

# Long Term Management Plan for the Great Western Lakes

March 2023

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Iascach Intíre Éireann  
Inland Fisheries Ireland



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# Executive Summary

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Historically, a number of large limestone lakes in the west of Ireland, Loughs Corrib, Mask, Carra, Conn, Cullin, Arrow and Sheelin, have been managed preferentially as wild brown trout fisheries. In accordance with Inland Fisheries Ireland (IFI)'s most recent policy direction and their statutory remit for the management of Ireland's inland fisheries resources, seven lakes, primarily in the West of Ireland, are managed as salmonid waters. The emphasis of proposed management programmes for these ecosystems will be to protect, conserve and, where possible, enhance their natural attributes and native biodiversity which will, in turn, optimise their potential as sustainable wild

brown trout and, in some cases, Atlantic salmon fisheries. IFI's conservation remit also extends to other threatened fish species such as the European eel (EC Regulation (Council Regulation 1100/2007) for the recovery of the eel stock). Also of concern are Arctic Char (which were once found in most of the 7 lakes but are now only found in Lough Mask), Ferox Trout, Sea, River and Brook Lamprey is also reflected in the plan. Through a series of targeted actions, IFI will coordinate programmes under 7 categories of High-Level Objectives (HLO). Each HLO aligns to IFI's Corporate Plan (2021 to 2025) and is summarised below with the associated series of actions:

<b>HLO 1. (Section 4)</b>	<b>Stakeholder Engagement</b>
<p><u>Action 1.1:</u> Establish a communication schedule, Identify and engage with existing catchment groups, federations, Clubs, trusts and associations to assist with the progression of common catchment management goals.</p> <p><u>Action 1.2:</u> Where such groups have not yet been established, engage local communities, stakeholders and relevant authorities in the protection, development and conservation of their lake and river catchments through the establishment of more Catchment Management Associations for the Western Lakes.</p> <p><u>Action 1.3:</u> Enhance communication mechanisms and networks between IFI, relevant stakeholder groups, state agencies, farming organisations, academic institutions local communities and catchment groups.</p>	
<b>HLO 2. (Section 5)</b>	<b>Climate Action &amp; Biodiversity</b>

Action 2.1: Identify manageable factors which will contribute to the climate resilience of sensitive habitats and species.

Action 2.2: Maintain existing woodland, where it occurs and promote the establishment of significant aquatic buffer zones to enhance biodiversity and ameliorate high temperatures and nutrient /sediment run-off.

Action 2.3: Develop spatial network models to inform the strategic planting of native woodlands to mitigate the impacts of elevated water temperatures and increased droughts, flood frequency and severity.

<b>HLO 3. (Section 6)</b>	<b>Water Quality</b>
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**Action 3.1:** Enhance the current statutory powers of Inland Fisheries Ireland by authorising officers to enforce the relevant provisions of the Habitat Regulations.

**Action 3.2:** Enhance the capacity of IFI to detect and enforce water quality offences by using all available technology and increasing the number of Fisheries Environmental Officers working in the catchment areas of the Western lakes.

**Action 3.3:** Continue to improve and enhance working relationships with key environmental authorities in the western lake catchments so that information is shared effectively and increased efficiencies, with regard to environmental enforcement, are achieved.

**Action 3.4:** Provide information and assistance with the designation of nutrient sensitive catchments and areas for action.

<b>HLO 4. (Section 7)</b>	<b>Invasive Species</b>
<p><u>Action 4.1:</u> Remove and/or manage high risk invasive species through strategic stock management and weed management programmes.</p> <p><u>Action 4.2:</u> Continue to use digital and conventional media to alert the public about potentially harmful invasive species in the western lakes and their wider catchments.</p> <p><u>Action 4.3:</u> Provide biosecurity advice and resources to stakeholder groups to prevent the spread of invasive species in the western lakes.</p> <p><u>Action 4.4:</u> Encourage relevant stakeholder groups to participate in a range of conservation activities including the management of invasive species.</p> <p><u>Action 4.5:</u> Enhance legislation and increase penalties for the illegal transfer of live fish.</p>	
<b>HLO 5. (Section 8)</b>	<b>Stock Management</b>
<p><u>Action 5.1:</u> Produce stock management plans annually, on a local RBD basis, to reduce impacts on salmonids from other fish populations.</p> <p><u>Action 5.2:</u> Adjust stock management plans as population models on each of the lakes are refined.</p> <p><u>Action 5.3:</u> Enable local stakeholder groups to contribute to population modelling and research programmes including creel surveys (through citizen science).</p> <p><u>Action 5.4:</u> Develop risk matrix for Atlantic salmon and trout based on physical characteristics of each waterbody and the implications of these for predation and survival bottlenecks.</p>	
<b>HLO 6. (Section 9)</b>	<b>Habitat Restoration</b>
<p><u>Action 6.1:</u> Address the salmonid habitat deficits in the western lakes catchments through targeted restoration projects.</p> <p><u>Action 6.2:</u> Streamline administrative processes to bring habitat restoration projects through planning processes to fruition with maximum efficiency.</p> <p><u>Action 6.3:</u> Ensure that all relevant environmental protection processes are in place to avoid damage to other sensitive species and habitats.</p>	
<b>HLO 7. (Section 10)</b>	<b>Research</b>

Action 7.1: Continue to develop new and refine existing fish stock monitoring programmes (e.g., WFD) to provide the necessary data for fish population models for the western lakes.

Action 7.2: Use all available sources of data incl. WFD surveys, Stock management and, where appropriate, angling returns to feed into fish population models for the western lakes.

Action 7.3: Continue research on climate change impact under current programmes (CCMRP) to help improve resilience in catchments and species.

Action 7.4: Continue to develop IFI's Brown Trout Research Policy with recommendations for the future conservation of all sub-species.

All seven lakes share a series of pressures which are impacting on their ecosystem stability and native fish stocks, including declining water quality, fisheries habitat loss, invasive species and the effects of climate change. These issues will be tackled through the various measures proposed in this plan.

However, there are many smaller lake catchments, particularly along the western seaboard which share a similar susceptibility to the issues outlined above. In some instances, salmon aquaculture appears to be

The overall objective of this plan is to improve environmental conditions in the Great Western Lakes to support sustainable salmonid fisheries as well as for the

having significant additional impacts. These small lakes support vulnerable stocks of Atlantic salmon, brown trout and their migratory form, sea trout as well as other threatened species such as Arctic char, Lamprey and eels.

There is a particular need to develop plans for these smaller catchments so that the conservation of important indigenous fish stocks can be addressed through such mechanisms as species action plans on a local and national basis.

conservation of their native biodiversity. This will, in turn, protect their inherent amenity value for the benefit of communities and tourism.



## 1.0. Introduction

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Inland Fisheries Ireland (IFI) has a statutory remit under the Inland Fisheries Act of 2010 - to protect, conserve and manage Irelands inland fisheries resources. An integral part of this resource is the habitats and waters inhabited by fish species of conservation interest (see table 3.2). This plan has been prepared for a group of waterbodies and their catchment areas to advance the conservation and restoration of their ecological integrity and thus, native fish stocks. Seven lakes and their catchments, primarily in Connaught, are managed as salmonid waters in Ireland (See section 2). These waterbodies are large by Irish standards (1,266 - 16,562 Ha.) and are generally based on carboniferous limestone. Their bathymetry, water chemistry and unique assemblages of flora and fauna has resulted in the evolution of rare and highly valued ecosystems that offer an abundance of services to society and the natural environment. The lakes have become an integral part of the European Natura 2000 network and immense centres for recreational and cultural activity, particularly angling.

This plan sets out a series of measures which aim to address and manage many of the factors currently impacting on the ecosystems and the status of native fish stocks on the designated lakes and their catchments.

Key objectives include:

- To ensure the sustainability of salmonid fish and fisheries within the designated waterbodies and to introduce measures to mitigate against the pressures currently impacting on their ecological integrity.
- To protect, manage and where they have been damaged, restore the natural attributes and aquatic biodiversity of the designated waterbodies.
- To restore damaged habitat and its potential to support sustainable wild brown trout and salmon fisheries.

Although this plan relates primarily to the conservation and management of salmonid fish, the importance of their co-dependence and relationship with other, flora and fauna must also be recognised. All seven lakes and significant parts of their catchments are designated as Special Areas of Conservation (SAC) or Special Protection Areas (SPA) under European Legislation (European Communities (Birds and Natural Habitats Regulations 2011 (S. I. No. 477 of 2011) . The protection of other species and habitats of community interest, which are

also important to the health and wellbeing of these important aquatic ecosystems, is also a vital component of the plan (NPWS 2017).

Appropriate Assessments will be carried out for all projects and management actions on the western lakes. These assessments are necessary to ensure that sensitive species and habitats, that are qualifying interests for the Natura sites are not adversely affected by any management measures proposed through this plan.

The implementation will require a multi-disciplinary, multi-agency approach and will seek to engage local communities and other interested stakeholders within the catchment areas.

The plan also endorses the concept of adaptive management, whereby actions and measures are periodically assessed in terms of their benefits and impacts on critical receptors, (e.g., Salmonid stocks, water quality, aquatic habitats) within the western lake catchments. The effects of various management strategies will be regularly evaluated and modified accordingly, to better achieve the desired outcomes.

Section 11 of this plan sets out timelines for actions over an initial 5-year period that align with IFI's Corporate Plan 2021 – 2025. The resources required to implement the plan including an outline of funding and staff required is in preparation and will accompany the final draft of this plan.

It is widely recognised that native fish stocks, water and habitat quality have declined on the western lakes over the last three decades. This plan proposes a series of actions aimed at redressing these declines and, in association with other relevant state authorities and local communities, IFI will endeavour to achieve improvements that will secure native fish stocks and their habitat into the future.

In order to successfully achieve the objectives and implement the measures set out in this plan, additional resources will be required. Once these have been allocated, a series of specific targets and performance indicators will be developed to ensure that critical elements within the plan are accomplished.



Fig. 1.1 Locations of the 7 Western Lakes

## 2.0. The Great Western Lakes

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The following summary descriptions are extracted from IFI's Water Framework Directive (WFD) fish sampling reports. (See <http://wfdfish.ie>)

### 2.1. Lough Arrow

Lough Arrow is a limestone lake situated in Co. Sligo, approximately 24km south-east of Sligo town and 6.4km north-west of Boyle, Co. Roscommon. It is sheltered on three sides by hills and is the source of the Unshin River. Lough Arrow is the smallest of the Western lake catchments fed largely by springs on the lake bed and as such is hydrologically different from most lakes in Ireland (Roscommon County Council, 2009).

Lough Arrow has a surface area of 1,266ha, with a mean depth of 9m and a maximum depth of 33m. It is categorised as typology class 12 (as designated by the EPA for the purposes of the Water Framework Directive), i.e. deep (>4m), greater than 50ha with high alkalinity (>100mg/l CaCO<sub>3</sub>). It is of major conservation significance as it conforms to a type (hard water lake) listed in Annex I of the EU Habitats Directive. The shores of the lake are, for the most part, stony, although the common club-rush (*Scirpus lacustris*) and common reed (*Phragmites australis*) occur abundantly in several bays (NPWS, 1999).

The lake was once stocked with hatchery reared in brown trout but this practice was discontinued (circa 2005) and there does not appear to be any genetic remnant in current stocks. Artificial augmentation of stocks in the western lakes was largely abandoned in the late 1990s and replaced with fisheries enhancement programmes. In the Lough Arrow catchment, spawning and nursery areas for brown trout were restored over the period 1998 to 2000 involving re-creation of pools and natural meander patterns, fencing of streams from livestock and the placing of additional spawning gravels in streams where appropriate (O' Grady, 2004). Adult wild brown trout average 0.45kg in weight, with fish up to 2.7kg having been taken by anglers in the past.

Up to 1994, only perch, pike and brown trout were recorded in stock surveys, although three-spined stickleback were also recorded in the stomachs of pike. Rudd were encountered for the first time in 2002 and were captured again in the 2007 survey. The lake has been surveyed by IFI every three years for the WFD fish monitoring programme since 2009 (Kelly et al., 2010, 2013, 2016 and Connor et al., 2019). During the 2018 survey, perch were found to be the dominant species present in the lake. Roach, brown trout, roach/rudd hybrids, roach x bream hybrids, rudd, pike and eels were also captured during the survey (Connor et al., 2019).

Lough Arrow was assigned an ecological status of Good in 2018 based on the fish populations present. In previous years the lake was also assigned Good fish ecological status. The EPA assigned Lough Arrow an overall ecological status of Moderate.

## 2.2. Lough Conn

Lough Conn is located in the Moy catchment in north County Mayo. It is connected to its immediate neighbour to the south, Lough Cullin, by a narrow channel that passes under a regional road at Pontoon village. The River Deel flows into Lough Conn and exits Lough Cullin at its southern end near Foxford, before joining the River Moy which discharges into the Atlantic at Killala Bay. The lake has a surface area of 4,704ha and a maximum depth of 37.9m. The lake is categorised as typology class 12 (as designated by the EPA for the Water Framework Directive), i.e. deep (mean depth >4m), greater than 50ha and high alkalinity (>100 mg/l CaCO<sub>3</sub>). Lough Conn is part of a Special Protection Area (SPA) (Site code: 004228) under the E.U. Birds Directive. It also forms part of the River Moy SAC where Atlantic Salmon are a qualifying interest.

The SPA is of special conservation interest for the following species: Greenland White-fronted Goose, Tufted Duck, Common Scoter and Common Gull. The E.U. Birds Directive pays particular attention to wetlands and, as these form part of this SPA, the site and its associated water birds are of special conservation interest. Lough Conn's reputation as a fine brown trout and salmon fishery goes back to the very beginning of angling in the west of Ireland. The main run of spring salmon enters Lough Conn from the end of March and continues right through April. The grilse run begins in May and continues into July.

The lake was surveyed by Inland Fisheries Ireland (IFI) on eight occasions between 1978 and 2001 (1978, 1984, 1990, 1994, 1998, 2001, 2005 and 2013) as part of a brown trout fish stock assessment programme. Brown trout, rudd, roach, perch and pike were captured in the surveys. More recently a whole lake fish stock survey was undertaken in 2016 (Kelly *et al.*, 2017) and 2022 (in prep). Roach followed by perch were found to be the most dominant species during the 2016 survey followed by brown trout, eel, pike, salmon and tench (Kelly *et al.*, 2017).

Historically the lake held a population of Arctic char; however, they have been extinct for some time. Following the apparent collapse of the Arctic char population IFI surveyed the spawning areas where Arctic char, if present, would be congregating to spawn. The surveys were carried out during the Arctic char spawning seasons of 1991 to 1994. Three Arctic char were captured in the 1991 sampling, one fish in 1992 and none thereafter in 1993 or 1994. An

examination of pike stomachs from fish captured in various parts of Lough Conn, throughout the 1990s, found no Arctic char. It is now established that Arctic char had become extinct in Lough Conn by the mid-1990s.

Based on the fish populations present, Lough Conn was assigned an ecological status of Good in 2016, the most recent survey under the WFD. In the 2013 to 2018 surveillance monitoring reporting period, the EPA assigned Lough Conn an overall ecological status of Moderate.

### **2.3. Lough Cullin**

Lough Cullin is a large, shallow lake situated to the west of Foxford, which is connected to Lough Conn by a narrow inlet at Pontoon, Co. Mayo. The outflow from the lake discharges directly into the River Moy south-west of Foxford (NPWS, 2004). Lough Cullin has a surface area of 1019.3ha with a maximum depth of approximately 3m (O' Reilly, 2007). The underlying geology of the lake is mainly granite with some areas of limestone present in the southern region of the catchment (NPWS, 2004). The lake is categorised as typology class 10 (as designated by the EPA for the purposes of the Water Framework Directive), i.e. shallow (100mg/l CaCO<sub>3</sub>).

Lough Cullin is located within the River Moy Special Area of Conservation (SAC) (NPWS, 2005). The underlying geology of the majority of the SAC is Carboniferous limestone, with areas of Carboniferous sandstone, Dalradian quartzites and schists also present. Some of the tributaries at the east and south of Lough Conn, and all inflowing to Lough Cullin are underlain by granite. The site has been selected as a candidate SAC for containing alluvial wet woodlands, raised bog, old oak woodlands (present on the shores of Lough Cullin), degraded raised bog and Rhynchosporion depressions (*Rhynchospora alba*), all priority habitats on Annex I of the E.U. Habitats Directive.

This SAC has also been selected due to the presence of the following species, listed on Annex II of the same Directive – Atlantic salmon, otter, sea and brook lamprey and white-clawed crayfish. Lough Cullin has relatively low colour and good water clarity. The phytoplankton in the lake is dominated by diatoms and blue-green algae. Lough Cullin also supports important wintering waterfowl and is designated as a Special Protection Area, as its one of the few breeding sites for Common Scoter in Ireland (NPWS, 2005). Lough Cullin was once regarded as one of Ireland's premier brown trout fisheries but was often considered to be the 'poor relation' of Lough Conn. Historically, in angling terms, Lough Cullin was noted for supporting a large population of relatively small (brown trout (O' Grady and Delanty, 2001). Today brown trout averaging 0.3kg to 0.45kg are often caught, with some weighing up to 1.8kg (O' Reilly 2007). The lake was also regarded as a very important salmon fishery and

receives a run of salmon during the spring and summer months (NPWS, 2004; O' Reilly, 2007). In fact, all the salmon, of which there can be many, destined for Lough Conn and its inflowing rivers must pass through Lough Cullin.

Lough Cullin was previously surveyed in 1994, 1998 and 2001 as part of a fish stock assessment by IFI's research section using seven-panel benthic braided survey gill nets. These surveys revealed that the brown trout population declined between 1995 and 2001. Eutrophication problems have been evident in the lake in recent years. There was a population of rudd in the lake since the 1960s; however, roach, a highly prolific non-native species, became established in the lake in the 1990s. The lake has been surveyed by IFI for the WFD fish monitoring programme in 2009, 2012, 2018 and 2022 (REFS needed)- [WFDfish.ie](http://WFDfish.ie). During the 2018 survey, roach were found to be the dominant species present in the lake. Perch, brown trout, tench, three-spined stickleback, rudd, pike, roach/rudd hybrids, salmon and eels were also captured during the survey. Lough Cullin was assigned an ecological status of Moderate following the most recent WFD survey (2018) based on the fish populations present. The EPA has assigned the lake an overall ecological status of moderate for the 2013-2018 monitoring period.

#### **2.4. Lough Carra**

Lough Carra is situated in County Mayo and forms the most northerly part of the Corrib catchment. It is located approximately 5km north of Ballinrobe, Co. Mayo. Lough Carra is the largest marl lake in Ireland, with a surface area of approximately 1,600ha. It is a hard water lake which acquires most of its water via the feeder streams that flow in at various points around its perimeter (Huxley and Huxley, 2009) with some contributions from ground-water springs. The majority of the lake is shallow with a mean depth of approximately 1.8m; however, there are sections of the lake where depths reach over 19m (Huxley and Huxley, 2009). Lough Carra is well known for its green/blue colour which is due to the formation of calcareous encrustations (NPWS, 2004). The lake contains well developed stonewort communities with *Chara curta*, *C. desmacantha*, *C. rudis* and *C. contraria* also recorded (NPWS, 2004). It is categorised as typology class 10 (as designated by the EPA for the purposes of the Water Framework Directive (WFD)), i.e. shallow (100mg/l CaCO<sub>3</sub>).

The average size of the brown trout taken from Lough Carra is greater than any of the other western lakes as they grow rapidly in this rich ecosystem. Lough Carra is believed to be one of the few remaining wild brown trout calcareous lakes within the EU (Irvine et al. 2003). During the 1990s fishery rehabilitation and enhancement works were undertaken in Lough Carra's spawning streams by Inland Fisheries Ireland (IFI) and this led to increased recruitment of juvenile

brown trout to the lake (O' Grady, 2009). The lake was surveyed eight times from 1978 to 2009 as part of IFI's brown trout research programme using seven-panel benthic braided survey gill nets; brown trout, perch and pike were recorded on all sampling occasions. The most recent results (March 2009) using this survey method suggested that the lake supported an excellent and healthy stock of brown trout (IFI, 2009). More recently, the lake was surveyed by IFI for the WFD fish surveillance monitoring programme in 2009, 2012, 2015, 2019 and 2022 (Kelly et al., 2010, 2013 and 2016; Corcoran et al., 2020). In these surveys, Perch were the most numerous fish with brown trout abundance declining slightly. Lough Carra was assigned a fish ecological status of Good in 2018 (Corcoran et al., 2020). In the 2013 to 2018 surveillance monitoring reporting period, the EPA assigned Lough Carra an overall ecological status of Good, based on all monitored physico-chemical and biological elements, including fish.

Notwithstanding this relatively recent designation, Lough Carra has experienced a significant deterioration in water quality over the last decade. Recent EPA reports indicate rises in ortho-phosphate and Nitrogen levels and increased algal biomass in lake water samples. These worrying trends lead to the formation of the Lough Carra Catchment Association in 2018. This community-based group aims to engage people living and farming in the Carra catchment area to help reduce harmful nutrient inputs. They have succeeded in raising awareness in the local community of the problems facing Lough Carra but their greatest challenge, one that is facing all of the great western lakes, is in shifting the current emphasis away from intensification of agriculture in sensitive western catchments to a more environmentally friendly land management policy.

## **2.5. Lough Mask**

Lough Mask is situated north of Lough Corrib, adjacent to the town of Ballinrobe, Co. Mayo. It is the sixth largest lake in Ireland with a surface area of approximately 8,218ha. The length of the lake from north to south is approximately 16km and the width is approximately 6.4km at its widest point. The main rivers flowing into Lough Mask are the Cloon, Robe, Owenbrin, Finny, Glensaul, Glentraig and the Keel River, which is the out flowing river from Lough Carra. Lough Mask is linked to Lough Corrib by the Cong Canal. It is generally a shallow lake with a mean depth of 5m; however it attains a maximum depth of 57m along a long narrow trench on the western shore of the lake (NPWS, 2004). The lake is categorised as typology class 12 (as designated by the EPA for the purposes of the WFD), i.e. deep (>4m), greater than 50ha and high alkalinity (>100mg/l CaCO<sub>3</sub>).

The underlying geology of Lough Mask is Carboniferous limestone, with areas of shale and sandstone, and it is an excellent example of a lowland



oligotrophic lake (NPWS, 2004). Lough Mask, Carra and Cloon make up the Lough Carra/Lough Mask Special Area of Conservation (SAC) complex. Six habitats listed on Annex I of the EU Habitats Directive are found in this site, including two priority habitats - limestone pavement and Cladium fen (NPWS, 2004).

Roach, an invasive fish species was first recorded in a fish stock assessment survey in 1996, since then the population has spread throughout the lake. Lough Mask is noted for its populations of brown trout and ferox trout, with the average size of brown trout ranging from 0.6kg to 1.4kg. The largest ferox trout can reach up to 9kg in weight (O' Reilly, 2007).

The lake was previously surveyed in 1996 as part of Inland Fisheries Ireland's (IFI) brown trout stock assessment programme using seven-panel benthic braided survey gill nets. Five fish species were recorded at that time; brown trout, Arctic char, pike, perch and a single roach. More recently the lake was surveyed by IFI for the WFD fish monitoring programme in 2009, 2012 and 2015 (Kelly et al., 2010, 2013 and 2016) and 2019 (Corcoran et al., 2020). During the most recent survey perch, roach, bream, roach x bream hybrid, brown trout, Arctic char, pike, three-spined stickleback and eels were recorded (Corcoran et al., 2020).

Lough Mask was assigned an ecological status of Good for 2019 based on the fish populations present. The lake was also assigned Good fish status in 2009, 2012 and 2015. In the 2013 to 2018 monitoring period the lake was assigned an overall draft ecological status of good based on all monitored physico-chemical and biological elements including fish.

## **2.6. Lough Corrib**

Lough Corrib, the largest of the western lakes and the second largest lake in Ireland (after Lough Neagh), is situated in Co. Galway in the River Corrib catchment. The lake stretches from outside Galway city to within three km of Maam Cross, a distance of over 50 km. The main rivers draining into Lough Corrib include the Black, Clare, Dooghta, Cregg, Cornamona, Maam, Owenriff rivers and the Cong canal which joins Lough Corrib to Lough Mask.

The lake can be divided into two parts: Lower Lough Corrib - a relatively shallow basin underlain by carboniferous limestone in the south (Fig. 1.1), and Upper Lough Corrib - a larger, deeper basin underlain by more acidic granite, schists, shales and sandstones to the north. The lake has a surface area of 16,562Ha (5,042ha Lower Lough and 11,520ha Upper Lough), and has a maximum depth of 42m. The lower lake is categorised as typology class 10 (as designated by the EPA for the Water Framework Directive), i.e. shallow (mean depth <4m – Total hardness >100mg/l CaCO<sub>3</sub>) and the upper lake fits into typology class 12, i.e. deep (mean depth >4m), greater than 50ha and high alkalinity (>100mg/l CaCO<sub>3</sub>).

The lake supports 14 protected habitats and six species, including salmon that are listed on Annex I and Annex II respectively of the EU Habitats Directive (NPWS, 2004). It is one of the best game fisheries in the world and is internationally renowned for its brown trout fishing. The lake is known to hold brown trout, salmon, perch, roach, bream, roach x bream hybrids, eels, 3-spined stickleback, 9 spine stickleback, pike, tench and stone loach. Unfortunately roach a non-native invasive fish species was first identified in Lower Lough Corrib in the early 1980s and subsequently spread to all corners of the lake. High numbers of roach were observed in routine netting operations on the lake from the late 1980s until 1992 when a decline in the stock was observed. It was during this period that Arctic char were thought to have disappeared from L. Corrib. In early 2007, large numbers of the protozoan parasite *Cryptosporidium* sp. were detected in water from the lake, leading to contamination of the public water supply and an outbreak of cryptosporidiosis in Galway city.

Another unwelcome visitor to the lake is the highly invasive plant species *Lagarosiphon major* (also known as "Curly Waterweed") which was first identified in the lake in 2005. This rapidly colonizing plant has already excluded native plant species from bays in which it has become established. The Zebra mussel (*Dreissena polymorpha*), another invasive species in Ireland was first recorded in Lough Corrib during 2007 and it is thought they were introduced to the lake in 2000/2001.

Lough Corrib has been included in Inland Fisheries Irelands long term water quality monitoring programme of lake ecosystems since 1975. The lake is currently classified as mesotrophic. It was previously surveyed to assess its fish stocks by Inland Fisheries Ireland (formerly the Central Fisheries Board and the Western Regional Fisheries Board) in 1986 and 1996.

The lake was also surveyed in 2008, 2011, 2014 and 2018 and 2021 as part of the Water Framework Directive surveillance monitoring programme (Kelly et al., 2009, 2012a and 2015; Connor et al., 2018 and McLoone et al., 2022). During the 2018 survey, perch followed by roach were found to be the dominant species present in the Upper Lough, while perch followed by roach x bream hybrids and roach were dominant in the Lower Lough. brown trout, salmon, three-spined stickleback, nine-spined stickleback, pike, bream, stone loach and eels were also captured during the survey.

## 2.7. Lough Sheelin

Lough Sheelin is situated in counties Cavan, Meath and Westmeath in the Inny sub-catchment of the River Shannon Basin District. The lake is located north-east of Finnea, Co. Westmeath. It is seven kilometres long and has a surface area of 1,900 hectares. The River Inny flows through the lake. Lough Sheelin is a relatively shallow lake with a mean depth of 4.4m, a maximum depth of 15m, and 51% of the lake is less than 5m in depth. The geology of the catchment is predominantly Carboniferous limestone, but Silurian/Ordovician formations underlie the western and northern drainage basin.

The lake is eutrophic, and is categorised as typology class 12 (as designated by the EPA for the Water Framework Directive), i.e. deep (>4m), greater than 50ha and high alkalinity (>100 mg/l CaCO<sub>3</sub>).

In the 1960s and 1970s Lough Sheelin was one of Ireland's top trout angling lakes, managed and developed by the Inland Fisheries Trust (now Inland Fisheries Ireland). Phosphorus originating from intensive agricultural developments has caused progressive enrichment of Lough Sheelin since the early 1970s (Champ, 1998 and 2003). This has resulted in the trout population diminishing and the fish stock becoming dominated by cyprinids.

The lake has been stocked with brown trout in the past, with approximately 16,000 2+ fish introduced in 2004, followed by between 3,000 and 6,000 per year thereafter. Stocking of brown trout into the lake ceased in 2011.

The water quality in the lake and the catchment was monitored on a continuous basis by Inland Fisheries Ireland (previously the Shannon Regional Fisheries Board and the Central Fisheries Board) from the 1970s to 2015. A modest decrease in the total phosphorus loadings to the lake was noted between 1988 and 2005, suggesting that the phosphorus losses from the catchment declined during that period but more recent data from 2006 to 2014, indicates that there has been no improvement in the nutrient loadings to the lake.

The fish population in Lough Sheelin has been surveyed regularly since 1978 by Inland Fisheries Ireland using a gill netting technique that was developed in the late 1970s to assess trout stocks (trout >19.8cm in length) on selected lake fisheries. Other fish species are also captured as a by-catch during these surveys. This work has proved to be an effective management tool in illustrating the fluctuations in fish stocks over time. An extensive database has been developed based on this method. The standing crop of trout (>19.8cm) in Lough Sheelin varied between 100,000 and 120,000 fish in the early 1980s and has since decreased substantially. Unfortunately, roach, a non-native invasive species, were introduced into the lake during the 1970s and their population has fluctuated dramatically since that time.

Whole lake fish stock surveys have been conducted on the lake every three years since 2008 for Water Framework Directive purposes. During the 2017 survey perch were the dominant species recorded followed by roach, brown trout, pike, three-spined stickleback, tench and roach x bream hybrids (Conor et al., 2018). The lake was assigned a fish ecological status in 2017, this is an improvement on previous years when it was assigned a fish ecological status of moderate. In the 2013 to 2018 Water Framework Directive surveillance monitoring reporting period, the EPA assigned Lough Sheelin an overall ecological status of Good.

### **2.8. Other Sensitive Catchments**

The issues currently impacting on vulnerable salmonid stocks are not confined to the lakes included in this plan. There are numerous river and lake systems, particularly in the western counties from Donegal to Kerry where salmonids and other rare native fish species are severely threatened. Problems associated with invasive fish introduction, water quality pressures and aquaculture are of particular concern in some of these catchments.

A series of separate plans are proposed for these catchments which will seek to address the issues currently impacting on these waterbodies and their fish stocks.

### 3.0. Fish

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There are currently 16 species of fish recorded in the western lakes (Table 3.2.). Seven of these are native to the region and are presumed to have arrived in Irish freshwaters subsequent to the most recent glaciation approximately 12 – 14,000 years ago. All of these species share an ability to tolerate salinity and are thought to have migrated from the marine environment once river systems thawed sufficiently to accommodate fish. The remaining eight species do not tolerate full marine conditions and are therefore presumed to have been introduced, although the founding events for populations of some species in the western lakes is a matter of conjecture. Table 3.2 below indicates the various fish species currently found in the western lakes and some biological notes are also included.

The fish species of principal concern in the context of the western lakes is the wild brown trout. Atlantic salmon, Arctic char and Eels are also considered but these species have separate conservation measures either already in place or under consideration. New policies and research programmes are currently in preparation for brown trout and this plan for the western lakes is consistent with this policy direction. Further information on IFI's Brown Trout policy is available at:

<https://www.fisheriesireland.ie/sites/default/files/migrated/docman/Brown%20Trout%20Report.pdf>

Other morphotypes of brown trout are also of concern, particularly the large Ferox trout which inhabit Loughs Mask and Corrib. Other sub-species of trout (e.g., Sonaghen and Gillaroo) are collectively known as sympatric trout species and have their own conservation measures proposed.

#### 3.1. Fisheries Regulations

The principal features of the regulations governing trout angling on the 7 Western lakes vary from one location to another (see table 3.1.) below) It is the intention of this plan to bring about a standardisation these regulations, allowing for local conditions, established practices and differing fish behaviours. Revised bag limits will be agreed with stakeholders to reflect current stock levels and exploitation estimates. Restrictions based on an upper or maximum takeable size limit will also be considered as a conservation measure for high spawning value and ferox stocks.

Loughs Conn & Cullin currently have no statutory bag limit and are unique in this regard, amongst the western lakes. This will be reviewed as part of the overall alignment of regulations for these lakes. Catch and release practices will be encouraged to reduce angler impact on stocks.

Table 3.1 Current angling regulations for brown trout on the western lakes.

<b>Angling conservation measure</b>	<b>Arrow</b>	<b>Conn</b>	<b>Cullin</b>	<b>Carra</b>	<b>Mask</b>	<b>Corrib</b>	<b>Sheelin</b>
Season	1 Apr – 30 Sep	15 Feb – 30 Sep	15 Feb – 30 Sep	15 Feb – 30 Sep	15 Feb – 30 Sep	15 Feb – 30 Sep	1 Mar 12 Oct
Size limit	30cm	30cm	30cm	33cm	33cm	33cm	36cm
Daily Bag limit	4	-	-	4	4	4	2

Status & Conservation Needs	Species	Description & Management Options	Presence
<b>Native Species of High Conservation value</b>	<p align="center"><b>Brown Trout</b> <i>(Salmo trutta)</i></p>	<p>This native species is represented by a number of genetically unique stocks, with sub-species in each of the lakes. It has a significant ecological, cultural, historical and economic presence in the region. Its place within the ecosystem, as well as the social fabric of all of the great western lakes is well established. Brown trout require clean river substrates (gravel) with cool, adequately oxygenated, water to reproduce and grow. Their future wellbeing in the western lake systems depends on the availability of this habitat in all of the tributary river systems of the western lakes. High priority must be given to the protection and, where appropriate, reinstatement of this habitat throughout the relevant catchment areas. IFI have recently published a national 5 year research program for wild brown trout. This program proposes a thorough evaluation of baseline information on brown trout ecology currently available in Ireland as well as a series of management tools</p> <p>The conservation and reinstatement of wild brown trout stocks and their habitats in all of the western lake catchments is one of the principal objectives of this plan. Separate regulations in relation to brown trout exploitation by recreational users are in place for each of the western lakes. These have been established on the basis of stock size, growth rates, age at maturity and fecundity. Some adjustments to these regulations are recommended as part of this plan so that conservation measures can be better aligned between all of the designated lakes.</p>	<p>L. Arrow, Conn, Cullin, Carra, Mask, Corrib, Sheelin</p>
	<p align="center"><b>Atlantic Salmon</b> <i>(Salmo salar)</i></p>	<p>Atlantic salmon are an iconic, migratory salmonid species, related to brown trout and Arctic char. They demonstrate an anadromous life history strategy, in that they migrate from the marine environment, where they feed until maturity, to our freshwater systems to reproduce. Once the adult fish have spawned in their natal rivers, their juveniles develop for 1-3 years before returning to the sea to grow and mature, returning after 1 to 4 years to spawn. Like brown trout, salmon require high quality river habitat with clean water and substrates to successfully reproduce and develop. Salmon stocks are present and in a healthy state in three of the western lakes (Conn, Cullin and Corrib) although they have been in decline throughout Europe and North America for over 30 years. Currently, their numbers are at their lowest recorded levels, intertionally, and they are now protected throughout their range. A series of measures have been in place since 2006 which strictly limit and regulate their exploitation using a tagging and log-book system. They are also included in annex ii of Council Directive 92/43/EEC of 21 May 1992 (the Habitats Directive) and listed as qualifying interest for many of the sites in Ireland where they occur.</p> <p>Many of our Natura sites are failing to achieve their conservation status with regard to salmon because they continue to decline both locally and nationally. It is unlikely that this plan alone can reverse the downward trend in salmon stocks but by protecting and restoring salmonid habitat and water quality throughout the western lake catchments where they occur, this plan could contribute to national and international conservation efforts.</p>	<p>Conn, Cullin, Corrib, Mask* (* Occasional visitor)</p>
	<p align="center"><b>Arctic Char</b> <i>(Salvelinus alpinus)</i></p>	<p>Arctic char, in Ireland, are diminutive relatives of trout and salmon which have lost their migratory habits and their ditribution here has become restricted our inland waterways. They are a sub-arctic species making them more sensitive to high temperatures and forcing them into the deep water refugia provided by some of our larger and high-altitude lakes. They are also extremely sensitive to changes in water quality and have become extinct in all but one ( L. Mask) of the western lakes over the last 50 years.</p> <p>Perhaps due to their relative commercial and recreational unimportance in Ireland and abundance in other, Nordic states, char are not protected in a European context. There is also no specific national legislation protecting their stocks or habitats despite the fact that they are severely threatened throughout their range in Ireland, Britain and mainland Europe. The range of threats to their future existence in Irish lakes is very similar to those affecting trout and salmon and there could be significant advantages to all three salmonid species if dedicated, European laws were enacted to prevent further declines in char stocks.</p> <p>It is a stated objective of this report to promote the introduction of arctic char to annex ii of the habitats directive and furthermore, to include them as qualifying interests in any Natura site where they occur. Should water quality become sufficiently good to support char stocks in any of the western lakes, a program of reintroduction should be considered in waters where they previously existed.</p>	<p>L. Mask</p>

Status & Conservation Needs	Species	Description & Management Options	Presence	
<b>Native Species of High Conservation Concern</b>	<b>European Eel (<i>Anguilla anguilla</i>)</b>	The Eel is a pan-European, migratory fish species with a catadromous lifestyle - That is- it breeds at sea but the larval stages drift on oceanic currents before reaching the Atlantic coasts of Europe, entering freshwater as diminutive glass eels or elvers. They spend many years (15 - 50), growing to maturity in freshwater until their outward migration to the marine environment to spawn, deep in the Sargasso sea. The European eel has suffered catastrophic declines in its populations throughout its range and is now classified as critically endangered in the International Union for Conservation of Nature (IUCN) Red List of threatened species. The number of young eels reaching our waters has declined over the past 30 years and amounts to as little as 8% of what was present during the 1970s. As a result, all exploitation of eels throughout the Republic of Ireland has ceased.	L. Arrow, *Conn, Cullin, Carra, Mask, Corrib, Sheelin	
	<b>Lampreys</b>	<b>Sea Lamprey (<i>Petromyzon marinus</i>)</b>	Lampreys are a group of primitive fish species with oral disk suckers instead of jaws. They feed by parasitising other fish or by sifting through benthic detritus. Three species are known in Ireland and all of which are protected in a European context and are listed in Annex ii of the Habitats Directive. The sea lamprey can reach lengths of up to 1 m and spends most of its life as an ectoparasite of other fish in the marine environment. Sea lamprey spawn annually in the lower reaches of large rivers and die after spawning. After hatching, larval lamprey drift downstream until they find a suitable muddy or silty part of the riverbed to burrow into. Lamprey then	L. Arrow, Conn*, Cullin, Corrib,
		<b>Brook Lamprey (<i>Lampetra planerii</i>)</b>	Brook lamprey live exclusively in freshwater and can be found in both large and small river channels, although they are more typically found in smaller rivers. The adults feed by sifting through detritus for microscopic organisms. They spawn in early summer in the bed of gravelly or sandy rivers using their suckers to remove stones. Immature brook lamprey spend several years in a blind, worm-like form known as ammocoetes, which filter feed microscopic organisms from the water and mud. Once they reach adulthood they cease feeding and live for only about six months during which time they spawn.	L. Conn, Cullin, Corrib
		<b>River Lamprey (<i>Lampetra fluviatilis</i>)</b>	River lamprey are also native to Irish freshwaters. They are external parasites that attach to host fish with their oral disc to feed on their flesh and blood. They spawn in rivers in mid to late spring in nests called redds, which they evacuate from the bed of gravelly or sandy rivers using their suckers to remove stones. After hatching, larval lamprey drift downstream until they find a suitable muddy or silty part of the riverbed to burrow into. Lamprey then spend several years in a blind, worm-like juvenile form known as ammocoetes, which filter feed microscopic organisms from the water and mud. After about four years, river lamprey ammocoetes develop eyes and turn silvery, transforming into free-swimming adults as they make their way downstream and migrate to sea. River lamprey remain relatively close to the coast for about 18 months before migrating back up into the river to spawn	L. Arrow, Conn, Cullin, Carra, Mask, Corrib



Status & Conservation Needs	Species	Description & Management Options	Presence
Native Species of less conservation concern	Sticklebacks	<p><b>3-spined (Gasterosteus aculeatus)</b></p> <p>The three-spined stickleback is native to Ireland and is one of our smallest fish species. Three-spined sticklebacks have three or four spines along their backs and a pair of pelvic fins with prominent bony spines on their bellies. Their high salinity tolerance allows the three-spined stickleback to inhabit a very diverse range of aquatic habitats where backwaters provide a refuge, including slow-flowing streams and rivers, ponds, lakes, canals, lagoons, estuaries and sheltered coastal waters. They are abundant in all of the western lakes and their tributaries and, although an important part of their ecosystems, they are not of immediate conservation concern</p>	L. Arrow, Conn, Cullin, Carra, Mask, Corrib, Sheelin
		<p><b>9-Spined (Pungitius pungitius)</b></p> <p>The nine-spined stickleback is native to Ireland, and this tiny species is one of the smallest fish in Europe. Its high salinity tolerance allows the nine-spined stickleback to inhabit a very diverse range of aquatic habitats where backwaters provide a refuge, including slow-flowing streams and rivers, ponds, lakes, canals, lagoons, estuaries and sheltered coastal waters. Coastal populations migrate back to fresh waters or brackish waters to breed. They like plant cover, and they are capable of living in very low oxygen conditions in shallow water that other fish cannot survive. Although they have only been recorded in one of the western lakes, Their high salinity tolerance allows the three-spined stickleback to inhabit a very diverse range of aquatic habitats where backwaters provide a refuge, including slow-flowing streams and rivers, ponds, lakes, canals, lagoons, estuaries and sheltered coastal waters. Although they have only been recorded in one of the western lakes (Corrib) they are not of immediate conservation concern</p>	L. Arrow, Conn, Cullin, Carra, Mask, Corrib, Sheelin

Status & Management Requirements	Species	Description & Management Options	Presence
<b>Non-Native species requiring management</b>	<p><b>Pink Salmon</b> <i>(Oncorhynchus gorbusha)</i></p>	<p>Also known as humpback salmon, pink salmon are a migratory species of salmon, native to river systems in the northern Pacific Ocean and nearby regions of the Bering Sea and Arctic Ocean. They are generally smaller than the native Atlantic salmon and tend to spawn on alternate years, in gravel beds located in rivers with direct communication to the sea. This species of Pacific salmon has found its way to and may have established populations in some of the western lake catchments. Although potential colonisation is at an early stage, this non-native species could severely impact on local fish populations (as has already occurred in Norway) and is cause for concern. The reporting of pink salmon catches by anglers is an important element of their management and publicity in relation to the role of anglers in assisting with their management, will be ongoing throughout the lifetime of this plan. Anglers will also be advised to retain pink salmon rather than release as is advised for native salmonids.</p>	<p>Corrib, Conn, Cullin Arrow* (* Identified in outflowing river)</p>
	<p><b>Pike</b> (<i>Esox lucius</i>)</p>	<p>Pike are a large predatory freshwater fish native to mainland Europe and North America. They spawn in shallow areas amongst submerged vegetation and their fecundity is estimated at approximately 1,800 oocytes per Kg of body weight.</p> <p>Pike are abundant in all of the great Western lakes but until recently, they were regarded as an introduced species throughout the Island of Ireland. The founding events for their arrival in the various western catchments was unknown but thought to have been somewhere between 200–400 years bp. In 2013 genetic studies Ireland indicated that pike could be present for considerably longer than had previously been thought. This study proposes a colonisation hypothesis for pike in Irish waters, comprising two distinct founding events, one relatively recent and one much older. Other evidence suggests that pike have been introduced to the western lakes from 200 to 500 years ago and they are, therefore, regarded as non-native in the region. Pike are a popular angling quarry species and their introduction to new areas, particularly small waterbodies (&lt;50Ha) continues to occur. This is one of the most significant threats to native fish stocks as pike and brown trout do not coexist in smaller lakes. Consequently, their introduction to previously uncolonized waters means that salmonids in these systems may become extinct unless rigorous management and removal can be achieved.</p> <p>This plan recommends the removal of any legislative protection conferred on pike (e.g. Bye-law 809) in waters where they are newly introduced. It also recommends that teams of IFI officers are deployed to manage and remove pike rapidly, if they are discovered in previously uncolonized waters. This legislation should also be reviewed in waters that are specifically designated for salmonids.</p>	<p>L. Arrow, Conn, Cullin, Carra, Mask, Corrib, Sheelin</p>
	<p><b>Perch</b> (<i>Perca fluviatilis</i>)</p>	<p>Perch are widespread throughout Europe and northern Asia, inhabiting lowland lakes, ponds and slow-flowing rivers. They were introduced to Ireland, probably in the middle ages and more recently to all of the western lakes where they are now abundant. They are a shoaling species and feed mainly aquatic invertebrates, zooplankton and small fishes. Perch are an extremely fecund fish that spawn in early summer with a female laying ribbons of up to 75,000 eggs amongst submerged vegetation. Their bold and aggressive feeding behaviour makes them a threat to juvenile salmonids both through direct predation and competition for food. Like roach, previous attempts to exert any meaningful control on perch populations on the western lakes have been unsuccessful so no dedicated stock control measures are proposed. However, consideration will be given to the rapid response removal of perch where they are newly introduced and could threaten native stocks, particularly of arctic char.</p>	<p>L. Arrow, Conn, Cullin, Carra, Mask, Corrib, Sheelin</p>

Status & Management Requirements	Species	Description & Management Options	Presence
<b>Non-Native species requiring management</b>	<b>Bream (<i>Abramis brama</i>)</b>	<p>The common bream is a cyprinid fish that is found in most river systems and nutrient rich lakes in Europe. They feed on invertebrates found in the sediments on the lake or river bed and shallow pits can sometimes be observed in the aftermath of feeding shoals of bream. They are a relatively slow growing and long lived species with low fecundity and a tendency to spawn, only when seasonal conditions are favourable.</p> <p>Bream have been recorded in all of the western lakes and are thought to be relatively recent introductions (&lt;50 ybp). In most lakes, Bream are non invasive and are not thought to severely impact on native species or habitats. However, on L. Mask, significant habitat damage has been observed in recent years and stock management, including transfer to other waters, is currently being considered in this case*.</p>	L. Arrow, Conn, Cullin, Carra, Mask*, Corrib, Sheelin
	<b>Chub (<i>Squalius cephalus</i>)</b>	<p>The chub is widespread across Europe, but it is not native to Ireland. In fact, fisheries staff confirmed anglers' reports of chub caught in the River Inny in 2005 and despite an eradication campaign, their presence was confirmed once again in 2020.</p> <p>Chub have a sturdy body, with brassy coloured sides, dark fins, a blunt head and a large mouth. Their scales are distinctively large and dark-edged, and they also can be distinguished by the dorsal fin on their backs and anal fin on their bellies, which both have a rounded, convex edge. Adult chub are a shoaling fish and are voracious predators that will eat almost any prey they can get their mouth around. For this reason, introduced chub threaten native species either by eating them, especially smaller juvenile fish, or by competing with them for food. They prefer to inhabit large lowland rivers with a moderate flow of water but are sometimes found in tributaries or deeper pools in rivers. There have been no records of Chub from any of the western lakes but their presence in a major tributary of L. Sheelin is cause for concern. IFI will continue to monitor and manage chub to minimise their risk to the conservation of native fish species.</p>	Sheelin
	<b>Roach (<i>Rutilus rutilus</i>)</b>	<p>Roach are a highly invasive extremely fecund species of cyprinid fish, found throughout Europe, most of Asia and, more recently Australia. They are a highly adaptable fish which can live in almost any freshwater body and can tolerate relatively high levels of pollution. Roach feed on a variety of plants, benthic invertebrates and plankton and spawn amongst aquatic vegetation in May and June. A female can produce up to 10,000 ova per season.</p> <p>Roach are now present in all of the Western lakes and are extremely numerous on lower L. Corrib, Conn, Cullin and Sheelin. Their populations on the remaining 4 Western lakes appear to be lower and it is important to gain a proper understanding of the factors behind this uneven distribution. Roach have brought about profound ecological change in many of the Irish lakes to which they were introduced over the last 50 years. Precise dates for the founding events of the roach stocks in each of the designated lakes are unknown but successive surveys over the last 3-4 decades indicate that they are relatively recent (&lt;50 years bp) arrivals and that their populations have grown rapidly in that time.</p>	L. Arrow, Conn, Cullin, Mask, Corrib, Sheelin

Status & Management Requirements	Species	Description & Management Options	Presence
Non-Native species Not Currently Requiring Management	<b>Tench (<i>Tinca tinca</i>)</b>	The tench is native throughout much of Europe and northern Asia, but it is not native to Ireland. Although it is an introduced species, tench are considered benign as they have no significant impact on native species or ecosystems. They are believed to have been introduced to Ireland during the Middle Ages to farm as food in fishponds at monastic settlements, but they were frequently redistributed to angling waters, resulting in a patchy distribution around the country.	Conn, Cullin, Sheelin, Corrib
	<b>Rudd (<i>Scardinius erythrophthalmus</i>)</b>	The rudd is native throughout most of Europe, but it is not native to Ireland. Although it is an introduced species, they are considered benign as they have no significant impact on native species or ecosystems. In Ireland, they have been redistributed for angling, often to areas with smaller, isolated lakes where they have managed to escape the impact of roach: rudd thrive best in waters from which roach are absent. They prefer clean waters with plenty of aquatic vegetation and typically reside lowland lakes, still backwaters of rivers and canals, in which they form shoals that feed on invertebrates, plankton and insects, especially at the surface. In Ireland, rudd can interbreed with other closely related species from the Cyprinidae family of fishes and forms hybrids with bream and, to a lesser extent, with roach.	Conn, Cullin, (Sheelin*) (*No recent records)
	<b>Hybrids Roach/Bream/Rudd</b>	Hybrids of the three cyprinid fish present in Ireland occur regularly throughout their range. They often outnumber members of the original species from which they hybridised. They share very similar life history strategies to their parent populations and are considered to have been indirectly introduced to the western lakes.	Conn, Cullin, Sheelin

## 4.0. Stakeholder Engagement

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### 4.1. Water and Communities

The involvement of interested parties, whether professionally invested or publicly engaged, in issues affecting the western lake catchments, is critical to the success of this plan. It is crucial that stakeholder groups, Angling federations, clubs and associations, local communities, academic institutions Environmental NGOs and government agencies, work together to achieve agreed objectives. Subject to resources, IFI will develop a framework whereby a schedule of consultation and feedback mechanisms will be rolled out to exchange information and provide access for stakeholders to staff and resources, including advice on funding for conservation projects.

The European Union Water Framework Directive (WFD) was transposed into Irish legislation in 2003 (SI. 722 of 2003) It requires EU member States to achieve water quality of at least 'good status' and prevent deterioration in rivers, lakes, groundwater, estuaries and coastal waters. The WFD is a pioneering piece of legislation because it mandates public consultation and recognises the value of community involvement in decision making. It is also results based and time-bound and, in conjunction with enforcement of relevant environmental legislation, is the most effective mechanism by which to achieve and/or maintain good ecological quality in the western lakes.

### 4.2. Water Framework Directive

In Ireland the WFD is implemented through a series of measures set out in the River Basin Management Plan (RBMP). This is delivered by a three-tiered structure consisting of 1) The Minister for Housing, Local Government and Heritage, 2) Environmental Protection Agency (EPA) 3) Implementation Bodies such as IFI & other Stakeholder groups.

The regional local authority structures, with five Local Authority Regional Water and Environment Management Committees, drive the delivery of supporting measures at local level. This work is further supported by the Local Authority Waters Programme (LAWPRO). The five regional committees are chaired at Chief Executive Level, with active participation and technical advice from the EPA. Each committee is supported by an Operational Committee with membership drawn from all the relevant public and implementing bodies and chaired at Director of Service level. The local authority structures are central to tracking the progress and effectiveness of implemented measures and have a vital role in supporting national policy development and implementation.

IFI already play a significant stakeholder and advisory role and are engaged with LAWPRO and other agencies through the Regional Operational Committees. See table 4.1 (below). IFI also provide essential data inputs to the RBMPs and characterisation reports for the WFD.

<b>Public Authority</b>	<b>Relevant Functions</b>
Local Authorities	Local authorities have many functions including Environmental licensing and protection
Inland Fisheries Ireland	Protection management and conservation of the Inland Fisheries Resource
LAWPRO	Collaborate with stakeholders to identify and address issues affecting water quality.
National Parks and Wildlife Service	NPWS have many functions such as: Securing the conservation of a representative range of ecosystems to maintain and enhance populations of flora and fauna in Ireland.
EPA (Catchments unit)	Collates and interprets environmental data relating to catchments.
EPA (Regional Office)	Implementing regulation and environmental compliance systems
Teagasc	Provides integrated research, advisory and training services to the agriculture and food industry and rural communities.

**Table 4.1: Functions of various bodies relating to water quality**

### **4.3. Catchment Management**

Effective management of water requires us to look at the pressures on our water resources at an appropriate scale – large enough that we can take account of all the relevant information, but small enough to ensure that people who live in the area can easily relate to their catchment. Experience around the world and in Ireland has shown that an integrated approach to managing individual catchments of an appropriate scale is necessary to protect and improve water resources. A catchment is an area where water is collected by the natural landscape and flows from source through river, lakes and groundwater to the sea (from: EPA/catchments.ie). In conjunction with the WFD, some effective community-based groups have emerged in various parts of the country and one of the western lakes already has a well-established catchment-based association, working towards the improvement of the ecological integrity of Lough Carra. The Lough Carra Catchment Association is a catchment-based group which has brought together relevant stakeholders to highlight the issues impacting on the rivers and lakes in their communities. They operate on the basis that public awareness is the cornerstone of effective catchment management, involving the public in the management and protection of natural resources and establishing a sense of ownership which results in locally based stewardship of these environmental assets.

#### 4.4. Inter-Agency Cooperation

IFI will continue to work with other relevant agencies, particularly LAWPRO and engage with established catchment groups, angling Federations, rivers trusts and associations to assist with the progression of common catchment management goals. Where such groups have not yet been established, IFI will continue to participate in the encouragement of local communities, stakeholders and relevant authorities to form local Catchment Management Groups for the Western Lakes. These will engage with communities, particularly, farming groups, to help raise awareness and assist with the implementation of measures to address water quality and habitat issues. IFI will endeavour to improve communication mechanisms with catchment organisations and relevant authorities, while continuing to enhance networking and reporting relationships at various levels within the organisations.

Concern has been expressed by some stakeholder groups in relation to the public safety and disturbance of sensitive species and habitats from powerboats and PWCs. IFI will consult with local authorities in relation to these concerns and seek to achieve the equitable sharing of amenity resources while safeguarding ecosystems



*Fig.4.1. Aerial image of Lough Carra taken in August 2021. The lake has shown the early signs of ecological stress due to eutrophication. An active catchment association has been established by members of the local community who are pursuing measures with other state agencies to address this.*

## 5.0. Fisheries Management and Climate Change

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### 5.1. Current Research

The likely impacts of climate change on Ireland's landscape and ecosystems are currently being considered and assessed by various agencies including IFI. A targeted research programme "the Climate Change Mitigation Research Programme" (CCMRP) is underway to address a knowledge gap related to the impacts of climate change on Ireland's fish species and their habitats. The primary objective of the CCMRP programme is to build an evidence-based assessment programme to evaluate the impact of climate change on the Irish inland fisheries sector, with the aim of informing and building capacity for fisheries conservation and protection measures. The work is being carried out through a series of work packages including the establishment of a long-term monitoring network for fish, water temperature and other environmental variables, undertaking a species vulnerability assessment, developing species distribution models, assessing potential mitigation/adaptation strategies and education.

<https://www.fisheriesireland.ie/sites/default/files/2021-09/ccmrp-annual-report-2020.pdf>

### 5.2 IFI's climate change monitoring network

The project is measuring long-term changes in water temperature and other environmental variables alongside undertaking long-term monitoring of fish populations in a range of catchments.

As part of the project a national water temperature monitoring network was initiated in 2019. To date 12 index catchments (rivers and lakes, two catchments are included in this plan (i.e. Moy (Conn and Cullin) and Inny (Sheelin) (Barry *et al.*, 2022) have been instrumented. Other environmental variables and meteorological data are also being collected in selected catchments (Barry *et al.*, 2022). A total of 328 water temperature dataloggers and 58 Tw data loggers have been installed in the 12 index catchment (rivers and lakes). Innovative real time data buoys have been installed in two lakes, one of which is Lough Sheelin, recording data on water temperature, dissolved oxygen and chlorophyll *a*. IFI have also partnered with the Office of Public Works to undertake some of this research.

### 5.3 Spatial network modelling

Advances in mapping and modelling tools (e.g. spatial network models) has made it possible to use the data being collected to model stream temperatures and other variables relevant to the fish life-cycle and identify areas in catchments at risk from climate change impacts.

These advanced spatial network modelling tools will model stream temperature and other variables and identify waterbodies most at risk from climate change impacts in each index catchment and at a national level (e.g. Barry *et al.*, 2022; Kelly *et al.*, 2022)



Benefits of the CCMRP programme

- It will provide IFI with an understanding of spatial variation in water temperature in Irish rivers and lakes and assist IFI to predict future trends to inform proactive management of the inland fisheries resource.
- The project will allow strategic prioritisation of fisheries conservation and protection measures (mitigation/adaptation programmes).

#### **5.4. Building Resilience**

IFI can also help to build climate resilience in catchments and species by focusing on climate positive actions such as the establishment of aquatic buffer zones, the identification of natural flood mitigation areas and continuing research activities that can yield positive outcomes with regard to habitat stability. More frequent events such as heatwaves, droughts, high rainfall and wind are predicted for the west of Ireland in the coming years. Likely impacts on catchments may include increased drought (high temperatures exceeding thermal limits of certain fish species), flood frequency and severity. Such extreme events (e.g. storms) can destabilise riverbed material with increased sedimentation and rates of erosion. IFI are working on the parallel climate resilience project and EREP-measures to be developed for drained catchments over the coming years.

IFI will also continue with annual salvage operations whereby fish are rescued from receding pools and channels and removed to nearby deeper water refugia. The requirement for this salvage work in drought conditions is likely to increase in the coming years. Extra vigilance and additional staff will need to be deployed to minimise fish mortality. In areas where stocks are at increased heat risk, suspension of angling activity will be recommended and enforced during extreme drought conditions

#### **5.5. Riparian Zone Management**

As well as wetter periods, particularly in the winter months, more severe summer droughts are also predicted. With low summer water levels and increased mean temperatures, surface water thermal conditions are likely to be elevated above current norms. Exposed sections of river could become intolerably warm for vulnerable fish species during these drought periods, reducing the potentially productive areas within catchments. Aquatic buffer zones with mixed grassland and native tree species offer a variety of ecological benefits to watercourses and help build climate resilience in catchments. These include interception of sediment and nutrient run-off from surrounding lands, structural protection of banks and riparian areas and amelioration of temperature excesses through effective shading. (See –

<https://www.fisheriesireland.ie/sites/default/files/migrated/docman/ifish/IFISH%20River%20Restoration%20Guidance%20in%20an%20era%20of%20Climate%20Change.pdf> )

### 5.6. Native Woodlands and Watercourse Protection

Tree planting should be carefully managed to avoid tunnelling of river channels but which will provide optimal shading to facilitate the reinstatement of habitats which are suitable for salmonids. Other important riparian plant species must also be considered to allow for high levels of biodiversity in aquatic and transitional zones.

Fig. 5.1. An IFI Officer planting native trees in the riparian zone of an important spawning tributary of L. Corrib – This restoration project is one of many intended for the western lakes catchments.



A programme of riparian tree planting is recommended as part of this plan. This programme will be targeted at areas which are likely to yield maximum benefits to temperature sensitive species and will be selected on the basis of spatial network models created by the CCMRP and other research activities (e.g. WFD monitoring). The models will evaluate variables such as channel width, orientation, residence time and flow volumes as well as logistical factors such as overall flood risk mitigation and land availability, to prioritise sites of highest potential.

## 6.0. Water Quality

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### 6.1. Current Pressures

Water Quality is the most important factor influencing the ecological health of the western lakes, their wider catchments and the fish communities they support. It has been declining in some areas and rivers over the last 3 decades although a rating of good status was assigned to all but one of these (L. Cullin) based on the most recent WFD-fish stock surveys (Table 6.1.). However, the disappearance of Arctic char, periodic algal blooms and the failure of many of the Annex1 habitats and Annex 2 species associated with the Western lakes to meet their conservation objectives under the Habitats Directive, indicate that water quality on the western lakes and their wider catchments is not in a sustainable condition in the long term.

The sources of pollution have changed over recent decades with point sources, e.g., wastewater treatment plants and diffuse sources, e.g. septic tanks being significant issues in the past. These pressures are usually known and generally subject to monitoring and risk assessment by the relevant public authority. IFI will continue to liaise with these authorities with a view to highlighting point sources on the Great Western Lakes and the negative impacts of pollution.

Although some water quality pressures still arise from these sources, the principal concern is now related to nutrient loss from agricultural lands with forestry being a more significant pressure in areas of low agricultural activity. Degraded hydromorphology, (i.e. from barriers or physical damage caused to watercourses) is also a significant pressure in the western lakes catchments. [https://www.corribbeo.ie/uploads/Corrib\\_Catchment\\_Assessment\\_2010-2015\\_\(HA\\_30\)](https://www.corribbeo.ie/uploads/Corrib_Catchment_Assessment_2010-2015_(HA_30)) This impact is often a cause for the failure of waterbodies to achieve good ecological status under the provisions of the water Framework Directive and can also compound nutrient problems. Significant areas of marginal land within the western lakes catchments have been reclaimed for use in intensive agricultural enterprises and the increased application of fertilisers and slurries on these lands has led to excessive inputs of Nitrogen and Phosphorus to many watercourses. Salmonids are the most sensitive group of fish to pollution and so are most profoundly impacted by water quality and hydromorphology problems.

Fig 6.1. Mats of filamentous algae along the shoreline of L. Corrib in 2020. Signs of increasing eutrophication have been evident on the lake for many years and the situation appears to be worsening.



## **6.2. Environmental Enforcement**

IFI has a specific and limited remit with regard to the management of water quality and the enforcement of regulations and laws which govern this critical environmental parameter (S.I. No. 42/1999 - Local Government (Water Pollution) (Amendment) Regulations, 1999). A robust framework of water quality monitoring throughout the state has now been established through the Water Framework Directive. LAWPRO and the EPA, who are the lead agencies for water quality management, have deployed teams of hydrology specialists and catchment scientists, to provide ongoing monitoring of the ecological status, pressures and pathways in all water bodies. IFI work in cooperation with these agencies to measure, report and develop policy in relation to water quality as well as all fish stock monitoring for WFD national reporting

## **6.3. Multi-Agency Approach**

Preventing deterioration and improving water quality in the great western lakes is a priority for IFI and is advocated as a key to the implementation of this plan. It is strongly recommended that interagency cooperation be enhanced through more formalised reporting relationships and cross compliance reporting between staff at all levels within IFI, EPA, LAWPRO, NPWS, Local Authorities and DAFM. IFI officers and research personnel also have significant, real-time knowledge in relation to watercourse conditions at local level. This tacit knowledge should continue to be used to assist with the designation of nutrient sensitive catchments and areas for action. IFI will also continue to participate in the development of pressure source maps which are used to produce 46 specific catchment management plans (see - <https://www.gov.ie/en/publication/f7c76-water-framework-directive/>)

## **6.4. Enforcement Officers**

Officers of IFI are authorised under the Local Authorities Water (Pollution) Act of 1977 (as amended) to enforce specific laws in relation to prohibiting deleterious matter entering waters and damaging fish, their spawn fry and habitat. IFI will continue to rigorously enforce the relevant sections of the Water Pollution and Fisheries Acts to the full extent of their powers. However, the number of Fisheries Environmental Officers currently employed within the catchment areas of the great western lakes is not adequate to detect and prosecute all pollution related offences to the maximum possible extent. This plan recommends an increase in the current number of these Officers to improve water quality enforcement, process and comment on the increasing number of planning applications, forestry applications, road schemes, windfarm applications, discharge licences etc

## **6.5. Habitat Regulations**

Damage to water bodies, essential habitat and fish can frequently take place without the knowledge of environmental authorities until a time subsequent to the damaging action. In such circumstances IFI Officers often do not have adequate powers to bring successful legal actions against offenders. Other

legislation (e.g. European Communities Birds and Natural Habitats Regulations 2011 (S.I. No. 477) can empower officers of the state to prosecute offenders who cause damage to habitats associated with Natura sites (SACs & SPAs), including water bodies, even after the damage is done. They also have powers to compel offenders to re-instate impacted habitat and impose financial penalties without the necessity for costly actions through the courts. It is recommended, as part of this plan, to engage in a process whereby the relevant authorities confer the necessary powers on Officers of IFI to enforce these regulations. This will bolster the existing legal protection currently afforded to designated sites and the waterbodies connected to them.

<b>Waterbody Code</b>	<b>Waterbody Name</b>	<b>Waterbody Type</b>	<b>Waterbody Local Authority</b>	<b>Iteration</b>	<b>Ecological Status or Potential</b>
IE_SH_26_709	Sheelin	Lake	Cavan County Council	SW 2016 - 2021	Moderate
IE_WE_30_347	Carra	Lake	Mayo County Council	SW 2016 - 2021	Good
IE_WE_30_665a	Mask	Lake	Mayo County Council	SW 2016 - 2021	Good
IE_WE_30_665b	Mask Upper	Lake	Galway County Council	SW 2016 - 2021	High
IE_WE_30_666a	Corrib Lower	Lake	Galway County Council	SW 2016 - 2021	Good
IE_WE_30_666b	Corrib Upper	Lake	Galway County Council	SW 2016 - 2021	Good
IE_WE_34_406a	Cullin	Lake	Mayo County Council	SW 2016 - 2021	Moderate
IE_WE_34_406b	Conn	Lake	Mayo County Council	SW 2016 - 2021	Good
IE_WE_35_159	Arrow	Lake	Sligo County Council	SW 2016 - 2021	Good

**Table 6.1. Recent WFD evaluations of ecological status on the western lakes**

## 7.0. Invasive Species

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### 7.1. Impacts

Alien Invasive species (AIS) are defined as novel plants, animals or even microorganisms which have been introduced accidentally or intentionally outside of their natural geographical range, causing significant damage to ecosystems, economies, and native species. Their introduction to new ecosystems is often irreversible and they pose a significant threat to existing biodiversity. A number of AIS have become established on the western lakes and their catchments, and wherever feasible, these will be removed and/or managed to minimise their impact on native species. The avoidance of further AIS introductions and the prevention of spreading existing ones will be a priority for IFI.

The approach to this issue will be firstly, to endorse the introduction of improved legislation comprising significant penalties for the wilful movement of IAS from one location to another and secondly by a campaign of public awareness to alert stakeholders of the importance of biosecurity and vigilance in relation to pernicious aquatic invasives. The same legislation which could enhance IFI's water quality enforcement powers (i.e. SI. 477 – see Section 6.5.), also has the potential to include pernicious IAS as scheduled species and prosecute individuals who undertake their unauthorised movement or introduction to new habitats

### 7.2. Fish

There are currently, 16 fish species present in the western lakes, all of which interact and may compete inter-specifically if certain resources are limited. The native species such as salmon, trout and eels are generally considered to be impacted negatively by some of the introduced, non-native fish species. The level of impact on native fish appears to vary from one lake to another may depend on the relative abundances of different species, water quality, habitat deterioration and predation.

Non-native, invasive fish species have been spread to new water-bodies (e.g. pike in Owenriff lakes and Chub in Sheelin catchment) and are thriving in most of the lakes to which they have been introduced. These species have the potential to cause severe and irreversible harm (to native fish stocks and their habitats). Unique sub-species and threatened populations have suffered severe declines and even local extinctions from these introductions.

### 7.3. Invasive Aquatic Plants

Curly waterweed (*Lagarosiphon major*) is an invasive species of European Union Concern (EU Regulation 2016/1141) that was first recorded in Lough Corrib in 2005. Also records of New Zealand Pygmyweed (*Crassula helmsii*) have been discovered on Corrib circa 2010. Since 2005, Inland Fisheries Ireland (IFI),

with assistance from several partner agencies, undertake extensive year-round control operations in the lake. An average area of 12.3 ha has been treated annually by the control team allowing native flora and fauna to re-establish at many sites since 2014. These treatments play a critical role in protecting the lake and preventing further spread.

At present, it appears that the annual control efforts undertaken on the lake are keeping the infestations at manageable levels and preventing the spread of the plant to the lower lake. However, the lower lake area is continually at risk from infestation due to vector pathways.

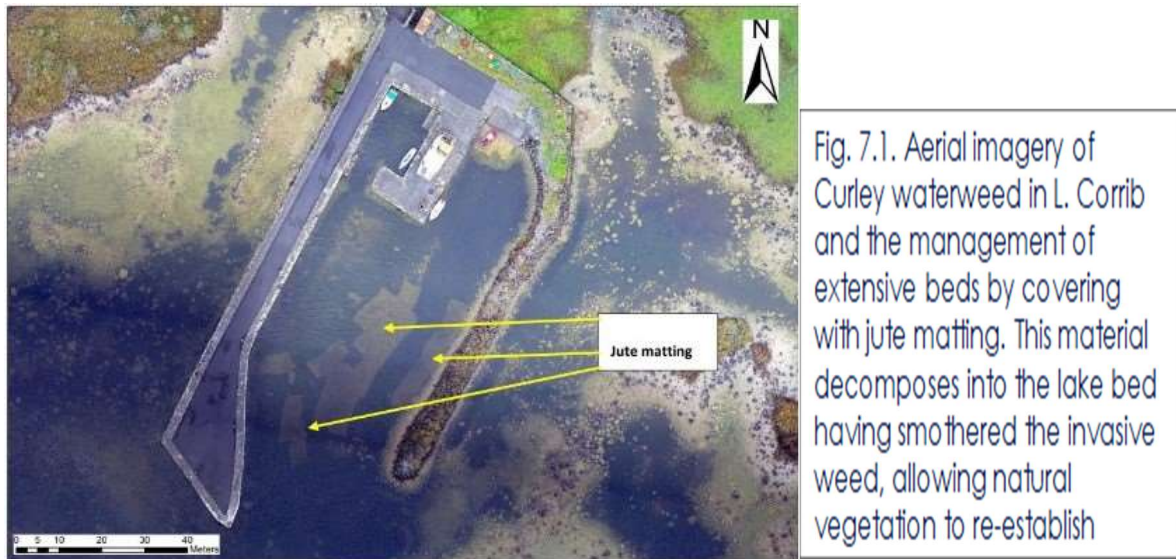


Fig. 7.1. Aerial Imagery of Curley waterweed in L. Corrib. It is currently being managed

IFI have developed novel survey and rapid assessment techniques for the monitoring and mapping of *Lagarosiphon* distribution on Lough Corrib as part of their LARC report (see - [https://www.fisheriesireland.ie/sites/default/files/2021-06/lagarosiphon\\_report\\_2018\\_2019.pdf](https://www.fisheriesireland.ie/sites/default/files/2021-06/lagarosiphon_report_2018_2019.pdf).) IFI will continue to monitor the spread of invasive weed and treat existing populations to avoid the catastrophic impacts aquatic invasive weed has on native biota and the wider economy of the lake.

To date, *Lagarosiphon* has only been recorded on L. Corrib but this population could act as a source for its spread to other locations. This could be facilitated by the movement of boats, engines or other equipment from L. Corrib to any of the other lakes by recreational users. IFI will continue to develop and publicise biosecurity protocols to reduce the risk of spread. Public awareness is key to the success of these protocols and the issue of AIS should be discussed with stakeholder groups at every opportunity.

#### **7.4. Biosecurity**

Biosecurity is the prevention of disease-causing agents or invasive species entering or leaving any place where they can pose a risk to ecosystems. Alien Invasive Species are easily transferred from one watercourse to another from angling tackle, boats/engines, protective gear and clothing. There is also increasing concern in relation to the deliberate spread of certain species, particularly fish, to previously uncolonised waters. Both pose different implications and are hard to remediate and eradicate – thus dramatically changing an area that may become unsuitable for recreation activities, such as fishing.

#### **7.5. Measures**

To ensure the non-transfer of AIS and harmful fish pathogens into our watercourses, a multi-annual awareness campaign will be devised, executed, measured and evaluated. The goal of this awareness campaign will be to:

- Increase awareness of AIS
- Highlight how they can be harmful
- Demonstrate how to prevent spread or contamination
- Encourage the reporting of sightings

The primary target audiences for this campaign will be:

- Anglers, angling clubs, federations and associations
- Angling trade (such as boat hire companies, accommodation providers, permit sellers and angling equipment suppliers)
- Local Catchment Management Groups
- Local farming community
- Local media

Secondary target audiences will include:

- Community and environmental groups, living/based around lakes and catchments
- Political representatives and elected officials
- Tourism bodies and operators
- Local authorities, state agencies and non-governmental organisations
- General public, living around lakes and catchments

It is anticipated that this plan will involve the following tactics:

- Development of promotional literature (hard copy and electronic copy) for circulation and dissemination to primary and secondary audiences. The source of this information could be IFI, the National Biodiversity Data Centre or other relevant bodies.
- Placement of targeted adverts in local media outlets (such as local radio stations, local newspapers and websites targeted at local communities around catchments).
- Placement of targeted adverts on social media platforms, utilising audience features such as location and interests



- Syndication of regular press releases to local/regional media and the setting up media interviews and opportunities for appropriate spokespeople
- Publication of regular posts across owned channels and platforms

A detailed plan that outlines timelines, messaging, Key Performance Indicators, tactics deployed and associated budget for this awareness campaign will be developed and reviewed on an annual basis, to optimise impact and results.

All IFI staff will continue to follow a biosecurity routine before and after every visit to a waterbody, which shows good practice to other anglers and recreational users, who visit such natural places regularly.

IFI also propose to enhance existing laws and increase penalties for the transfer of live fish and continue to work with customs officials to prevent new species from entering the island.

## **8.0. Stock Management**

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### **8.1. Species Control**

Stock management entails the manipulation of fish populations through the removal of key groups which are impacting on other, priority species. In the case of the Western Lakes, their designation and management as salmonid fisheries, means that other, non-native species may require management where evidence arises in relation to likely ecological impact. Stock management plans for each lake are produced annually and these will be subject to the Appropriate Assessment Process. They will be used to control numbers of certain fish species where the evidence base indicates that they are impacting on salmonids and their habitats.

### **8.2. Management Methodologies**

Stock management programmes will entail gill netting and/or electrofishing and will run concurrently with ongoing research and modelling of fish populations. They will be modified, over time, using an adaptive management framework, learning from management actions and adapting to account for changes in our knowledge of the dynamics of fish stock interactions and the response of priority species. Fish collected during these operations may, in some instances, be re-stocked to coarse fish lakes (where feasible) or used to contribute to future research programmes (e.g. biometrics, age and feeding behaviour) which will, in turn, further develop population models designed to inform future management options.

### **8.3. Standard Operating Procedures (SOPs) and Policies**

SOPs have been drawn up in relation to all stock management operations and these, as well as policies for different species, will be updated over the next number of years as our understanding of fish population interactions develop. The disposal of fish, once removed from designated waters will also be re-examined to evaluate whether they can be made available for consumption or transfer to other fisheries.

### **8.4. Roach & Perch**

In the western lakes, populations of invasive fish such as roach and, in some instances perch, fluctuate hugely in response to environmental variables. Previous efforts to control roach and perch numbers in large Irish waterbodies have been unsuccessful, so other than the incidental removal of specimens captured during pike management operations, there is no stock specific management programme proposed for roach and perch in this plan. However, when these species are encountered during programmes designed for the removal of other species (e.g. Pike or Bream) they may be retained by the stock management teams for research purposes.

It is not known if the presence of pike, the main predator of roach, has a significant influence on their numbers, as the presence of both species in high numbers has been observed on some lakes (e.g. L. Cullin) and this issue will also be investigated in the fish population modelling programme (see section 10).

Roach are known to thrive in lakes with poor or deteriorating water quality. Improvements in the ecological status of lough Sheelin between 2008 and 2021 resulted in significant declines in roach populations, although numbers appear to be increasing again in more recent years. The collective effort to improve water quality (See section 6) will therefore, be considered as an indirect management strategy to reduce roach numbers in the western lakes.

Although it is unlikely that any changes in angling exploitation of roach in the western lakes will have a significant impact on their numbers, it is recommended that the protection conferred upon them under bye-law 806 (Conservation of and Prohibition on Sale of Coarse Fish, Bye-Law 806 2006) is removed in these catchments as an additional measure to help somewhat reduce numbers if the evidence base indicates that this will be beneficial to wild brown trout.

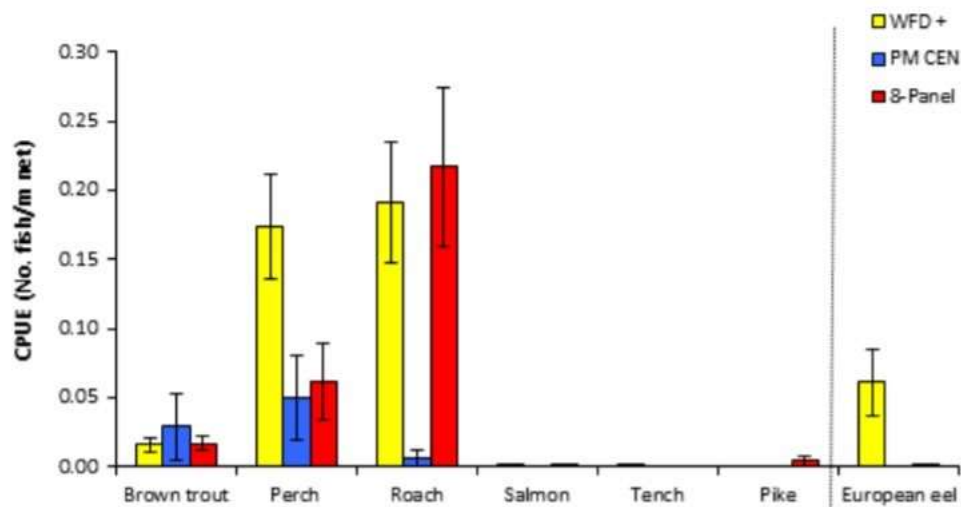


Fig. 8.1. Taken from WFD Surveillance Monitoring Fish Stocks –L. Conn 2016. – This graph illustrates the current predominance of Roach and Perch typical in the Western Lakes.

### 8.5. Pike

Pike are presumed to have been introduced to the western lakes, although the precise timing of founding events for their populations are not known with any degree of certainty. Genetic studies carried out in 2013 indicate that there may have been 2 waves of pike colonisation in Ireland, one relatively recent (300 – 400 Ybp) and one much older (possibly over 2,000 ybp). However, the weight of available evidence, (e.g. RIA archives and current distribution

patterns) and the absence of pike remains from archaeological sites, indicate that pike were probably unknown in Connaught until sometime in the seventeenth century. They may have been present in L. Sheelin since before this assumed date, but it is unclear when the founding event for this waterbody may have occurred.

Surveys and observations conducted over 4 decades on the western lakes, indicate that pike prey on salmonids, particularly at times of year when juvenile trout and salmon are migrating from tributary rivers to the larger waterbodies (NPWS 2007, Kennedy *et al.* 2018). However, recent studies have suggested that pike may shift their feeding behaviour in response to increases in cyprinid populations in some lakes (McLoone *et al.* 2018). This shift needs to be further studied to provide answers to a number of key questions. For example, what level of predation by pike on salmonids occurs in each of the western lakes and how might this be influenced by roach abundance? Do larger pike preferentially prey on salmonids? Does predation by pike significantly influence roach abundance? How does roach abundance affect salmonids?

Fig. 8.2. A recently consumed salmon smolt, retrieved from the stomach of a pike during stock management operations on L. Conn in 2019 – Pike are frequently found by RBD staff, feeding on juvenile salmon during the annual smolt run



The management of pike stocks has been ongoing for over 5 decades, on the western lakes. This has always been regarded as an important management tool for the conservation of salmonids. Research by IFI and AFBINI on Lough Erne indicated that lake entry is believed to be a pike predation bottleneck for salmonids in natural systems, further suggesting that targeted stock management may be more beneficial. It is intended that these management programmes will be continued but may be subject to modification as our understanding of species interaction is improved by sampling and population modelling. Through this process, a series of management “levers” will be developed, and these will be applied to various degrees on the different lakes, to bring about more effective stock management processes. Consideration Should also be given to a review of the current Conservation of Pike Bye-law No. 809, 2006 which confers special legal protection on pike with regard to their exploitation by angling. This is inappropriate on lakes which are being managed specifically for salmonids or where pike have been recently introduced.

### **8.6. Bream**

Bream have been present in small numbers on most of the western lakes and are a non-native species that can be invasive in certain circumstances, sometimes impacting on native fish or their ecosystems.

In recent years, bream have been appearing in increasing numbers on L. Mask and there is growing concern that they are damaging charophyte beds and the complex species assemblages that they support. Evidence of this damage has been observed for a number of years and in 2021, bream were removed, on a trial basis, by IFI officers in areas where this damage was most apparent.

Habitats appear to be recovering rapidly in areas where bream were removed, and it is likely that these operations can be scaled down in future years once sustainable numbers have been achieved. However, the need for repeated management measures will be assessed through the use of an adaptive management process. Officers will continue to monitor damage caused by bream and, subject to analysis through the appropriate assessment process, may carry out further management in affected areas to safeguard important habitats and species. Studies will be carried out to identify other waterbodies where bream stocks may be depleted and subject to appropriate health checks, L. Mask fish can be transferred to supplement these, where appropriate.

### **8.7. Pink Salmon**

This species of Pacific salmon has found its way to and probably established populations in some of the western lake catchments. Although, if this colonisation has commenced, it is at an early stage. The potential for this non-native species to impact on local fish populations is cause for concern. Circumstances in the lower catchments of any western lake where colonisation by pink salmon is possible (i.e. Conn, Arrow, Corrib) mean that these migrating invasives could possibly be intercepted without undue impact on native migratory species. If pink salmon are noted to be migrating into these systems, a programme of removal by interception will be considered.

### **8.8 Chub**

Chub were recorded in the Inny river Co. Longford in 2010 and are thought to have been introduced by visiting anglers. The arrival of Chub in Ireland is a cause for concern, particularly for salmonids, as they are thought to prey upon and compete with these species. A programme of removal was immediately initiated by IFI and although this programme initially appeared successful, subsequent detection in 2018 revealed that some individuals remained and have probably reproduced subsequently. Chub have not been recorded in L. Sheelin or any other catchments of the Western lakes at this time but the spread of current stocks in the Inny will be closely monitored to provide early warnings.

## **9.0. Habitat Management**

Hydromorphology is one of the most significant pressures currently impacting on the integrity of aquatic ecosystems in the Great Western Lake catchments. In many cases the river habitat of the inflowing and outflowing channels has been significantly modified and structurally compromised by arterial drainage. This pressure is exacerbated by ongoing channel maintenance/ management practices. In some cases, the extent and bathymetry of the lakes themselves have been modified by these drainage programmes. IFI will continue to address this issue through evaluating the extent to which the relevant water-bodies have departed from their natural state, expanding the current programme of habitat restoration to address this damage and seeking to re-imagine future drainage programmes so that their primary focus is on nature based solutions, essential (urban) flood relief and restorative works.

### **9.1. Catchment Surveys**

Habitat surveys identifying functioning and impacted ecosystems, mainly in the tributary rivers which flow to the western lakes, are ongoing. A significant dataset of fish stock distribution, habitat characteristics and potential barriers has also been established. Using these data sources, together with on-the-ground measurements and observations, individual plans to restore damaged or sub-optimal habitat in sections of river channel are continuously being produced by IFI's Project Office.

### **9.2. Habitat Database**

Channels and their habitats will continue to be surveyed in all of the western lake catchments to add to current databases of physical and ecological characteristics. From this, a prioritised list of potential sites will be added to, each year, as works are completed on already listed sites. Priority will be given to sites where water quality is sufficient to support self-sustaining populations of salmonids.

### **9.3. Arterially Drained Channels**

In catchments where arterial drainage schemes have been undertaken, IFI will continue to advocate for the protection of watercourses, allowing them to recover naturally wherever possible. In instances where restoration requires physical intervention, IFI will work with the national drainage and flood relief authority - OPW to carry out habitat development work. OPW have confirmed their intention to continue with their involvement on these projects by providing engineering expertise, machinery and in some cases materials for river habitat restoration works.

### **9.4. Restoration of Damaged Habitat**

IFI will continue to focus on channels which have been modified by previous drainage practices with the intention of restoring habitats damaged by anthropogenic activities. The fundamental measure of the necessity for

habitat development work will continue to be the degree to which a river channel has departed from its natural state. In instances where channels containing sites in need of habitat restoration by physical intervention, do not fall under the OPW drainage remit, IFI will appoint contractors to carry out these habitat works under local RBD staff supervision.



Fig. 9.1. Structures like the paired deflectors shown here help to vary flows and create more diverse hydrological conditions in arterially drained rivers. This helps to naturalise modified channels to improve biodiversity and conditions for salmonids. Fencing and strategic tree planting will also be carried out at many such sites to further enhance the recovery of watercourses to approximate their natural state

IFI will undertake to carry out habitat restoration works on a series of sites in each catchment every year. Appropriate assessments, applications for planning permission land-owner approvals and applications for other relevant authorisations will be addressed. The objective will be to streamline the process of site identification, project planning, acquisition of all relevant authorisations through to project execution in the most efficient possible manner while adhering to relevant environmental and planning regulations. IFI will also support the protection and restoration of existing wetlands.

### 9.5. Barriers

Throughout the catchments of the western lakes, barriers have been identified on inflowing and outflowing channels. IFI have initiated analysis of these man-made structures such as weirs, bridges and culverts to categorise the severity of each structure to ecological connectivity and fish passage. This information is vital to the formulation of habitat restoration plans as the restriction of access for fish to vital spawning and nursery habitats is a determining factor in the progression and prioritisation of individual plans.

The identification of man-made barriers is part of a Europe-wide programme (AMBER) which has highlighted major barriers in some of the channels in the western lake catchments. A programme of barrier mitigation is now underway which will dovetail with this one, ensuring that as many barriers as possible are made accessible to fish migration in the most efficient manner through the lifetime of the Western Lakes Plan.

Most tributaries of the Great Western Lakes provide essential spawning and nursery habitat for salmonids. These channels must provide unfettered access for fish both to and from the lakes. Any project or plan which could potentially result in the obstruction of ecological continuity or the diversion/abstraction of river flows, will be subject to rigorous scrutiny by IFI. The maintenance of their structure and function as salmonid breeding areas will be emphasised in any submissions to licencing and planning authorities when commenting on applications for structures in or adjacent to these channels.

IFI will continue to develop policies in relation to small hydroelectric schemes and are currently participating, as statutory consultees, in the development of legislation in this sector. We will continue to defend the best interests of Freshwater fish species and their habitats through this process.



*Figs. 9.2.a & b Protection of watercourses allows channels to re-establish riparian flora and recover naturally from the damage caused by drainage*



## **10. Research, Current Information and Knowledge Gaps**

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### **10.1. Fish Stock surveys (lakes and rivers)**

Periodic fish stock surveys have been carried out on all of the western lakes over the last 4 decades and there is a substantial bank of data established in relation to fish species present, their relative abundances and population structures. However, their populations are extremely dynamic and numerous physical and environmental factors influence their numbers and govern inter-species interactions. Surveys will continue on these lakes on a triannual basis as part of an established survey programme. These surveys will also be conducted on a number of tributary rivers within the western lake catchments.

### **10.2. Population Modelling**

IFI has developed a preliminary version of a process-based mathematical model of population dynamics for brown trout and a predator species. It is intended that this type of model will be further developed and reproduced on other Western lakes with a view to informing future decisions and predicting likely outcomes from various management strategies. The influence of pike predation on other species, particularly brown trout and roach, may be significant and the current focus of population modelling is, therefore, primarily focussed on these species. Previous studies by IFI indicate that the diet of pike may shift as other cyprinid fish become more abundant. There may therefore be implications for the management of pike with regard to roach, although the relationship between pike numbers and roach abundance is not fully understood. There also remains the question of whether increased abundance of cyprinids or percids would result from high removal rates of pike. It is also not clear if high roach densities have a significant impact on salmonids.

The potential of bream to damage lake ecosystems and impact on salmonid stocks will require the establishment and analysis of an evidence base. This species may also be included in future modelling scenarios

### **10.3 Alternative Methodologies and Citizen Science**

Other research programmes such as the development of an app-based assessment tool fish sampled using standardised fish survey data, (e.g., Water Framework Directive (WFD) CEN Gillnets) are proposed to add to our current understanding of fish stock dynamics and interactions in the western lakes.

This may involve requesting the involvement of local stakeholders to provide scientifically valid samples of pike within critical size ranges which will feed into the population models that will inform stock management programmes. Any citizen science programmes will be conducted within well-defined parameters and samples and results will be vetted by IFI before use in models.

#### **10.4 Risk Management**

Pike are a popular angling quarry species and their introduction to new areas, particularly small waterbodies (<50Ha) has become commonplace. This is one of the most significant threats to native fish stocks, particularly in small waterbodies. Pike and brown trout do not coexist in smaller lakes, so their introduction to previously uncolonized waters means that trout in these systems may become extinct unless rigorous management and removal of pike can be achieved.

Existing research has proposed that salmonid stocks can be exposed to variable levels of risk with regard to predation based on the physical characteristics of the water body they inhabit. Factors such as water-body size, depth profiles, complexity and connectivity influence the exposure of salmonids to predation, particularly by pike. The relevant characteristics of each lake should be assessed so that a matrix of risk can be compiled. This, in conjunction with fish stock data can then be used to inform the level of stock management which may be required for each lake.

#### **10.5 Climate Change Mitigation Research Programme**

IFI are currently collecting data in 12 index catchment which will help monitor and predict the likely impacts of climate change in Irish surface waters. The initial nine catchments selected were near natural catchments and in 2021 three additional drained catchments were added to the programme through a collaborative project with OPW. Two of the three drained catchments are the Inny and Moy which capture the western lakes of Sheelin, Conn and Cullin. Significant monitoring infrastructure has been installed in Lough Sheelin (e.g. real time data buoy monitoring temperature, dissolved oxygen and chlorophyll a) and there are plans to complement this infrastructure with novel real time monitoring instruments in two inflowing rivers in spring 2023. If these are successful they could be rolled out to other western lake catchments for operational use. This research will inform managers in relation to possible actions which can help build resilience in both catchments and species.

## 11. Timelines

The actions required to achieve each of the High level objectives of this plan are listed in table 11.1 below along with the timelines for the delivery of the actions. These timelines depend on the provision of appropriate resources to carry out the actions. If adequate resources are not engaged in the delivery of the actions, their delivery may not happen or may be delayed.

HLO 1.	Stakeholder Engagement	Start	Finish
	<u>Action 1.1</u> Establish a communication schedule, identify and engage with existing catchment groups, federations, Clubs, trusts and associations to assist with the progression of common catchment management goals.	2023	Review need after 5 years
	<u>Action 1.2:</u> Where such groups have not yet been established, engage local communities, stakeholders and relevant authorities in the protection, development and conservation of their lake and river catchments through the establishment of more Catchment Management Associations for the Western Lakes.	2023	Review need after 5 years
	<u>Action 1.3:</u> Enhance communication mechanisms and networks between IFI, relevant stakeholder groups, state agencies, farming organisations, academic institutions, local communities and catchment groups.	2023	Ongoing
HLO 2	Climate Action & Biodiversity		
	<u>Action 2.1:</u> Identify manageable factors which will contribute to the climate resilience of sensitive habitats and species.	Started	TBC
	<u>Action 2.2:</u> Maintain existing woodland where it occurs and promote the establishment of significant aquatic buffer zones to enhance biodiversity and ameliorate high temperatures and nutrient / sediment run-off.	Started	Review need after 5 years
	<u>Action 2.3:</u> Develop spatial network models to inform the strategic planting of native woodlands to mitigate the impacts of elevated water temperatures and increased droughts, flood frequency and severity.	TBC	TBC
HLO 3.	Water Quality		

	<p><u>Action 3.1:</u> Enhance the current statutory powers of Inland Fisheries Ireland by authorising officers to enforce the relevant provisions of the Habitat Regulations.</p> <p><u>Action 3.2:</u> Enhance the capacity of IFI to detect and enforce water quality offences by using all available technology and increasing the number of Fisheries Environmental Officers working in the catchment areas of the Western lakes.</p> <p><u>Action 3.3:</u> Continue to improve and enhance working relationships with key environmental authorities in the western lake catchments so that information is shared effectively and increased efficiencies, with regard to environmental enforcement, are achieved.</p> <p><u>Action 3.4:</u> Provide information and assistance with the designation of nutrient sensitive catchments and areas for action.</p>	<p>2023</p> <p>2023</p> <p>Started</p> <p>Ongoing</p>	<p>Review need every 5 years</p> <p>2028</p> <p>Review need every 5 years</p> <p>2028</p>
<b>HLO 4</b>	<b>Invasive Species</b>		
	<p><u>Action 4.1:</u> Remove and/or manage high risk invasive species through strategic stock management and weed management programmes.</p> <p><u>Action 4.2:</u> Continue to use digital and conventional media to alert the public about potentially harmful invasive species in the western lakes and their wider catchments.</p> <p><u>Action 4.3:</u> Provide biosecurity advice and resources to stakeholder groups to prevent the spread of invasive species in the western lakes.</p> <p><u>Action 4.4:</u> Encourage relevant stakeholder groups to participate in a range of conservation activities including the management of invasive species.</p> <p><u>Action 4.5:</u> Enhance legislation and increase penalties for the illegal transfer of live fish</p>	<p>Started</p> <p>Started</p> <p>Started</p> <p>2023</p>	<p>Review need every 5 years</p> <p>Review need every 5 years</p> <p>Review need every 5 years</p>
<b>HLO 5</b>	<b>Stock Management</b>		

<p><u>Action 5.1:</u> Produce stock management plans annually, on a local RBD basis, to reduce impacts on salmonids from other fish populations.</p> <p><u>Action 5.2:</u> Adjust stock management plans as population models on each of the lakes are refined.</p> <p><u>Action 5.3:</u> Enable local stakeholder groups to contribute to population modelling and research programmes including creel surveys (through citizen science).</p> <p><u>Action 5.4:</u> Develop risk matrix for Atlantic salmon and trout based on physical characteristics of each waterbody and the implications of these for predation and survival bottlenecks.</p>		Started	Review need every 5 years
			TBC
			TBC
<b>HLO 6</b>	<b>Habitat Restoration</b>		
<p><u>Action 6.1:</u> Address the salmonid habitat deficits in the western lakes catchments through targeted restoration projects.</p> <p><u>Action 6.2:</u> Streamline administrative processes to bring habitat restoration projects through planning processes to fruition with maximum efficiency.</p> <p><u>Action 6.3:</u> Ensure that all relevant environmental protection processes are in place to avoid damage to other sensitive species and habitats.</p>		Underway (in Corrib, Mask, Cara, Sheelin and Conn) Started	Review need every 5 years  2023
		Ongoing	Ongoing
<b>HLO 7</b>	<b>Research</b>		

Action 7.1: Continue to develop new and refine existing fish stock monitoring programmes (e.g. WFD) to provide the necessary data for fish population models for the western lakes.	2022	Ongoing
Action 7.2: Use all available sources of data incl. WFD surveys, Stock management and, where appropriate, angling returns to feed into population models for the western lakes.	Started	Ongoing
Action 7.3: Continue research on climate change impact under current programmes (CCMRP) to help improve resilience in catchments and species.	Started	Ongoing
Action 7.4: Continue to develop IFI's Brown Trout Research Policy with recommendations for the future conservation of all sub-species	Started	Ongoing

## 12. References

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