data for real-time management of fisheries	Monitor counter numbers and type of salmon returning	Underway	2010-19	Inform management of fishery exploitation policy.
B. Understand affect of trends in adult numbers on juvenile and smolt recruitment	Redd count / habitat / E-fish surveys	Underway	2010-19	Establish estimates of smolt run and conservation limits for adult returns / egg deposition
C. Better understand exploitation of different salmon populations by the fishery	Genetic / fishery surveys	To be initiated	2015-19	
D. Better understand stock structuring of trout populations and fishery exploitation	Genetic / fishery surveys	To be initiated	2016 19	
E. Better understand complexities of fish community and competition for resources in Loch Awe	Fish community studies; life-history, habitat use and diet	On-going	2011-19	Loch survey data (2011) suggest increase in biomass of coarse fish species
F. Identify migration routes of salmon / sea trout in coastal waters to better protect key habitats	Smolt tracking	To be initiated	2015-19	
G. Assess the health of sea trout in Loch Etive / Firth of Lorn. Inform aquaculture development.	Sweep netting surveys and sea lice counts	On-going	2014-19	Long-term data set on parasite burdens of sea trout..

5.1.6 Biosecurity; control and eradication of invasive non-native plants

The increasing spread of priority invasive non-native species (INNS) of plant; Japanese knotweed (JK), Himalayan balsam (HB) and Rhododendron ponticum (RP) through the catchment has significant potential to undermine biodiversity, fisheries and other activity in the catchment. The biosecurity (CIRB 1) project (2011-14) has begun the process of raising awareness, identifying and controlling the spread of these species with a longer-term aim to eradicate them from the catchment. Further funding is being sought to continue this work in the future.

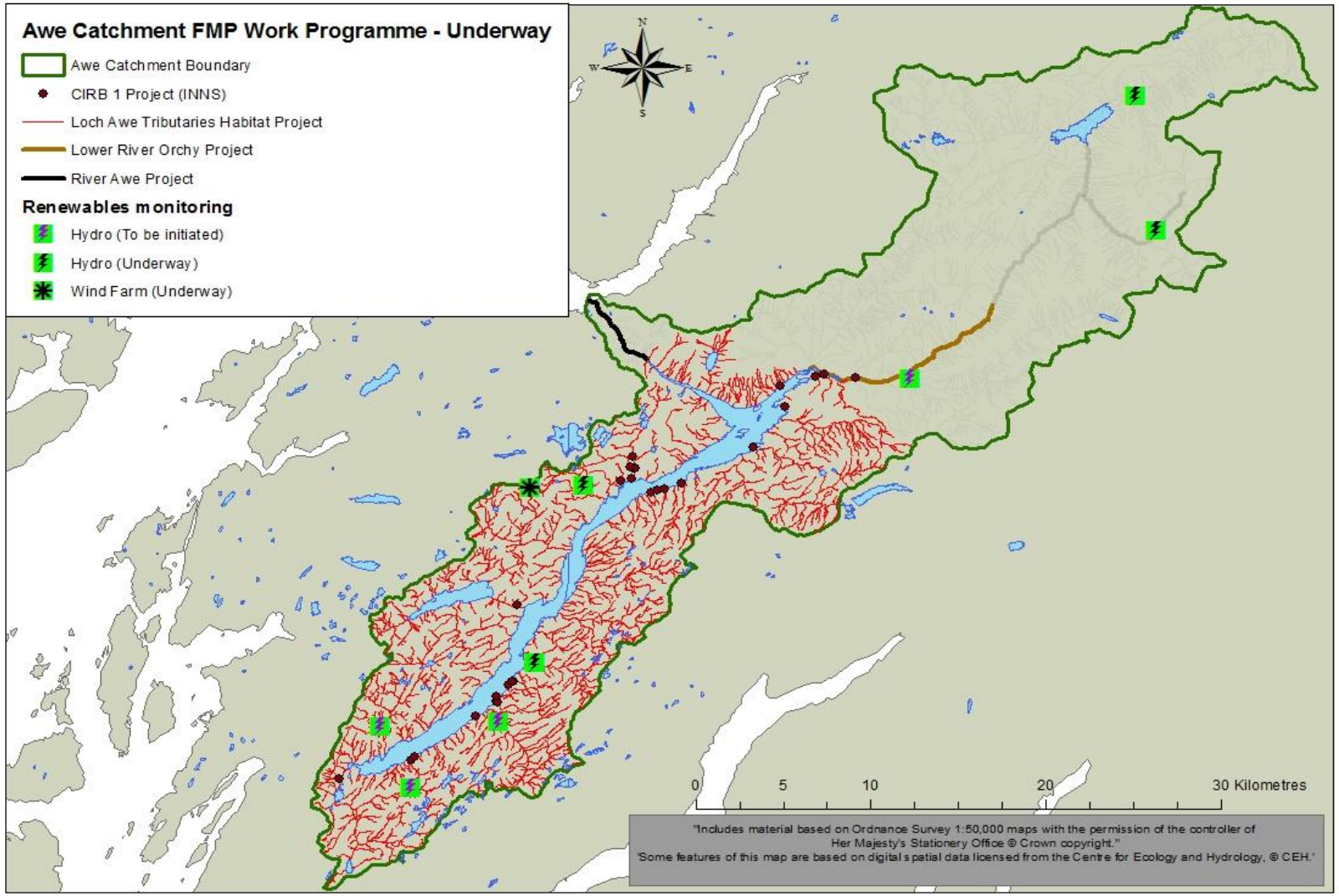
Project Aims	Activity	Status	Duration	Outcomes
A. Raise awareness of INNS	Media releases and project presentations	On-going	2010-14	Higher profile of INNS within local communities.
B. Identify, species and range present in the catchment	Habitat survey and reporting	Complete	2010-14	JK - widespread patches HB – occasional patches RP – widespread infestation
C. Control and where possible eradicate INNs	Plant treatments; cutting and spraying.	Underway	2011-14	
D. Assess response of plant communities to treatments	Habitat survey and reporting .	Underway	2013-14	
E. Develop new biosecurity / climate change projects	Eradication of INNS / re-establish native plants	To be initiated	2014-19	

5.1.7 Management and consultation

The variety of habitats, fish species and fisheries in the catchment require that management activities need to be coordinated to ensure that they are effective and make best use of limited resources.

Project Aims	Activity	Status	Duration	Outcomes
A. Protect fish and habitats from inappropriate development	Understand and consult with developers and regulators	On-going	2014-19	Maintain current status of habitat productivity.
B. Have consensus for joined-up approach to management activities	Regular meetings / liaison between fisheries	On-going	2014-19	Improve management on a catchment scale

Location of work programmes currently underway



5.2 Work programmes yet to be initiated

Some of the work programmes identified have yet to be initiated, but may get underway during the life-time of this phase of the management plan.

5.2.1 Upper River Orchy Project

This project aims to investigate potential to improve habitat condition in the upper River Orchy and the tributaries of Loch Tulla with an emphasis on building resilience to climate change through large-scale regeneration of native riparian woodland. Increasing shading of the river channels using native species has multiple benefits for biodiversity and increasing productivity in nutrient poor habitats. The initial data collection to inform the project requires supported by ADRIA, but other funding will also be required to complete habitat improvements.

Project Aims	Activity	Status	Duration	Outcomes
A. Establish baseline data on spawning habitat and juvenile fish populations	E-fish, habitat & redd count surveys	Underway	2013-14	Some habitat in sub-optimal condition
B. Identify factors limiting recruitment of juveniles	Data analysis and reporting	On-going	2014-15	Morphology and riparian habitat impair juvenile recruitment
C. Consult with land owners and fund habitat improvement measures	Consultation & project proposal	To be initiated	2014-16	
D. Restore access to tributaries and marginal spawning in main river	Remove obstacles (tribs.) and croys (main river)	Underway	2013-16	
E. Improve condition of riparian habitat improve resilience to climate change.	Fencing, coppicing & regenerate diverse vegetation structure	To be initiated	2014-17	
F. Assess response of fish populations to changes in flow regime	E-fish & redd count surveys. Counter analysis	To be initiated	2015-18	

5.2.2 Allt Kinglass Project

This project aims to investigate and inform management of the flow regulation on the Allt Kinglass tributary of the River Orchy in relation to the abstraction of flow to the Glen Lyon hydro electric generation scheme. There is also potential to improve riparian habitat condition and build-in resilience to further climate change through re-establishment of riparian woodland which will also benefit biodiversity and increase productivity in nutrient poor habitat. Project partners may include AFT, ADRIA, ADSFB, SEPA and SSE. The initial start-up phase (baseline surveys) of the project will need to be funded by ADRIA and further work may be supported by SSE. There budget for initial investigation phase in 2014-2016 is £2,000 per year.

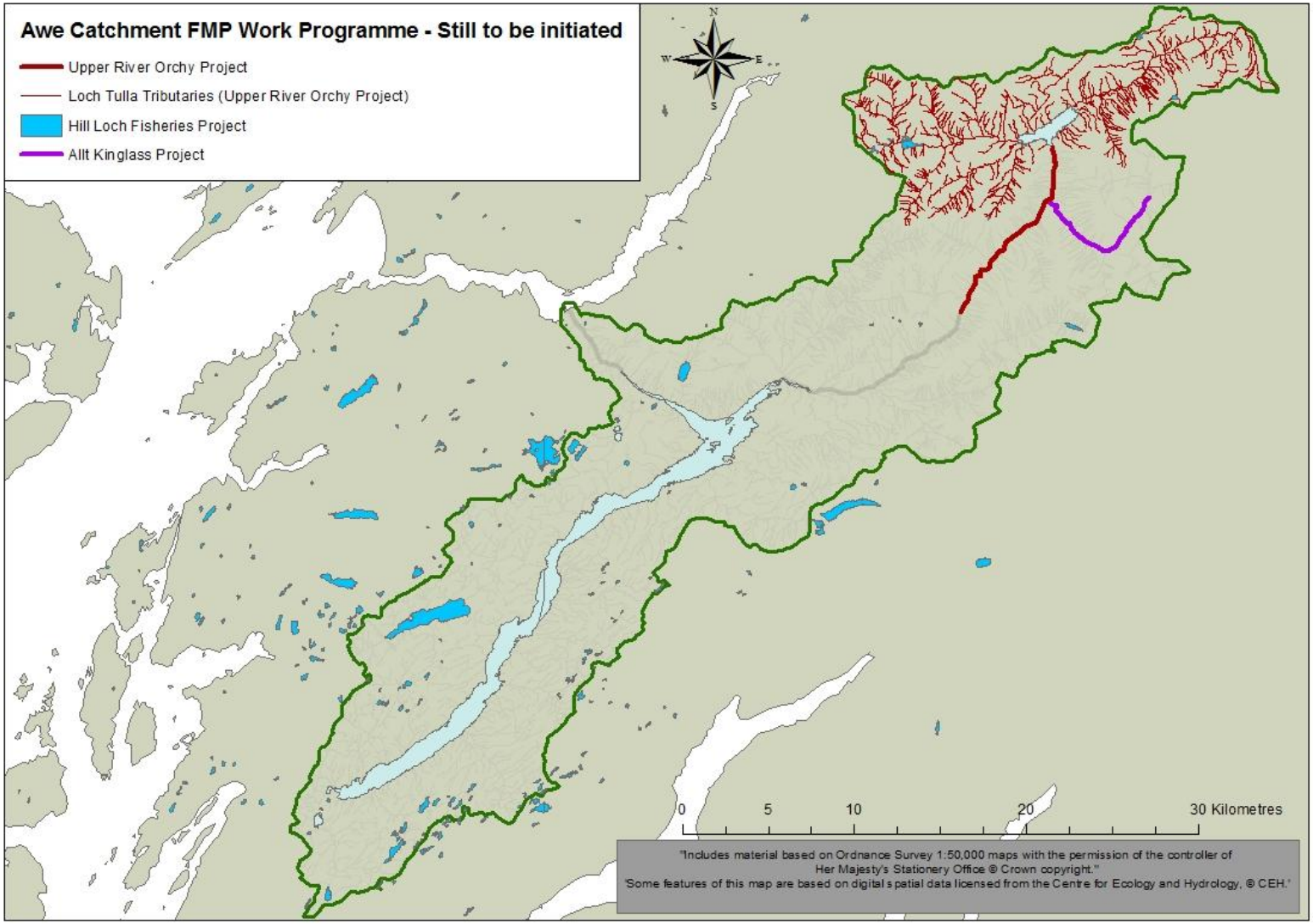
Project Aims	Activity	Status	Duration	Outcomes
A. Establish baseline data on spawning habitat and juvenile fish populations	Habitat, E-fish & redd count surveys	To be initiated	2014-16	
B. Identify factors limiting recruitment of juveniles	Data analysis and reporting	To be initiated	2016-17	
C. Inform and seek improvement in flow regime	Consultation	To be initiated	2017-20	
D. Improve condition of riparian habitat.	Re-establish riparian woodland	To be initiated	2014-19	
E. Assess response of fish populations to changes in flow regime	E-fish & redd count surveys. Counter analysis	To be initiated	2018-23	

5.2.3 Hill Loch Fisheries Project

This project aims to improve access, use and revenue from brown trout fisheries on hill lochs. Such fisheries will need to be based on sustainable use of the resource which will require baseline data on trout populations to be collected. Access for anglers to remote hill lochs will require co-operation from fishery owners and development of a permit scheme that ensure that revenue from permit sales are secured. Initial investigation work may be undertaken on fisheries where some revenue is already being realised from established fisheries, but where none is available, other avenues of potential funding need to be found.

Project Aims	Activity	Status	Duration	Outcomes
A. Improve angler access to hill loch fisheries	Consult with fishery owners	To be initiated	2015-16	
B. Establish a permit scheme where none exist.	Develop web-based permit sales outlet	To be initiated	2016-17	
C. Collect baseline data on habitat and fish populations.	E-fish, habitat & netting surveys	To be initiated	2017-20	
D. Identify factors limiting recruitment of juveniles. Prescribe conservation measures where required	Analysis and reporting	To be initiated	2016-19	
E. Improve condition of riparian habitat.	Re-establish diverse riparian habitat	To be initiated	2016-19	
F. Assess response of fish populations to fishery activity	E-fish & netting surveys.	To be initiated	2019-23	

Location of work programmes yet to be initiated



5.3 Summary Budget and timeline

5.3.1. Projects already underway

Project	Activity	2014	2015	2016	2017	2018	2019	Total
River Awe Project	Fish / flow studies	5,000	5,000					10,000
	Habitat restoration	2,500	2,500					5,000
	Total	**7,500**	**7,500**	**-**	**-**	**-**	**-**	**15,000**
Lower Orchy Project	Fish / spawning studies	1,500	1,500				1,500	4,500
	Habitat plan / implementation	3,000	3,000	3,000	3,000	-	-	12,000
	Fencing / planting / LWD	5,000	10,000	7,000				22,000
	Total	**9,500**	**14,500**	**10,000**	**3,000**	**-**	**1,500**	**38,500**
Loch Awe Tribs. Project	Fish studies / habitat proposals	2,000	2,000	2,000	2,000	2,000	2,000	12,000
	Habitat restoration	10,000	10,000	10,000	10,000	10,000	10,000	60,000
	Total	**12,000**	**12,000**	**12,000**	**12,000**	**12,000**	**12,000**	**72,000**
Renewable schemes	Fish studies / report / consult	5,000	2,000	5,000	1,000	1,000	1,000	15,000
Stock monitoring	Counter analysis / fish study	1,000	1,000	1,000	1,000	1,000	1,000	6,000
Biosecurity	Treatment of INNS / awareness	30,000	-	1,000	1,000	1,000	1,000	34,000
	Total	**36,000**	**3,000**	**7,000**	**3,000**	**3,000**	**3,000**	**55,000**
		2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
	Total	**65,000**	**37,000**	**29,000**	**18,000**	**15,000**	**16,500**	**180,500**

5.3.2 Projects yet to be initiated

Project	Activity	2014	2015	2016	2017	2018	2019	Total
Upper River Orchy Project	Fish / flow studies	3,000	2,000				1,500	6,500
	Habitat restoration		2,500	3,000	3,000	5,000	5,000	18,500
	Fencing / planting / tree protection			10,000	17,000			27,000
	Total	**3,000**	**4,500**	**13,000**	**20,000**	**5,000**	**6,500**	**52,000**
Allt Kinglass Project	Fish / spawning studies	1,000	1,000	3,000	3,000	3,000	3,000	14,000
	Habitat restoration			5,000	5,000	5,000	3,000	18,000
	Fencing / planting / tree protection					17,000	17,000	34,000
	Total	**1,000**	**1,000**	**8,000**	**8,000**	**25,000**	**23,000**	**66,000**
Hill Loch Fisheries Project	Fish studies / habitat proposals	-	-	1,000	1,000	1,000	1,000	4,000
	Fishery development		1,000	1,000	500	500	500	3,500
	Total	**-**	**1,000**	**2,000**	**1,500**	**1,500**	**1,500**	**7,500**
Biosecurity	Treatment of INNs	-	20,000	20,000	20,000	20,000	20,000	100,000
	Disinfection points / awareness		5,000	1,000	500	500	500	7,500
Climate change	Water temp.studies	500	300	100	100	100	100	1,200
	Total	**500**	**25,300**	**21,100**	**20,600**	**20,600**	**20,600**	**108,700**
		2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
	Total	**4,500**	**31,800**	**44,100**	**50,100**	**52,100**	**51,600**	**234,200**

5.3.3. Project partners

Partner	2014	2015	2016	2017	2018	2019	Total
Awe District Improvement Assoc. (ADRIA)	12,000	13,500	12,000	13,000	12,000	13,000	75,500
Loch Awe Improvement Association (LAIA)	2,000	2,000	2,000	2,000	2,000	2,000	12,000
Scottish & Southern Energy Plc. (SSE)	5,000	5,000	3,000	3,000	3,000	3,000	22,000
Renewable Developers	5,000	2,000	5,000				12,000
CIRB1	30,000						30,000
Other funding (TBA)	15,500	46,300	51,100	50,100	50,100	50,100	263,200
Grand Total	**69,500**	**68,800**	**73,100**	**68,100**	**67,100**	**68,100**	**414,700**