Lough Neagh Fishery Management Plan

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1. Foreword

The Inland Fisheries Group (IFG) of the Department of Culture, Arts and Leisure (DCAL) has a statutory responsibility for the conservation, protection, development and promotion of salmon and inland fisheries as set out in the Fisheries Act (NI) 1966. The commercial and recreational fishing sectors make an important contribution to the socio economic development of the local economy through employment, income, and exports as well as contributing to the health and well being of people.

The IFG strategy states that: “IFG aims to manage our natural fisheries resources in a sustainable way to add social and economic value. To do this we conserve, protect, develop and promote recreational and commercial fisheries, by developing evidenced based policy, working with partners, educating the public and delivering service excellence to our customers”.

Lough Neagh is at present, an underutilised resource; its hypereutrophic state makes it less suitable for the production of the more favoured species such as brown trout, however it is suitable and there is a market for the other coarse fish species present. There is broad support from fisheries stakeholder interests for IFG to develop a more strategic long term approach to the management of the fish stocks in Lough Neagh and its tributaries in view of the many activities that impact on it from both internal and external sources. For this to be meaningful, it requires a catchment based approach of integrated fisheries management, combining biological aspects along with social and economic considerations.

The aim of the Fishery Management Plan (FMP) is to provide this strategic approach to the sustainable management of the fisheries resources and its habitat whilst also maximising its value to the economy and the environment and ensuring stakeholder input to it. The FMP sets out how IFG will seek to manage the fishery and what scientific information is required to fully inform this process. It also highlights many of the key issues / concerns raised by stakeholder in consultation meetings that have taken place to date. There is wide recognition that the Lough Neagh catchment has the potential to play an even more significant role in contributing to the development of the local economy.

We will do this by:

- Conserving, protecting, enhancing and restoring fish stocks and their habitat in the Lough and its tributaries
- Maintaining and developing fisheries for both the angling and commercial sectors
- Optimising long-term and sustained economic and social returns to local communities dependent on fishing and addressing poverty and social exclusion
- Using the best available science to inform management decisions
- Engaging with stakeholders, involving them in the management process and to ensure transparency in any decisions taken
- Developing education programmes that promote compliance and understanding of fisheries regulations

2.1 OVERVIEW OF THE FISHERY

Lough Neagh

Lough Neagh is situated in the centre of The North of Ireland and is the largest freshwater lake in the British Isles. There are 6 major inflowing rivers, all of which are important angling waters along with the Lower Bann River which discharges from the north end of the Lough at Toome. The total catchment area draining into Lough Neagh is 4,450 km², (which amounts to about 43% of The North of Ireland), plus a small area in the Republic of Ireland (390km²). The principal physical statistics of the lough are listed below:

- Surface Area: 383 km²
- Average depth: 8.9m
- Maximum depth: 30m
- Volume: 3.45 million Megalitres (Ml)
- Length of shoreline: approx 125km
- Maximum length: 30.5km (SW-NE)
- Maximum width: 12.1km (W-E)
- Trophic status: Hypertrophic (enriched)
- Major tributaries: Blackwater, Ballinderry, Moyola, Six Mile Water, Main & Upper Bann Rivers
- Minor tributaries: Glenavy & Crumlin Rivers

The Rivers Agency regulates and controls water levels in Lough Neagh within a specified range; that is 12.450 metres to 12.600 metres Ordnance Datum, as defined in the Lough Neagh Levels Scheme (1955) (as amended).

Water levels in the Lough are controlled by means of flood gates at Toome at the head of the Lower Bann River. Further control within the Lower Bann River is managed by two sets of flood gates. These are located at Portna (near Kilrea), and The Cutts at Coleraine. The channel in the Lower Bann River, downstream of Lough Neagh, tends to impede the rate of outflow from the Lough during periods of heavy

rainfall. At such times the floodgates at Toome are fully opened, where possible, in advance of an anticipated rise in water level.

The Fishery

Some recreational angling takes place on L Neagh but the vast majority is on the main tributaries that drain into the Lough. Fishing activity on Lough Neagh is dominated by the commercial fishery which targets eels, trout and coarse fish stocks such as pollan, perch, roach and bream. Lough Neagh has had a commercial fishery for centuries which is utilised by local people (McKenna et al., 2008, Donnelly, 1986). The main target species is the European eel. This fishery is controlled by the Lough Neagh Fishermen's Cooperative Society (LNFCS) which issue permits to fish for eel to 112 fishermen annually. LNFCS has managed the eel fishery since 1971 and the majority of practicing fishers' are share holders. No LNFCS permit is required to fish commercially for coarse fish stocks on the Lough.

The Lough is fished between May and September for yellow eels; the traditional means being a long line of over one thousand hooks fished overnight. Hook baits include earthworms (*Lumbricus* spp.), fish fry captured in bait nets, pieces of fish flesh, and more recently mealworms (various coleopteran larvae available through the pet food trade). There is also draft net fishing, using an 80-100m seine net with a cod-end deployed from a boat in open water. Emigrating silver eels are caught at two fixed stations on the River Bann. Fixed mesh structures in the flow channel capture downstream migrating eels in to fixed "Coghill" nets lowered into the flow.

Commercial fishing for trout and coarse fish is mainly by gill net and these are fished outside of the closed seasons for the respective species; with current markets, pollan and roach are the most sought after species with annual catches of these species occasionally exceeding 200 tonnes. There is also demand albeit substantially smaller for brown trout, perch and bream (dealer register data: appendix B). The vast majority of fish caught on Lough Neagh are exported to Europe for sale.

Governance/Policy

Anyone fishing requires a DCAL licence and Table 1 below shows the number and type of commercial licences issued for Lough Neagh by DCAL over the period 2005 - 2014. To buy or sell trout, sea trout, salmon, eels, pollan, and pike a person must be a registered dealer and details of the recorded amount of each species landed annually to the commercial fish dealers by Lough Neagh fishermen can be found in Appendix B

Table 1

Analysis of Lough Neagh Commercial Licence sales 2005-2014

Year	Eel Long line <1200 hooks	Eel Draft	Eel Long line >1200 hooks	Eel weir	Fyke nets	Salmon Draft net	Trout net YARDS	Coarse net YARDS	Bait net
2005	58	38	3	3	72	20	13,400	22,900	34
2006	54	28	2	4	80	18	15000	22,900	25
2007	51	22	3	3	55	15	11,800	21,400	20
2008	62	29	2	3	76	18	11,600	23,500	34
2009	84	32	2	3	120	20	12,100	35,200	44
2010	79	37	2	3	69	16	11,400	46,300	44
2011	93	38	2	3	nil	20	10,400	56,700	50
2012	86	45	9	2	nil	21	12,600	61,700	70
2013	90	47	7	2	nil	24	14,300	75,000	73
2014	81	45	17	2	nil	16	17,200	78,500	90

DCAL's policy with regard to inland fisheries is enshrined within various domestic and international legislation and guidelines and the main ones are listed below:

The Fisheries Act (NI) 1966 – provides for the conservation, protection and development of inland fisheries;

The Fisheries Regulations (NI) 2014 regulates recreational and commercial fishing activity for all fish species bar eels;

The Eel Fishing Regulations (NI) 2011 prescribes methods of fishing, minimum sizes and time for eel fishing;

Council Regulations (EC) No. 110/2007 established measures for the recovery of the stock of European eel, necessitating the implementation of Eel Management Plans for all river basins including Neagh/Bann;

Water Framework Directive (2000/60/EC) to protect the water environment and to achieve "good status" for all waters;

Habitats Directive 1992 defines a common framework for the conservation of wild plants and animals and habitats of Community interest. This protection extends to both pollan and salmon;

North Atlantic Salmon Conservation Organisation (NASCO) whose objectives are to conserve, restore, enhance and rationally manage Atlantic salmon through international co-operation.

Economic, Social and Cultural Importance of the Fishery

Eel fishing has been a major industry on Lough Neagh for centuries (evidence of eel fishing on Lough Neagh during the bronze age has been found) and traditional skills are passed down to each successive generation within families. Many of the traditional methods of eel fishing are still used, e.g. Fishermen still use hand-made straw ropes to help elvers pass up river.

Locally, the Lough Neagh eel fishery is worth approx. £3.2m to the NI rural economy (second only in value to Nephrops or prawns with regards to total fish landings into NI) and supports over 300 families along the Lough shore. It is the largest remaining

commercial wild eel fishery in Europe, producing 16% of total EU landings and supplying 3.6% of the entire EU market in 2007. The Lough Neagh eel also has Protected Geographical Indication status recognising and protecting this species l as a unique regional food product. In terms of overall value for all fin fish landings in NI, it has held the no.1 position several times in the past five years. No assessment has been made on the value of coarse fish or trout taken in the commercial fishery on Lough Neagh.

Good quality, well-managed fisheries are a valuable asset which can make a significant contribution to social and economic conditions in the immediate area. Local businesses derive economic benefit from the existence of the commercial fishing sector through the manufacture of fishing gear, the repair of boats and provision of fuel etc. IFG also recognises the potential to generate further socio-economic growth through the development of angling on the Lough recognising that visiting anglers will spend varying amounts of money on accommodation, food and drink, and fishing tackle etc.

Fishery Management Plan Process

This Fishery Management Plan has been developed through dialogue with relevant stakeholders and is now subject to full public consultation which will include distribution of the document to key stakeholders, advertisement in daily newspapers and publication on the DCAL website. As part of the consultative process we will engage with interested groups and Assembly Committees as appropriate, to ensure that as wide a range of views as possible is reflected in the final analysis. Following collation and consideration of responses, a final Plan will be submitted for Ministerial and Assembly approval. Implementation of agreed proposals will be subject to budgetary cover and the plan will be subject to review every three - five years. Where legislation is required, this too will be subject to public consultation and the normal Ministerial and Assembly approval processes.

2.2 FISH STOCKS

Biological Synopsis

The Lough Neagh catchment including the Lough, afferent and efferent rivers and tributaries and the Lower Bann provide habitat for many species of fish including the native species; salmon, trout, pollan, eel, sticklebacks, lamprey, flounder, bream and pike (McElarney et al., 2015, LNAC, 2002). The fish community of Lough Neagh has been the subject of a number of historical reviews. Much of the emphasis in both the historical and scientific studies was based on the commercial importance of the European eel (Allen et al., 2006, Rosell et al., 2005) and pollan *Coregonus autumnalis* (Pallas) (Dabrowski, 1981, Harrod, 2001, Wilson, 1979, Wilson and Pitcher, 1984). The Dollaghan is a brown trout variant endemic to the Lough Neagh system, spending most of their life in the Lough and returning to feeder streams only to spawn (Vaughan, 2009, Crozier, 1983). Lough Neagh also supports the largest population of pollan a species endemic to Ireland (Harrod, 2001).

Although nutrient rich and isothermal throughout the water column (Vaughan, 2009, Harrod, 2001, Wood and Smith, 1993), Lough Neagh supports populations of several species more characteristic of cooler, nutrient depleted systems including pollan and river lamprey *Lampetra fluviatilis* (L.). The fish community of Lough Neagh is currently dominated by perch (*Perca fluviatilis* (L.)), pollan (*Coregonus autumnalis*) and roach (*Rutilus rutilus*) (McElarney et al., 2015). Perch and roach, both non-native species, are considered keystone species in European lakes as they have been implicated in driving changes to ecosystem function (Maguire et al., 2011, Brabrand and Faafeng, 1993). Roach are atypical in the context of European freshwater fish as they are generalist omnivores. They switch from a juvenile diet of zooplankton to a diet dominated by macroinvertebrates as they enter sexual maturity (Persson and Greenberg, 1990). This generalist diet, efficient zooplanktivory, and capacity to rapidly produce abundant populations are all factors in the capacity of roach to succeed in lakes outside of their natural distribution (Rask et al., 2000, Fitzmaurice, 1981), presumably through competitive superiority over native or other resident fishes (Persson, 1991, Bergstrand, 1990, Persson and Greenberg, 1990). Perch are carnivorous throughout their life cycle, but follow a marked and well

reported dietary shift from zooplanktivory, benthivory through to piscivory throughout the course of their development (Svanbäck and Eklöv, 2002, Hjelm et al., 2001).

The pollan is a unique and threatened freshwater fish (Harrison et al., 2012). Ireland has approximately 4,000 lakes larger than five hectares however the distribution of pollan is limited to five lowland lakes, these lakes are Lough Neagh, Lower Lough Erne, Lough Allen, Lough Derg and Lough Ree (Harrison et al., 2012, Harrison et al., 2010, Harrod, 2001) and of these lakes Lough Neagh supports the largest population of this species (McElarney et al., 2014). It is thought that each stock has been isolated from conspecific populations since the last glacial maxima (circa 10,000 years ago) (McCormick, 1998). The presence of pollan in Lough Neagh affords the lake an elevated conservation status.

Stock Assessment

DOLMANT Project – Fish Stock Assessment of Lough Neagh

The fish community described by the most recent fish stock assessment was atypical for a lowland Irish lake (McElarney et al., 2015). Approximately 15,000 (N = 15,177) individual specimens of fish were taken during the draft net surveys of Lough Neagh from 4 sampling periods (summer 2011, autumn 2011, summer 2012 and autumn 2012). The survey found that species distribution varies greatly due to weather conditions and natural seasonal events such as spawning cycles. A total of 7 species were encountered during this study; bream, eel, pollan, three spined stickleback, river lamprey, perch and roach. Three additional species were captured in a complimentary parallel study; these were stoneloach, nine spined stickleback and Atlantic salmon (Table 2).

Table 2 The fish community of Lough Neagh, sample size and origin.

Common Name	Specific Name	N	Origin
Bream	*Abramis brama* (L.)	53	Introduced
European Eel	*Anguilla anguilla* (L.)	77	Native
Stone Loach*	*Barbatula barbatula* (L.)	1	Introduced
Pollan	*Coregonus autumnalis* (Pallas	3,124	Native

	1776)		
Three spined stickleback	*Gasterosteus aculeatus* (L.)	948	Native
River Lamprey	*Lampetra fluviatilis* (L.)	8	Native
Perch	*Perca fluviatilis* (L.)	5,333	Introduced
Nine spined stickleback*	*Pungitus pungitus* (L.)	1	Native
Roach	*Rutilus rutilus* (L.)	5,356	Introduced
Brown Trout	*Salmo trutta* (L.)	152	Native
Atlantic Salmon*	*Salmo salar* (L.)	1	Native

* observed from complimentary survey

Survey catches were dominated both in abundance (Table 5.15) and biomass (Table 5.16) by different species during different seasons. Perch, pollan and roach were the most numerous species encountered with lesser contributions made by other species (eel, bream, three spined stickleback, rudd, roach x bream hybrid, brown trout and river lamprey) (Table 5.15 and 5.16).

In addition to the lake survey 9 primary salmon rivers (Agivey, Clady, Lower Bann, Ballinderry, Upper Bann, Sixmile and Main) are routinely monitored for stock status and international reporting (ICES and NASCO). This also feeds local DCAL area allocation of any available harvest quota. Adult salmon stocks in primary rivers are assessed based on a hierarchical data system, from the optimum assessment of a calibrated counter on some rivers, through telemetric tracking of Bann salmon to apportion runs to spawning, rivers rod catch information, and at least by extrapolation from juvenile fry densities (Kennedy et al., 2015). Some Rivers use more than one of these methods. Depending on summer conditions, in rivers variable numbers of electrofishing sites for fry are achieved year-on year.. The data are reported annually in arrears on the DCAL digest of fishery statistics:

http://www.dcalni.gov.uk/index/quick-links/research_and_statistics-3/statistical_publication/angling_and_inland_waterways_publications/fisheries_digest_2015.htm

Genetics

A recent study conducted by Queen's University Belfast (Keenan and Prodohl, 2015), genetically screened specimens of Brown Trout (n = 6200) from the major Lough Neagh river catchments. This study , despite the known long history of stocking regimes within the catchment, (which one would presume would lead to genetic homogenisation) actually indicated quite significant natural population genetic structuring. The presence of detectable patterns of sub structuring within the Ballinderry River is particularly interesting and the evident degree of population structuring questions the validity, efficiency and resource expenditure of fish stocking in the system.

Keenan and Prodohl (2015) also found that the degree of genetic divergence between and among populations is generally linked to the geographic distance between them. It is proposed that due to the high levels and geographical patterns of population substructuring and the likelihood that these differences are potentially associated with important adaptive traits, movement of individual specimens between river catchments should be limited and/or closely monitored. Unregulated movement of brown trout individuals within the Lough Neagh system, without consideration for the genetic patterns outlined here, which are linked both to evolutionary history (i.e. colonisation history after the retreat of ice following the last glacial maximum) and local adaptation (i.e. natural selection), could potentially lead to the breakdown of naturally occurring adaptive and spatial differences, thus resulting in the loss of biodiversity unique to the local area.

Another key finding from Keenan and Prodohl (2015) is that there is no genetic evidence to suggest that the Dollaghan trout comprises a distinct genetic lineage. Trout which one would phenotypically classify as Dollaghan are common both in the Sixmile Water and the River Main catchments which are each genetically distinct from each other.

Population genetic structure of the Atlantic salmon (*Salmo salar*) stocks of the River Bann catchment/Lough Neagh basin has also been reported on in several recent studies (Ensing and Crozier, 2010, Ensing et al., 2013, SALSEA-MERGE TEAM,

2012). This data, augmented by unpublished data confirms that the Bann/Lough Neagh Atlantic salmon population is genetically very distinct from other such populations in the UK and Ireland. Whether this uniqueness is a result of a different origin of the founding population after the Pleistocene glaciations, founder effects, or recent population bottlenecks, requires additional study, but it is clear that this population is reproductively isolated from neighbouring rivers such as the Bush and Foyle and forms a unique genetic lineage within the European North Atlantic salmon stock.

Further genetic structure exists within the Bann/Lough Neagh salmon population. Four distinct genetic groups can be indentified; a Lower Bann group consisting of tributaries of the Lower Bann (Agivey, Clady, etc.), a northern Lough Neagh group (Rivers Ballinderry, Moyola, Main, and Sixmile Water), with the Blackwater and Upper Bann the third and fourth group respectively.

In order to conserve the unique genetic structure both within the Bann/Lough Neagh salmon population and between this population and adjacent ones any movement of fish within the catchment should be discouraged. Introductions of salmon from outside the Bann/Lough Neagh area would be an even greater threat to the future survival of the Bann/Lough Neagh lineage, and would be a direct violation of the Williamsburgh Declaration (NASCO, 2003) of the North Atlantic Salmon Conservation Organisation, to which the UK is a signatory.

Stocking

Freshwater fish throughout Ireland have been frequently moved and stocked to new waters, and populations manipulated by man either intentionally or inadvertently for centuries (Rosell et al., 2012). Transfer and stocking of fish may be carried out to create new recreational or commercial fisheries, for mitigation or restoration of loss of fish through pollution events or over – exploitation, to enhance angling opportunities through increasing stock density or by adding a novel species (Rosell et al., 2012).

A major shift is underway in the scientific view of the long term desirability of some stocking practices, capable of at worst, damaging genetic diversity within species

(Rosell et al., 2012) and at best having no major long-term significant impact on stock density (Keenan and Prodohl, 2015). This work has started with salmonids, and has demonstrated a degree of local adaptation to environments. Advice flowing from this field of research indicates that supplemental stocking with non native / local strains, or other hatchery selected fish might sometimes at best achieve nothing in terms of long term contribution to wild stocks and might even cause harm by weakening or taking resource space from those wild stocks.

Until now a salmon and trout stocking programme has taken place in Lough Neagh's seven sub–catchments (Ballinderry, Blackwater, Lower Bann, Crumlin, Main, Moyola, Sixmile Water and Upper Bann) spanning approximately 40 rivers and streams. Over a 25 year period it is estimated that approximately 6 million salmonids (Brown Trout & Salmon) have been stocked into the Lough Neagh catchment. In light of recent genetics studies, future stocking programmes in the Lough Neagh catchment should fully consider the information reported by Keenan and Prodohl (2015), and have precise objectives to prevent biodiversity loss and resources should now be prioritised to habitat restoration.

Traditional or local Ecological Knowledge

Incorporating traditional ecological and fishers' knowledge is a an approach taken in fisheries research that has a history spanning generations, yet traditionally has failed to become incorporated in fisheries science and management alongside approaches that rely primarily on the knowledge of professional scientists (Hind, 2014). This knowledge is often passed down generation to generation and some is learned at first-hand through personal experiences and therefore provides an insight into long – term ecological trends or fluctuations. Effective and sustainable fishery management plans can potentially be developed with the aid of traditional ecological knowledge which compliments a scientific research programme. Local fishermen hold a wealth of industrial, fishery, ecological and environmental knowledge that is pivotal to the fishery management plan.

Invasive Species

Non-native invasive species are one of the greatest threats to biodiversity worldwide and this threat is amplified on islands with depauperate flora and fauna such as Ireland. Invasive species often out-compete or prey upon native species resulting in the domination and often bioengineering of the occupied habitat and environment.

The zebra mussel is a freshwater bivalve which attaches itself to hard substrates. It is native to the Ponto-Caspian region and has spread throughout much of central and northern Europe through canal networks over the past two centuries. Zebra mussels are considered a significant threat to aquatic environments and can cause dramatic changes to an ecosystem through both direct and indirect actions. Abiotic impacts of zebra mussel invasion include the fouling of aquatic structures and enhanced water clarity due to the filtering of the water column by the mussels. Biotic impacts can include the suppression of zooplankton populations due to competition and predation. Zebra mussels have also been shown to change fish population structures due to loss of spawning grounds to mussel colonies, and lack of food resources due to the reduction in the zooplankton population. Strayer et al. (1999) predicted that shallow or well-mixed systems, such as that of Lough Neagh (Figure 1), may experience a shift in energy and biomass from pelagic to benthic food webs. The improved water clarity may also cause an increase in macrophyte growth due to increased light transmission through the water column. This increase in water clarity and subsequent decrease in chlorophyll *a* has been reported in many Irish lakes invaded by zebra mussels.

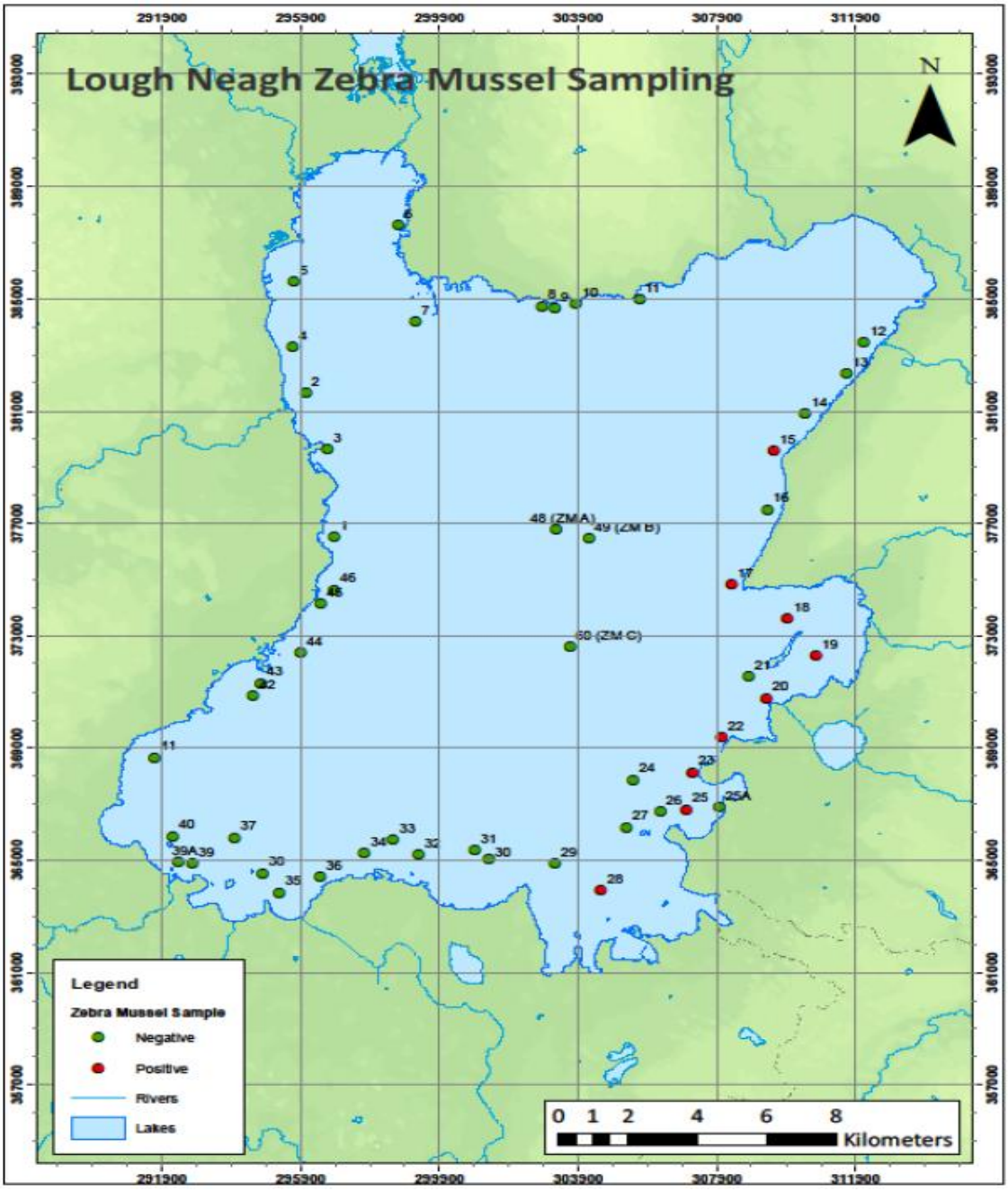

Figure 1 Recorded distribution of Zebra Mussels Lough Neagh April/May 2013 (taken from:Rosell et al. (2013)

2.3 WATER QUALITY

The Northern Ireland Environment Agency (NIEA) is responsible for water quality in the North of Ireland. The NIEA's policy on water quality is to maintain or improve quality in surface waters and waters in underground strata as required by national policy, European Commission (EC) directives and international agreements, and to generally manage river, estuarine, and coastal waters to be at least "Good" under the adopted classification schemes with no downward movement between classes.

The most recently published status assessments are in the plans:

http://www.doeni.gov.uk/niea/water-home/rbp_water_framework_directive/2015-water-framework-directive.htm and the associated web mapper http://maps.ehsni.gov.uk/wmuviewerplan2/. Section 7 of the plans gives summaries at a Local Management Area Level

The detailed LMA for Lough Neagh is available at:

http://www.doeni.gov.uk/niea/water-home/rbp_water_framework_directive/wfd/neagh_bann_rbp/nb-actionplans.htm

2.4 FISHERY MANAGEMENT ISSUES

Consultation meetings were held with both recreational and commercial stakeholders in 2014 and 2015. Details of the dates and groups that attended these meetings, can be found on Page 86. These meetings were well attended and it was very useful way to not only find out what he main fishery issues were in the L Neagh catchment but also to discuss possible management options directly at a very early stage in the process.

The following is a summary of the issues raised that stakeholders considered the Fishery Management Plan needed to consider:

- **Legislation**

    1. Some of the legislation for the commercial fishery on Lough Neagh is out of date and does not reflect modern net construction methods or custom and practice;
    2. Commercial fishing should be allowed over the weekend period;
    3. Restrictions on the length of nets that can be used on Lough Neagh;
    4. Clarification of legislation around the use of agents by commercial fishermen;
    5. Allow the use of draft nets by more commercial fishermen;
    6. Legislation is complex and there is a need to simplify.

- **Governance**

    1. Cost of angling licences compared to commercial licences;
    2. Need for commercial fishermen to submit catch details;
    3. Need to introduce a permit for coarse commercial and recreational fishermen;
    4. Improve communication with commercial fishermen;
    5. Improve level of angling catch returns;
    6. Licence / permit to cover both game and coarse angling..

- **Development**

    1. Develop angling and its infrastructure on Lough Neagh;
    2. Co-ordinate the promotion and development of angling on the tributaries with the relevant statutory and non statutory stakeholders;
    3. Maximise the economic returns from both the recreational and commercial fishing sectors;

- **Protection**

    1. Ensure an effective enforcement programme is in place to protect fish stocks and their habitat;
    2. Educate stakeholders to improve compliance with the legislation.

- **Conservation**

    1. Net mesh sizes to be reviewed to ensure juvenile contribution to the spawning stock for each species;
    2. Allow the use of draft nets by more commercial fishermen;
    3. Restrictions be placed on the length of nets that can be used on Lough Neagh;
    4. Change minimum landing size and introduce bag limits for recreational trout fisheries;
    5. Review and adjust seasons to protect spawning stock;
    6. Collect catch per unit effort (CPUE) data on the yellow eel fishery and identify an upper limit on maximum catch annually;
    7. Consider allowing methods to reduce juvenile eel mortality through long line fishing;
    8. Improve coarse fish stocks on both the Upper and Lower Bann;
    9. Improve fisheries habitat, remove fish barriers or improve fish passage at barriers in the tributaries of Lough Neagh;
    10. Regulation of sand dredging to protect juvenile fish stocks;
    11. Reduce the level of bycatch or discards of non target species from commercial netting;

12. Stocking.

- **Scientific Data**

1. Require regular scientific monitoring of fish stocks on Lough Neagh & tributaries to provide long term datasets to identify trends in fish populations;
2. Collect catch per unit effort (CPUE) data on the yellow eel fishery and identify an upper limit on maximum catch annually;
3. Require commercial fishermen to submit catch details to improve monitoring and management of fish stocks;
4. Improve level of angling catch returns;
5. Acquire more genetic information on commercial catches of Dollaghan on Lough Neagh;

2.5 FISHERY MANAGEMENT PLAN OBJECTIVES

The aim of the Fishery Management Plan (FMP) is to provide a strategic approach to the sustainable management of the fisheries resources and its habitat whilst also maximising its value to the economy and the environment and ensuring stakeholder input. Management objectives identified need to be clear and measurable and the approach must be strategic, effective and efficient.

Key Objectives:

With the key priority areas for the Fishery Management Plan as follows:

Fishery Management Plan – The Precautionary Approach (PA)

The precautionary approach / principle should be applied when ecosystem resilience and anthropogenic impact (including mitigation measures) are difficult to predict and hard to decipher from natural changes (Cochrane and Garcia, 2009). The precautionary approach requires the assumption that an action risks harm and should not be undertaken until proven otherwise by scientific research. In practice, implementing a precautionary approach means that the less that is known about a system (i.e. greater uncertainty), the more caution is required and the more conservative, fishery managers should be in relation to fishing effort (Cochrane and Garcia, 2009). To avoid population collapse, fishing mortality must be kept to a level which will ensure that stocks are sustained and maintained. This approach allows a legal and social framework for the fishery. It establishes rules controlling the fishery e.g. licensing, open/closed season and minimum landing sizes. This framework also facilitates data reporting requirements.

2.6 FISHERY MANAGEMENT PLAN PROPOSALS

Having considered the issues and listened to stakeholder concerns IFG would propose the following:

1. DCAL to review legislation for the commercial fishery on Lough Neagh to reflect modern net construction methods and to permit established custom and practice e.g. bait net trawling

Background

Regulations are an important component of fisheries management but they must be understood, accepted and enforced in order to be effective. Some of the legislation for the commercial fishery on Lough Neagh needs updating. For e.g. the use of monofilament nets is not currently permitted due to the fact that it was more effective than the traditional natural materials. Monofilament is however no longer more effective than the best modern multifilament nets. The use of bait net to collect small fish for use on eel long lines is defined in the 2014 Fisheries Regulations (NI) 2014 (S.R. 2014 No. 17), however over a number of decades methods other than those prescribed in legislation have been used effectively, meaning fishermen are acting illegally.

Proposal

This is a difficult issue to resolve and requires further scientific research using different twine diameters and assessing the catch rates and by catch effects for each

type of net used. This should make the legislation much simpler to understand and make it easier for Fishery protection staff to assess compliance with the legislation. Under a section 14 authorisation IFG has commissioned AFBI to carry out some research into the trawling of bait nets for catching eel bait before any policy decision is taken to determine if the legislation needs to be amended to allow their use in this way, or if authorisation by means of a section 14 should continue.

2. DCAL to allow commercial fishing on Lough Neagh over the weekend period

Background

The current legislation prohibits the taking of coarse fish over the weekend period from 06.00 am Saturday morning to 06.00 am Monday. Fishermen have indicated that this restricts the period of time they can operate and they require time to “soak” nets.

Proposal

There is no scientific reason for the legislation to prevent fishing over the weekend period and therefore it is proposed to remove this from the legislation. This should however only be carried out in conjunction with the other conservation measures proposed, on numbers who are entitled to fish commercially and on the maximum length of nets allowed to be used for fishing.

3. DCAL to introduce restrictions on the length of nets that can be used on Lough Neagh: to be set at a maximum of 1500m of single/combined netting per licence holder, with fixed standard licence fee for this type of net

Background

The current legislation only provides that the maximum length for a single net for the capture of trout by any licence holder is 1235m. However there is no limit in place for maximum length for a single net used for the capture of coarse fish, which will also capture other non target species.

Proposal

Discussions to date have indicated that fishermen require approximately 1500 yards of net to catch enough fish to earn a living. It is therefore proposed that the maximum length for a single net or combination of nets for the capture of coarse fish would be set in legislation to 1500m per licence holder. A fixed standard licence fee would apply.

4. Agents will not be allowed to operate on behalf of licenced commercial fishermen other than pre-approved named substitutes submitted at the time of licence application can be permitted to do so

Background

The 2014 Fisheries Regulations allows the use of agents by licenced fishers to operate on their behalf. However the detail in legislation is vague and possibly open to mis-interpretation.

Proposal

It is proposed to remove this section of legislation so as to not allow the use of agents but instead require the licence holder to provide a crew list to DCAL at the beginning of each year naming persons that could also operate the licence on behalf of the licence holder. Thus only authorised named substitutes could operate under this arrangement.

5. DCAL to consider the increased use of draft nets by more commercial fishermen

Background

The current legislation restricts the use of draft nets for the taking of salmon and trout to those licenced to do so in any of the 5 years prior to 1st January 1972 or if dependent on such fishing for their livelihood, those who were licenced between January 1968 and 1986. Gill nets (most common type of net used) are by their nature non selective for species and therefore non target species also get caught with many unlikely to survive. Draft nets allow fish to be caught in a less destructive manner with most capable of being released back to the fishery if they are not required.

Proposal

It is proposed to review the policy around the use of draft nets on Lough Neagh and consider if it is legislatively possible to allow more fishermen to use this type of net as it is more fish friendly. Clearly this and other conservation measures need to be linked to ensure sustainable use of the fishery.

6. DCAL to consider the introduction of a single licence to to allow both game and coarse angling

Background

The current legislation for commercial fishing can be complex and it may be difficult for those involved to know when they are compliant or in breach of the legislation. The same is true for recreational anglers and many visiting tourists who get confused over the requirement to have either a game licence (allowing fishing for trout, sea trout or salmon) or a coarse licence (allowing fishing for other species such as pike, bream, perch, roach etc). An angler with a game rod licence is only entitled to fish with one rod but the angler with a coarse rod licence can use up to 2 rods but only at designated coarse fisheries.

Proposal

It is proposed to have a single rod licence that will entitle the holder to use up to 2 rods at both a game and coarse fishery and a single type Department permit is also proposed which permits someone to fish at both a DCAL game and coarse fishery. This should make it simpler for visitors or tourists to understand and comply with the legislation. Some of the earlier proposals previously listed will help to simplify the legislation for commercial fishermen on Lough Neagh.

7. DCAL to review of the cost and number of available commercial and angling licences

Background

There are concerns that the current recreational angling licence is similar in cost to that for 100yds of a commercial net that can be used to commercially catch fish on Lough Neagh. A significant number of recreational anglers consider that their licence is too cheap and that its cost should be raised and that the cost of a commercial licence should also be raised to reflect the use of this to earn a living and catch fish on a commercial scale. Revenue raised through the sales of licences and permits is factored into annual budget allocations and used to finance core IFG business activities such as enforcement, habitat improvements, community education and outreach events etc.

Proposal

IFG would propose to carry out a full review of the cost structure for both licences and permits. This will also form part of a wider business review of all licences and statutory permissions granted by IFG. Consideration should also be given to simplifying the licensing regime by reducing the number and type available.

8. DCAL to regulate so that all commercial fishermen are required to submit daily catch records of all fish caught

Background

Fishermen are entitled to sell their own catch and these details are not required to be reported, unless they are sold to a registered dealer. The dealer is then required to record fish bought or sold for the list of species defined in legislation. However not all species (such as perch, roach and bream) are required to be recorded in the dealer's register. This makes the task of managing the fishery much more difficult as the basic requirement is to know what stocks levels of each species are present but also how many are harvested each year and by whom. This allows monitoring of stock levels each year which helps to identify trends in their levels compared to historic data. Proof that Lough Neagh is managed as a sustainable fishery resource could result in a higher market return for fish sold.

Proposal

It is proposed that legislation would be put in place to require all commercial fishermen to record data on their catches daily on log books supplied by DCAL, including data on the effort required to catch the amount of fish e.g. how many lines with how many hooks or what length of net and for how long. Changes to the legislation to require dealers to record purchases or sales of perch, bream and roach have already been consulted on and agreed by stakeholders and can therefore be effected at the next opportunity. Proof that the Lough Neagh fishery resource is managed in a sustainable way could lead to an increased price for catches.

9. LNFCS to introduce a permit system for commercial coarse fishermen and anglers

Background

The LNFCS manage the fishing rights to Lough Neagh and currently issue permits to fishermen to allow them to capture eels. However no permit is issued in respect of the capture of trout or coarse fish either commercially or by recreational anglers. This is an essential element in the management of a fishery as it is an aid to controlling access and effort which may be required to protect fish stocks. This is could be achieved by the issue of permits by the LNFCS rather than requiring to change primary legislation to control the number of licences issued for the fishery.

Proposal

IFG would propose that the LNFCS would set up a process to issue permits for both commercial fishermen and anglers in respect of fishing for trout and coarse fish on Lough Neagh. It is also proposed that commercial fishermen would be required to permanently display their licence number of the side of their boats. This would require in particular the LNFCS to consider what eligibility criteria which would apply to those wishing to fish commercially on Lough Neagh and this may take time to introduce. Scientific advice and commercial catch data would also be required to ensure the sustainability of fish stocks present. To define a cap on the number of commercial permit holders for Lough Neagh will require a period of scientific assessment (approximately 5 years) to agree a level of commercial fishing effort.

10. DCAL to hold regular meetings with representatives of commercial fishermen

Background

The fishermen attending the stakeholder meetings have expressed their dissatisfaction regarding communication with DCAL in the past and state that they

were never directly consulted over relevant management issues or decisions concerning Lough Neagh that could affect their livelihoods.

Proposal

IFG would propose that regular meetings are held with commercial fishermen and that there is a consultation process for all significant proposals which could affect them. IFG have already increased the level of contact with fishermen and the LNFCS in relation to the drafting of the FMP for Lough Neagh and details of formal meetings held to date can be found in this document.

11. DCAL to consider mechanisms to improve the return rate of annual angling catch returns

Background

Angling catch returns provide very useful data on stock levels of salmonids and other species on a yearly basis which helps to identify trends in stocks. The Standing Scientific Committee for salmon in the DCAL area uses this rod catch data to help assess stocks levels in rivers and make an assessment on whether to recommend to DCAL that such rivers could be re-opened for the harvesting of salmon by anglers. Anyone holding a rod licence is legally required to make a catch return for any salmon or sea trout caught (even if released) throughout the fishing year. Despite this legal requirement less than 25% of anglers make any return at all. In addition, the current method for the collection of data on rod licence sales makes it difficult to identify individual anglers that have failed to make a catch return or to follow up enforcement action on those anglers to ensure compliance with the legislation.

Proposal

It is proposed that IFG modernise its data system which would allow for non compliant anglers to be targeted making them aware they have not submitted an angling catch return and that legal proceedings could follow. In addition education

around the use made of the catch return would help anglers to appreciate how valuable they are and how they can contribute to reopening their fishery for the harvesting of salmon.

12. DCAL to consider the development of angling and its infrastructure on Lough Neagh and its tributaries

Background

The fishing rights of the Lough are controlled by the LNFCS but some rights are also exercised by Shanes Castle Estate and the Honourable Irish Society in the Northern part of the Lough. For reasons that are unclear, recreational angling on Lough Neagh has not been a significant presence; however the reverse is the case for the major tributaries that flow into the Lough where fishing for both game and coarse fish takes place. There are no formal arrangements in place for visitors fishing on Lough Neagh to purchase a permit to fish on the Lough for either coarse or game species but day tickets or permits are available for angling club stretches. There are many active angling clubs on the tributaries and they play a key role in managing, maintaining and improving access to their fisheries and carrying out enhancement works in many tributaries to try and boost stocks present. It is clear that use of the fisheries resource by recreational anglers could play a significant role not only in raising the socio and economic benefits to the North of Ireland and in particular to rural areas, but also improving the health and well being of those who participate.

The Price, Waterhouse, Coopers report titled The Social and Economic Impact to The North of Ireland, and areas within the Loughs Agency, of Recreational Fisheries, Angling and Angling Resources indicated that "potential exists to increase the net economic value of angling". The key question is "what is the potential for angling on Lough Neagh?" The Lough Neagh Angling Study confirms that there is great potential for angling but in common with other reports it does highlight the need to develop coarse fishing areas along the shore and to co-ordinate the promotion and marketing of this to both local and visiting anglers.

Proposal

It is proposed that IFG will along with other key stakeholders seek to develop recreational angling on Lough Neagh and angling opportunities already existing in the tributaries to maximise the social and economic benefit from this activity. Much of the preparatory work has been carried out in existing reports such as Lough Neagh and its Waterways Tourism Destination Management Plan, Assessing the Current and Potential Outdoor Recreation Facilities and Opportunities around Lough Neagh but this now requires co-ordination to advance many of the key targets and objectives therein.

13. Co-ordinate the promotion and development of angling on the tributaries with the relevant statutory and non statutory stakeholders

Background

IFG is responsible for the promotion and development of angling in the DCAL area. The Strategic Review of Angling in The North of Ireland carried out by Sport NI highlighted a number of key issues in relation to the promotion of angling and the need to co-ordinate better around its promotion by all the stakeholders involved. This has also been highlighted as a problem by many of stakeholders that IFG have met with.

Proposal

IFG will continue to work as a member of the North of Ireland Angling Forum in partnership with the other members and other key stakeholders to advance the promotion and development of angling in the Lough Neagh catchment. It will seek to set out realistic targets and goals in relation to this and assess progress on these issues.

14. DCAL to work with the Fishery owners to maximise the economic returns from both the recreational and commercial fishing sectors

Background

The socio economic importance of inland fisheries is in the value it contributes to the local social and economic welfare, which is primarily based in the rural areas. Both the recreational and commercial fisheries have the potential to increase the benefits derived, providing the fisheries are managed in a sustainable way and the fisheries resource is used in a way that maximises its value to the local economy. Many stakeholders consider that much of this potential is untapped due the lack of co-ordination along with poor marketing of services and goods.

Proposal

IFG will seek to work with the fishery owners and other appropriate bodies to maximise the value of the fishing resource in the Lough Neagh catchment. Key to this will be assessing the opportunities to exploit the fish stocks present is sustainable way and also to maximise the income generated.

15. DCAL to ensure an effective enforcement programme is in place to protect fish stocks and their habitat which will include training and support for Private Water Bailiffs

Background

IFG is responsible for the protection of salmon and inland fish stocks in the DCAL area. This is a key role in ensuring that fish are taken only when they are legally allowed to be, so to ensure that stocks are kept at a sustainable level. There are 11 full time Fisheries Protection staff involved in enforcement as their main role. There are also approximately 300 Private Water Bailiffs (PWBs) who carry out this enforcement role in their own fisheries to protect fish stocks present from illegal activity.

Proposal

IFG will carry out intelligence led patrols to protect fish stocks and their habitat throughout the DCAL area and will provide reports on the key enforcement activities on a regular basis. It will provide training and support for the PWBs in protecting their own fisheries and where appropriate will take forward prosecution cases based on their evidence.

16. DCAL to promote the education of stakeholders to improve compliance with the legislation

Background

It is clear that in instances where an offence is detected, that the defendant is unaware of the legislation. Whilst this is not in itself a defence, it does highlight the complexity around fisheries rules affecting both commercial and recreational fishermen which makes it difficult to ensure compliance. Clearly where voluntary compliance is not achieved, we can use a variety of sanctions, including prosecution, to compel compliance.

Proposal

IFG will seek to promote compliance and provide more education on the legislation to both commercial and recreational anglers. This will be carried out through a wide variety of mediums and through a variety of opportunities.

17. Net mesh sizes should be reviewed to ensure juvenile contribution to the spawning stock for each species as follows:

Roach/pollen/perch – 27-32mm knot to knot

Trout/bream/pike – minimum of 57mm knot to knot

Background

Net mesh sizes are set to ensure that when fish reach first spawning age that they are not all taken out of the fishery and have a chance to contribute to the spawning stock. This can be a complex issue given the different sizes of fish and the overlap that can exist, where a mesh size selected may catch fish above a size that ensure they get to spawn for a species but may catch other juveniles of another species that has not had a chance to spawn. As a result mesh size can also impact on the size of fish caught as a bycatch. Ideally mesh size should be set so that any such negative impacts on fish stocks are kept to a minimum and this is also linked to the discussion on net twine thickness as well. Currently there is no mesh size specified for the capture of roach.

Proposal

The proposal is as follows:

Roach / pollen / perch - the mesh size would be set at 27 – 32mm from knot to knot. The upper limit of 32mm is required to avoid a trout by catch

Trout / bream / pike – minimum mesh size of 57mm from knot to knot. This means there is no upper limit and there is no change to the current mesh size set for trout.

This may require some field testing to assess the changes. This should also make the legislation much simpler for fishermen to understand and for Fishery protection staff to assess compliance with the legislation.

18. Minimum landing size of commercially caught trout on Lough Neagh to remain at 35.5cm. This will also apply to angling caught trout on the Lough. DCAL also propose a daily bag limit for anglers of 3 trout per day to apply to Lough Neagh and all other trout fisheries with a minimum landing size of 25.4cm for trout caught outside of Lough Neagh and Lough Erne)

Background

Net mesh sizes are set to ensure that when fish reach first spawning age that they are not all taken out of the fishery and have a chance to contribute to the spawning stock. This can be a complex issue given the different sizes of fish and the overlap that can exist where a mesh size selected may catch fish above a size that ensure they get to spawn for a species but may catch other juveniles of another species that has not had a chance to spawn. As a result mesh size can also impact on the size of fish caught as a by catch. Additionally to this a minimum landing size is also set to ensure that any fish caught, below the size where it may not have spawned, will be returned to the water and to discourage the targeting of these juvenile fish. It is also important that as a conservation measure that the number of fish allowed to be retained by anglers is also restricted so that sufficient adult fish remain in the system to produce the next generations. There is currently no bag limit for trout in the DCAL area other than at PAE waters.

Proposal

Proposal would be to leave the current minimum landing size of 35.5cm for brown trout caught in the commercial fishery unchanged. However, this minimum size will now also apply to angling on the Lough. A bag limit for anglers of 3 trout per day per licence will also be introduced to apply to all waters (minimum size of 25.4cm).

19. DCAL to adjust the close seasons to protect spawning stock as follows:

Commercial trout fishing to be changed from 20 August – end of February to 1st August – end of February;
(other close seasons to be reviewed following further scientific analysis)

Background

Closed seasons are one of many tools used in fisheries management to protect and manage fish stocks when they congregate to spawn. The vulnerability lies not only that they maybe be caught more easily and in larger numbers, but also the negative impact this can have on future generations if insufficient numbers are able to reproduce.

Proposal

IFG propose to reduce the closed season for commercial fishing for brown trout on Lough Neagh form the current period 20th August – last day of February to the 1st August – last day of February. Any adjustment of the closed seasons for other stocks will require some further work on water temperature data for Lough Neagh before finalising any proposals.

20. Catch per unit effort (CPUE) data to be collected annually from commercial yellow eel fishermen to help identify an upper limit on annual maximum catch

Background

Catches of eels both from the yellow and silver eel fishery are collected, collated and monitored each year. Whilst this information is important to help manage the fishery it would be very useful to have data on fishing effort i.e. how many lines or hooks and for how long are required to catch an amount of eels. This would provide information over time to assess if it is more difficult to catch eels compared to historical trends. This information is collected on other fisheries and allows comparisons to be made on different stocks.

There is currently no upper limit on the amount of yellow eels that can be taken from Lough Neagh and those that are not caught will turn silver and head to sea to spawn after a period of years. Yellow eel catch is a good indicator of future silver eel numbers and therefore it is important to try and understand the relationship as the catch from the yellow eel fishery ultimately influences the escapement from the catchment.

Proposal

IFG propose that CPUE data will be collected from eel fishermen annually and that a maximum amount of catch of yellow eels should be calculate to ensure a high probability of meeting the required EU escapement target for the catchment.

21. DCAL to carry out further research into alternative methods of baiting long-lines allowed and increase the hook size allowed to reduce juvenile eel mortality in the fishery

Background

Fishermen use different bait to catch eels using longlines. Some research has been carried out on these different baits and it has highlighted that they, along with different hook sizes have different impacts on the number of juvenile eels (<30cm) caught in the yellow eel fishery. This can impact on future eels stocks as there are a number of juvenile mortalities associated with their capture using longlines.

Proposal

IFG propose that fishermen should move from using a size 4 to a size 3 hook for catching eels and that further research be carried out with the LNFCS on other possible baits. Consideration should also be given to other possible conservation measures that could be introduced to the fishery to reduce the number of juveniles caught and ultimately the number of associated mortalities.

22. DCAL to carry out further research to assess coarse fish stocks on both the Upper and Lower Bann

Background

There is limited scientific information on coarse fish stocks in Lough Neagh catchment but especially and on the Upper and Lower Bann rivers. Anecdotal evidence from anglers would indicate that stock levels are not at the level they had been in preceding years and this is borne out by low numbers of visiting and local anglers who would once have been regulars to these areas.

Proposal

IFG propose that further research is carried out to assess coarse fish stocks in these rivers to identify the causes that may be limiting fish stocks present and to consider what conservation measures may be taken to improve the stock levels.

23. DCAL to improve fisheries habitat, remove fish barriers or improve fish passage at barriers in the tributaries of Lough Neagh

Background

Habitat, water quality and free passage for fish movement are key elements for the maintenance of healthy fish stocks in rivers. NIEA have carried out work to assess barriers on some of the rivers in the Lough Neagh catchment and identified a number that represent a total or significant barrier to the movement of salmonids. It is clear from the discussions with stakeholders and assessment work being carried out to date, that there are areas of habitat that could be improved to increase fish stock production especially for salmonids and that there are barriers that prevent fish moving upstream to spawn. To improve fish stocks throughout the catchment these issues need to be addressed and this can only be done by working with all the stakeholders involved.

Proposal

IFG propose that regular meetings are held with stakeholders to plan and prioritise actions to improve habitat and fish passage throughout the catchment. In particular to hold meetings with the fishery owners / angling clubs to plan how they can assist with this work.

24. DCAL to regulate sand dredging to protect juvenile fish stocks

Background

Sand extraction has taken place on Lough Neagh for a considerable period of time but it is however a finite resource and there are concerns that the current areas for extraction could be impacting on important juvenile fish production shallow areas. Once sand has been removed from these areas the bed of the lough is left full of holes making it impossible for fishermen to trawl for bait in the area. The Department of Environment have now considered that sand extraction needs formal planning approval and this process is now underway to regulate the sand industry on Lough Neagh.

Proposal

It is proposed that DCAL and other stakeholders will inform the planning process to ensure the protection of fish stocks in Lough Neagh.

25. DCAL to introduce measures to reduce the level of by catch or discards of non target species from commercial netting

Background

Gill nets (most common used type of net used) are by their nature non selective for species and therefore non target species also get caught, with many unlikely to survive. The current legislation requires that where fish caught that may not be taken, due to the fact that they are not the legal size or that it is the closed season for them, that they are returned to the water immediately and cannot be landed. This can cause difficulties for fishermen especially if the weather is poor and they have requested that DCAL should provide advice as to how they will interpret the legislation to make it clear what flexibility will be given on this issue. Closed seasons are important to ensure that fish species are protected and not deliberately targeted

during their spawning period when they tend to congregate in larger numbers. Mesh size is key to this issue also as it dictates the size of fish caught. This dilemma is also present in the sea fishing industry currently and the new EU landing obligation requires that all catches have to be kept on board, landed and counted against the quotas but undersized fish cannot be marketed for human consumption purposes.

Proposal

It is proposed that DCAL will provide information to fishermen as to how they will interpret the current legislation, however the immediate return to the water of brown trout that cannot be taken would be a priority. This is a difficult issue to resolve and will be further informed with the scientific research proposed on nets.

26. DCAL to review stocking policy under-pinned by further scientific analysis

Background

The placing of additional fish into rivers and lakes has long been used in fisheries, most often with the specific intention to increase or boost fish stocks present. There is a concern that stocking could actually be in the best case scenario a waste of effort or in the worst case scenario, possibly harmful to locally adapted fish populations present. Clearly there may be cases where a population is extinct and the only way to reintroduce the species is by stocking fish from elsewhere. With the advance of genetic techniques scientists are now able to differentiate stocks at a much lower local level than previously possible and the differences that are present in populations are likely to help them adapt to their specific environment. These differences are important to help fish adapt to their local environment and scientific advice is that this local diversity should be maintained to allow the species to adapt to environmental conditions now and in the future. There is currently no policy in place regarding fish stocking in the DCAL area. One of the recommendations in the

recent report by Queens University on Dollaghan genetics was that future stocking programmes in Lough Neagh should fully consider the information from the genetics study, and have clear and well defined objectives to prevent biodiversity loss. Other, less impacting approaches for assisting local trout populations including; habitat and water quality improvement, should also be considered.

Proposal

IFG should develop a policy on stocking based on the best scientific advice available. Such a policy should then be subject to public consultation to allow stakeholder input to the process and should link up with Loughs Agency and Inland Fisheries Ireland to create a joined up approach on this issue.

27. DCAL to commission regular scientific monitoring of fish stocks on Lough Neagh & tributaries to provide long term datasets to identify trends in fish populations

Background

The aim of fisheries Management can vary but in general should be to maintain the system in a biologically and economically productive state so that it can benefit society e.g. in the form of jobs, food, earnings and recreation etc. The question of how many of a species there are and the state of stocks in comparison to historical levels are fundamental questions for any fishery. The use of fish stocks

assessments, and in particular regular assessments over a period of time, are therefore essential requirements for the sustainable management of fish stocks. Whilst frequent assessments have been carried out in the main tributaries of Lough Neagh, for salmonids and significant data exists for eels, there are significant gaps in the knowledge for other species and areas which do not allow long term trends in species to be identified. There is also a need to integrate data from both the lough and the tributaries which will help to develop a stock relationship for Dollaghan. This scientific approach provides a formal and consistent means of evaluating management alternatives with respect to outcomes and ensures uncertainties are described and evaluated, during the decision making process.

Proposal

It is proposed that DCAL will carry out a regular assessment of fish stocks in Lough Neagh, with a full lake survey for all species every three years and a pollan larvae survey conducted annually. Index sites on the tributaries will be surveyed for juvenile salmonids annually and data collected on adult and juvenile eels also. In between surveys, data from the log books can be analysed. The collection and collation of catch data for both commercial and recreational fisheries in the catchment is an essential element of this scientific assessment and proposals have already been included to cover these issues.

28. DCAL to commission more genetic research on commercial catches of Dollaghan on Lough Neagh

Background

The L Neagh Dollaghan genetics report http://www.dcalni.gov.uk/dcal_-_lough_neagh_brown_trout_genetics_report-2.pdf provides evidence of the existence of significant levels of population genetic structuring among brown trout populations inhabiting the main catchment rivers of Lough Neagh. Over 6200 trout samples were analysed, however the number of samples derived from the commercial fishery is still relatively small. The report recommends additional

samples should be taken from the commercial fishery, systematically covering the whole fishing season, to obtain more reliable estimates regarding the source of trout taken by them. This will be especially important for the management of trout stocks in the future, to protect weak stocks and in identifying rearing areas in the lough.

Proposal

It is proposed that additional dollaghan samples should be collected from the commercial fishery and analysed to identify the source of those fish.

Glossary Terms

Abundance: Number of individuals in a stock or a population.

Age Composition: Proportion of individuals of different ages in a stock or in the catches.

Anadromous: An anadromous species, such as salmon, spends most of its life at sea but returns to fresh water grounds to spawn in the river it comes from.

Bait net: Net used to catch juvenile fish to use as bait for long lines to catch eels

Biomass: total weight of all individuals in a stock or a population.

By-catch: The unintentional catch of one species when the target is another.

Catch per Unit Effort (CPUE): The amount caught for a given fishing effort. Ex: tonnes of shrimp per tow, kilograms of fish per hundred longline hooks.

Licences*: Regulations* for participation in the general commercial fishery.

Discards: Portion of a catch thrown back into the water after they are caught in fishing gear.

Ecosystem-Based Management: Taking into account species interactions and the interdependencies between species and their habitats when making resource management decisions.

Escapement: Reference to salmon - the number of fish escaping the fishery and reaching the spawning grounds. For eels refers to the number of silver eels leaving the catchment to migrate to sea to spawn.

Fishing Effort: Quantity of effort using a given fishing gear over a given period of time.

Fishing Mortality: Death caused by fishing, often symbolized by the mathematical symbol F.

Fixed Gear: A type of fishing gear that is set in a stationary position. These include traps, weirs, gillnets, longlines and handlines.

Gillnet: Fishing gear: netting with weights on the bottom and floats at the top used to catch fish. Gillnets can be set at different depths and are anchored to the lake bed.

Hypereuthropic: A nutrient rich system

Landings: Quantity of a species caught and landed.

Licences*: Issued by Government* for participation in the general recreational or commercial fishing.

Long lining: Using long lines with a series of baited hooks to catch eels.

Maximum Sustainable Yield (MSY): Largest average catch that can continuously be taken from a stock.

Mesh Size: Size of the mesh of a net. Different fisheries have different minimum mesh size regulation.

Mobile Gear: A type of fishing gear that is drawn through the water by a vessel to entrap fish. These include otter trawls and Danish/Scottish Seines.

Natural Mortality: Mortality due to natural causes, symbolized by the mathematical symbol M.

Otolith: A hard calcium carbonate structure located posterior of the brain in bony fish. Otoliths are used to determine the age of fish: annual rings can be observed and counted. Daily increments are visible as well on larval otoliths.

Permit: Permission issued by the fishery owner to allow someone to catch fish in their fishery

Population: Group of individuals of the same species, forming a breeding unit, and sharing a habitat.

Precautionary Approach: Set of agreed cost-effective measures and actions, including future courses of action, which ensures prudent foresight, reduces or avoids risk to the resource, the environment, and the people, to the extent possible, taking explicitly into account existing uncertainties and the potential consequences of being wrong.

Purse Seine: Large net used to encircle fish from a boat called a "seiner" and equipped with a wire rope on the bottom to draw the net together. A small boat, called "skiff", participates in manoeuvring the net.

Quota: Portion of the total allowable catch that a unit such as vessel class, country, etc. is permitted to take from a stock in a given period of time.

Recruitment: Amount of individuals becoming part of the exploitable stock e.g. that can be caught in a fishery.

Research Survey: Survey on a research vessel, allowing scientists to obtain information on the abundance and distribution of various species and/or collect oceanographic data. Ex: bottom trawl survey, plankton survey, hydroacoustic survey, etc.

Silver eel fishery: An interceptor fishery for migratory eels

Spawner: Sexually mature individual.

Spawning Stock: Sexually mature individuals in a stock.

Stock: Describes a population of individuals of one species found in a particular area, and is used as a unit for fisheries management. Ex: NAFO area 4R herring.

Stock Assessment: Scientific evaluation of the status of a species belonging to a same stock within a particular area in a given time period.

Total Allowable Catch (TAC): The amount of catch that may be taken from a stock.

Traditional Ecological Knowledge (TEK): A cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the

relationship of living beings (including humans) with one another and with their environment.

Tonne: Metric tonne, which is 1000kg or 2204.6lbs.

Trawl: Fishing gear: cone-shaped net towed in the water by a boat called a "trawler".
Validation: The verification, by an observer, of the weight of fish landed.

Year-class: Individuals of a particular size class. Also called "cohort".

Yellow eel fishery: A fishery for immature / resident eels

Appendix A

Fish Community Structure

The fish community as sampled during the current study was atypical for a lowland Irish lake. Approximately 15,000 (N = 15,177) individual specimens of fish were taken during the draft net surveys of Lough Neagh from four sampling periods (summer 2011, autumn 2011, summer 2012 and autumn 2012). A total of seven species were encountered during this study; bream, eel, pollan, three spined stickleback, river lamprey, perch and roach. Three additional species were captured in a complimentary parallel study; these were stoneloach, nine spined stickleback and Atlantic salmon (Table 5.12).

Table 5.12 The fish community of Lough Neagh, sample size and origin.

Common Name	Specific Name	N	Origin
Bream	*Abramis brama* (L.)	53	Introduced
European Eel	*Anguilla anguilla* (L.)	77	Native
Stone Loach*	*Barbatula barbatula* (L.)	1	Introduced
Pollan	*Coregonus autumnalis* (Pallas 1776)	3,124	Native
Three spined stickleback	*Gasterosteus aculeatus* (L.)	948	Native
River Lamprey	*Lampetra fluviatilis* (L.)	8	Native
Perch	*Perca fluviatilis* (L.)	5,333	Introduced
Nine spined stickleback*	*Pungitus pungitus* (L.)	1	Native
Roach	*Rutilus rutilus* (L.)	5,356	Introduced
Brown Trout	*Salmo trutta* (L.)	152	Native
Atlantic Salmon*	*Salmo salar* (L.)	1	Native

* observed from complimentary survey

Survey catches were dominated both in abundance (Table 5.13) and biomass (Table 5.14) by different species during different seasons. Perch, pollan and roach were the most numerous species encountered with lesser contributions made by other species (eel, bream, three spined stickleback, rudd, roach x bream hybrid, brown trout and river lamprey) (Table 5.13 and 5.16).

Table 5.13 Variation in mean (±SD) abundance of fishes captured per m^2 of lake area using draft nets in Lough Neagh.

Species	Summer 2011	Autumn 2011	Summer 2012	Autumn 2012
Three-spine Stickleback	0.000063 ± 0.000	0.000715 ± 0.001	0.008526 ± 0.056	0.014518 ± 0.029
Bream	0.000147 ± 0.001	0.000457 ± 0.001	0.000163 ± 0.000	0.000603 ± 0.001
Brown Trout	0.001279 ± 0.002	0.000886 ± 0.001	0.000745 ± 0.001	0.000734 ± 0.001
European Eel	0.001384 ± 0.003	0.000143 ± 0.000	0.000140 ± 0.000	0.000000 ± 0.000
Gudgeon	0.000356 ± 0.001	0.001544 ± 0.003	0.000373 ± 0.001	0.000419 ± 0.001
Perch	0.014403 ± 0.012	0.063922 ± 0.080	0.025157 ± 0.017	0.034853 ± 0.041
Pollan	0.008155 ± 0.008	0.009949 ± 0.009	0.029164 ± 0.024	0.029743 ± 0.019
River Lamprey	0.000021 ± 0.000	0.000086 ± 0.000	0.000093 ± 0.000	0.000000 ± 0.000
Roach	0.000377 ± 0.001	0.016152 ± 0.044	0.019147 ± 0.074	0.103538 ± 0.168
Roach x Bream Hybrid	0.000000 ± 0.000	0.000172 ± 0.001	0.000116 ± 0.000	0.000183 ± 0.000
Rudd	0.000000 ± 0.000	0.000000 ± 0.000	0.000000 ± 0.000	0.000131 ± 0.001

Table 5.14 Variation in mean (±SD) biomass (kg) of fishes captured per m^2 of lake area using draft nets in Lough Neagh.

Species	Summer 2011	Autumn 2011	Summer 2012	Autumn 2012
Three-spine Stickleback	0.000040 ± 0.000	0.000843 ± 0.002	0.005183 ± 0.033	0.016372 ± 0.035
Bream	0.188661 ± 0.973	0.055423 ± 0.192	0.068875 ± 0.245	0.138670 ± 0.388
Brown Trout	0.196846 ± 0.277	0.232816 ± 0.375	0.241800 ± 0.391	0.307509 ± 0.428
European Eel	0.266367 ± 0.503	0.026699 ± 0.136	0.021411 ± 0.082	0.000000 ± 0.000
Gudgeon	0.008672 ± 0.017	0.030539 ± 0.064	0.006581 ± 0.018	0.009635 ± 0.018
Perch	0.291858 ± 0.246	1.210773 ± 1.381	0.631056 ± 0.472	0.883694 ± 0.893
Pollan	0.405778 ± 0.464	0.620278 ± 0.636	1.950870 ± 2.075	1.924174 ± 1.543
River Lamprey	0.000187 ± 0.001	0.005283 ± 0.023	0.005430 ± 0.021	0.000000 ± 0.000
Roach	0.009327 ± 0.039	0.567707 ± 1.922	0.073532 ± 0.149	0.884841 ± 1.641
Roach x Bream Hybrid	0.000000 ± 0.000	0.002735 ± 0.011	0.003108 ± 0.014	0.006012 ± 0.017
Rudd	0.000000 ± 0.000	0.000000 ± 0.000	0.000000 ± 0.000	0.009049 ± 0.063

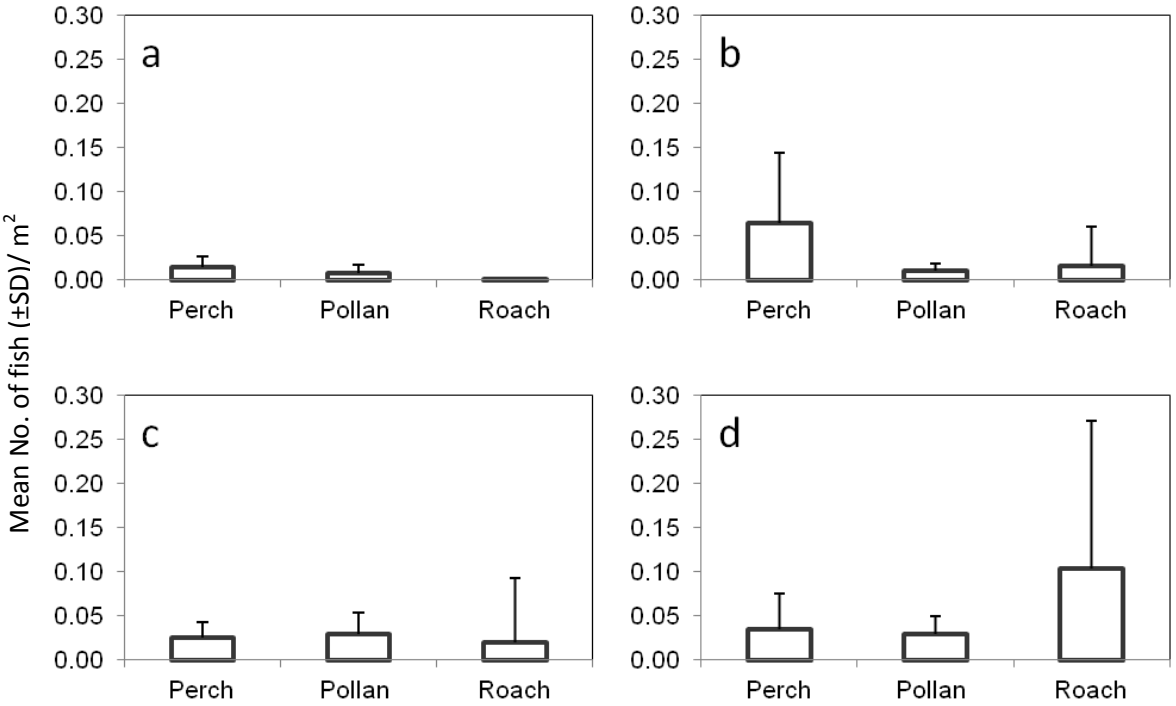

Figure 5.16 Catch per unit effort of dominant species in draft nets a=summer 2011, b=autumn 2011, c=summer 2012, d=autumn 2012

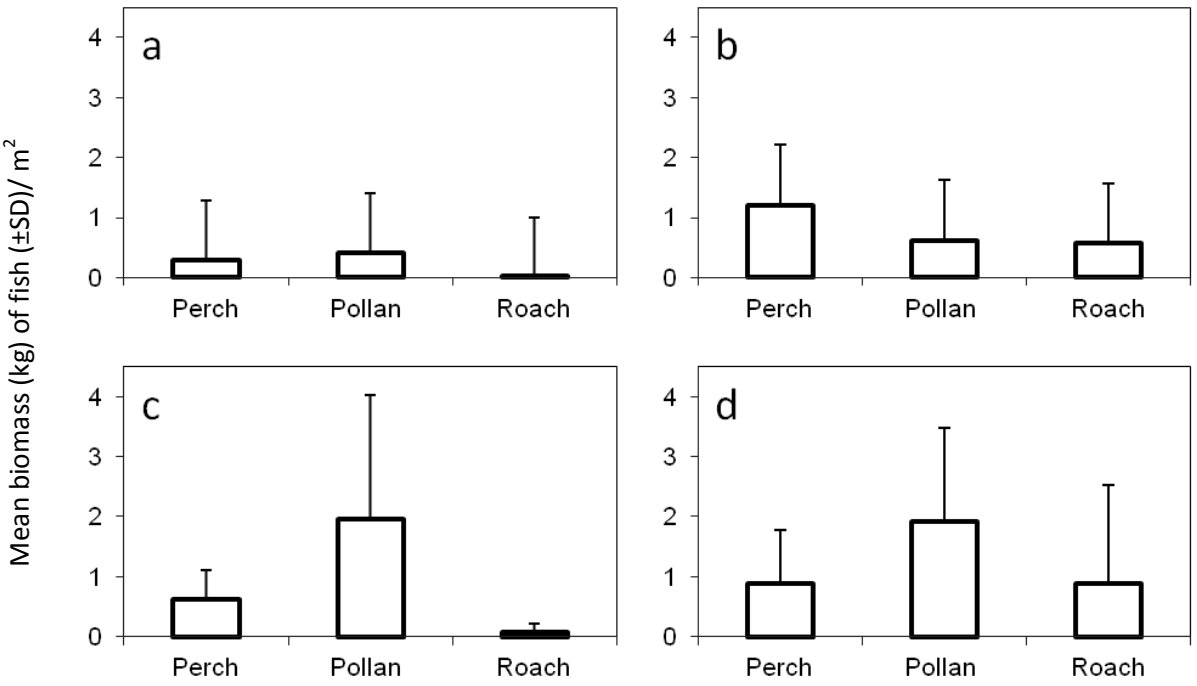

Figure 5.17 Biomass (kg) per unit effort of dominant species in draft nets a=summer 2011, b=autumn 2011, c=summer 2012, d=autumn 2012

Summer 2011 Survey

This survey yielded in excess of 1,000 samples (N = 1,249) from Lough Neagh. Throughout this period the fish community of Lough Neagh comprised of nine species and was dominated in both abundance and biomass primarily by perch (N = 687) and pollan (N = 389) (Figure 5.16a and Figure 5.17a). Three spined stickleback (N = 3), bream (N = 7), brown trout (N = 61), European eel (N = 66), gudgeon (N = 17), river lamprey (N = 1) and roach (N = 18) were also all encountered in lesser abundances (Table 5.13), and biomass' (Table 5.14). It must be noted that the reduced number and biomass of roach during this season was most likely due to their aggregated spawning behaviour (Wedekind, 1997) in river mouths and feeder streams.

Autumn 2011 Survey

During this survey in excess of 3,000 fish samples (N = 3,249) were removed from Lough Neagh. Perch (N = 2,236) was the dominant species both by number and biomass during this period. Pollan (N = 348) and roach (N = 565) were also quite abundant (Figure 5.16b and Figure 5.17b). Three spined stickleback (N = 25), bream (N = 16), brown trout (N = 31), European eel (N = 5), gudgeon (N = 53), river lamprey (N = 3) and roach x bream hybrid (N = 6) were also encountered in lesser abundance (Table 5.13) and biomass (Table 5.14).

Summer 2012 Survey

This survey yielded in excess of 3,000 samples (N = 3,590) from Lough Neagh. Pollan (N = 1,252) was marginally the dominant species by abundance and also largely the dominant species by biomass during this period. Perch (N = 1,080) and roach (N = 822) contributed significantly to the overall catch (Figure 5.16c and Figure 5.17c). Three spined stickleback (N = 366), bream (N = 7), Brown Trout (N = 32), European eel (N = 6), gudgeon (N = 16), river lamprey (N = 4), and roach x bream hybrid (N = 5) were also encountered in lesser abundance (Table 5.13) and biomass (Table 5.14).

Autumn 2012 Survey

During this survey in excess of 7,000 samples (N = 7,049) were removed from Lough Neagh. Roach (N = 3,951) and pollan (N = 1,135) were the dominant species by abundance and biomass respectively during this period (Figure 5.16d and Figure 5.17d). Perch (N = 1,330) also contributed significantly to the overall catch. Three spined stickleback (N = 554), bream (N = 23), Brown Trout (N = 28), gudgeon (N = 16), roach x bream hybrid (N = 7) and rudd (N = 5) were also encountered in lesser abundance

(Table 5.13), and biomass (Table 5.14). No European eels or river lampreys were captured during this survey.

Fish growth - Perch

Growth patterns in perch were similar across all sampling terms, indicating temporal stability in growth rates during the study period and c. 4 years prior to study (Figure 5.18 and Table 5.15). Back calculated lengths at age from the current study were compared with those from the last work concerning growth of Lough Neagh perch; Montgomery (1990). Lengths at ages 1 and 2 were similar, however, divergence occurs from age 3, with fish in the current study seeming to have a depressed growth rate compared to those in Montgomery's work. The growth of Lough Neagh perch in the current study was compared with that of the other large lake in The North of Ireland, Lower Lough Erne (Figure 5.19). Neagh perch exhibited similar growth to Erne fish (post zebra mussel) up to age 2. Slow growth of Erne perch in year 1 (pre zebra mussel), compared to Neagh, may be attributed to competition with roach. Thereafter growth rate is substantially slower in Neagh, with fish being shorter lived and reaching a smaller size than in Erne. Maximum observed age of Lough Neagh perch is six, compared to 14 in Lower Lough Erne.

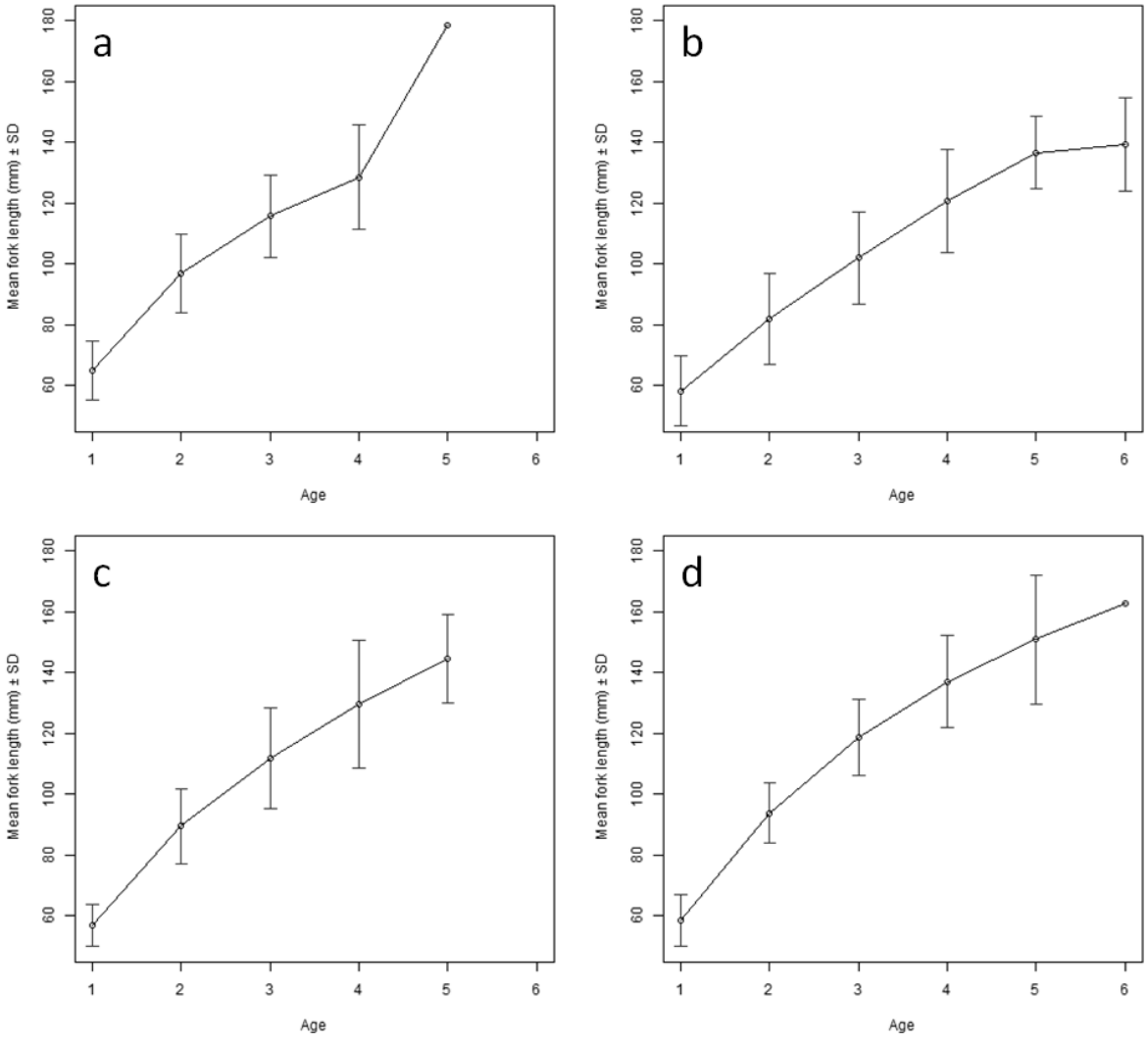

Figure 5.18 Perch mean back-calculated length at age a=summer 2011, b=autumn 2011, c=summer 2012, d=autumn 2012.

Table 5.15 Mean fork length (mm) ± SD attained at age by Lough Neagh perch

	1	2	3	4	5	6
Summer 2011	64.9 ± 9.7	97 ± 12.9	115.9 ± 13.5	128.6 ± 17.0	178.5	
Autumn 2011	58.2 ± 11.5	81.9 ± 14.9	102.1 ± 15.1	120.7 ± 17	136.7 ± 11.9	139.4 ± 15.2
Summer 2012	56.9 ± 6.9	89.5 ± 12.2	112 ± 16.5	129.7 ± 20.9	144.7 ± 14.6	
Autumn 2012	58.7 ± 8.5	93.9 ± 9.9	118.9 ± 12.5	137 ± 15.2	150.9 ± 21.1	162.8

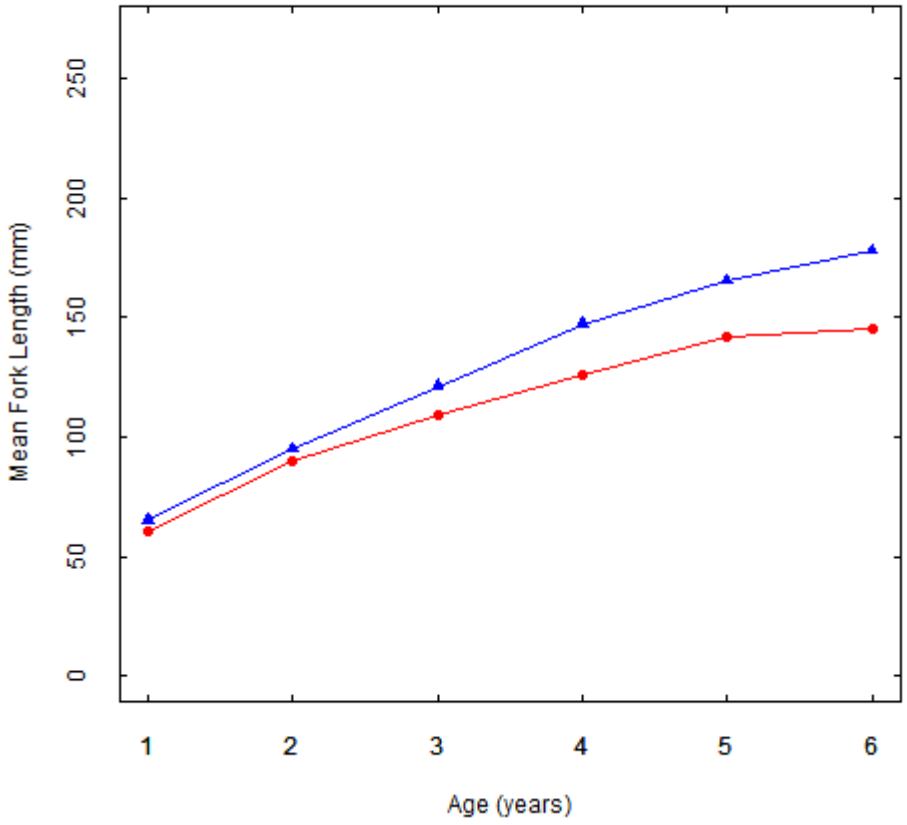

Figure 5.19 Perch mean back calculated length at age red●-current project, blue▲- Montgomery (1990)

Fish growth - Pollan

Growth of pollan was similar during all sampling periods, with little variation over the duration of the study (Figure 5.20 and Table 5.16). Lough Neagh pollan appear to be short lived, with no fish older than 3 years of age observed.

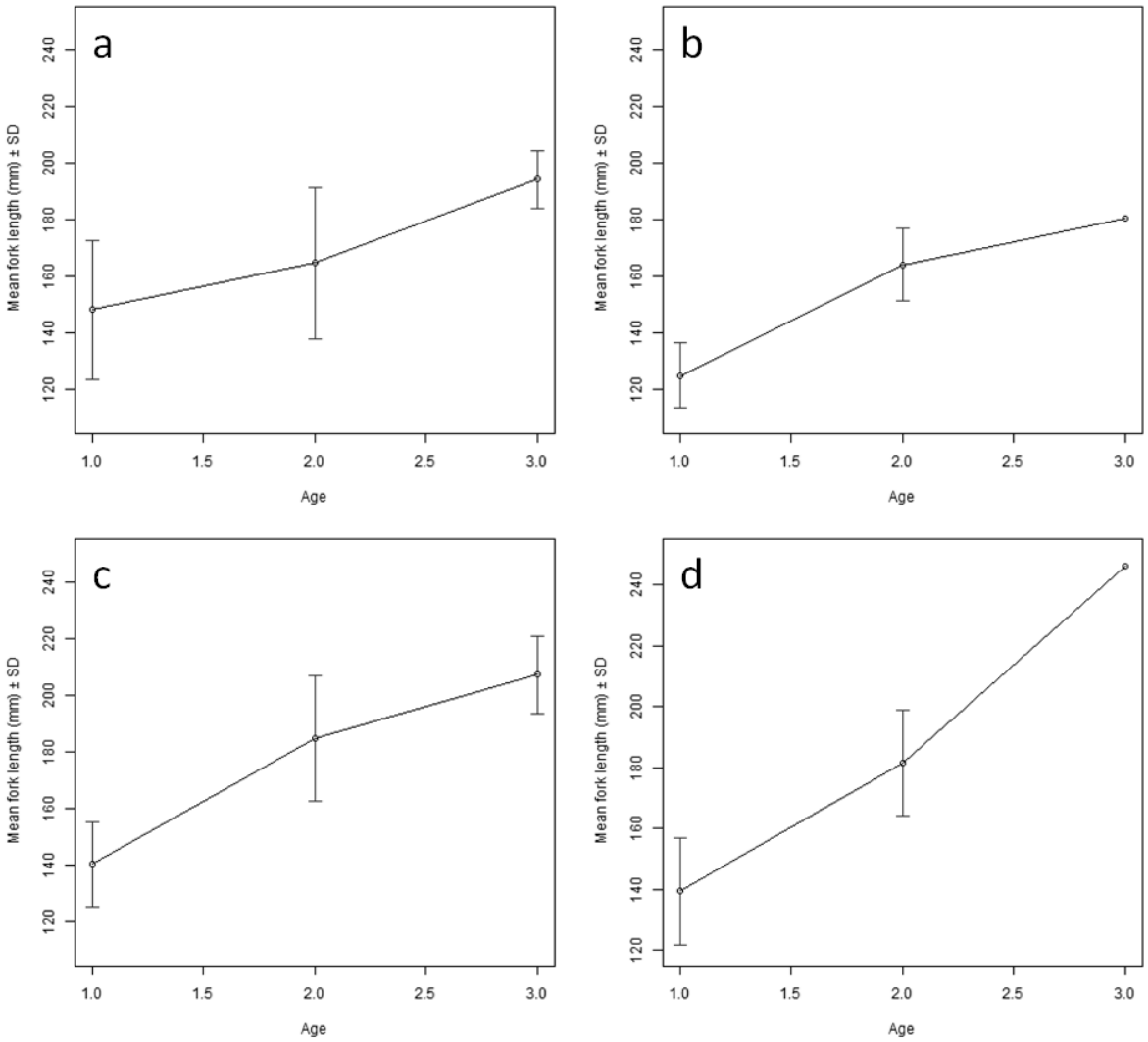

Figure 5.20 Pollan mean back-calculated length at age a=summer 2011, b=autumn 2011, c=summer 2012, d=autumn 2012

Table 5.16 Mean fork length (mm) ± SD attained at age by Lough Neagh pollan

	1	2	3
Summer 2011	148.2 ± 24.5	164.7 ± 26.7	194.3 ± 10
Autumn 2011	125.1 ± 11.6	164.2 ± 12.8	180.4
Summer 2012	140.3 ± 15	184.8 ± 22	207.4 ± 13.7
Autumn 2012	139.3 ± 17.5	181.5 ± 17.3	246.2

Back calculated growth rates from the current study were compared with those observed by Wilson (1979), Broughton (1972), and Harrod Harrod (2001) (Figure 5.21). Whilst the earlier studies observed pollan of up to 5 or 6 years of age, the current study only observed fish to 3 years of age. Mean fork length was similar between all studies at year 1, but the current study found a reduced rate of growth in the years thereafter. It is difficult to elucidate why pollan growth has changed so dramatically.

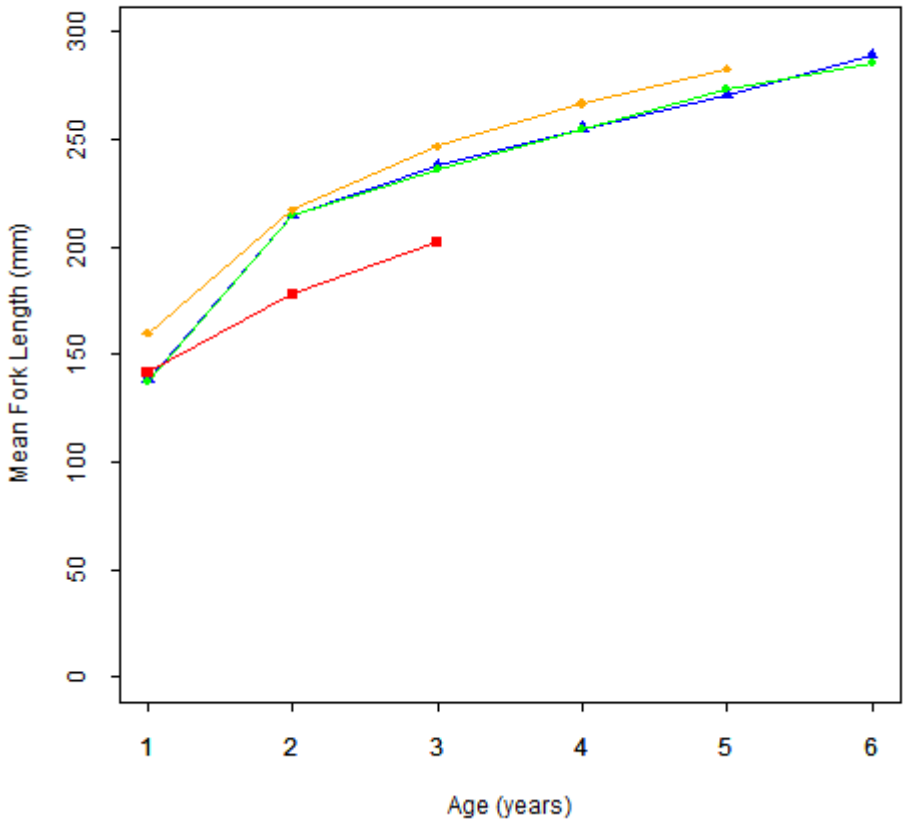

Figure 5.21 Pollan mean back-calculated length at age; red■- Lough Neagh (present study), green●- Broughton (1972), blue▲- Harrod (2001), orange♦- Wilson (1979)

Fish Growth - Roach

The growth rate of roach was similar throughout the study period (Figure 5.22 and Table 5.17). Apparent declines in growth after year 5 in autumn 2011 are deceptive, and are a function of a low sample size of fish in these year classes. A growth curve for summer 2011 could not be produced due to the small number of roach captured during that sampling period.

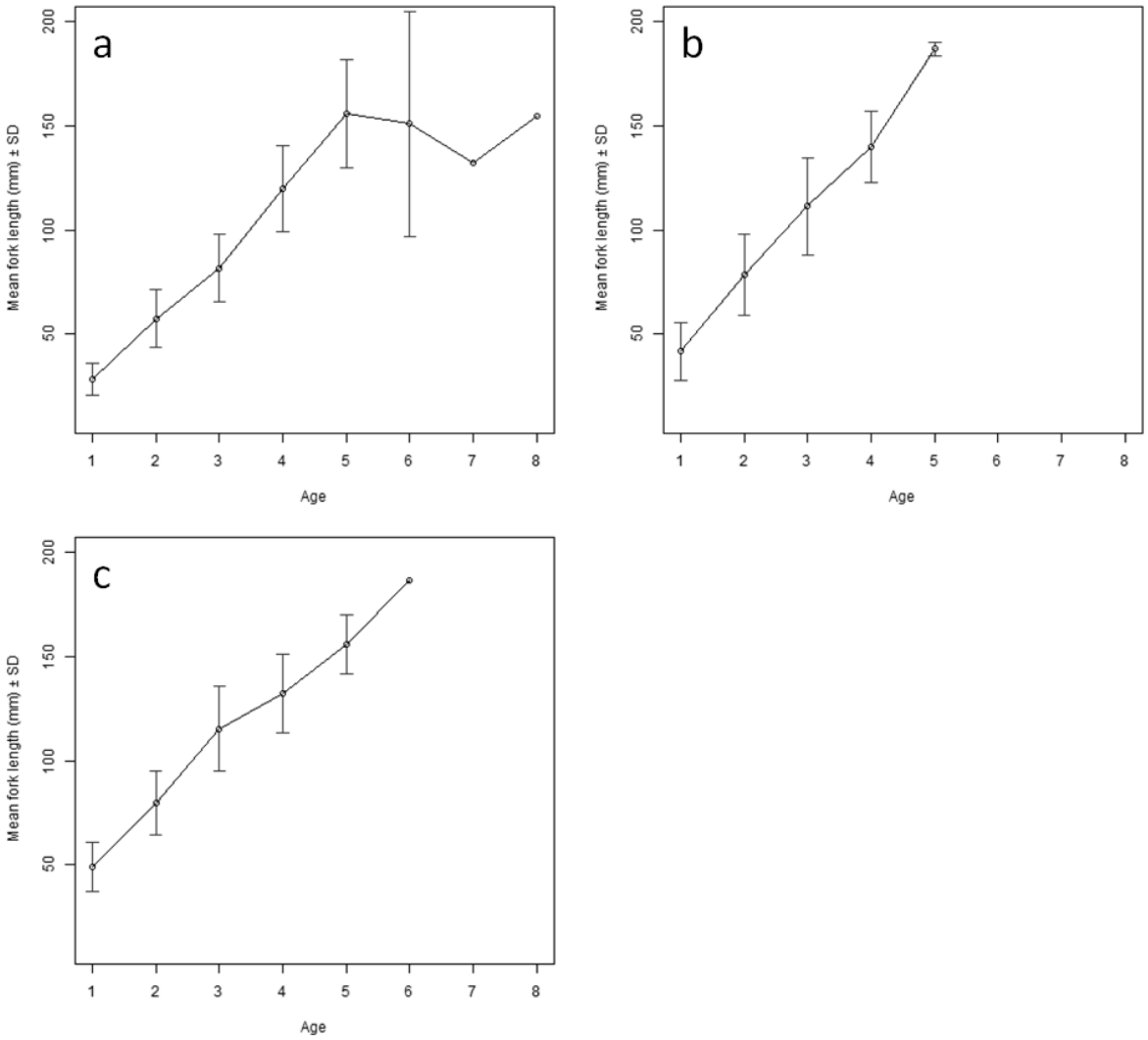

Figure 5.22 Roach mean back-calculated length at age a=autumn 2011, b=summer 2012, c=autumn 2012

Table 5.17 Mean fork length (mm) ± SD attained at age by Lough Neagh roach

Age	Autumn 2011	Summer 2012	Autumn 2012
1	28.4 ± 7.6	41.8 ± 13.6	49.1± 11.9
2	57.4± 13.9	78.5 ± 19.5	79.7± 15.3
3	81.7 ± 16.2	111.4± 23.4	115.5± 20.5
4	119.8 ± 20.6	140.1± 17.2	132.1± 18.9
5	155.8± 26	187.2 ± 3.3	156.2± 14.2
6	150.9 ± 54		186.8 ± .9
7	132.2		
8	154.6		

The growth of Lough Neagh roach calculated in the current study was compared with historic data (Figure 5.23). Todd Todd (1983) and Tobin (1990) reported slightly greater mean lengths at all ages, but with a similar rate of growth. The apparent dip in growth at age 7 in the current study is likely to be a result of a small sample size of fish in this year class, rather than a true reflection of growth rate.

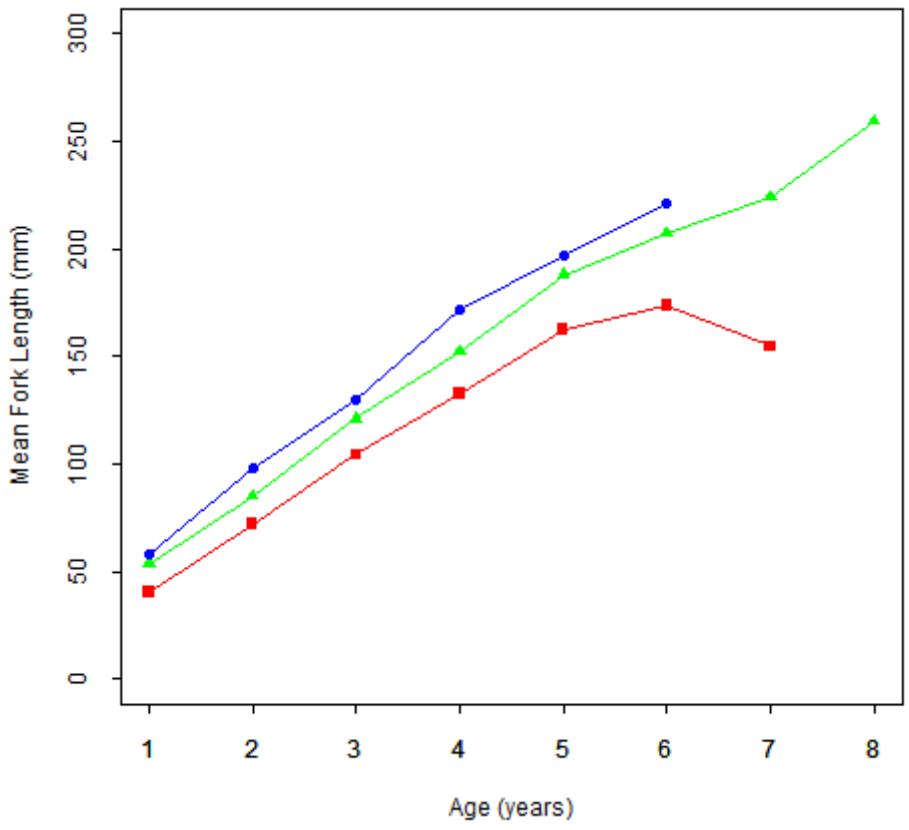

Figure 5.23 Lough Neagh roach mean back-calculated length at age red■- Current study, blue●- Todd (1983), green▲- Tobin (1990)

Explaining declining growth rates of Lough Neagh fish

Whilst growth rates of fishes can be accurately quantified, identifying factors impacting growth rate is more difficult, often because more than one factor is at work (Morrongiello et al., 2014, Minto et al., 2008). The growth rates of the most abundant species in Lough Neagh observed in this study were all reduced in comparison to those found historically. Cross-species decline suggests a common cause, or combination of causes. Lough Neagh is under a constant state of flux regarding productivity (Wood, 1993, Bunting et al., 2007). Tomankova et al. (2014), described a c. 70 % decline in macroinvertebrate biomass in Lough Neagh between 1998 and 2010, this coincides with the reduction in chlorophyll *a* concentration observed in the DOLMANT study. Tomankova et al. (2014) observed declines in chironimid larvae; sampling methods used in their study underestimated the biomass of motile macroinvertebrates. However, Griffiths et al. (in review) observed a 96 % decline in mean abundances of *Mysis salemaai* between 1993 and 2012. Both of these macroinvertebrate taxa are important food sources for pollan, perch and roach in Lough Neagh (Rooney and Montgomery, 2013, Tobin, 1990, Harrod, 2001), indicating that reduction in prey availability could be limiting growth rates.

Apart from declines in productivity, commercial exploitation has been shown to create life history changes in fish species, due to size selective mortality of fishing gear, and changes in fish density (Ricker, 1975). Landings of non-anguillid species are poorly recorded on Lough Neagh and recording of catch of some species (e.g. perch) is not legislated for. This means that it is difficult to quantify changes in exploitation, or its impacts upon fish density, accurately. However, there has been a recent increase in the sale of coarse fish net licences, suggesting increased fishing effort. It is unlikely that exploitation alone can explain changes in growth rate, as population density and growth rate have been shown to have an inverse relationship (Jensen, 1995), yet growth rate has declined in the face of increased fishing effort.

Fish Sampling Gear Comparison

Measurement of fish body-size distribution is frequently used as a management tool to assess the status of fisheries (Clement et al., 2014). While species composition is informative there is growing interest in using size distributions to evaluate aquatic food webs in lacustrine environments (Petchey and Belgrano, 2010, Emmrich et al., 2011). Gear selection is a crucial issue in evaluating species composition and size structure (Appelberg et al., 1995, Ceni and Vieira, 2013, Clement et al., 2014).

Gears often differ in effectiveness and often have biases relating to fish size, species and behaviour (Murphy et al., 1996, Shoup et al., 2003).

Standard lake fish surveys in NI/ROI have to date employed a combined approach of gill netting supplemented with fyke nets as per CEN (2005) recommendations. However the fish survey of Lough Neagh posed several challenges; its large size, the prohibition of of fyke net use, and its productivity due to its high trophic status. For these reasons a new methodology had to be developed to assess Lough Neagh's fishery status. Two surveys were run concurrently; these were a gill net survey using CEN (2005) compliant nets and a draft (seine) net survey using a standard Lough Neagh commercial fisherman's draft net (see Methods Section for more detail).

A total of 7,368 fish, representing seven species; brown trout (Figure 5.24), gudgeon (Figure 5.25), perch (Figure 5.26), pollan (Figure 5.27), roach (Figure 5.28), three spined stickleback (Figure 5.29) and bream (Figure 5.30) were captured using both gear types. Overall, gill nets captured fewer fish than draft nets. Length frequency data distributions were compared statistically between each gear type for each species independently using raw unbinned fork length data with a 2-sample Kolmogorov-Smirnov test following Clement et al. (2014).

For brown trout and bream gill nets failed to capture a sufficient sample size. Our results showed no significant differences in the length frequency distributions of gudgeon and pollan. Major significant differences in length frequency arose with perch and roach and a lesser but significant difference was found in three spined stickleback catches.

Statistical differences in the length frequency distribution of perch may be a result of the draft net catching a reduced number of 0+ fish when compared to gill net catches. In most waterbodies the under representation of 0+ perch in a fish survey would perhaps not be of great concern however in Lough Neagh juvenile perch are occasionally exploited and used as bait for the commercial eel fishery and in this instance monitoring of the 0+ cohort is useful for lake managers. To achieve this, future draft net surveys could be supplemented with several 5.5 mm monofilament gill nets.

A significant statistical difference was also found when comparing the length frequency distributions of roach captured in gill nets and draft nets. The draft net yielded a far greater sample size (N = 3,951) when compared to the gill net (N = 128). In this instance the gill net under represented the 0+ cohort and the draft net provided a more representative sample.

Our analyses also found a significant difference between three spined stickleback length frequency comparisons between gear types. The gill net survey yielded a reduced sample size (N = 44) as

opposed to the draft net survey (N = 554). Gill nets also missed all three spined stickleback with a fork length ranging from 55 to 63 mm which contributed greatly in draft net catches (N = 71).

Because gear efficiencies often differ based on physical habitat and target species characteristics (e.g. size, morphology and behaviour), the extent to which gears complement one another or indeed become redundant is highly variable depending on specific local conditions and underpin the importance of careful and conservative interpretations of data. The question of which methods / techniques will yield the most accurate results has plagued and will continue to plague fishery managers(Appelberg et al., 1995, Ceni and Vieira, 2013, Clement et al., 2014, McKenna et al., 2013, Stallings et al., 2014). This problem is amplified by a movement from assessing the status of single species to whole assemblage and community fish stock assessments as per the EU WFD (EU, 2000). This study found that data gathered from draft net surveys was generally more useful than data from the gill net surveys. This coupled with the added benefits of draft net sampling (limited gear loss, instant results and low mortality of fish) makes it a more appropriate method for future accurate fish stock assessments of Lough Neagh.

Table 5.18 Results of size distribution comparison between gill and draft net techniques (Kolmogorov – Smirnov)

Species	Common Name	D	p-value	Significance Level
Gobio gobio	Gudgeon	0.389	0.0992	
Perca fluviatilis	Perch	0.424	<0.0001	***
Coregonus autumnalis	Pollan	0.128	0.2256	
Rutilus rutilus	Roach	0.692	<0.0001	***
Gasterosteus aculeatus	three spined Stickleback	0.245	0.0194	*

* = P < 0.05, *** = P < 0.001

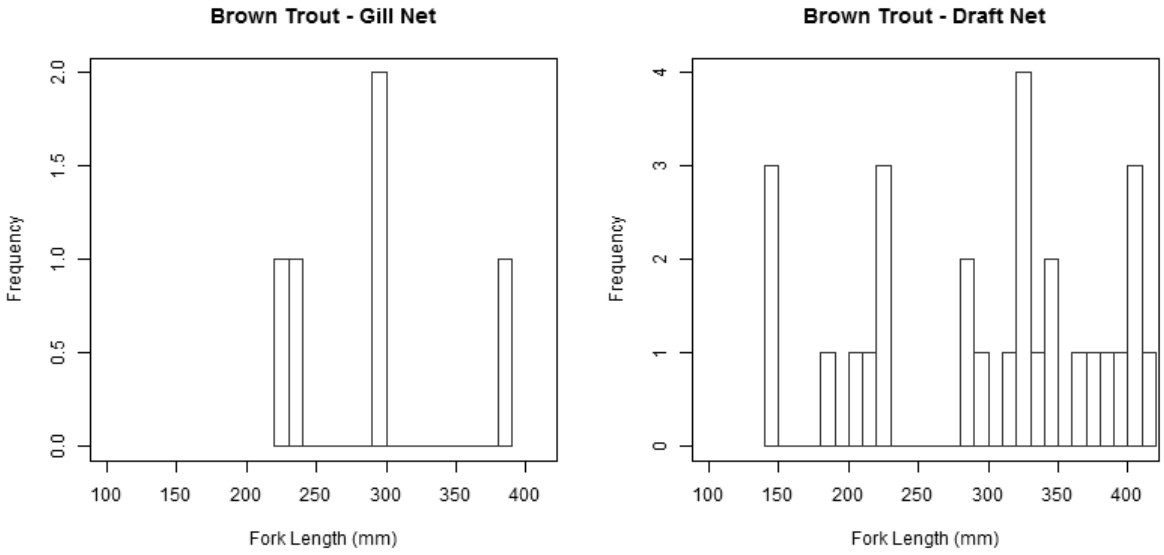

Figure 5.24 Length - Frequency distribution of brown trout captured in gill nets (left) and draft nets (right).

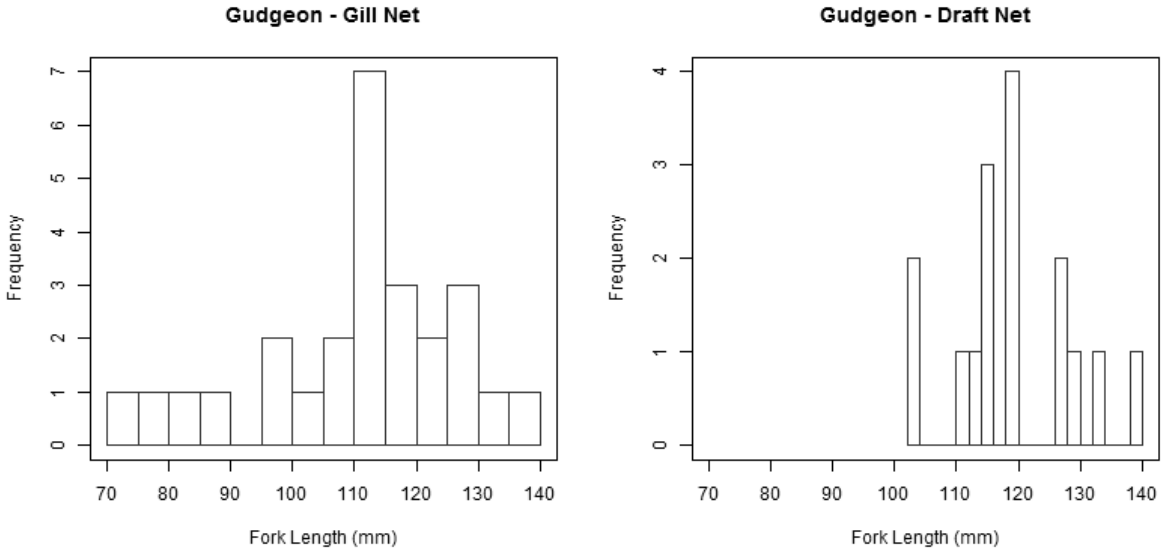

Figure 5.25 Length - Frequency distribution of gudgeon captured in gill nets (left) and draft nets (right).

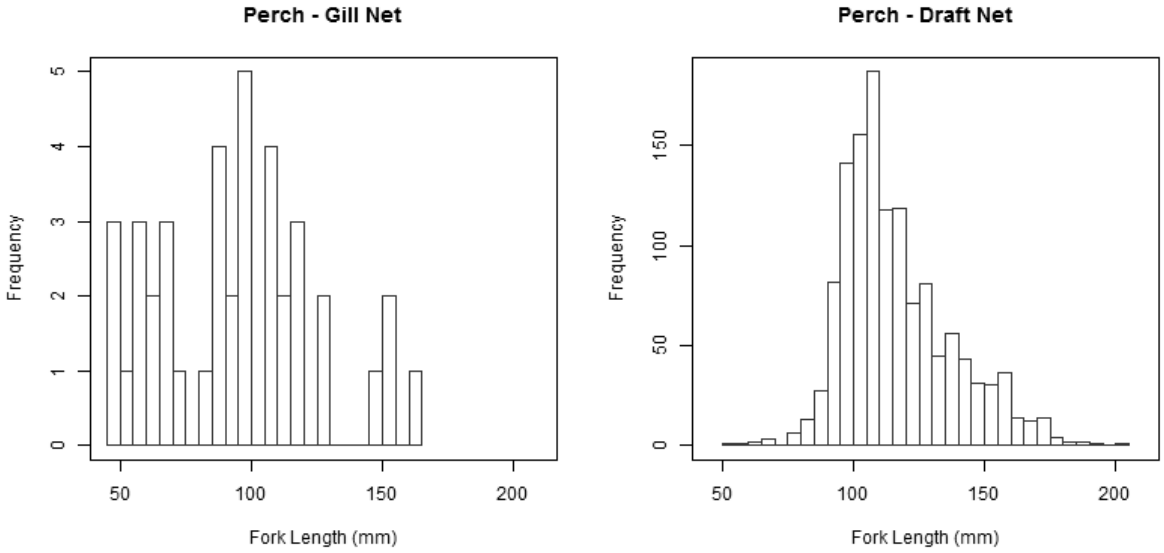

Figure 5.26 Length - Frequency distribution of perch captured in gill nets (left) and draft nets (right).

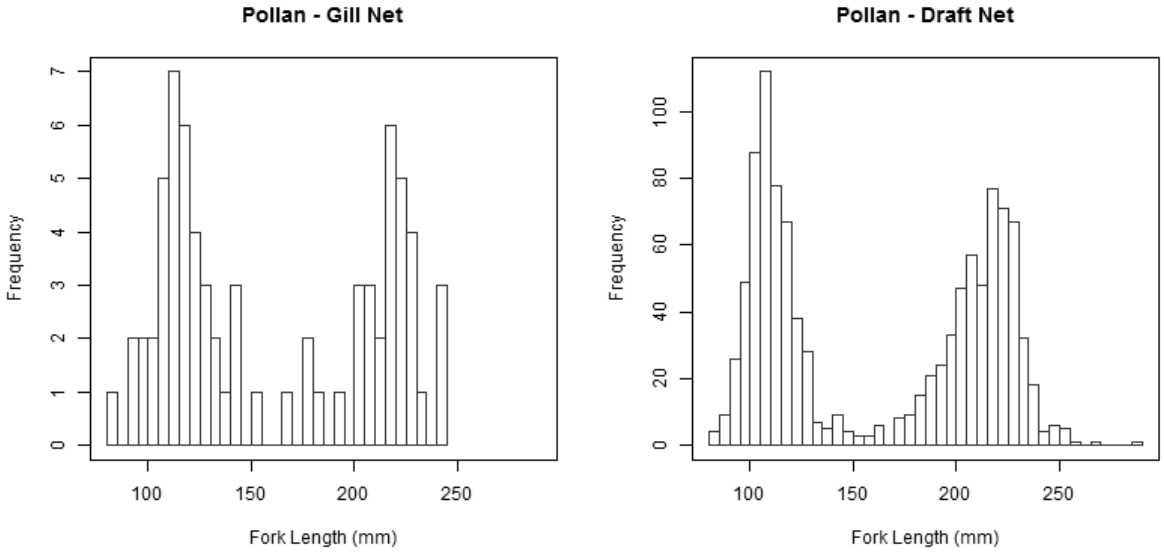

Figure 5.27 Length - Frequency distribution of pollan captured in gill nets (left) and draft nets (right).

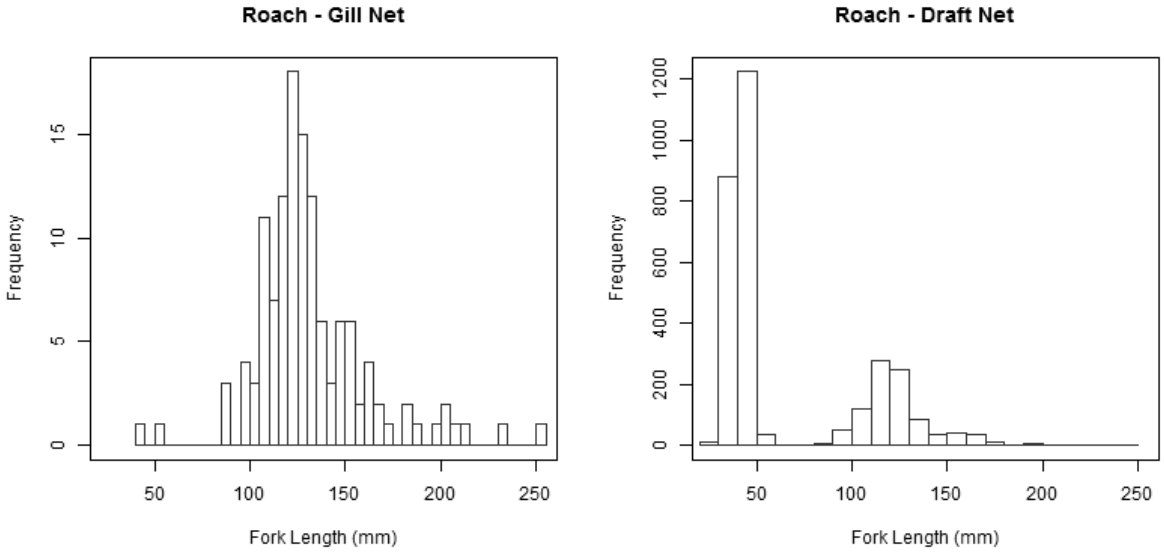

Figure 5.28 Length - Frequency distribution of roach captured in gill nets (left) and draft nets (right).

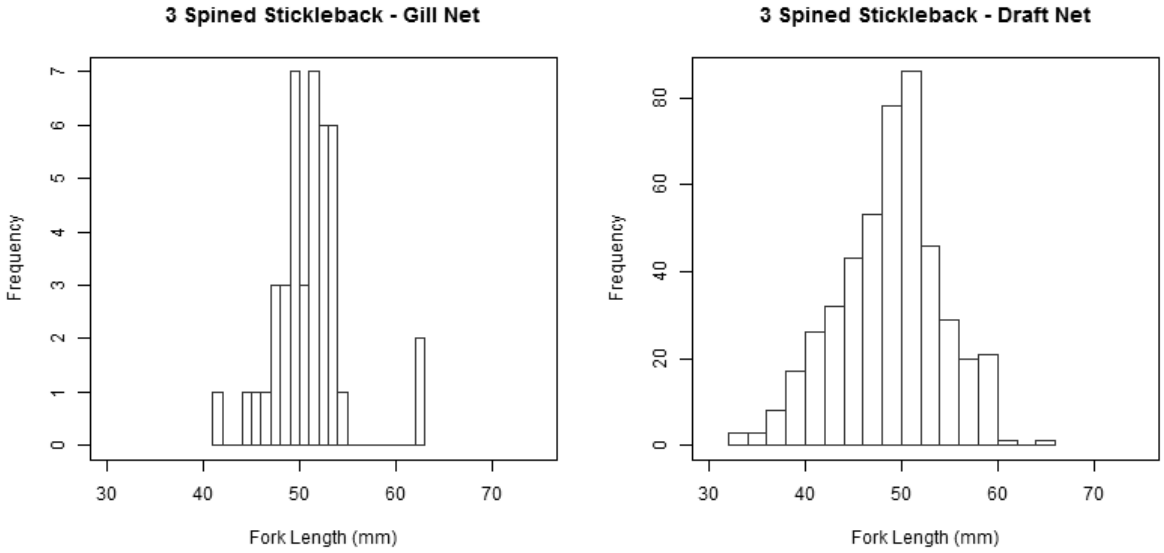

Figure 5.29 Length - Frequency distribution of three spined stickleback captured in gill nets (left) and draft nets (right).

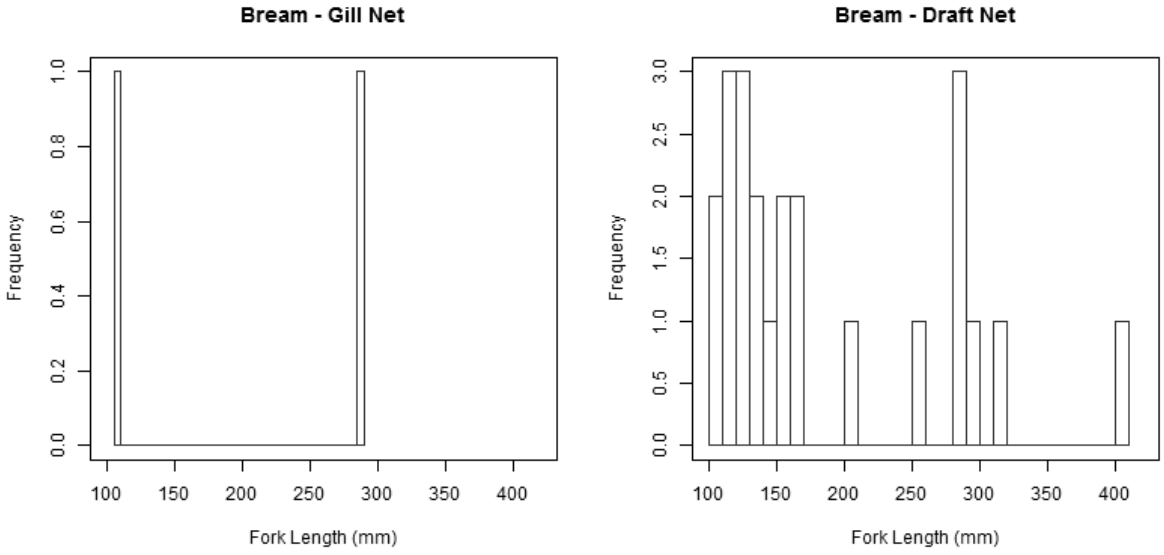

Figure 5.30 Length - Frequency distribution of bream captured in gill nets (left) and draft nets (right).

Studies of Lough Neagh pollan larvae

Cohort strength of fish is often determined in the first months of life (Nelson, 1968), and may be examined by investigating success of early life stages (Mooij, 1996, Anderson, 1998, Karjalainen et al., 2000).

Recruitment is a major factor in determining pollan abundance (Wilson, 1983). This is a function of the short-lived (max. 3yrs in current study) and fast growing nature of pollan. As such, this study of pollan larval abundance during the years 2011-2014, the first completed since 1977 (Dabrowski, 1981), is an important tool for predicting future pollan population size.

Data collected in the Ballyronan Bay area was analysed, c. 30 days post hatching. This area has been noted as especially important to juvenile pollan 1977 (Dabrowski, 1981). Observed pollan larvae densities varied between years (Figure 5.31). From the results of Kruskal-Wallis analysis (Table 5.19) (chi-squared = 17.6642, df = 3, p = 0.0005) we can conclude that 2011 produced particularly low larval densities, with 2013 and 2014 producing greater densities, and 2012 between the two extremes.

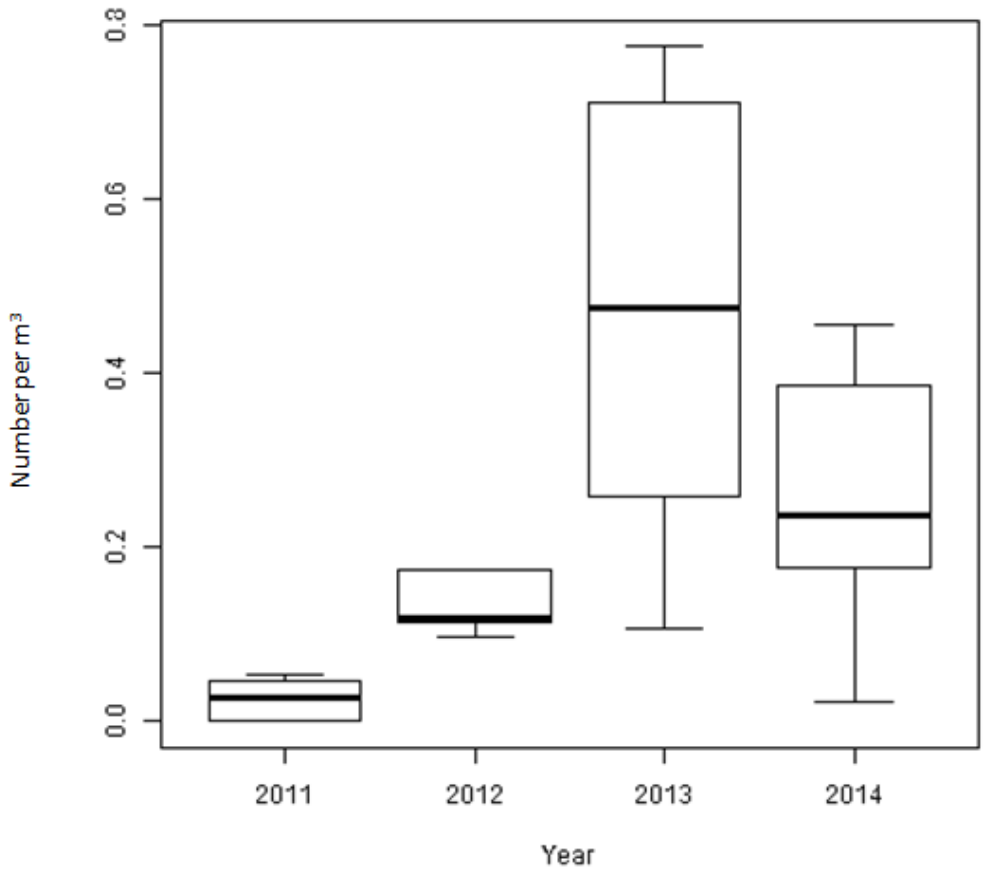

 Figure 5.31 Density/m^3 of c. 30 day old pollan larvae in Ballyronan Bay

Table 5.19 Results of Kruskal-Wallis comparisons

Comparison	Observed difference	Critical difference	Statistical difference
2011-2012	10.22	12.38	False
2011-2013	19.51	13.24	True
2011-2014	15.11	12.38	True
2012-2013	9.29	13.24	False
2012-2014	4.89	12.38	False
2013-2014	4.40	13.24	False

Larval density results (Figure 5.31) were verified by studying the length frequency histograms of pollan captured in our draft netting survey (Figure 5.32) during summer. The graphs exhibit a tri-modal distribution, with each mode representing a year class of pollan. The first mode represents fish born in the spring of that year (age 0+), the second fish born the previous spring (age 1+), and so on. Population structure varied significantly between years (two sample Komogorov-Smirnov: $D = 0.3$, $p<0.001$).

The small numbers of 0+ fish in the length frequency histogram for summer 2011 support the use of the low observed larval densities in the spring of that year as an accurate measurement of recruitment. We can track that cohort through to the small mode of 1+ fish in the summer 2012 histogram.

This means that, since the size of each mode reflects cohort strength, and since we can infer recruitment levels from the pollan larvae survey, we can follow the performance of a year class right from initial recruitment to death. That is, larval density data from our work can be a predictor of future pollan population size, including numbers of marketable size pollan (>200mm), an important tool for conservation and adaptive fishery management. This is a requisite for a fishery of a species of variable cohort strength, reliant upon only one year class.

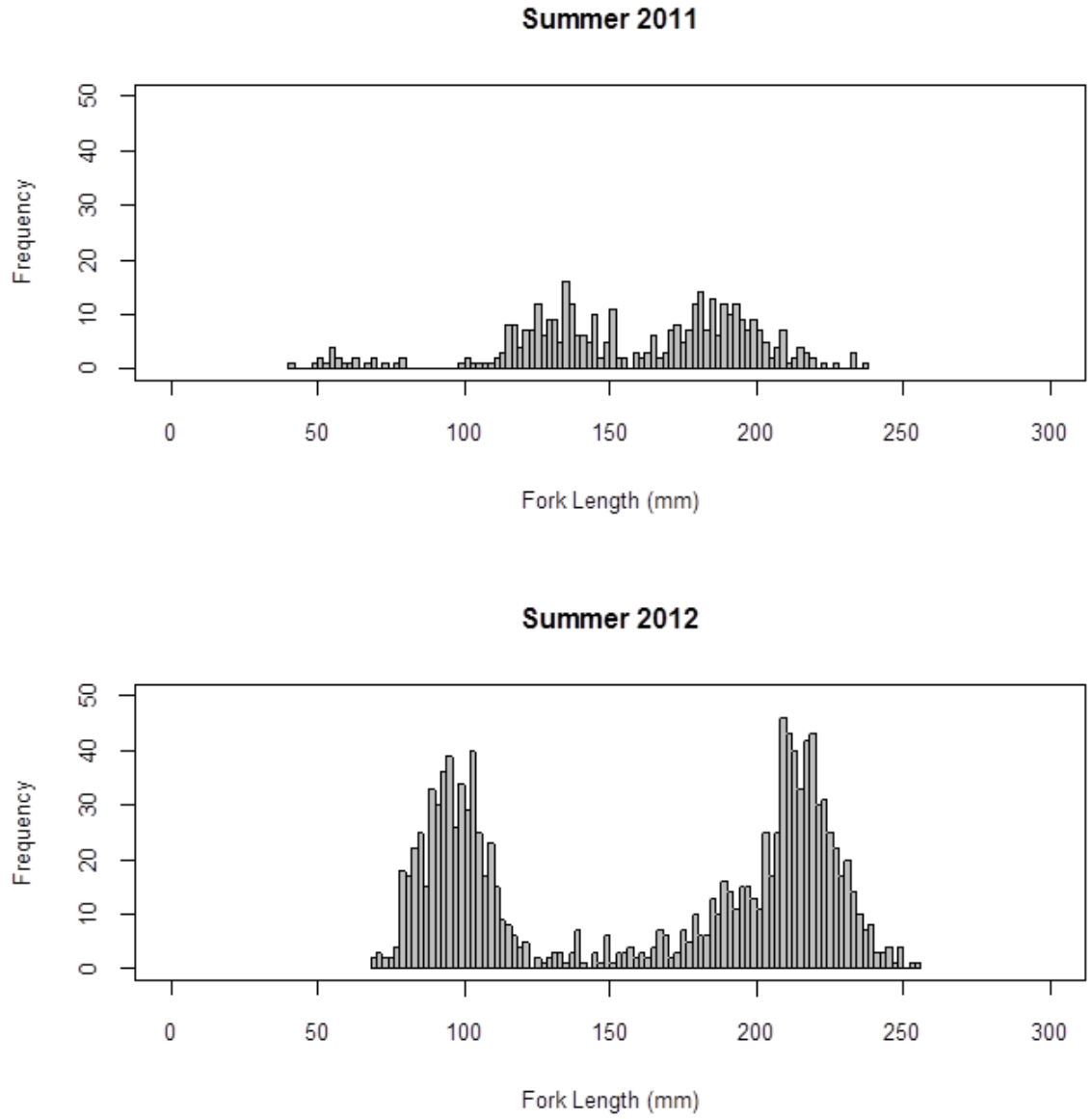

Figure 5.32 Length frequency histograms of pollan captured during draft netting survey

Ecological Classification of Lough Neagh

An ecological assessment of Lough Neagh's fish community was assessed using the established Fish in Lakes Tool (FIL2)(Allen and Rosell, 2010, Kelly et al., 2012, Kelly et al., 2013) for each of the four draft net surveys and gill net surveys of Lough Neagh. The Lough Neagh water body was designated as a Type four waterbody due to an alkalinity of >67 mg L^{-1} $CaCO_3$ and a maximum depth exceeding 17 m as stipulated by (Kelly et al., 2012). To assess the ecological status using FIL2, five metrics (Table 5.20) were pre-calculated (Table 5.21 and 5.22) for each survey.

Table 5.20 List of the five metrics used in the FIL2 ecological classification tool for type four Irish lakes.

Fish metric	Explanation
TOTAL_BPUE	Sum of mean BPUE (biomass (g) of fish per linear metre of net – gill nets and fyke nets) for each fish species
NAT_BPUE	Sum of mean BPUE of native (*group 1) fish species
PERCH_BIO	% composition of perch based on BPUE (PERCH BPUE/TOTAL BPUE*100)
MAX_L_DOM_BIO	Maximum length of dominant (based on BPUE excl. eels and adult salmon) species
LITH_IND	% individuals (excl. eels and adult salmon) that are lithophilic (as per FAME consortium (2004) classification)

*Group 1 (Natives): Brown trout, sea trout, salmon, Arctic char, Pollan, European eel, Killarney shad, Three-spine stickleback, nine-spine stickleback, brook lamprey, river lamprey, sea lamprey and flounder (Kelly et al., 2012).

Table 5.21 FIL2 results for draft net surveys of Lough Neagh.

Lake Name	TOTAL_BPUE	NAT_BPUE	PERCH_BIO	MAX_L_DOM_BIO	LITH_IND	EQR	EQR Lower 95% C.I.	EQR Upper 95% C.I.	EQR Classification
Summer 2011	1.101	0.869	26.5	23.7	5.2	0.92	0.733	0.978	High
Autumn 2011	2.774	0.889	44.1	20.4	0.9	0.92	0.741	0.976	High
Summer 2012	3.016	2.225	31	25.6	0.9	0.91	0.721	0.974	High
Autumn 2012	4.18	2.248	21.1	28.6	0.4	0.9	0.693	0.973	High

Table 5.22 FIL2 results for gill net surveys of Lough Neagh.

Lake Name	TOTAL_BPUE	NAT_BPUE	PERCH_BIO	MAX_L_DOM_BIO	LITH_IND	EQR	EQR Lower 95% C.I.	EQR Upper 95% C.I.	EQR Classification
Summer 2011	11.561	0.037	99.7	18.9	0	0.87	0.52	0.976	High
Autumn 2011	55.269	0.875	87.2	20.3	0	0.66	0.33	0.882	Good
Summer 2012	22.539	2.711	53	21.1	0.4	0.85	0.665	0.945	High
Autumn 2012	24.519	10.501	4.6	25.1	1.6	0.87	0.632	0.962	High

Across all 8 surveys the ecological status of the Lough Neagh fish community (ecological quality ratio (EQR)) was deemed high (N = 7) or good (N = 1). Draft net survey results consistently produced a small but significantly higher EQR than gill net surveys (Wilcoxon rank sum test: W = 16, p = 0.03) (Figure 5.33), this was predominantly due to eels (a native species) being underestimated in gill net catches.

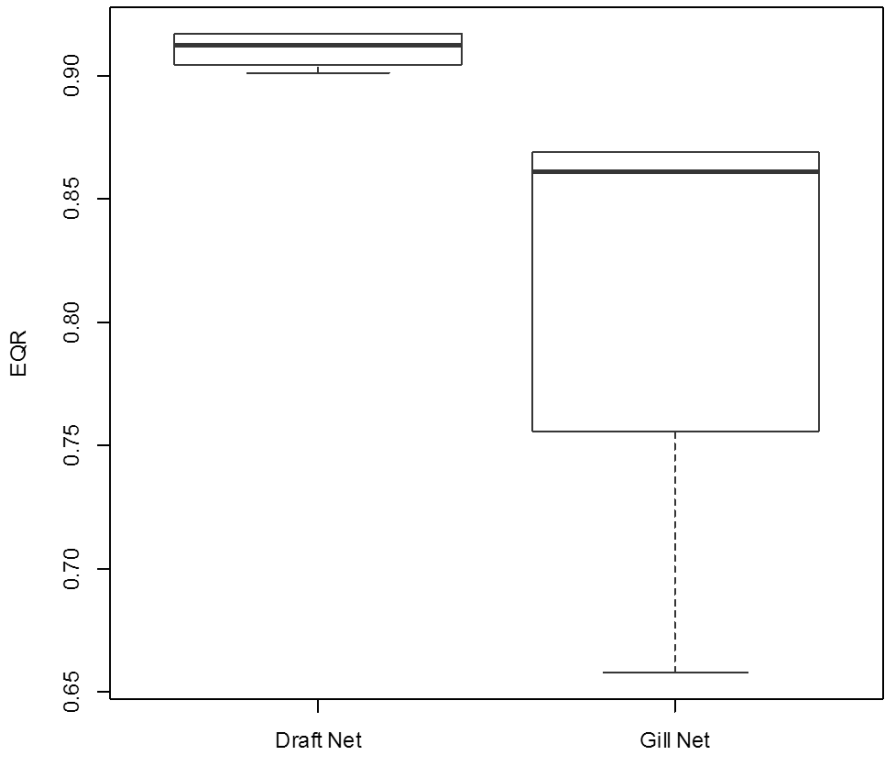

Figure 5.33 Boxplot of ecological quality ratio (EQR) by net type

Appendix B

Table 1: Summary table detailing declared biomass landed from L Neagh as per DCAL Licenced Fish Dealers register data

Year	Bream	Pike	Pollan	Trout	Perch	Salmon	Roach
1996	1802.9	2889.6	0	0	0	0	0
1997	2239.6	1043.6	175014.5	3946.1	9442	0	0
1998	0	0	225460.6	145.9	0	0	0
1999	0	0	105191.4	0	0	0	0
2000	0	0	355010.2	1785.4	0	0	0
2001	0	0	348004.1	0	0	0	0
2002	0	0	136679.4	0	0	0	0
2003	0	0	97382.3	1379.8	0	148.7	0
2004	889.8	2166	164847.5	333.5	0	66.4	0
2005	1143	1028.9	83904.6	3102	0	0	40889
2006	3219.5	21260.6	120497	3437.5	0	0	79066.1
2007	0	696.1	60527.3	2557.3	0	0	5600.7
2008	3105.2	1643.1	59853.9	1644.5	3136.9	0	67979.4
2009	20921.4	2357.6	192496.4	7857.104	990.6	0	202669.4
2010	11328.4	5525.9	229167.4	3759.6	419.1	33.4	64954.7
2011	1206.5	7160	32288.1	337.1	31.8	0	2882.9
2012	658.26	5298.86	223834.1	8140.15	2985.1	27.63	52517.43
2013	8804.28	10401.89	298066.2	11710.67	60970.21	4.4	209117.3
2014	958.85	0	26653.85	7903.56	2048.41	0	20986.29

Note there is currently no legal requirement to record sales of perch, roach or bream by Registered dealers.

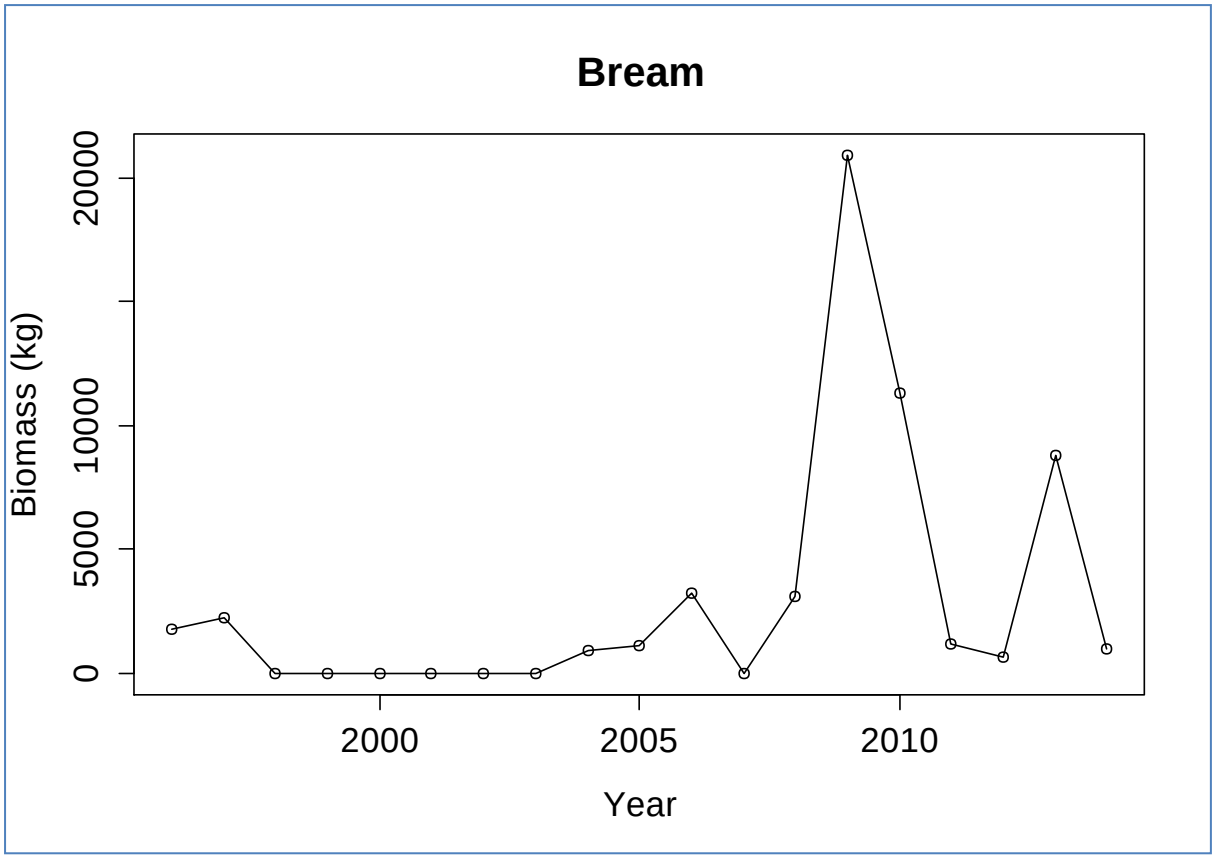

Figure 2: Bream purchased by DCAL Licenced Registered Fish dealers 1996 - 2014

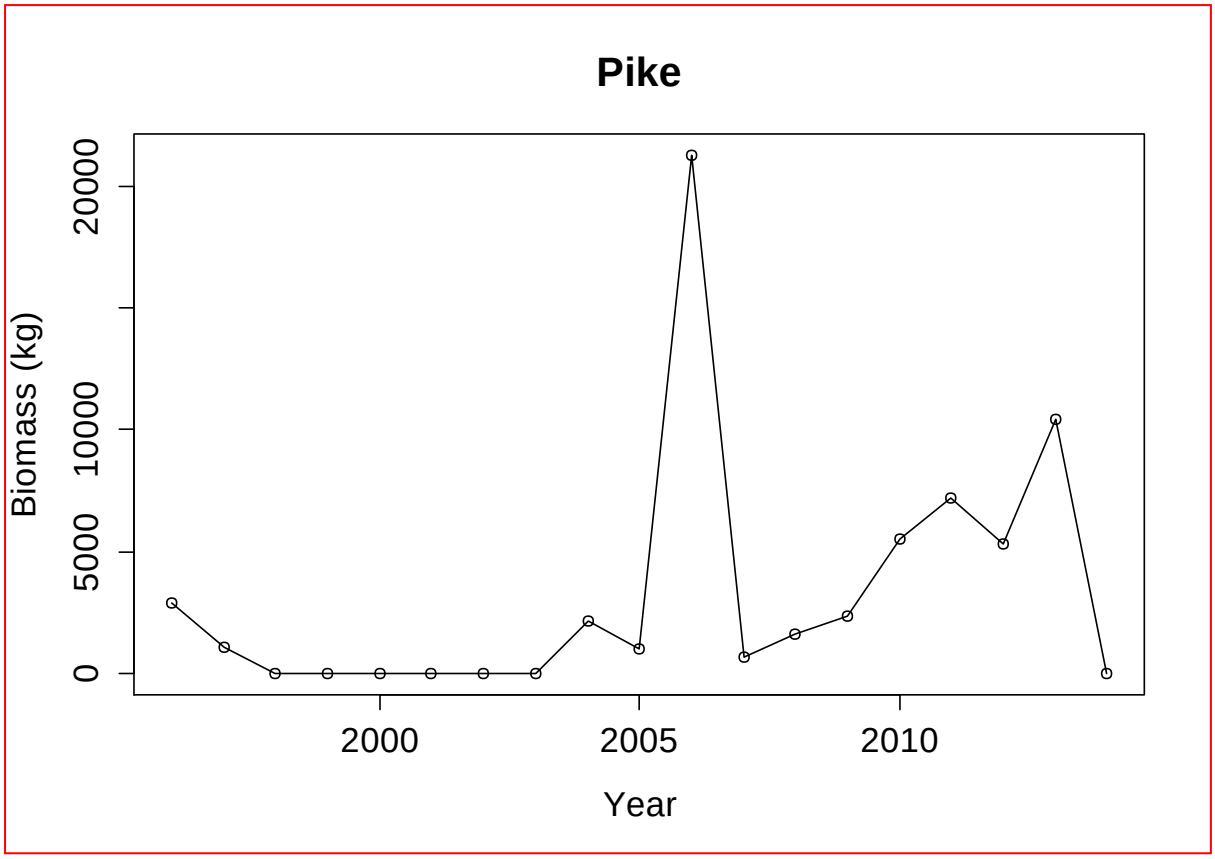

Figure 3: Pike purchased by DCAL Licenced Registered Fish dealers 1996 – 2014 *includes pike captured by commercials fishers' on Lough Erne

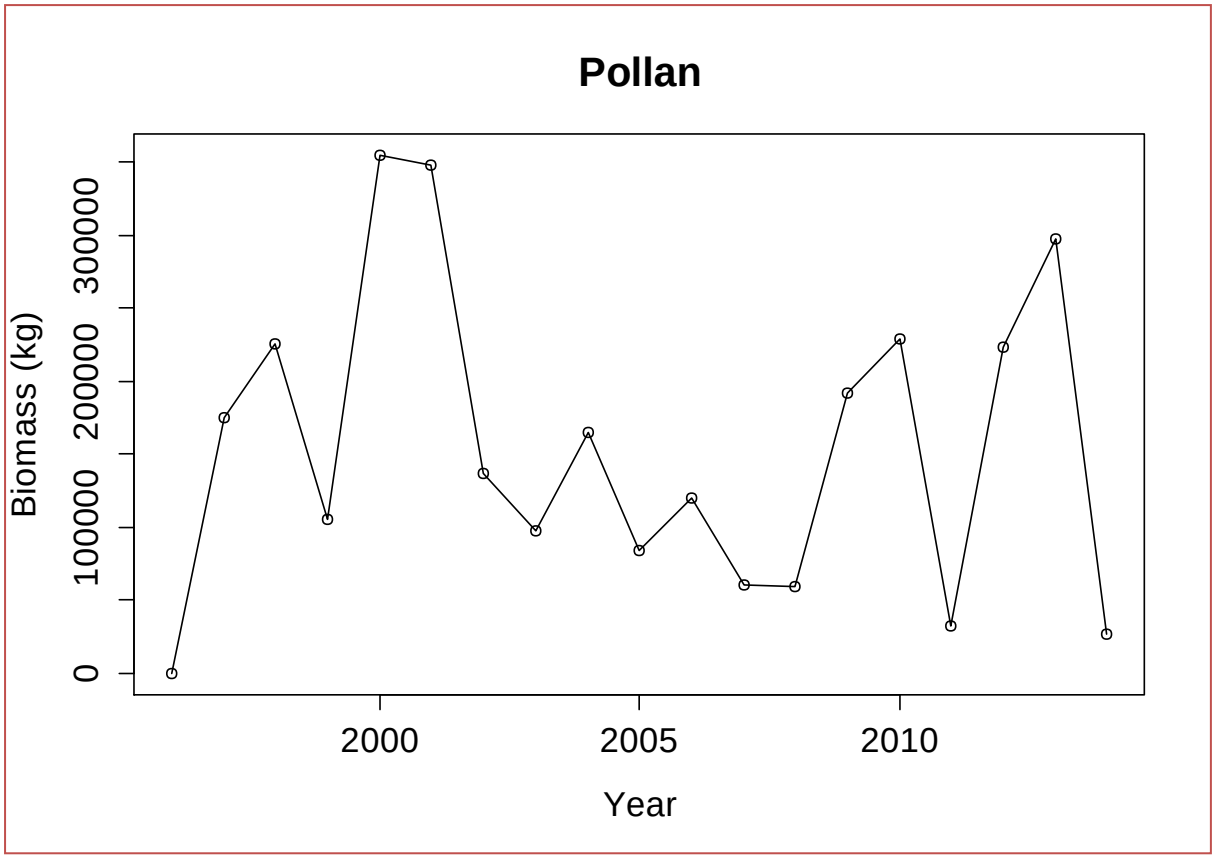

Figure 4: Pollan purchased by DCAL Licenced Registered Fish dealers 1996 - 2014:

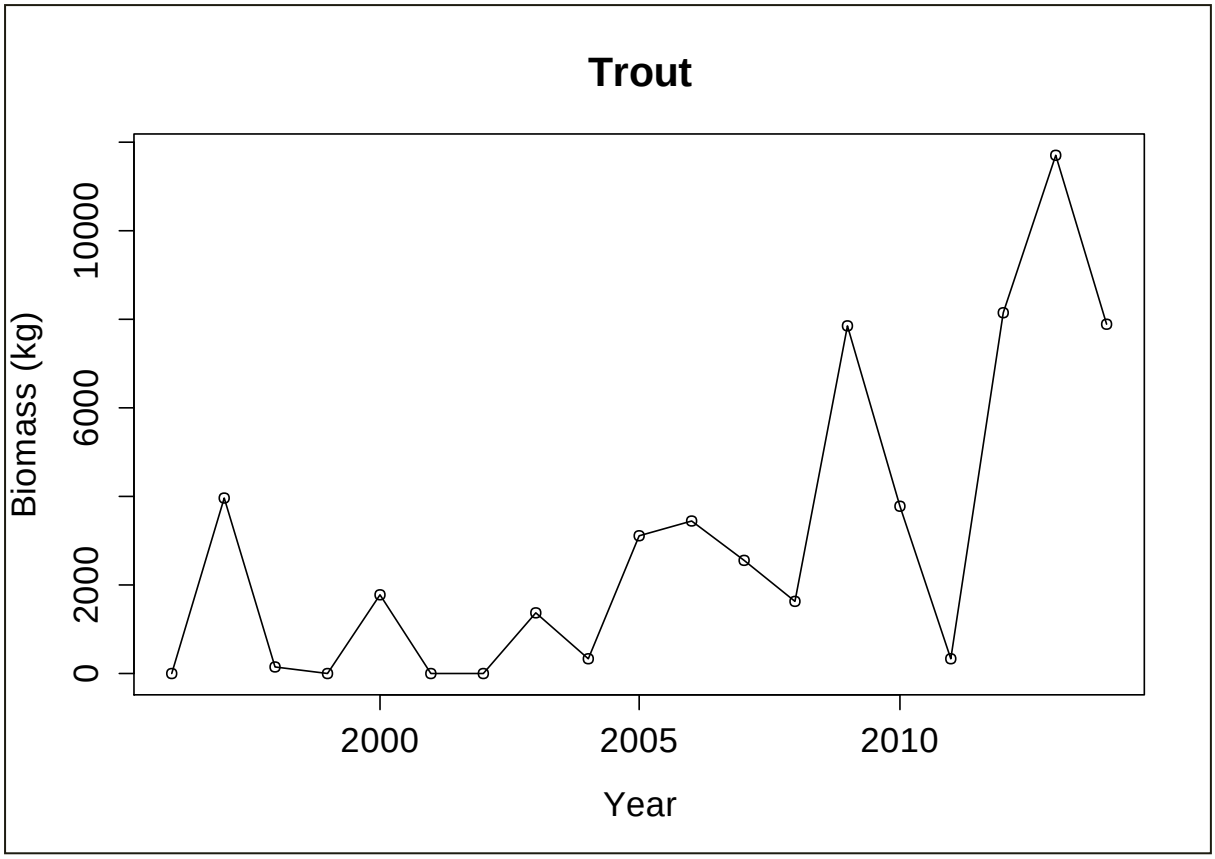

Figure 5: Trout purchased by DCAL Licenced Registered Fish dealers 1996 - 2014

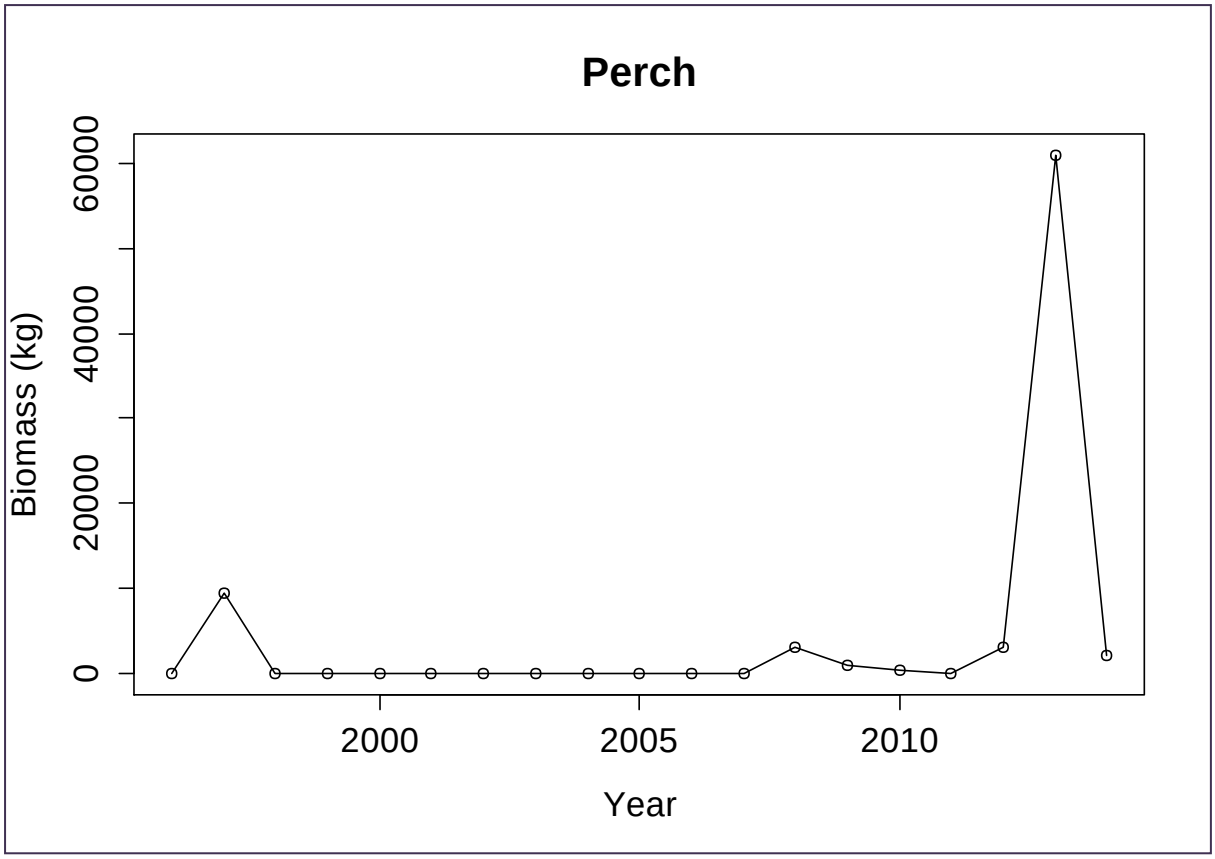

Figure 6: Perch purchased by DCAL Licenced Registered Fish dealers 1996 - 2014

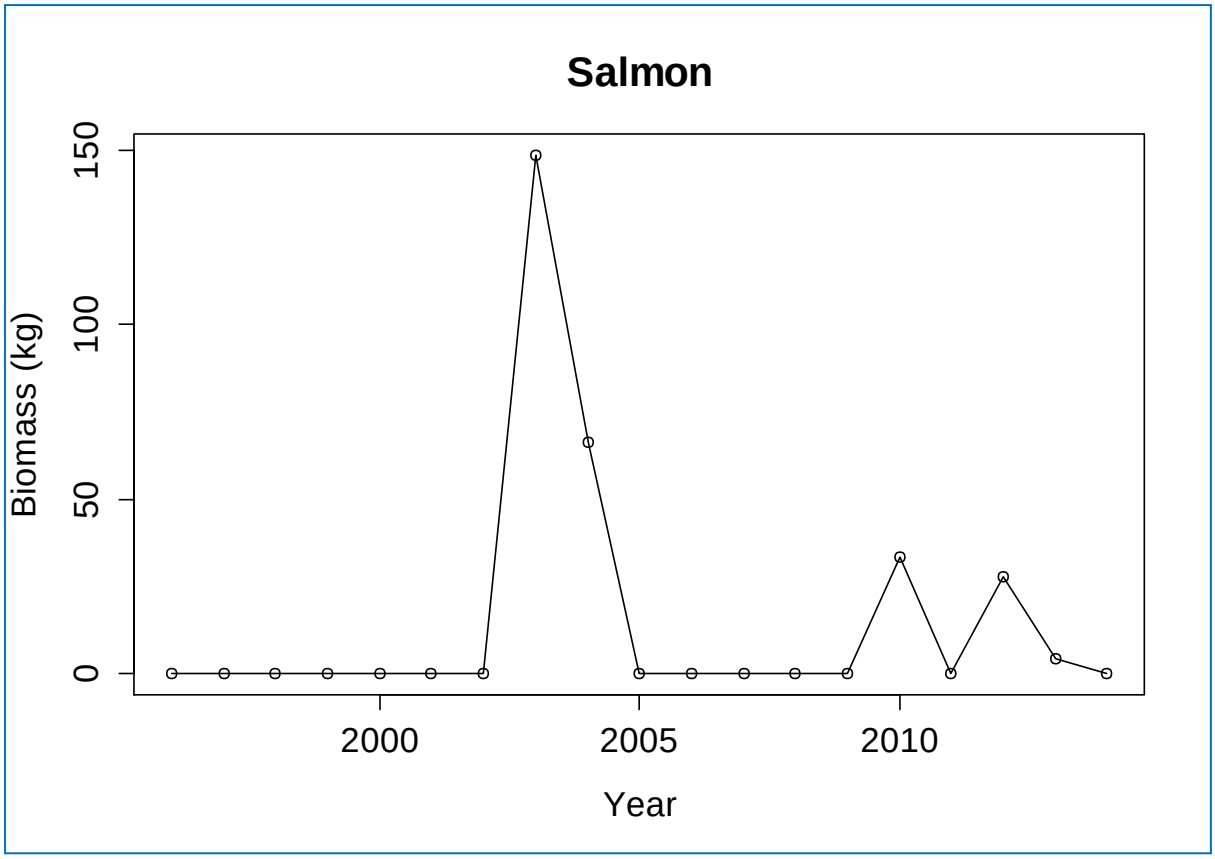

Figure 7: Salmon purchased by DCAL Licenced Registered Fish dealers 1996 - 2014

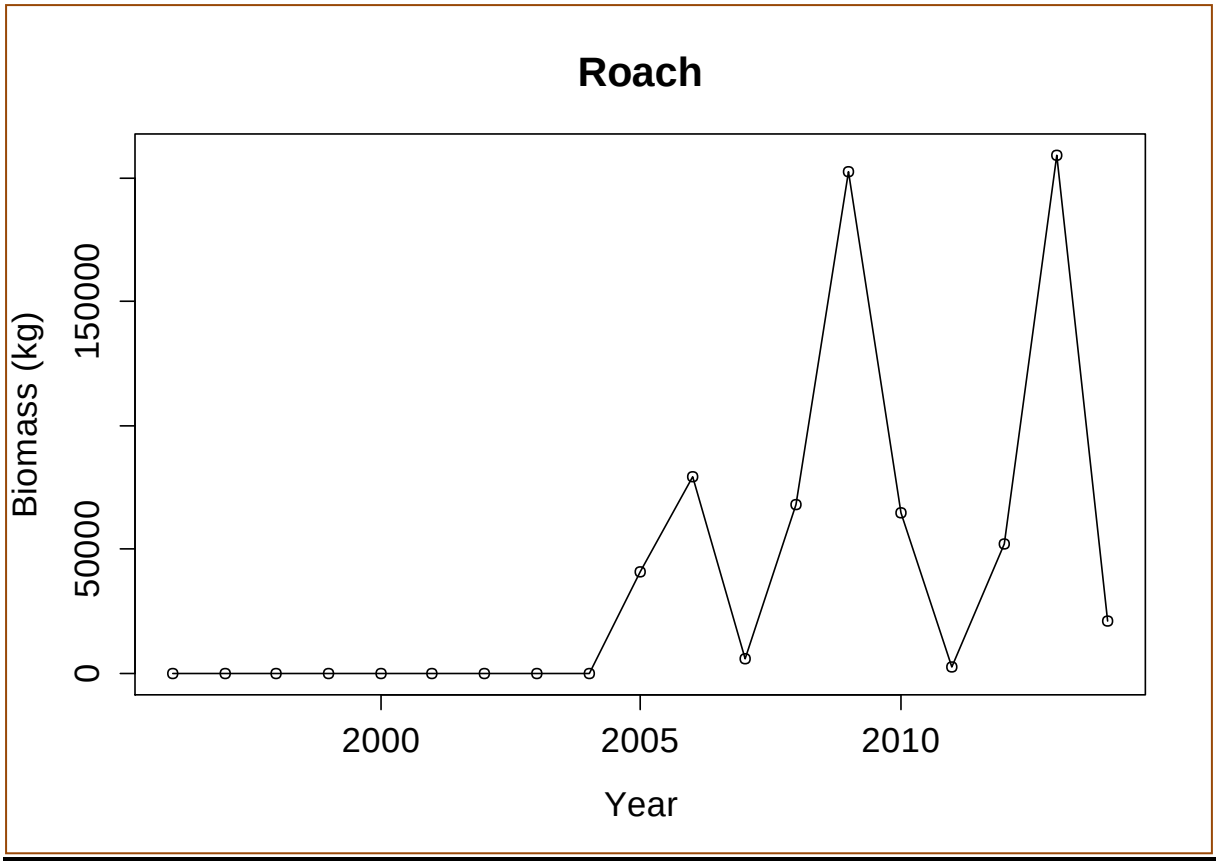

Figure 8: Roach purchased by DCAL Licenced Registered Fish dealers 1996 - 2014

Stakeholder Engagement on Lough Neagh Fishery Management Plan

Date	Stakeholder Group	Venue
18 June 2014	Commercial Fishermen and Fish Dealers	Toomebridge
24th June 2014	Angling Groups	ECOS Centre
15th December 2014	Lough Neagh Fishermens Co-operative Society	Toomebridge
15th December 2014	Lough Neagh Fishermen's Association	Ballyronan
4th February 2015	Angling Groups	Movanagher
21st February 2015	Salmon and Inland Fisheries Forum	Portadown

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