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GALLOWAY GLENS - FISH, FISHERIES AND ANGLER SURVEY IN LOCH KEN

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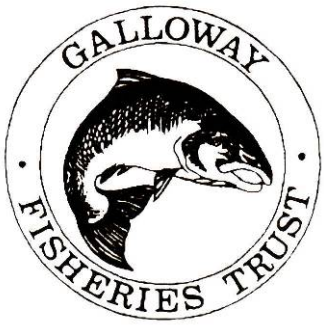
Summary



Galloway Glens - Fish, Fisheries and Angler Survey in Loch Ken

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Keywords

Loch Ken; coarse angling; seine netting; crayfish; pike; citizen science.

Background

This study was commissioned by the Galloway Glens Partnership Project. Finance for the study was provided by Galloway Glens Partnership Project, Scottish Natural Heritage and the Scottish Environmental Protection Agency, and was managed by a steering group of these funders and Dumfries and Galloway Council.

Loch Ken in South West Scotland is a popular angling venue, particularly for coarse fish with competition and recreational anglers fishing for the diverse fish community present. This fishery has been important to the local economy for many years. During the mid-1990's North American signal crayfish were identified within the Kirkcudbrightshire Dee catchment and in Loch Ken itself. These non-native crayfish are now firmly established within Loch Ken and have had, it has been suggested, an adverse impact on fish within the system, and hence the value and quality of the fishery. However, such adverse impacts have not been quantified or robustly assessed. Based on current technologies and methods there is no prospect of eradicating North American signal crayfish from Loch Ken or the wider catchment of the Kirkcudbrightshire Dee.

The main objective of this study was to undertake an assessment of the condition of the fish stocks within Loch Ken, and the overall status of Loch Ken as an angling venue. Information

and data was collected via open, public stakeholder events, the distribution of an angler questionnaire, interviews with anglers fishing (creel surveys), seine netting and through catch sampling at angling matches. These data collection techniques were developed during the recent pilot project undertaken on Loch Ken in 2016.

Using the data collected, recommendations for the future management, monitoring and development of Loch Ken as a coarse fishery have been made.

Main findings

- Loch Ken continues to be a popular fishery particularly for visiting anglers from out with Dumfries and Galloway, with most anglers stating they are 'satisfied' or 'very satisfied' with their angling experience on the loch.
- The loch is a popular venue for match anglers providing good catches over much of the year. Many match anglers feel that if further additional access opportunities to the loch were available, then more matches could be held.
- There is a concern amongst anglers that North American signal crayfish are negatively impacting on their angling particularly through interference with their baits. Many anglers report adapting their fishing techniques to minimise these problems.
- The main fish species targeted by anglers on the loch are bream, roach, pike, perch and to a lesser extent dace and ruffe. Consideration of the overall health of these fish populations including growth rates suggested all were healthy. Limited samples were collected from pike and these suggested a low growth rate which should be investigated further.
- Anglers feel that the population of large perch in Loch Ken has increased in recent years due to their feeding on juvenile signal crayfish. Examination of perch growth rates found a large increase in growth rates in perch over four years old which is consistent with this view.
- At present it appears that the coarse fish population in Loch Ken is able to support a viable and sustainable fishery in spite of the presence of a significant North American signal crayfish population. Ongoing monitoring is required to assess fish populations over time and to identify change and trends.
- Some biosecurity measures are undertaken by over half the anglers on the loch to help reduce the risk of transfer of invasive non-native species to or from the site.
- A number of recommendations are provided regarding understanding the fish populations in the loch and the future maintenance and development of Loch Ken as an important coarse fishery. These include - Future Monitoring of Fish Populations; Governance - Management and Planning of the fishery; Fishery Protection - Access and Local Management; Development - Promotion and increasing accessibility; Biosecurity; and Education and Research.

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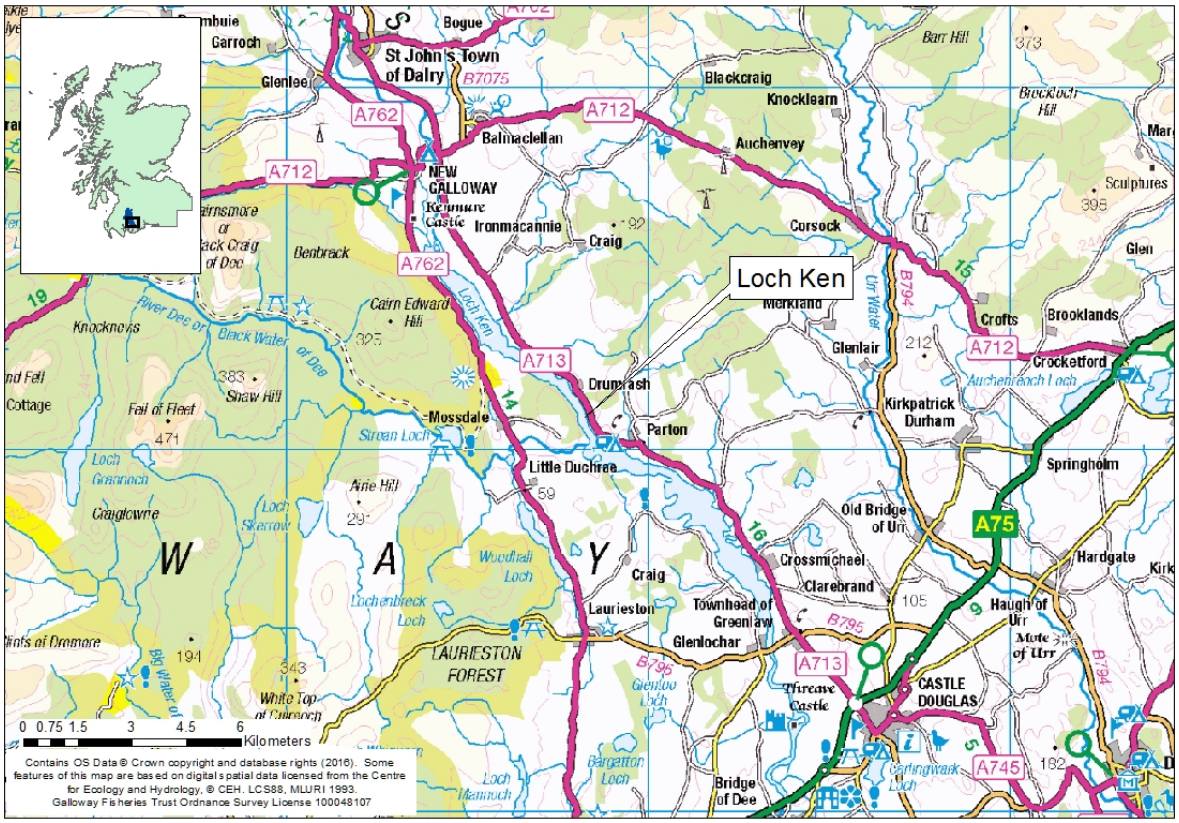
1. INTRODUCTION

1.1 Location and management

Loch Ken is a 14.5 km long freshwater loch situated in Dumfries and Galloway, South West Scotland (see Map 1). The flow of the loch is dominated by two inflowing river channels; the Black Water of Dee from the west and the Water of Ken from the north. The river leaving the loch is known as the Kirkcudbrightshire Dee which flows for nearly 15 km before entering the Solway Firth near the town of Kirkcudbright. In 1929 the Galloway Water Power Act authorised the construction of The Galloway Hydro-electric Energy Scheme. The scheme was built between 1932 and 1936, which included the construction of Glenlochar Barrage. While the loch feature was part of the natural form of the river, the construction of the Glenlochar Barrage significantly increased the overall size of Loch Ken and nearly doubled its length.



Map 1: Location map of Loch Ken

The control barrage at Glenlochar allows water to be stored in Loch Ken to assist with power generation further downstream at Tongland Power Station. There are long-standing operating procedures for the barrage which manage water levels in the loch. These procedures have been established to meet and accommodate a range of interests not solely related to power generation. For example, the barrage gates are closed when the loch level drops to a specified height in order to protect the ecology of the wetlands and the amenity value for the many users of the loch. There are no specific provisions for compensation flow volumes below Glenlochar. Under increased flow conditions the gates will typically be fully open allowing water to flow un-impeded through Loch Ken.

The villages around Loch Ken include Glenlochar at the south, Laurieston and Mossdale on the west bank, and Crossmichael and Parton on the east bank. The village of New Galloway lies immediately to the north.

1.2 The fishery

The Kirkcudbrightshire Dee was known historically for supporting excellent runs of salmon of which high numbers were caught by a combined rod and net fishery. Andrew Symson in 1823 wrote in the 'A large description of Galloway' that *'This river [Dee] is abundantly plenished with excellent salmon'*. In 1909, William L Calderwood wrote in his book 'The salmon rivers and lochs of Scotland' that Loch Ken was only about four miles long and the *'sluggish stream that flow from it'* formed a confluence with the Blackwater below Parton. *'The slack loch-like water between Parton and Crossmichael is a stronghold of pike …. A systematic war should be waged against these wretched fish when they spawn amongst the weeds in the spring, and all the little boys in the neighbourhood might set pike trimmers with advantage'.* In 1774 it is reported that a huge 72 lb pike was caught by John Murray in Loch Ken. There are various accounts of the bait used with some suggesting a large fly made out of peacock feathers, live bait or spinning. One record even suggests the bait used was a dead duck! Another large pike was recorded in 1904 which was found emaciated and dying at the edge of the loch but still was weighed in at 39 lb.

The increased size of Loch Ken following the construction of the Glenlochar Barrage would have made the water even more suitable for the resident pike population. The Dee District Salmon Fishery Board (DDSFB) and Dee Fishery Association supported a gill netting programme in Loch Ken aimed at reducing predation of salmon and trout. Many large pike were culled including one just over 35 lb in 1935. The Board ceased netting many years ago.

As interest in pike angling grew and became more accessible and affordable for anglers, Loch Ken became a popular venue for pike anglers who could easily fish the loch from both the shore and boats. In 1972 a visiting German Kurt Vogel caught a pike of 40 lb 4oz while spinning for salmon in Loch Ken. It was weighed officially on post office scales. The loch continues to be recognised as a venue for catching good sized pike and is considered to be the second most popular pike fishing water in Scotland after Loch Lomond. In Dumfries and Galloway, Loch Ken is recognised by anglers as the prime location for pike angling of the region both due to the quality of its pike catches and angler accessibility.

Although the loch lacks some migratory fish (eels and lamprey species) due to Tongland fish ladder being designed for salmon only, it holds one of the most diverse fish populations of any river system in Scotland. Many of the species present are not considered native to Scotland and appear to have been introduced as unused pike baits.

Easy access and affordable fishing is offered at various points around Loch Ken and this has made it popular for anglers fishing for many of the species present - anglers report catching good numbers of pike, perch, dace, roach, ruffe and bream. Match angling has been popular on the loch for many years and historically it was known as a renowned roach fishery which was particularly popular with English anglers. As additional fish species have been introduced to the loch, such as dace and ruffe, the fish species caught during matches has changed over time and although the roach population appears to have reduced the catches of bream have grown and in ideal conditions bags of 80 lb are reported in the angling press.

The importance of the fishery to the local economy is significant. In a 2009 Dumfries and Galloway Council study it was found that 'Loch Ken and the angling it supports' was worth between £273,321 and £553,651 per annum (Cameron 2010). The protection and enhancement of the economic value of the fishery to the local economy is, therefore, important.

1.3 North American signal crayfish

In Dumfries and Galloway the first record of the non-native invertebrate North American signal crayfish (*Pacifastacus leniusculus*) (referred to as signal crayfish in the rest of the report) was made in two tributaries of the Kirkcudbrightshire Dee in 1996 (Maitland 1996; West Galloway Fisheries Trust 1996 and Sinclair & Ribbens 1999). By 2004 signal crayfish were present in the Water of Ken (between Loch Ken and Glenlee) and were starting to be reported as a nuisance by anglers in Loch Ken (Ribbens & Graham 2004). In recent years, particularly since the mid 2000's, there has been an increasing number of complaints made to Galloway Fisheries Trust (GFT), Scottish Environment Protection Agency (SEPA) and Scottish Natural Heritage (SNH) from anglers stating that they were catching numerous signal crayfish as by-catch when pike angling in Loch Ken. These fishermen also reported that it was becoming increasingly difficult to successfully pursue their activities due to bait interference from signal crayfish.

In 2009 the Scottish Government funded a five month trapping project on Loch Ken which examined the practicality and success of large scale signal crayfish trapping on a large water body, detailed the crayfish distribution within the loch and gathered a range of information on the population present (Ribbens & Graham 2009). The study confirmed both that large numbers of signal crayfish could be trapped in Loch Ken but also that this was expensive and could not eradicate signal crayfish from the loch.

Distinct from angling, it is unclear if and how the signal crayfish population has impacted upon the fish populations in or ecology of Loch Ken. There are, however, many documented concerns relating to their potential impact on fish species in particular due to: their burrowing activity in banksides, competing for habitat, grazing pressure on aquatic plants and predation on invertebrates, fish and fish eggs (Maitland et al. 2001, Maitland 1996, Sibley in Rogers & Brickland 2000).

Angling is affected by the presence of the signal crayfish, largely through interference with fishing baits. A Dumfries and Galloway Council (DGC) study conducted in 2009, found that '50% of the anglers surveyed felt that less signal crayfish in the loch would improve their experience' and rated it their top priority to improve the fishery (Cameron 2010). In the same study, New Galloway Angling Association (NGAA) reported a significant fall in the value of Loch Ken ticket sales between 2002 and 2009 due to the negative publicity surrounding the presence of signal crayfish in the loch.

In 2016 SNH and SEPA commissioned a study on Loch Ken to investigate the practicality of using a range survey options (including angler interviews) which could be deployed to gather information on fish populations present (Galloway Fisheries Trust 2016). Within that work, of 35 anglers interviewed, eight stated they felt the signal crayfish were a negative aspect of the fishery and 14 stated that removing the signal crayfish would improve the fishery.

It is not possible to eradicate signal crayfish from Loch Ken.

1.4 This study

This study was commissioned by the Galloway Glens Partnership Project (GGPP). Finance for the study was provided by GGPP, SNH and the SEPA, and was managed by a steering group of these funders and DGC.

The main objective of this study is to undertake an assessment of the condition of the fish stocks within Loch Ken, and the overall status of Loch Ken as an angling venue deploying specified data and information collection methods. These data collection techniques were developed during the 2016 pilot project undertaken on Loch Ken (Galloway Fisheries Trust

2016). Using the data collected, recommendations for the future management of Loch Ken as a coarse fishery have been made.

The study also considered the current extent of deployment of angler biosecurity measures and makes recommendations as to how biosecurity actions could be enhanced and developed on the loch.

2. METHODOLOGY

2.1 Public engagement

To establish links with relevant stakeholders that would have an interest in the fishery of Loch Ken, GFT attended the Loch Ken Management Advisory Group on 5th October 2016, where they delivered a presentation to introduce the Loch Ken Fisheries Study and gathered contact details from individuals interested in inputting to the project. Thereafter, contact was initiated by email with these individuals.

To seek public involvement in the study, two public drop-in events were arranged and these were publicised with an advert in the Galloway News (issue 03/11/2016) and through posters which were distributed widely in the local area and electronically via the GFT website and social media pages. Email contact was made with all angling interests identified within the pilot study (NGAA, Dalry Angling Club (DAC), members of the DDSFB, members of the Scottish Coarse Fishing Federation). The poster was shared on the Loch Ken Match Banter page – a Facebook page with 391 members, which details Loch Ken coarse fish matches and results – and once invited to join the page, a personal introduction to the project and a request to seek assistance from match organisers was posted by GFT.

Two fliers were produced and approved by the Steering Group in advance of the open events – an information leaflet and a feedback form. The events took place on Wednesday the 16th and Wednesday the 23rd November in and around New Galloway. The first event was held during the day at CatStrand in New Galloway. The second event was held during the evening at the Ken Bridge Hotel, New Galloway.

Fliers were distributed to recognised ticket outlets around the loch, McCowans angling shop in Castle Douglas and to match officials during attended matches on the 3rd December 2016, 31st March 2017 and 14th April 2017. Anglers engaged during the Creel Surveys were encouraged to complete the Loch Ken Angling Record (see 2.2), which were available on the Loch Ken Fisheries Study page of the GFT website.

GFT attended a further Loch Ken Management Advisory Group on 1st March 2017, and delivered an update on the Loch Ken Fisheries Project within the main agenda on Galloway Glens Landscape Partnership Projects. Attendees were encouraged to participate in the project if they had not done so to date.

2.2 Loch Ken angling record

In order to establish a citizen science recording scheme for anglers on Loch Ken to report details of their catches, an angler questionnaire, composed during the pilot study, was revised to include information on participating outlets where records could be returned to. These were Loch Ken Holiday Park (Parton), The Post Office (New Galloway) and J R Hopkins Newsagents (New Galloway) and a postal return and email address for GFT (see record sheet in Annex 1). During the stakeholder engagement events, all anglers in attendance were given the Angling Record and requested to complete it on every occasion they fished the loch. McCowans Fishing Tackle Shop in Castle Douglas and Mossdale Village Shop also agreed to distribute and collect records.

A downloadable version of the Angling Record was made available from the 'Loch Ken Fisheries Study' page on the GFT website. Match organisers were supportive and the record was distributed to anglers at the three matches GFT attended as well as matches they did not. Finally, the survey was sent out with an introductory letter to all boat users on Loch Ken via the DGC boat license registration service in February 2017. Altogether, it was felt that by the means described previously, most avenues for distributing the Angling Record had been utilised.

During this time, ticket outlets were encouraged to inform anglers of the incentive scheme, whereby completed and returned records would be entered into a monthly draw for a £50 angling tackle voucher. This incentive was displayed on all records distributed throughout the project.

Outlets where the record was placed were visited on most occasions when the creel surveys were being undertaken. In total, 68 completed records were received during the project.

2.3 Loch Ken creel record

It was identified that a more in-depth angler and catch survey could take place via individual angler interviews conducted at Loch Ken. These interviews, undertaken on an ongoing basis throughout the project, would have three main purposes.

Firstly, to gather information on fish species present, their whereabouts, sizes and catches to better inform management of the fishery, secondly, to provide a more detailed profile of current anglers and of their opinions and perceptions on the quality of the fishery, its viability and future development and, thirdly, to allow for relevant information on biosecurity measures, knowledge and awareness to be collected.

Annex 2 shows the Loch Ken creel survey used. In total, 110 interviews were completed using this method across 18 days (8.5 weekend days and 9.5 week days).

2.4 Seine netting

It is standard protocol when sampling fish populations in still waters to utilise nets. There are various types which can be used including gill nets, fyke nets and seine nets. Following a protocol developed during the 2016 pilot study, seine netting was identified as the most appropriate, and non-lethal, method for gathering fish population information and data on Loch Ken.

Three days of seine netting were undertaken at Mains of Duchrae (in the vicinity of GR:270470 568770) which was identified as the most suitable seine netting location on Loch Ken, after consideration of various parameters such as site access, water depth and substrate type.

When netted, captured fish were processed on site and then returned to the water alive. A record of site conditions (weather, wind direction, water depth, water temperature and grid reference from the mid-point of net landing) were noted and fish caught were processed for species mix, length and weight before their return to the loch. A representative sample of each species was also sampled for scales. Data was collected from 248 coarse fish during the three netting events.

2.5 Angling matches

In the pilot and this study, angling matches were identified as having the potential to provide an important source of coarse fish and fishery data due to the quantity of fish being landed and held during a single match. To understand the potential of utilising angling matches for collecting fisheries data, the match organisers from NGAA and DAC were approached to consider GFT involvement during a match and discuss potential match dates.

Both organisers were supportive of GFT involvement and three dates were agreed which met the study requirements to access larger matches (including the Easter Festival) so as to gain access to a larger fish sample. These dates were Saturday 3rd December 2016, Friday 31st March 2017 and Friday 14th April 2017.

Two GFT staff attended each match from the opening of the competition and were joined by a further two staff at the competition close to undertake the fish sampling process. A match protocol was developed and revised following attendance at match 1 (Annex 3) in order to maximise data collection on fish health (length and weight) and age (scale data).

In total, data was gathered from 2618 coarse fish during the three match days attended.

3. RESULTS

3.1 Public engagement

The first public engagement event was held during the afternoon at CatStrand in New Galloway. The event was staged as a drop-in event, where members of the public were free to come and go as they pleased between 12:00 and 17:00. Thirteen people attended the event including representatives of the main angling interests on the loch – the NGAA and the DAC, their match organisers, coarse and trout fishing interests, members of the DDSFB and a member of the Federation of Coarse Anglers Scotland – and residents of New Galloway. Lengthy discussions took place with those present and both general and specific issues recorded. Comments raised included shifts in fish species in relation to crayfish presence, angling match popularity and a need to improve access for bank fishing. All comments were recorded for consideration within the recommendations section of the report.

Seven people attended the second event, held during the evening at the Ken Bridge Hotel. Again, this event attracted NGAA members and boat and pike anglers from the loch. Amongst some lengthy discussions, one individual referenced the control of crayfish being the main priority of any management plan for the loch. These views were not shared by others present and in general, across the two events most accepted that crayfish were now an established and non-removable, if undesirable, part of the lochs ecology and that some fish populations were benefitting from the food source they provided.

Most attendees at the open events were present as a result of personal invites by email or by viewing the posters. Only one individual said they attended due to the advert in the Galloway News.

A final project event was advertised and held on 19th July at the CatStrand in New Galloway and attended by 22 people where the Steering Group and GFT were able to present draft findings and recommendations from the report. Attendees included members of all interested groups present at the earlier open events in November, an established coarse fish biologist and author and members of the general public.

3.2 Loch Ken angling record

GFT received 68 Loch Ken Angling Records (Annex 1) completed by 46 different anglers (11 anglers being repeat visitors to the loch). Match organisers were quickly identified as being pivotal to higher return rates of the record and many of the records came via this means (78% of anglers who participated in the voluntary questionnaire were match attendees). Ticket outlets produced very few completed angling records during the project. Nine records came directly to GFT via email. This line of communication proved useful to a few key anglers engaged in the project from the start.

Completed records were returned during eight of the nine months that the survey was in operation (October 2016 to June 2017). During the months of October, November, March, April, May and June – numbers of completed records received was as few as two and at most nine. December and January provided the best returns of 18 and 15 records – with match anglers making the greatest contribution during these months. Eleven records did not include a fishing visit date and so could not be accountable to any month.

The Angling Record surveys responses are summarised below.

3.2.1 Angler profiles

Of the Angling Records completed, 43 (63%) of anglers gave an indication of where they were fishing the loch by circling on the map provided. 39 bankside and four boat locations where a grid reference could be established from the maps are shown in Annex 5. Anglers covered an area on the banks along the upper West side of the Loch and down the middle to lower East side of the loch from Glenlaggan to Crossmichael.

All anglers who completed the survey gave their name. 11 anglers were repeat visitors to the loch of between one and five times. The age of anglers were; 1 (2%) were <18, 1 (2%) were 18-24, 3 (7%) were 25-34, 5 (11%) were 35-44, 16 (35%) were 45-54, 14 (30%) were 55-64 and 4 (9%) were >65 years old and 4% did not provide an age.

A total of 36 (78%) respondents provided a home address with 33 (71%) providing a telephone number and 24 (52%) an email address. Where an address was not provided, a general home location was given with only one angler refusing to provide any such detail. Most anglers (28 (61%)) were found to come from northern or central England, eight (17%) from Dumfries and Galloway, five (11%) from central Scotland and two (4%) from both Ayrshire and Ireland.

The duration that each angler spent fishing the loch was recorded as: < half a day, half a day or full day. Of the 68 fishing visits recorded; 46 (68%) of anglers reported they spent the day fishing, 17 (25%) a half day and only one (1%) for less than a half day on the loch. Four anglers did not fill in their fishing trip duration.

When asked if anglers had a fishing permit, 37 (54%) anglers said 'yes', which, after accounting for repeat visiting anglers, came to 25 anglers in total from the 46 who completed a survey. Permit issuers were noted as Glenlaggan Marina (7 permits), Match organisers (27 permits), NGAA tickets (5 permits including one member) and "the gentleman at Shirmers" (one permit). 17 (25%) anglers said 'no' and 14 anglers declined to comment. From the 68 angler surveys completed; 50 anglers fished from the bankside and 12 from boats. Six anglers did not specify this detail.

Anglers were given a choice of target fish species. All 46 anglers responded to this question and answers fell into two groups. Of those fishing at matches (36 anglers), 31 anglers targeted bream, roach, perch and dace, three anglers – bream only and two anglers did not respond. From the non-match anglers (10 anglers), most targeted larger and predatory fish with five anglers targeting pike only, two anglers perch only, two anglers pike and perch and the one angler pike, perch and bream.

From the 68 fishing events detailed, 27 anglers (40%) fished a single rod; 3 (2%) fished two rods and 7 (10%) fished three rods. The remaining 48% of anglers made no comment on this section.

Anglers were asked whether they used methods to avoid contact with signal crayfish. A total of 19 records (representing 13 different anglers) said 'yes', and 42 records said 'no'. Methods adopted for avoiding signal crayfish included the use of float, trolling or paternoster, floating maggots, pop-ups, lure fishing and avoiding baits that attract signal crayfish. Seven anglers left no response in this section.

3.2.2 Biosecurity

Anglers were asked to comment on levels of biosecurity awareness and their use of biosecurity measures.

When asked 'Do you undertake any biosecurity measures, actions or precautions' an answer was provided by 42 respondents; 24 (35%) anglers answered 'yes' and 18 (26%) answered 'no'. A total of 26 (39%) records, did not respond to this question. The 24 positive responses to this question were provided by 13 (28%) individuals (many of which were repeat visitors). From these responses angler suggestions of biosecurity measures to be undertaken included cleaning and checking boats and equipment after usage on the loch and visual checks of tackle and drying with a dehumidifier. Five anglers left nets to dry in sunlight after use, three anglers only used their equipment on Loch Ken and one angler applied a 'check, clean, dry' policy.

A final question was asked: 'Would you use disinfection stations if these were available next to the loch with clear instructions for use?' 25 (54%) of the 46 anglers responded 'yes' and the remainder left no comment.

3.2.3 Catch returns

From the 68 individual records received, 65 (96%) contained catches. Catches could be displayed by two means; fish species mix as a total bag weight or as individual fish species by length and/or weight. Table 1 and Table 2 show the species mix and bag weights or individual fish length/weight of fish returned per angler event.

Table 1: Details of individual fish species recorded within the Loch Ken Angling Record

Record No.	Date	Fish Species	Length (cm)	Weight (lb/oz)	Comments
1	03/11/2016	Pike		4lb	
		Pike		3lb	
2	12/11/2016	Pike		22.2lb	Fish captured 2 weeks previously
		Pike		19.8lb	
		Pike		2lb	
		Pike		2lb	
3	22/10/2016	Pike		11lb 8oz	
		Bream		<3lb 8oz	
		Perch		2lb 8oz	
4	23/10/2016	Pike		12lb 8oz	
		Pike		18lb 8oz	
		Bream		<2lb	
		Roach		<4oz	
32	17/01/2017	Perch	32	1lb 6oz	
		Dace	21	4oz	
		Pike	62	3lb 8oz	
		Pike	76	6lb 8oz	
33*	22/01/2017	Pike	104	19lb 08oz	
36	27/01/2017	Pike	66	6lb 2oz	
		Pike	59	4lb 8oz	Lean
		Pike	63	5lb 8oz	
		Pike	54	3lb	Skinny
		Pike	70	8lb 2oz	
		Pike	76	8lb	
44*	30/01/2017	Roach	16	4oz	

		Pike	61	5lb 8oz	
		Pike	64	5lb 10oz	
		Pike	59	5lb	
		Pike	59	4lb 2oz	
		Pike	50	4lb	
46	20/06/2017	Perch		2.09	Caught at mouth of River Ken
		Perch		2.04	As above
		Perch		2.02	As above
		Perch		5 @ 1lb-1.10	As above
		Perch		9 @ 4-12oz	As above
		Bream		5 @ 1.5lb - 3.02	As above
47	21/06/2017	Perch		2.06	Caught at mouth of River Ken
		Perch		2.02	As above
		Perch		4 @ 1lb- 1.12	As above
		Perch		9 @ 4-12oz	As above
48	21/05/2017	Perch		2.12	Caught at mouth of Blackwater of Dee
		Perch		2.06	As above
		Perch		2.02	As above
		Perch		4 @ 1lb - 1.12	As above
		Perch		8 @ 4-12oz	As above
		Perch		5lb	As above
		Perch		2 @ 1.5lb	As above
49	20/05/2017	Perch		2.08	Caught at North end of loch
		Perch		2.04	As above
		Perch		4 @ 1.00 - 1.12	As above
		Perch		10 @ 4-12oz	As above
		Bream		2 @ 1lb	As above
50	17/05/2017	Pike		2lb	
		Perch		2.08	Spawned out. Caught just North of Glenlaggan viaduct.
		Perch		2.02	Spawned out. Caught at north end of loch.
		Perch		3 @ 1lb - 1.08	Most spawned out. Location as above.
		Perch		10 @ 4 - 12oz	Caught near Glenlaggan viaduct and north end of loch.
51	17/04/2017	Perch		1.08	Appeared to be spawn-filled.
		Perch		11 @ 4oz - 12oz	Captures in 18-25ft of water at north end of loch.
52*	21/05/2017	Perch		1lb 8oz	
		Bream		1lb 4oz	
55*	14/04/2017	Bream		3lb	
		Bream		2lb	

57*	14/04/2017	Bream	20	8oz	
		Roach	4-8	1-3oz	
		Perch	6	1oz	
		Dace	5-8	1-2oz	
		Pike	60	3.5lb	
58*	14/04/2017	Dace		2oz	
		Perch		2oz	
		Roach		2-3oz	
59*	15/04/2017	Bream	10-30	4-15oz	
		Dace	5	1oz	
60*	14/04/2017	Roach	5-15	5-8oz	
		Dace	5-15	2-0oz	
		Perch	5-15	10oz	
61*	14/04/2017	Roach	6-15	1-4oz	Some rough, ready to spawn.
		Dace	6-12	1-4oz	
		Perch	5	1oz	
		Ruffe	3	<1oz	
		40			
62*	14/04/2017	Roach			Small roach
		Bream		8oz	
		Perch		2 @ 4oz	
		Pike			
63*	14/04/2017	Perch	2-3	2-3oz	
		Roach	2-3	2-3oz	
		Dace	2	2oz	
66	29/03/2017	Pike		13lb	Several jacks also. Females spawned out.
67	13/03/2017	Pike	57	6.5lb	Good condition
68	18/03/2017	Pike	88	14lb	Heavily gravid
		Pike	60	6.5lb	Skinny
		Pike	55	5lb	Scarred (half tail)
		Pike	48	5lb	

Record No.- underlined represent match data.
Record No. - data can also be found as total bag weight within Table 2*

Table 2: Details of total bag weight by fish species mix recorded within the Loch Ken Angling Record

Record No.	Date	Species Mix or Match tally	Bag weight (lb/oz)
7	03/12/2016	2 Bream, 10 Ruffe, (2 SC˜)	1lb 15oz
8	03/12/2016	3 Bream, 1 Roach, (3 SC˜)	
9	03/12/2016	10 Bream, 1 Ruffe, (6 SC˜)	7lb
10	03/12/2016	Bream, Dace, Perch, Ruffe	5lb
11	03/12/2016	9 Bream, 2 Roach	5lb 12oz
12	04/12/2016	4 Bream, (1 SC˜)	3lb 10oz

13	03/12/2016	2 Bream, 2 Roach, 2 Perch, (5 SC˜)	2lb 8oz
14	03/12/2016	Bream, (3 SC˜)	1lb 2oz
15	03/12/2016	5 Bream, 1 Roach, 1 Perch, (14 SC˜)	2lb 14oz
16	03/12/2016	20 Bream, 1 Perch, (3 SC˜)	18lb
17	03/12/2016	6 Bream, 3 Perch, (3 SC˜)	15lb 2oz
18	03/12/2016	9 Bream, 2 Roach, (6 SC˜)	6lb 4oz
19	03/12/2016	5 Bream, 2 Roach, 3 Dace, (1 SC˜)	
20	03/12/2016	9 Bream, 1 Roach, 1 Perch	6lb
21	04/12/2016	1 Bream, 2 Hybrids, (3 SC˜)	1lb 2oz
22	03/12/2016	12 Bream, (1 SC˜)	6lb 14
23	03/12/2016	2 Bream, 14 Roach, (4 SC˜)	
24	03/12/2016	3 Bream, 1 Perch, (3 SC˜)	1lb 13oz
25	03/12/2016	1 Ruffe	1oz
26	04/12/2016	1 Bream, 1 Roach, (6 SC˜)	1lb 14oz
27	04/12/2016	4 Bream, (1 SC˜)	2lb 2oz
28	04/12/2016	5 Bream, 1 Roach, (1 SC˜)	2lb
29	03/12/2016	30 Roach, 3 Perch	2lb
30	08/01/2017	6 Roach, 2 Perch, 16 Dace & Ruffe	5lb 11lb
31	15/01/2017	15 Bream, 2 Roach, 1 Perch & Ruffe	10oz
33*	22/01/2017	Pike	30lb
		Perch	6lb
34	22/01/2017	5 Bream, 1 Roach, (8 SC˜)	4lb 14oz
35	22/01/2017	11 Bream, Roach, Perch, 9 Dace, (6 SC˜)	9lb 2oz
36*	27/01/2017	6 Pike	35lb 4oz
37	29/01/2017	1 Bream, 11 Roach, 20 Dace, (15 SC˜)	3lb 8oz
38	29/01/2017	11 Bream, 1 Roach, (18 SC˜)	11lb
39	29/01/2017	9 Bream, 2 Roach, 1 Perch, (2 SC˜)	6lb 4oz
40	29/01/2017	6 Bream, 1 Roach, 1 Perch, (11 SC˜)	3lb 8oz
41	29/01/2017	11 Bream,2 Roach, 3 Perch, (2 SC˜)	8lb 8oz
42	29/01/2017	5 Bream, 1 Roach, 1 Perch, (27 SC˜)	3lb 8oz
43	29/01/2017	1 Bream, (2 SC˜)	1lb 4oz
44*	30/01/2017	Pike	27lb 8oz
45		Pike	26lb 7oz
		Perch	1lb 4oz
		Bream	1lb 6oz
		Roach	1lb
		Ruffe	2oz
52*	21/05/2017	Perch	6lb
53	20/06/2017	Perch	10lb
54	14/04/2017	Bream, roach, perch	2lb 13oz
	15/04/2017	Bream, roach, perch	0lb 8oz
	16/04/2017	Bream, roach, perch	4lb
55*	14/04/2017	Bream, roach, perch	4lb 6oz
	15/04/2017	Bream, roach, perch	0lb 4oz
	16/04/2017	Bream, roach, perch	10lb 8oz

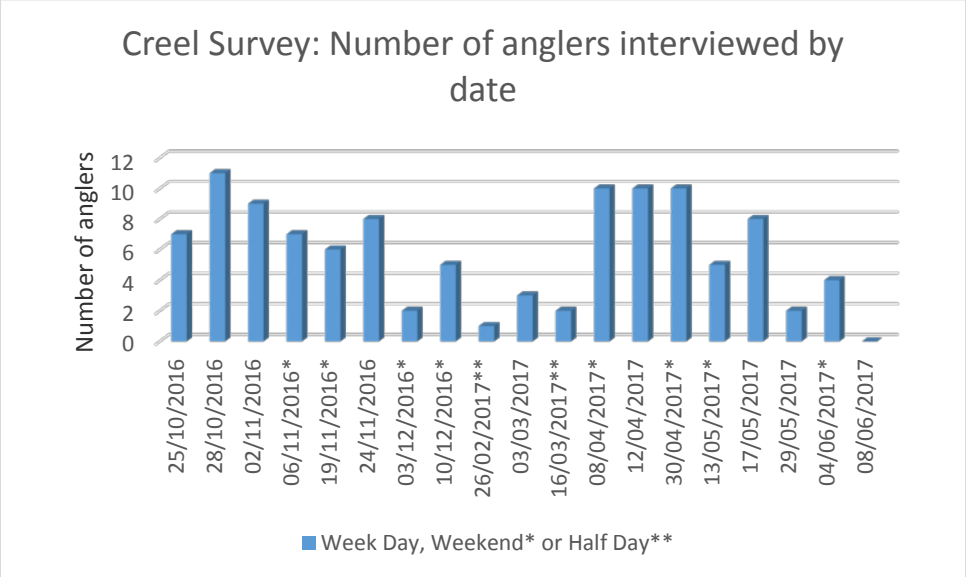
56	14/04/2017	Bream, roach, perch	9lb 2oz
57*	14/04/2017	1 Bream, 25 Roach, 1 Perch, 8 Dace	3lb 2oz
58*	14/04/2017	9 Roach, 4 Perch, 1 Dace	1lb 4oz
59*	15/04/2017	12 Bream, 1 Dace	7lb 9oz
60*	14/04/2017	40 Roach, 3 Perch, 20 Dace	8lb 2oz
61*	14/04/2017	60 Roach, 1 Perch, 10 Dace, 1 Ruffe, (4 SC˜)	8lb 4oz
62*	14/04/2017	1 Bream, 40 Roach, 2 Perch, 5 Dace,10 Pike, (20 SC˜)	4lb 10oz
63*	14/04/2017	1 Bream, 20 Roach, 6 Perch, 10 Dace	4lb 6oz
64*	14/04/2017	16 Bream, (50 SC˜)	9lb 6oz
65*	14/04/2017	80 Roach, 10 Perch, 1 Dace	6lb 8oz

Record No.- underlined represent match data. Record No. - data can also be found as individual fish species within Table 1*
˜signal crayfish recorded for information and as it indicates interaction with angling activities

3.3 Loch Ken creel record

The Loch Ken creel survey (Annex 2) was completed on 110 occasions by 105 different anglers (two anglers were repeat visitors) across 8.5 weekend days and 9.5 week days between the months of October 2016 and June 2017. Participation in these surveys by anglers was not compulsory and respondents were able to decline to provide information to any section(s) of the survey they did not wish to answer.

Graph 1 gives a breakdown of number of anglers recorded on each visit. At most, 11 anglers were interviewed in one day (28/10/2016 – a Friday) and at least, zero anglers were interviewed (08/06/2017 – a Thursday). In general, angler presence and numbers were found to be similar during week and weekend days (weekends accounted for 47% of survey time and produced 50 records, whilst week days accounted for 53% of survey time and produced 60 records).



Graph 1: Number of anglers interviewed using the Creel Survey during the study period

The survey responses are summarised below.

3.3.1 Angler profiles

The locations where surveys were conducted are shown in Annex 6. The majority of anglers were located on the banks along the upper West side of the Loch and down the middle to lower East side of the loch from Glenlaggan to Crossmichael. Whilst the bankside anglers could be interviewed throughout the day, boat anglers were much harder to locate and meet. In total, 98 anglers were interviewed on the bankside and 12 anglers when they returned with their boat to the bankside.

102 (97%) of 105 anglers interviewed were male whilst three (3%) were female. Each angler gave an indication of their age. 2 (2%), were <18, nine (9%), were 18-24, 22 (21%), were 25-34, 19 (18%), were 35-44, 21 (20%), were 45-54, 18 (17%), were 55-64 and 14 (13%), were >65 years old.

A small number of anglers 5 (<5%) were prepared to provide a home address.

Due to the high proportion of non-paying, and potentially non-permitted, anglers involved in the interview, it is possible that anglers did not want to be contacted or identified beyond the interview process and were happier to share a council area or city in which they resided rather than a home address. As a result, most anglers (61 (58%)) were found to come from England, 14 (13%) from Dumfries and Galloway, 12 (11%) from the Central Belt of Scotland, 10 (10%) from Ayrshire, two (2%) from North Scotland, two (2%) from the Borders and one (1%) from Wales. Three anglers (3%) would not provide their residency.

This corresponded to a distance travelled to reach Loch Ken with 4 (4%) anglers travelling 0-10 miles, 8 (8%) anglers travelling 10-30 miles, 6 (6%) of 105 anglers travelling 30-50 miles and 87 (83%) anglers making a journey of >50 miles to reach the loch.

32 (30%) anglers visited the loch on a day trip basis with 76 (70%) anglers staying overnight. Of the anglers making an overnight stay that responded when questioned about the length of their stay (out of 73 responses); 53 (73%) stayed for more than two nights, 12 (16%) stayed for two nights and 8 (11%) stayed for one night. 76 anglers gave a response to where they were staying; 28 (37%) anglers stayed in a campsite, 24 (32%) wild camped by the loch side, 12 (16%) stayed in self-catering accommodation, 6 (8%) stayed in a hotel, 4 (5%) of in B&B accommodation, 1 (1%) on their boat and 1 (1%) with friends. When asked if anglers would be happy leaving a contact detail; 12 out of 105 anglers (11%) obliged with a telephone number and 17 out of 105 anglers (16%) gave an email address.

Anglers were able to confirm their target fish species. A total of 102 (97%) of 105 anglers responded and answers ranged from a single fish species to five.

58 (57%) of respondents confirmed a single species target with pike (55 anglers (95%), trout (two anglers (3%) and bream (one angler, <2%) the target species.

18 (17%) of respondents confirmed two target species with perch most commonly targeted alongside pike (8 (8%) anglers), bream (1 (1%) angler) and roach (3 (3%) anglers). Bream and roach were targeted by 5 anglers and perch and trout by a single angler (1%).

12 (12%) of respondents confirmed three target species with; bream, roach and perch the most common combination (9 (9%) anglers).

10 (10%) of respondents confirmed four target species; perch, roach, bream and pike were the most frequently selected fish species.

And finally, 4 (4%) of respondents confirmed 5 target species; pike, bream, roach and perch were selected in equal measure ahead of trout and dace.

Of the 105 anglers, 86 (82%) had visited Loch Ken previously and 19 (18%) reported this as their first visit to the fishery. Of those 86 anglers that were repeat visitors, when asked to estimate the number of annual visits each had made to Loch Ken, 78 anglers responded and over half (42 (54%)) would make 1-5 visits annually, 14 (18%) anglers would make 5-10 visits annually, 6 (8%) anglers would make 10-15 visits annually, 3 (4%) would make 15-20 visits annually and 13 (17%) would make upwards of 20 visits including three anglers that estimated visiting Loch Ken 50-100 times annually.

Considering specifically their fishing trips to Loch Ken, anglers were asked to rate their fishing experience on a scale of 1-5 (1 being least satisfied and 5 being most satisfied). The large majority of anglers were either very satisfied (56 (56%) of 101 anglers), or satisfied (35 (35%) of 101 anglers). Seven (7%) anglers remained neutral in their evaluation of their fishing experience and three (3%) bordered into un-satisfied. Four (4%) anglers did not comment.

Anglers were asked to provide positive and negative feedback to support their angling satisfaction score. Almost all (104 (99%) of 105) anglers answered this question.

Positive feedback was received from 93 (89%) anglers and included comments on the wildlife, nice scenery, peacefulness, good campsites and good fishing opportunities for big fish. Other comments included the clean and tidy location, friendliness of locals and good opportunity for a variety of fishing methods and mixed species catch.

Negative feedback was received from 33 (31%) anglers and included comments on signal crayfish by 15 (14%) of all respondents whilst other issues raised included concerns on the need for overall water management needing reviewed, access being difficult especially for the elderly, poor fishing, some angling groups killing too many fish and litter. A single angler referenced poor toilet facilities, hotels and too many children as negatively impacting on their experience of the loch.

A record of the date and time that each angler was interviewed was made, with duration of the fishing trip being recorded as < half a day, half a day or full day. Of the 107 anglers who provided an answer; 72 (67%) anglers spent the day fishing, 30 (28%) - a half day and 5 (5%), less than a half day fishing upon the loch.

When asked if anglers had a fishing permit, 54 (50%) of 107 anglers said ‘yes’, including two anglers from NGAA, six anglers with boat licences, four with Loch Ken Holiday Park permits and two who had paid a farmer (though one gave no tickets). 53 (50%) anglers said ‘no’ and three (3%) anglers declined to comment. From the 110 angler surveys completed; 99 (90%) anglers fished from the bankside and 11 (10%) from boats – two (2%) of which had no fishing permit.

3.3.2 Creel specific returns

From the 110 interviews completed, fish were only available to process on the bankside from two anglers, as a consequence of anglers immediately returning most fish as soon as they had been unhooked. However, many more anglers were able to provide an estimation of the number of fish species caught and their weights. Table 3 shows the species and weights of fish returned per angler event.

Table 3: Details of fish species recorded during Loch Ken creel survey

Date	Location	Grid reference	Fish caught	Weight(lb/oz) and/or length (cm)	Processed by GFT (Y/N)
25/10/2016	Bankside	270812 569229	Dace	4oz/20 cm	Y
28/10/2016	Bankside	270812 569229	Roach	39g/14cm	Y
28/10/2016	Bankside	270812 569229	Roach	51g/15cm	Y
28/10/2016	Bankside	270812 569229	Perch	34g/13.5cm	Y
25/10/2016	Bankside	268761 570054	Dace	<1oz/8cm	Y
26/10/2016	Bankside	270812 569229	Pike	3-4lb	N
25/10/2016	Boat	265768 573458	Pike	6-7lb	N
25/10/2016	Boat	265768 573458	Pike	6-7lb	N
25/10/2016	Boat	265768 573458	Pike	5-6lb	N
25/10/2016	Boat	265768 573458	Pike	5-6lb	N
25/10/2016	Bankside	268761 570054	Dace	1oz	N
25/10/2016	Bankside	268761 570054	Dace	1oz	N
25/10/2016	Bankside	268761 570054	Dace	1oz	N
28/10/2016	Bankside	263898 575039	Pike	3lb	N
02/11/2016	Boat	265284 572853	Perch	2lb	N
02/11/2016	Boat	283284 572858	Pike	6lb	N
02/11/2016	Bankside	272641 566261	Pike	10lb	N
06/11/2016	Bankside	271092 569085	Pike	5-6lb	N
06/11/2016	Bankside	264249 574560	Pike	8lb	N
06/11/2016	Bankside	264249 574560	Pike	7lb	N
06/11/2016	Bankside	264249 574560	Pike	4lb	N
19/11/2016	Bankside	263897 575034	Pike	3.5lb	N
10/12/2016	Boat	271428 568214	Pike	3lb	N
10/12/2016	Bankside	268052 571270	2 roach	2oz	N
24/11/2016	Bankside	264717 574008	Pike	8-10lb	N

		263875			
16/03/2017	Bankside	574999	Pike	14lb	N
		263883			
08/04/2017	Bankside	575056	Pike	4lb	N
		268731			
08/04/2017	Bankside	570156	Pike	3.5lb	N
		268731			
	Bankside	570156	Pike	7lb	N
		264947			
08/04/2017	Bankside	573577	Bream	2.5lb	N
		264947			
	Bankside	573577	Roach	n/a	N
		264947			
	Bankside	573577	Perch	n/a	N
		264947			
	Bankside	573577	Dace	n/a	N
		264947			
	Bankside	573577	Ruffe	n/a	N
		264947			
12/04/2017	Bankside	573577	Bream	Around 5lb	N
		264947			
	Bankside	573577	Roach	n/a	N
		264947			
	Bankside	573577	Perch	n/a	N
		263883			
12/04/2017	Bankside	575056	Pike	7lb 2oz	N
		268194			
30/04/2017	Bankside	570942	Roach	1.5lb	N
		268194			
	Bankside	570942	Ruffe	n/a	N
		268600			
30/04/2017	Bankside	570253	Pike	n/a	N
		268194			
30/04/2017	Bankside	570942	Dace	8-10lb	N
		268194			
	Bankside	570942	Roach	8-10lb	N
		268145			
30/04/2017	Bankside	570986	Roach	6oz	N
		268145			
	Bankside	570986	Skinner	n/a	N
		268634			
17/05/2017	Bankside	570148	Roach	n/a	N
		268581			
17/05/2017	Bankside	570280	Roach	n/a	N
		268680			
17/05/2017	Bankside	570197	Pike	16lb	N
		268035			
17/05/2017	Bankside	571274	Perch	n/a	N
		268573			
17/05/2017	Bankside	570277	Perch	3/4lb	N
		268010			
17/05/2017	Bankside	571310	Perch	2-3lb	N
		268010			
	Bankside	571310	Roach	2-3lb	N

		264944			
17/05/2017	Bankside	573602	Pike	10lb	N
		264944			
	Bankside	573602	Pike	14lb	N
		268212			
04/06/2017	Bankside	570915	Roach	n/a	N
		268212			
	Bankside	570915	Bream	n/a	N
		268070			
04/06/2017	Bankside	571144	Roach	2oz	N
		268070			
	Bankside	571144	Perch	4oz	N
		268094			
04/06/2017	Bankside	571112	Roach	4oz	N
		268094			
	Bankside	571112	Perch	4oz	N
	Bankside	268610			
28/10/2016	and Boat	570237	Pike	8lb	N
		268761			
25/10/2016	Bankside	570054	Roach	2oz/12.5cm	N
		268761			
25/10/2016	Bankside	570054	Dace	1.5oz/12cm	N

3.3.3 Biosecurity

As part of the creel survey, anglers were asked to comment on biosecurity and their use of biosecurity measures. This was felt to be an important feature of angler behaviour given the heightened protocols that should be adopted due to the presence of signal crayfish within the loch and the impact signal crayfish is reported to have had on angler success and perception of Loch Ken.

Of the 105 anglers surveyed, 93 (89%) were aware of invasive non-native species (INNS), with 92 (88%) anglers referring to signal crayfish presence in Loch Ken. In addition to crayfish, one angler noted dace, bream and Japanese knotweed as INNS and the final angler singled out fish 'hybrids' as notable INNS within the loch. When asked if anglers had come across any evidence of INNS during their current fishing trip, 25 said they had – all of which related to signal crayfish. When asked if signal crayfish had affected their current fishing experience; 64 (58%) of 110 anglers said 'no' and 38 (34%) of 110 anglers said 'yes'. Eight anglers did not comment. When asked if anglers were using a particular fishing method to avoid crayfish; 68 (64%) of 105 said 'yes' and 33 (31%) of 105 said 'no'. Of those that said 'yes', 61 anglers provided a range of techniques including the use of pop-up dead baits (technique used by >63% of respondents), float fishing (used by 18% of respondents), lure fishing (used by 8% of respondents). A few anglers also used trolling, spinning, fly fishing, rapid fishing as techniques to evade crayfish. One angler described feeding signal crayfish and then fishing outside the feeding area.

Questions were also set in the creel survey in relation to the application and awareness of biosecurity measures and issues. 68 (65%) of 105 anglers said they did perform some sort of biosecurity checks on their fishing tackle and equipment whilst 33 (31%) recorded that they did not. Four (6%) anglers refused to comment. For anglers that did carry out biosecurity checks, they were asked 'how often'. 62 (91% of those practicing biosecurity measures) anglers responded with 'always', four (6%) anglers undertook measures 'sometimes' and one angler (1%) answered 'only if moving between waterbodies/catchments'.

For anglers who did not carry out biosecurity measures, they were given a series of options as to why they did not. From the prescribed answers, only 7 (19%) of 37 anglers chose to select an option whilst 9 anglers gave an alternative answer. From the prescribed answers, three anglers noted a lack of disinfecting facilities, two stated they did not know what to do, one stated they did not visit waters with INNS species and one reporting that undertaking biosecurity was inconvenient and they did not have time. From the nine alternative answers; six anglers noted that their equipment was only used on Loch Ken. 'Equipment is always clean', 'only if they see crayfish' and 'I was not aware of biosecurity issues' were the other answers provided.

Concerning the 'Check, Clean, Dry' (CCD) campaign http://nonnativespecies.org/checkcleandry/, 78 of 105 anglers had not heard of the campaign and four anglers refused to comment (together 78% of those surveyed). Using four prescribed answers, anglers were asked which means should be adopted to raise awareness of biosecurity on Loch Ken. 94 (90%) anglers responded and selected between one and four of the options offered. 'Erect information panels' was selected by 84 (>89%) anglers, 'provide basic information on permits' was selected by 58 (>61%) anglers, 'distribute leaflets' by 14 (14%) anglers and 'run events for loch users to provide information' by four (4%) anglers.

Two anglers provided their own ideas which were to inform loch users via angling forums. Similarly, in addition to the prescribed answers, five anglers suggested using social media (Facebook), radio stations, Trout and Salmon magazine and tackle shops to disseminate information. Two anglers suggested including information in the Loch Ken Holiday Park information packs.

When asked if anglers would use disinfecting stations at Loch Ken if they were made available; 94 (89%) anglers responded positively and 7 (6%) responded negatively. Four anglers gave no response. When asked 'where would you suggest disinfectant stations be positioned to encourage usage', 98 (93%) of anglers responded by providing at least one of the three prescribed answers. 92 (93%) anglers favoured the positioning of disinfectant stations 'on banksides, within 100 m of popular fishing locations, 10 (10%) anglers selected 'in villages, e.g. New Galloway or at entry points to the loch e.g. marina' and only four (4%) anglers selected 'at ticket outlets'.

Finally, the 105 anglers were asked to answer the question 'Are there any ways Loch Ken fishery and fishing experience could be improved' using a series of prescribed answers which they could also provide comments on. 90 (85%) anglers selected between one and four of the prescribed answers. For those anglers who provided only a single response: 30 (55%) stated 'No, leave water/fishery as it is', 14 (25%) with 'Yes – make a crayfish control plan', 8 (15%) with 'Yes – undertake bankside management' and 3 (5%) with 'Yes, construct a fishery management plan'. 10% of anglers responded with the option of 'Yes – all of the above suggestions'.

Of those that responded with multiple answers, collectively 'No – leave the fishery as it is' was selected by 35%, 'Yes – make a crayfish plan' by 35%, 'Yes – undertake bankside management' by 27%, 'Yes – construct a fishery management plan' by 20%, 'Yes – run a hatchery programme' by 13% and 'Yes – carry out predator control' by 4%.

In addition, 54 (>51%) of the 105 anglers wished to comment further and provide additional management suggestions.

Suggestions made were: 13 anglers (24% of respondents) who considered signal crayfish control/eradication as being important for improving fish numbers in the loch (one angler went as far as suggesting the introduction of an invasive species like Wels catfish could help control the crayfish population); 10 (19%) anglers wanted to see better access which related to

improving parking facilities, more swims and launch areas for boats and increasing boat hire; nine (17%) anglers considered improving bin facilities a priority and tackling litter created by wild campers. Managing poaching was seen by six anglers (11%) as a problem, particularly concerning the killing of coarse fish by anglers originally from outside the UK. General policing of the loch was raised by some anglers who felt there was a need for better information on permits and signage surrounding the loch. Concerning predatory species, two anglers (4%) felt there was a need to prohibit the killing of pike. Better flow management was mentioned by three (6%) anglers; increasing awareness of other loch users, by two anglers (including the introduction of speed restrictions for boat users near Loch Ken Holiday Park), more camping spaces by three anglers, better toilet facilities by one angler and a request for less competitions on the loch by another. Three anglers (6%) said to leave the loch as natural as possible, with one (2%) reasoning that managing banksides only increased littering.

3.4 Seine netting

3.4.1 Netting undertaken

Three days of netting were undertaken, each within the bay near Mains of Duchrae on the West side of the loch. On each occasion, fish caught were processed for length and weight and a scale sample was taken where possible. As a measure of fish health; the condition factor (K) was calculated for all fish captured during each netting event.

3.4.1.1 Netting on 29 September 2016

On the 29 September 2016, netting was undertaken six times in the vicinity of Mains of Duchrae (Table 4).

Table 4: Details of the netting undertaken near Mains of Duchrae on 29 September 2016

Location	Grid Ref	Netting attempt	Water depth (m)	Water temperature (^{o}C)	Fish caught
Inner Bay	270437 568776	Successful	0.9	14.0	4 Roach, 3 Perch
Inner Bay	270470 568776	Successful	1.2	14.0	5 Roach, 2 Perch
Inner Bay	270491 568778	Successful	0.9	13.9	2 Dace
Side Bay	270541 568758	Successful	0.9	13.9	2 Dace, 1 Roach, 1 Perch
Side Bay	270584 568778	Successful	1.2	14.5	3 Dace, 1 Roach
Inner Bay	270419 568771	Successful	0.8	14.4	10 Roach, 1 Pike
Total netted fish					**35 (1 Pike, 6 Perch, 7 Dace, 21 Roach)**

Weather conditions on the day of netting were mostly cloudy with a south westerly wind. The inner bay was netted four times and the net was successfully set and landed each time. Water depths, slope of the bed and substrate type (largely silt) were all suitable and no obstructions caused any problems. A total of 27 fish were caught (19 roach (*Rutilus rutilus*), five perch (*Perca fluviatilis*), two dace (*Leuciscus leuciscus*) and a pike (*Esox lucius*)).

The edge of the bay was netted twice. Rain fell during the netting of site 5 within this side of the bay. Some snagging experienced during the landing of the net on this side of the bay, may have led to the escapement of some fish. A total of eight fish were caught (five dace, two roach and a perch).

Three signal crayfish were also captured.

Figure 1: A roach being weighed during netting on 29/09/16

3.4.1.2 Netting on 4 October 2016

On the 4 October 2016, netting was undertaken seven times in the vicinity of Mains of Duchrae (Table 5).

Table 5: Details of the netting undertaken near Mains of Duchrae on 4 October 2016

Location	Grid Ref	Netting attempt	Water depth (m)	Water temperature (°C)	Fish caught
Inner Bay	270473 568760	Successful	1.1	13.1	4 Dace, 2 Perch, 2 Pike
Inner Bay	270482 568775	Successful	1.2	13.1	None
Inner Bay	270444 568779	Successful	0.8	13.9	1 Perch
Side Bay	270594 568787	Successful	1.4	13.2	1 Roach, 1 Pike
Side Bay	270610 568796	Successful	1.5	13.0	1 Dace
Inner Bay	270422 568771	Successful	0.5	14.6	11 Roach, 1 Perch, 1 Pike
Inner Bay	270446 568778	Successful	0.5	13.3	9 Roach, 4 Perch, 1 Dace
Total netted fish					**39 (4 Pike, 8 Perch, 6 Dace, 21 Roach)**

Weather conditions on the day of netting were dry, overcast with a north-east wind. The inner bay was netted five times and the net was successfully set and landed each time. Water depths, slope of the bed and substrate type were all suitable and no obstructions caused any problems. A total of 36 fish were caught (20 roach (*Rutilus rutilus*), eight perch (*Perca fluviatilis*), five dace (*Leuciscus leuciscus*) and three pike (*Esox lucius*)).

The edge of the bay was netted twice. Some difficulties with dragging in the net (created by a silt shelf and some rocks) meant that the net had to be lifted and this is the likely reason that only three fish were caught (one roach, one pike and a dace).

Ten signal crayfish were also captured, all but one of which were captured during the two nettings on the side bay.

Figure 2: A perch caught during the netting on 04/10/16

3.4.1.3 Netting on 20 June 2017

On the 20 June 2017, netting was undertaken six times in the vicinity of Mains of Duchrae (Table 6).

Table 6: Details of the netting undertaken near Mains of Duchrae on 20 June 2017

Location	Grid Ref	Netting attempt	Water depth (m)	Water temperature (°C)	Fish caught
Inner Bay	270465 568778	Successful	1.1	20.7	30 Dace, 2 Roach, 1 Ruffe, 1 Perch
Inner Bay	270438 568780	Successful	0.8	21.3	8 Dace, 5 Roach, 2 Ruffe, 1 Bream
Inner Bay	270418 568772	Successful	0.8	23.4	9 Dace
Inner Bay	270487 568776	Successful	1.2	24.2	2 Roach, 3 Ruffe
Side Bay	270605 568798	Successful	1.6	20.5	52 Roach, 1 Pike, 1 Bream, 1 Ruffe
Side Bay	270544 568760	Successful	1.3	23.4	46 Roach, 4 Ruffe, 2 Perch, 2 Dace, 1 Pike
Total netted fish					**174 (107 Roach, 49 Dace, 11 Ruffe, 3 Perch, 2 Pike, 2 Bream)**

Weather conditions on the day of netting were hot with bright sunshine, clear skies and a slight East/North-East breeze. The inner bay was netted four times and the net was successfully set and landed each time. Water depths, slope of the bed and substrate type were all suitable and no obstructions caused any problems. Landing the net within site 3 which was positioned

most westerly in the bay, produced most silt. A total of 64 fish were caught (nine roach (*Rutilus rutilus*), one perch (*Perca fluviatilis*), 47 dace (*Leuciscus leuciscus*), six ruffe (*Gymnocephalus cernua*) and one bream (*Abramis brama*)).

Figure 3: Landing the net within the inner bay on 20/06/17

The edge of the bay was netted twice. Some difficulties with snagging (created by a silt shelf and some rocks) meant that the net had to be lifted to release drag (*Figure 4*). Despite the potential loss of fish on this occasion, 110 fish were caught between the two nettings (98 roach, five ruffe, two perch, two dace and one pike).

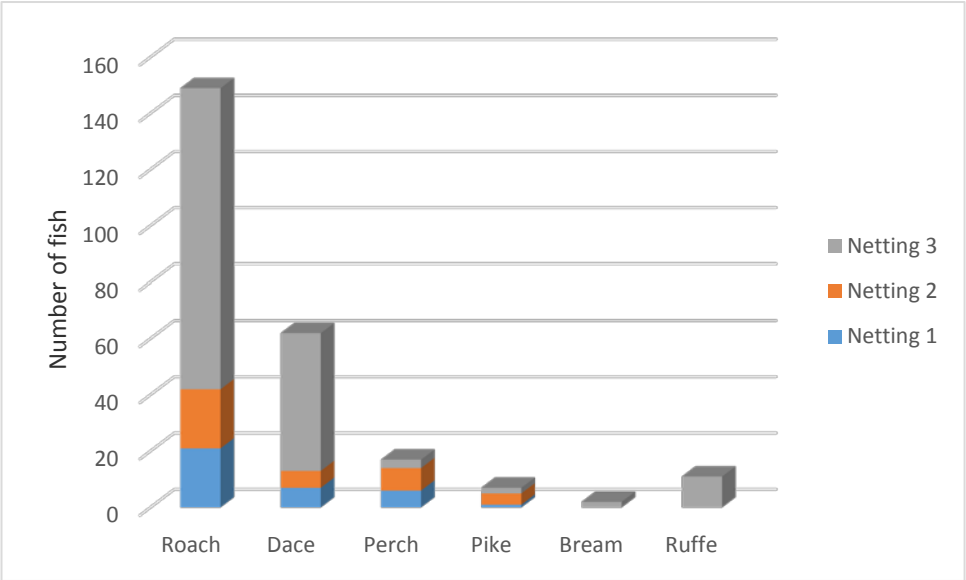
22 signal crayfish were also captured distributed equally between the two bays netted.

Figure 4: Landing the net within the side bay on 20/06/17

Figure 5: A pike caught during the netting on 20/06/17

3.4.2 Fish species sampled

In total, 248 fish were sampled during the three seine netting activities and six coarse fish species were identified. Graph 2 shows species composition across the three nettings.



Graph 2: Numbers of fish caught by species mix and netting event

Of the 248 fish netted; 35 fish (14%) were captured during Netting 1 on 29/09/16, 39 fish (16%) were captured during the second netting on 04/10/16 and 174 (70%) were captured in the final netting on 20/06/17. Regarding species mix; roach accounted for 60% of the total catch recorded across the three nettings, dace – 25%, perch – 7%, ruffe – 4%, pike – 3% and bream – 1%.

3.4.3 Condition factor

All fish captured during each seine netting event were sampled for length and weight. These measurements were used to calculate the condition factor or health of each individual fish as a basis for comparison between species and within species netted at different times of year.

Generally, fish that are heavier than the standard weight for their length are considered healthier, having more energy reserves for normal activities, growth and reproduction. Whilst this is a useful metric and indicator if fish health it should be noted that it can be highly variable for example across seasons and dependent on feeding habits of the species being assessed.

The standard Fulton Condition Factor formula was used on this occasion. This formula assumes that the standard weight of a fish is proportional to the cube of its length:

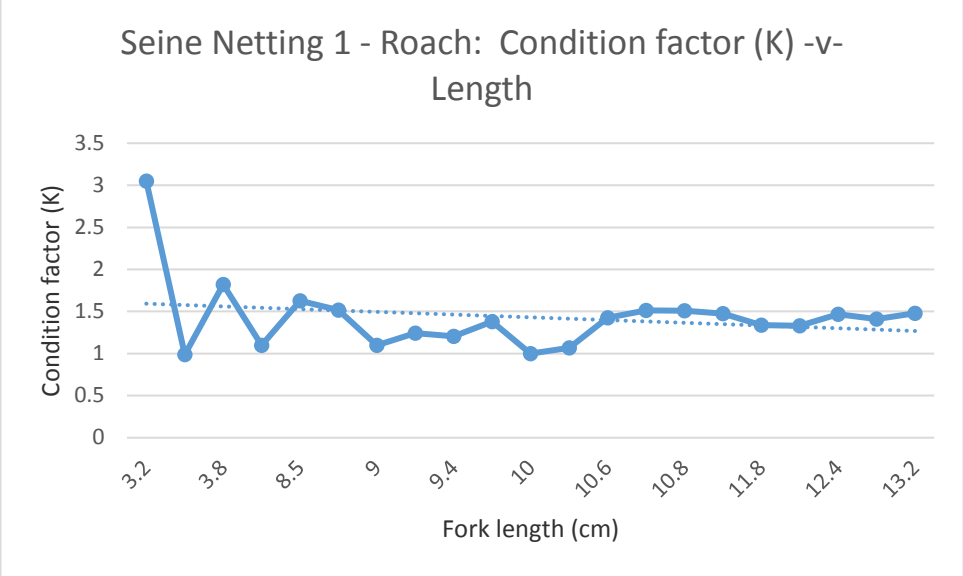
$K = 100(Weight/Length)^3$

where weight is the whole body weight of the fish in grams and length is the fork length of the fish in centimetres. The factor 100 is used to bring K close to a value of one. Fish with a condition factor of greater than one are considered to be in better condition than those fish with condition factors less than one.

Condition factors for individual fish species were calculated and are shown in the graphs below, with separate graphs representing each fish species sampled per netting event.

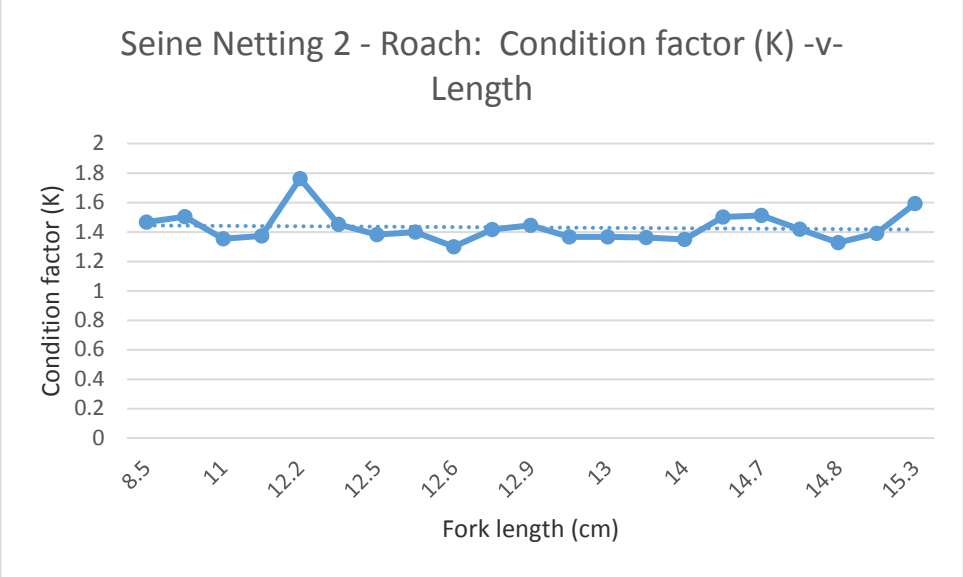
3.4.3.1 Condition factor: Roach

In total, 149 roach were sampled during the three seine netting events, (21 during nettings 1 and 2 and 107 during netting 3). The condition factor of each individual fish was calculated and can be seen plotted in Graphs 3, 4 and 5 below.



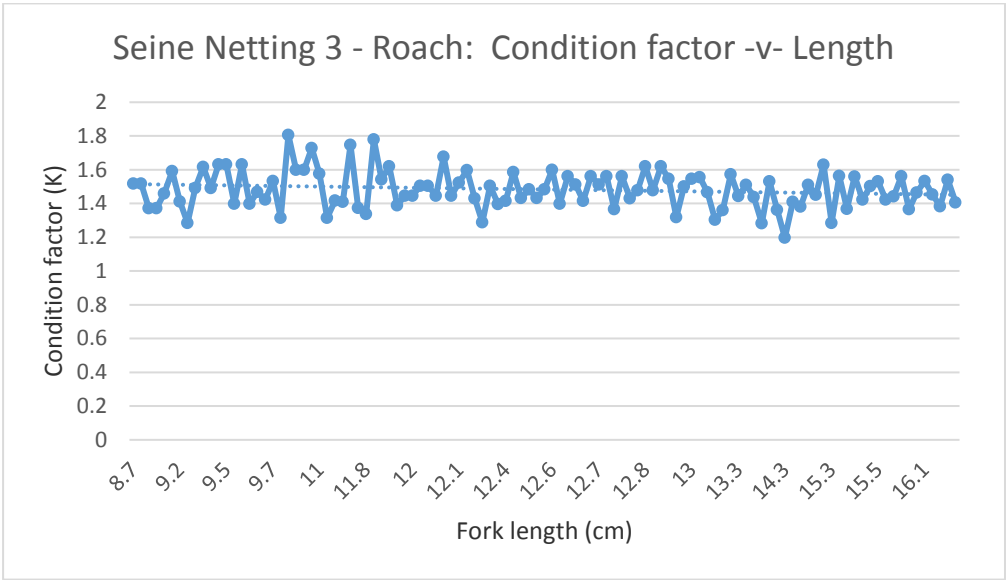
Graph 3: *Condition factor of roach captured during seine netting on 29/09/2016*

From the 21 roach sampled during the seine netting at the end of September 2016; only one (amongst the very smallest roach sampled) produced a condition factor of <1.



Graph 4: *Condition factor of roach captured during seine netting on 04/10/2016*

From the 21 roach sampled during the seine netting at the beginning of October 2016; all were found to display condition factors greater than K=1.2.

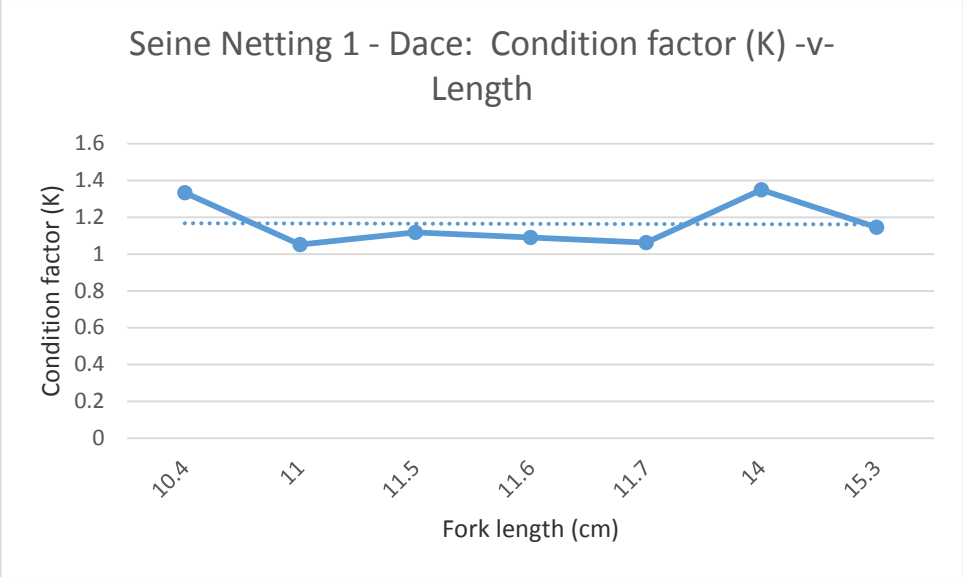


Graph 5: *Condition factor of roach captured during seine netting on 20/06/2017*

From the 107 roach sampled during the seine netting on 20 June 2017; all were found to display condition factors greater than K=1.2.

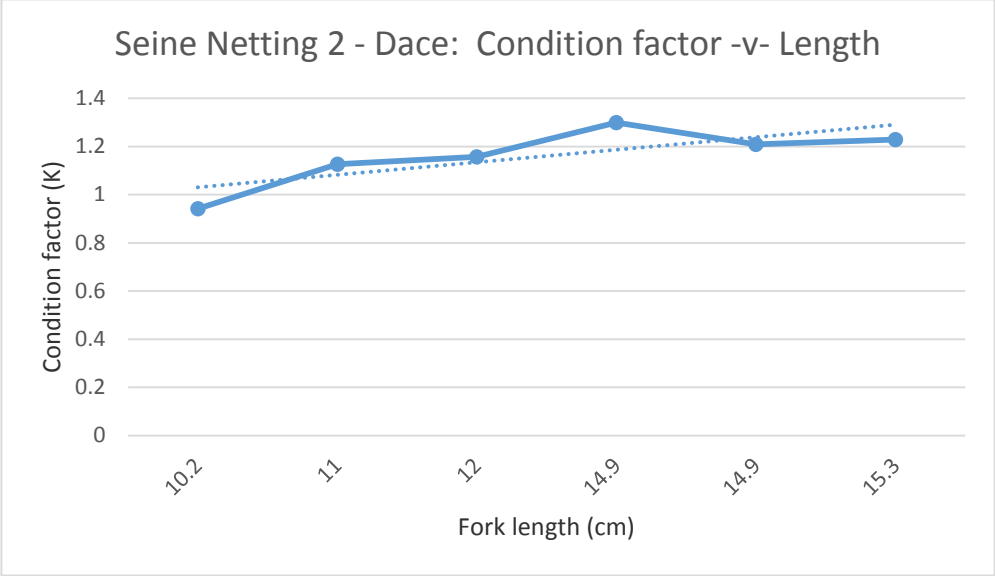
3.4.3.2 Condition factor: Dace

In total, 62 dace were sampled during the three seine netting events, (seven during netting 1, six in netting 2 and 49 in netting 3). The condition factor of each individual fish was calculated and can be seen plotted in Graphs 6, 7 and 8 below.



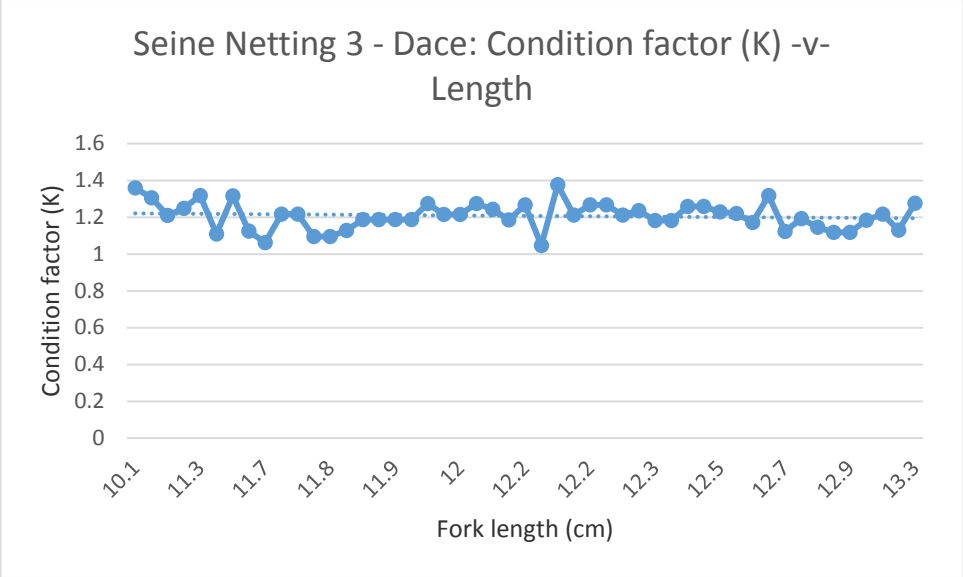
Graph 6: *Condition factor of dace captured during seine netting on 29/09/2016*

From the seven dace sampled during seine netting on 29/09/16, none displayed a condition factor of <1.



Graph 7: *Condition factor of dace captured during seine netting on 04/10/2016*

From the six dace sampled during seine netting on 04/10/16, one was measured as having a condition factor <1 and 5 fish had a condition factor >1 (maximum k=1.25). Two recorded K less than 1.2 and the further three fish produced a condition factor close to 1.2.

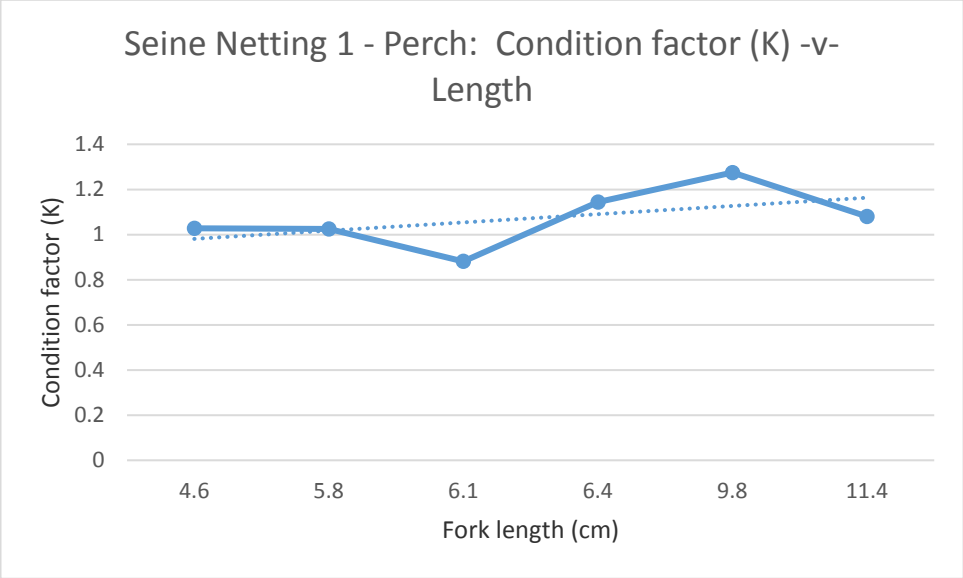


Graph 8: *Condition factor of dace captured during seine netting on 20/06/2017*

From the 49 dace sampled during seine netting on 20/06/2017, none were recorded as having a condition factor <1.

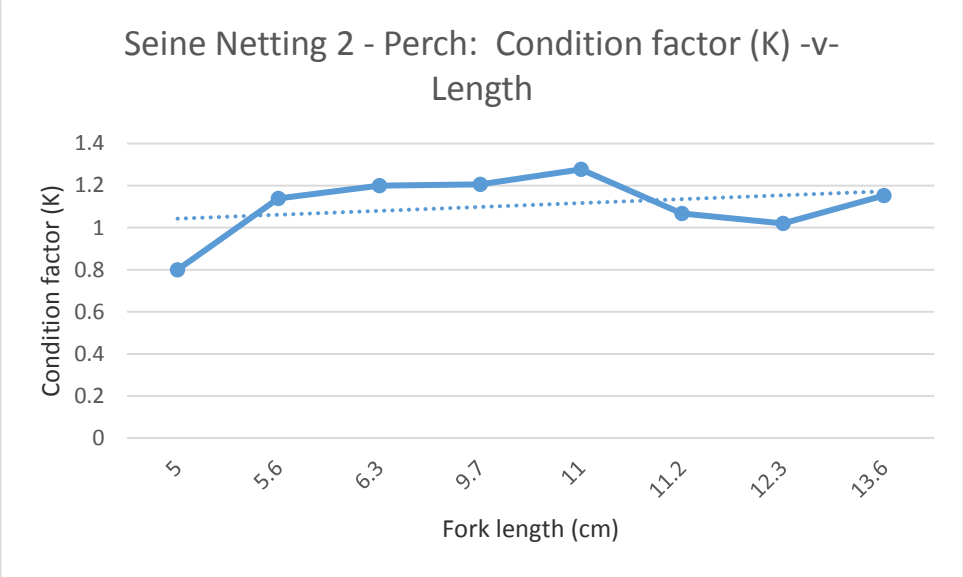
3.4.3.3 Condition factor: Perch

In total, 17 perch were sampled during the three seine netting events, (six during netting 1, eight in netting 2 and three in netting 3). The condition factor of each fish was calculated and can be seen plotted in Graphs 9, 10 and 11 below.



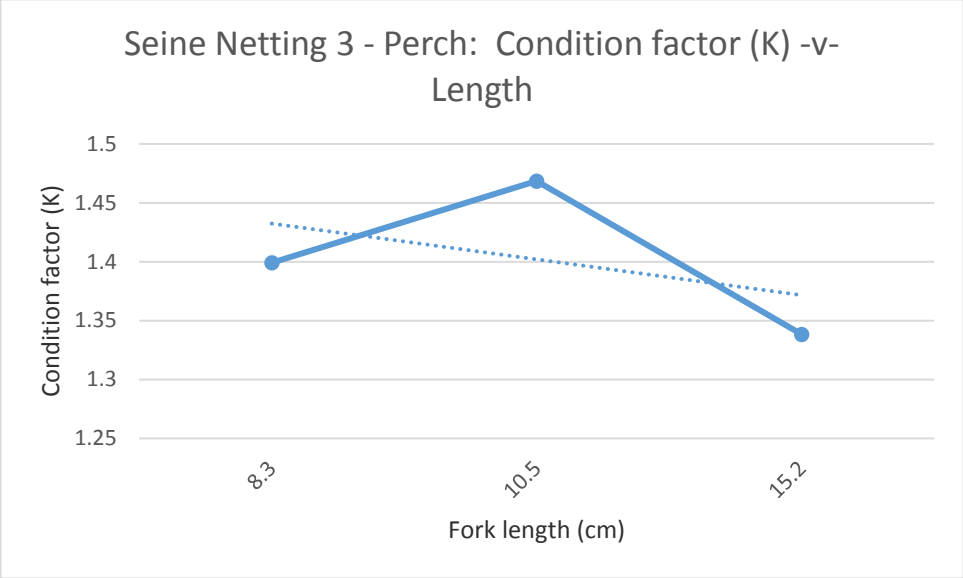
Graph 9: *Condition factor of perch captured during seine netting on 29/09/2016*

From the six perch sampled during seine netting on 29/06/2016, only one was recorded as having a condition factor below 1. Within this small sample, the highest condition factor was K=1.27.



Graph 10: *Condition factor of perch captured during seine netting on 04/10/2016*

From the eight perch sampled during seine netting on 04/10/2016, one was recorded as having a condition factor below 1. Within this small sample, condition factor peaked at K=1.27.

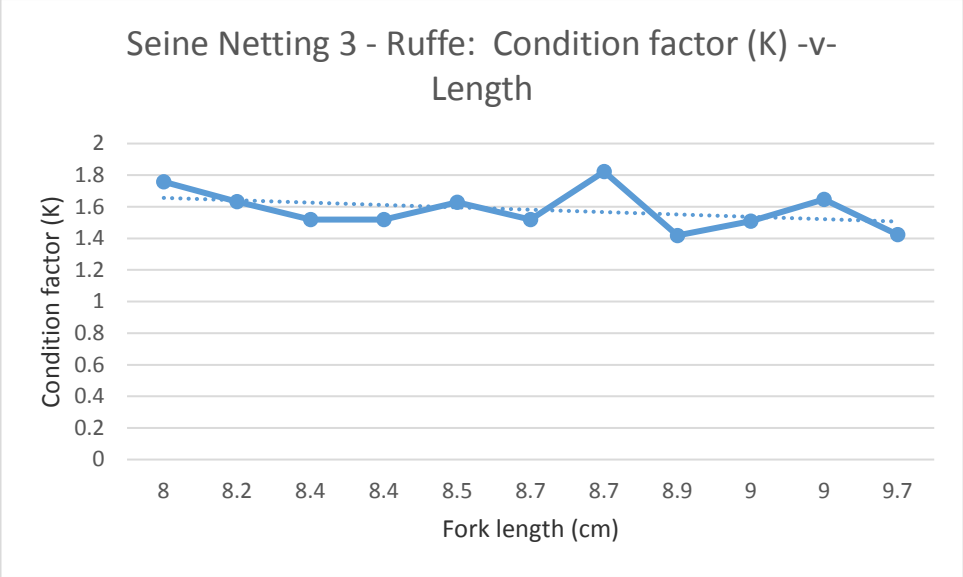


Graph 11: *Condition factor of perch captured during seine netting on 20/06/2017*

From the three perch sampled during seine netting on 20/06/2017, each was calculated as having a condition factor >1, with the highest at 1.46.

3.4.3.4 Condition factor: Ruffe

In total, 11 ruffe were sampled during the three seine netting events – all during the final netting on 20/06/2017. The condition factor of each individual fish was calculated and can be seen plotted in Graph 12 below.

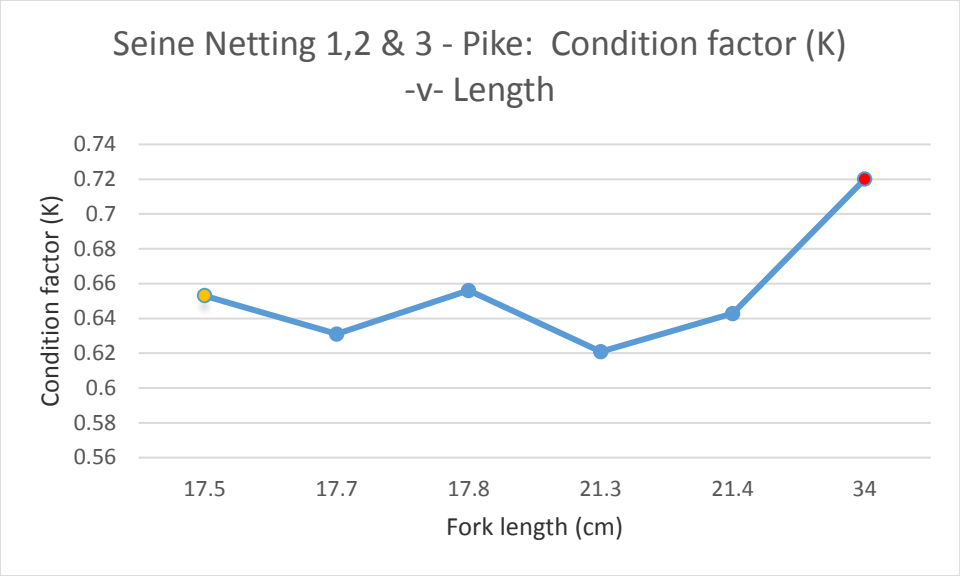


Graph 12: *Condition factor of ruffe captured during seine netting on 20/06/2017*

From the 11 ruffe sampled during seine netting on 20/06/2017, all were calculated as having a condition factor >1, with the highest at K=1.82.

3.4.3.5 Condition factor: Pike

In total, six pike were sampled during the three seine netting events. The condition factor of each individual fish was calculated and can be seen plotted in Graph 13 below.

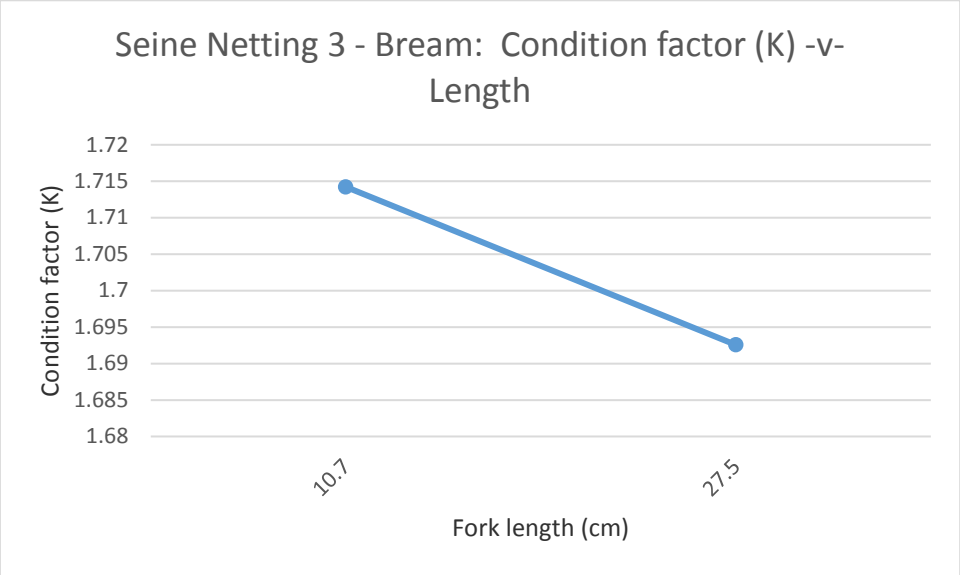


Graph 13: *Condition factor of pike captured during seine netting on 29/09/2016 (yellow marker), 04/10/2016 (blue markers) and 20/06/2017 (red marker)*

From the six pike sampled, all were found to have condition factors below 1 with the healthiest individual (and largest individual – measuring 34 cm) recording the best condition of K=0.72. This fish was the only pike sampled for length and weight during the third netting event on 20/06/2017.

3.4.3.6 Condition factor: Bream

In total, two bream were sampled during the three seine netting events – both during the final netting on 20/06/2017. The condition factor of each individual fish was calculated and can be seen plotted in Graph 14 below.



Graph 14: *Condition factor of bream captured during seine netting on 20/06/2017*

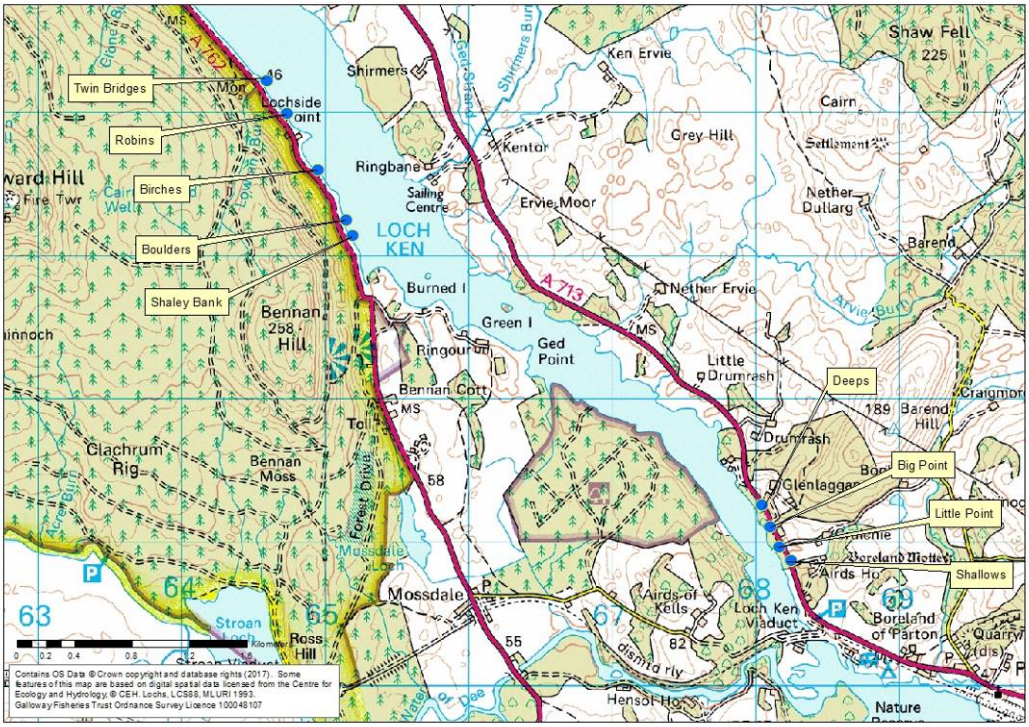
From the two bream sampled during seine netting on the 20/06/2017, both fish displayed K >1 with the juvenile fish peaking at K=1.71.

3.5 Angling matches

3.5.1 Angling matches attended

After discussion with coarse angling match organisers from NGAA, DAC and through the Facebook Loch Ken Match Banter page; GFT attended a series of matches in order to gather detailed coarse fish data. Of the matches available, two or three day matches, likely to be attended by the greatest number of anglers, were chosen in preference to smaller one day matches in order to maximise the number of fish caught and available for sampling in each match day.

There are two main areas on Loch Ken where matches are held; on the upper West Bank NGAA water and on the East Bank at Glenlaggan. These locations and the given section names can be seen in Map 2 below.



Map 2: Location map of sections fished during Loch Ken matches

3.5.1.1 Match attended on 3 December 2016

Beginning at 08:00, two GFT staff attended this match, meeting anglers at the Lochinvar Hotel in Dalry where they introduced themselves and the project to match officials and competitors, and discussed what fish data they hoped to attain at the close of the match. Once entry was complete and peg numbers drawn, anglers took up their fishing stations on the East (Glenlaggan) and West (NGAA bank) side of the loch. Beginning on the West side of the loch, GFT walked each of the match sections, to familiarise themselves with the match layout and record section names and grid references at peg numbers at each section extent (see Annex 4). 36 anglers fished the competition between 10:30 and 15:30 (see *Figure 6* showing angler ready to start match).

Figure 6: A match angler positioned at their peg

Beginning at 14:00, working in pairs along the East and West bank; four GFT staff distributed keep nets at each of section fished in the competition, without disturbing the anglers as they fished. At 15:30, at the match closed and in place to begin weigh-in; GFT shadowed the anglers as they transferred their day's catch from a keep net into a weigh bag hooked onto a tripod with scales (*Figure 7*). Once the total bag weight had been recorded for each angler, GFT transferred all fish within the weigh bag into their own keep nets and secured these at each match section.

Figure 7: Competition anglers transferring their day's catch into the weigh bag

Having completed the weigh-in in each section GFT were able to process and sample the catch. On this occasion, limited by light availability and having limited knowledge on how the fish would respond to handling, it was decided that fish would be sampled for species and

length to limit handling time and stress on the fish. Sampling and processing was completed within two hours of commencement.

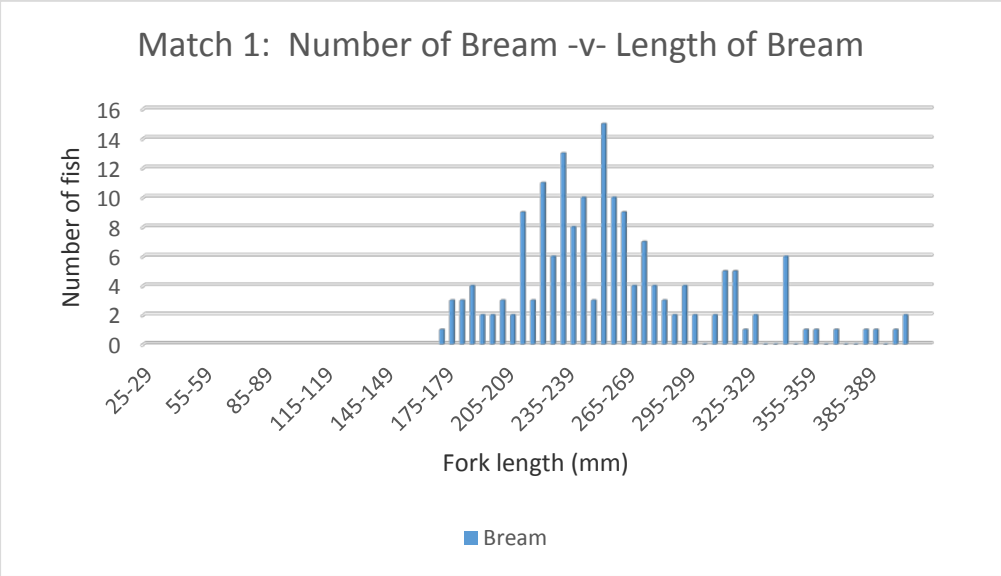
In total, 302 coarse fish were processed for length: 172 bream, 55 roach, 15 perch, 15 dace and 45 ruffe.

Bream lengths, which made up the majority of fish captured during match 1 (57% of total), were plotted on a histogram (*Graph 15*) to both help identify bream age structure within Loch Ken and to direct sampling for weight and scales at future matches (see Annex 3 – Match Sampling Strategy).

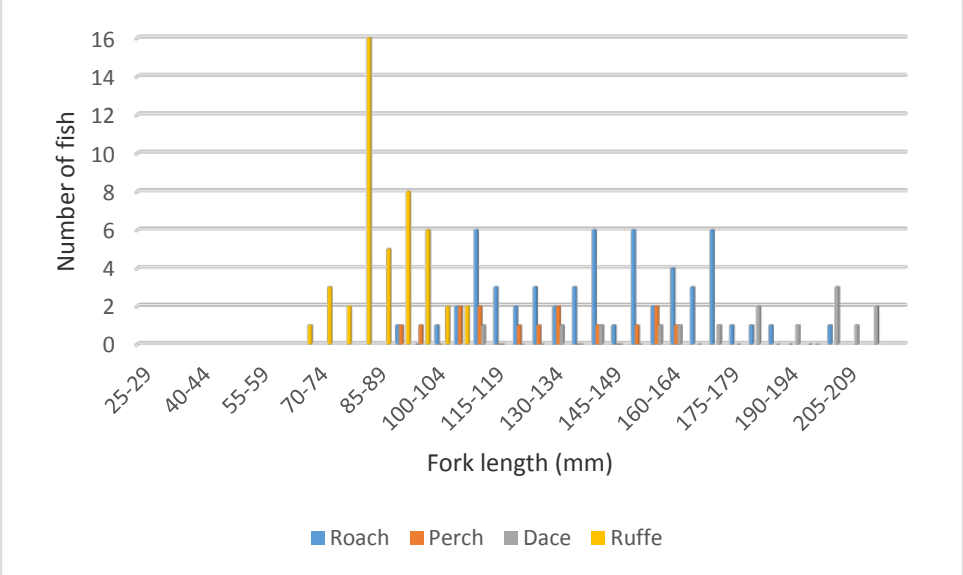
The same was done for roach, perch, dace and ruffe (*Graph 16)*.

Length samples ranged by species as follows - bream 17-40 cm; roach 9-20 cm; perch 9 -16 cm; dace 11-21 cm and ruffe 6-11 cm.

Following match 1 a sampling strategy for future matches was developed to maximise the data collected but recognising the resource and time constraints of sampling at each match (see Annex 3).



Graph 15: Length histogram of bream sampled during match 1



Graph 16: Length histogram of roach, perch, dace and ruffe during match 1

3.5.1.2 Match attended on 31 March 2017

On the 31st March, GFT attended their second match on Loch Ken when 28 anglers competed. Details of sections fished and corresponding peg grid references can be found in Annex 4. Despite having fewer angler entries than match 1, a total of 827 fish were available for sampling from 18:30. GFT completed processing this sample by 21:00.

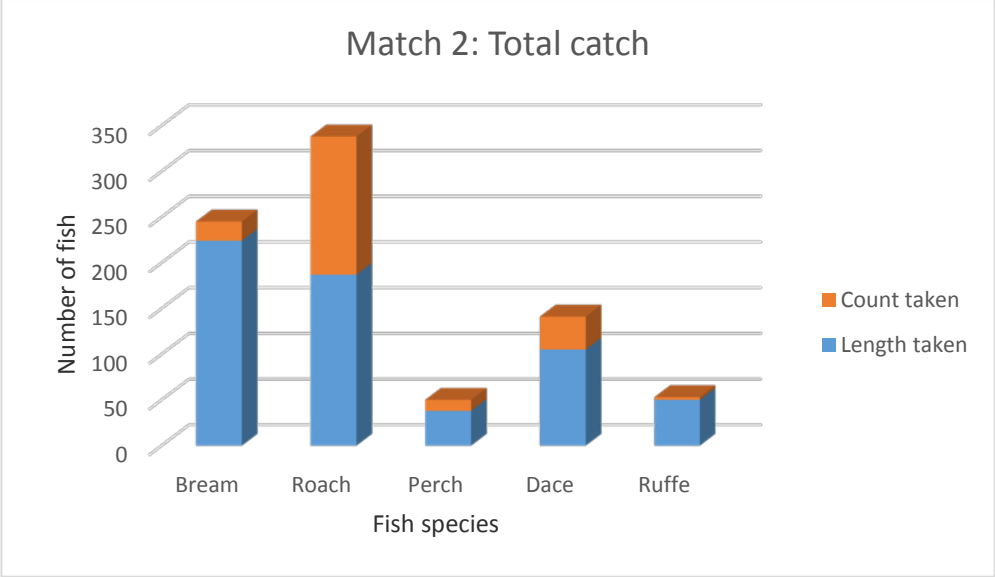
In total, 604 length measurements were taken from 224 bream, 187 roach, 38 perch, 105 dace and 50 ruffe. In addition, weights were obtained from 150 of these fish (55 bream, 35 roach, 26 dace, 17 perch and 17 ruffe) to help compile weight to length conversion charts.

To begin understanding age structure of coarse fish in Loch Ken, scale samples were taken from 64 fish (31 bream, 14 roach, 10 dace and 9 perch). Scale samples were not taken from ruffe (see Annex 4).

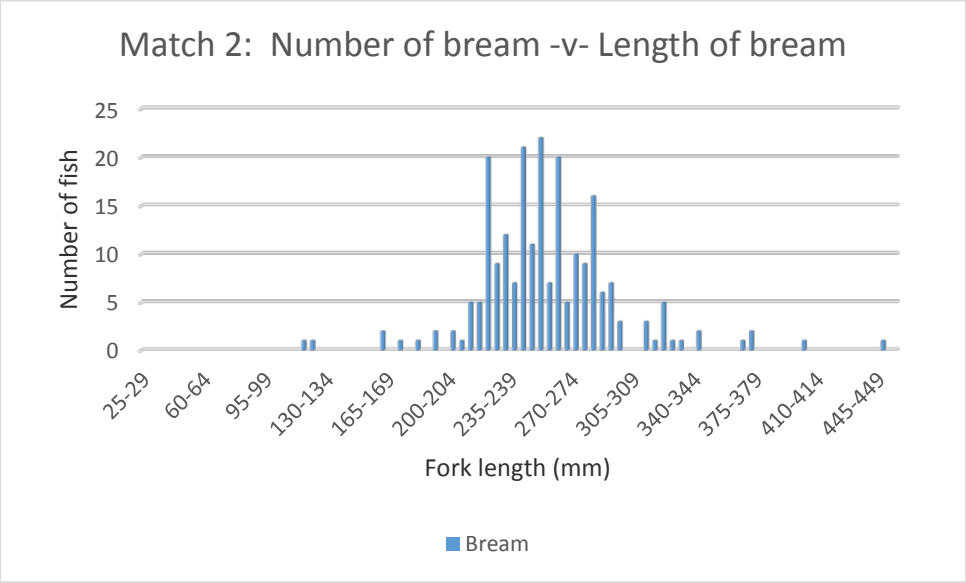
A further 223 fish had species recorded bringing the total number of fish handled during match 2 to 827.

Graph 17 shows the distribution of fish available for processing from match 2, with those shown in blue all fish where species length and a proportion of weight was recorded and scale samples taken. The proportion of the sample where a species count only was made is shown in orange.

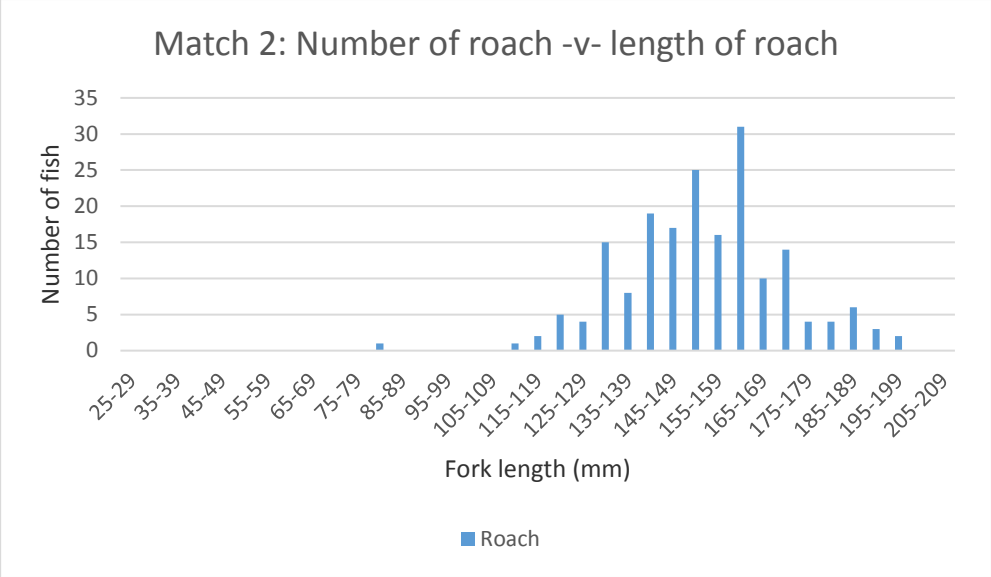
Length samples ranged by species as follows - bream 11-44 cm (*Graph 18*); roach 8-20 cm (*Graph 19*); perch 9 -33 cm; dace 10-21 cm and ruffe 7-11 cm (*Graph 20*).



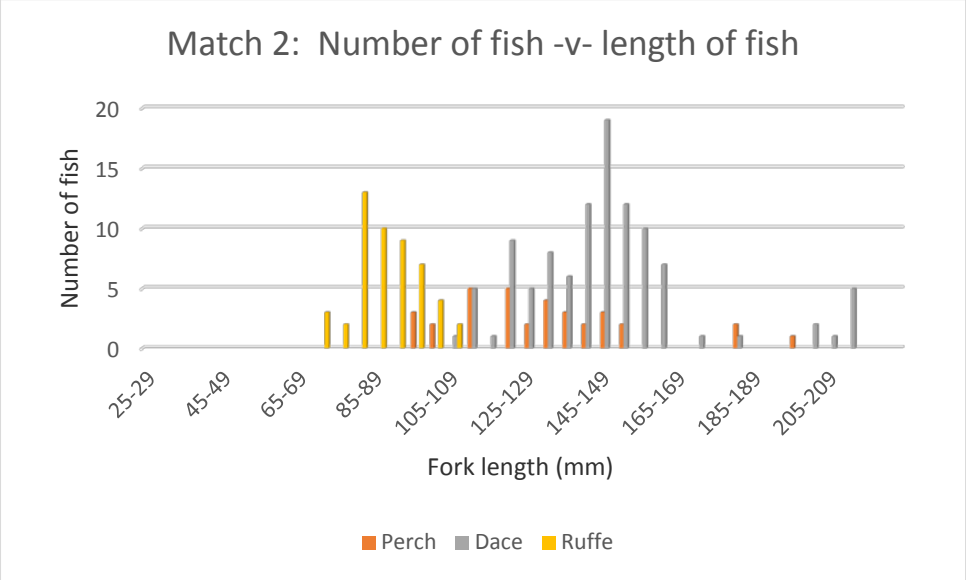
Graph 17: Total fish captured in match 2 shown as number of fish where length (and a proportion of weight and scale) sampling was completed and numbers of fish where only a count of individuals was taken



Graph 18: Length histogram of bream sampled during match 2



Graph 19: Length histogram of roach sampled during match 2



Graph 20: Length histogram of perch, dace and ruffe sampled during match 2

3.5.1.3 Match attended on 14 April 2017

On the 14th April, GFT attended a third match on Loch Ken. This match was part of a three day match, known as the Easter Festival and 45 anglers competed. Details of sections fished and corresponding peg grid references can be found in Annex 4. Of the matches attended, this provided the most fish for sampling (1489) from 18:30. GFT completed processing on the East bank by 21:30 and West Bank by 22:30.

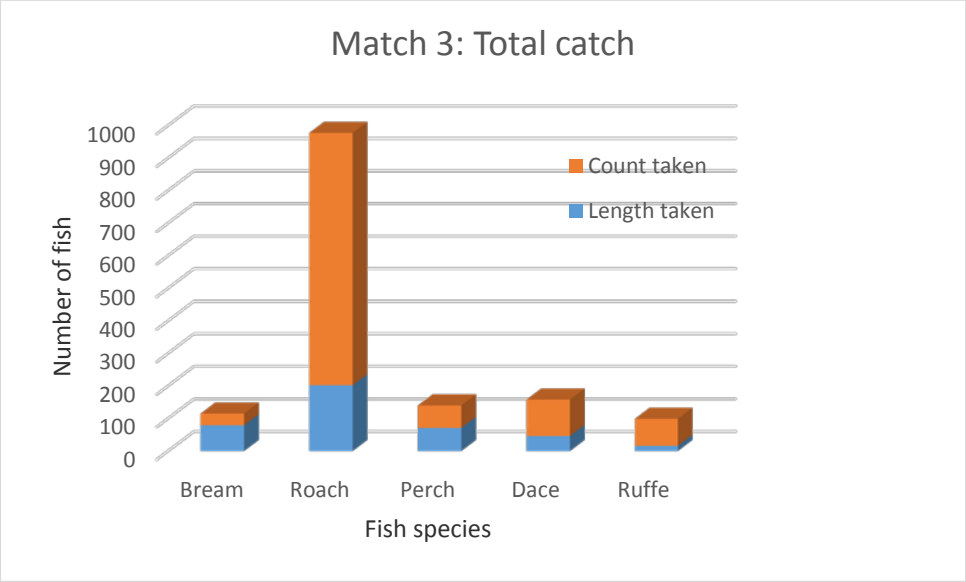
In total, 414 length measurements were taken from 79 bream, 202 roach, 71 perch, 46 dace and 16 ruffe. In addition, weights were obtained from 123 of these fish (33 bream, 34 roach, 15 dace, 37 perch and 4 ruffe) to help compile weight to length conversion charts.

To help understand age structure of coarse fish in Loch Ken, scale samples were taken from 85 fish (26 bream, 17 roach, 14 dace and 28 perch). Scale samples were not taken from ruffe (see Annex 4).

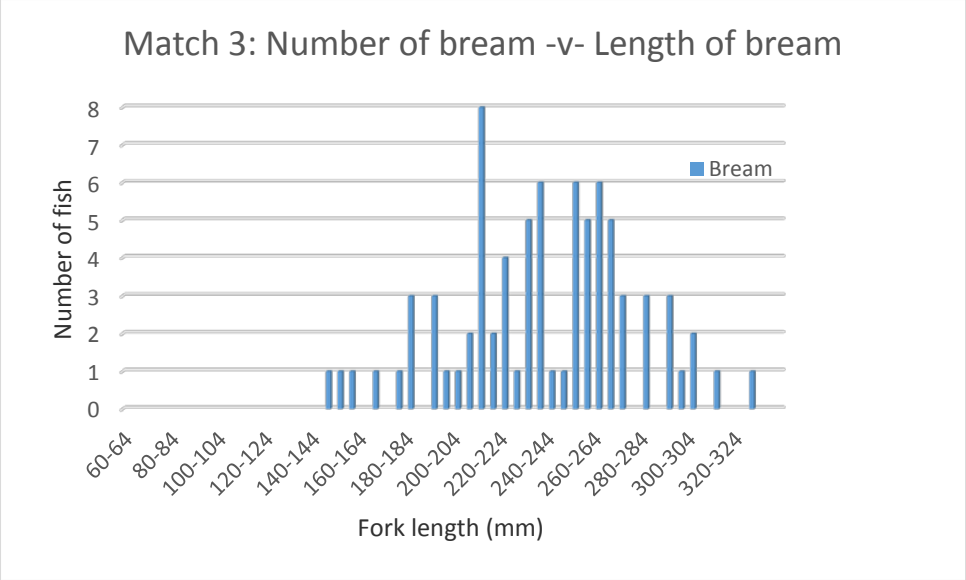
A further 1075 fish had just species recorded bringing the total number of fish handled during match 3 to 1489.

Graph 21 shows the distribution of fish available for processing from match 3, with those shown in blue all fish that were processed for lengths (including individuals where weights and scale samples were taken) and the proportion of fish shown in orange, where only a count was taken.

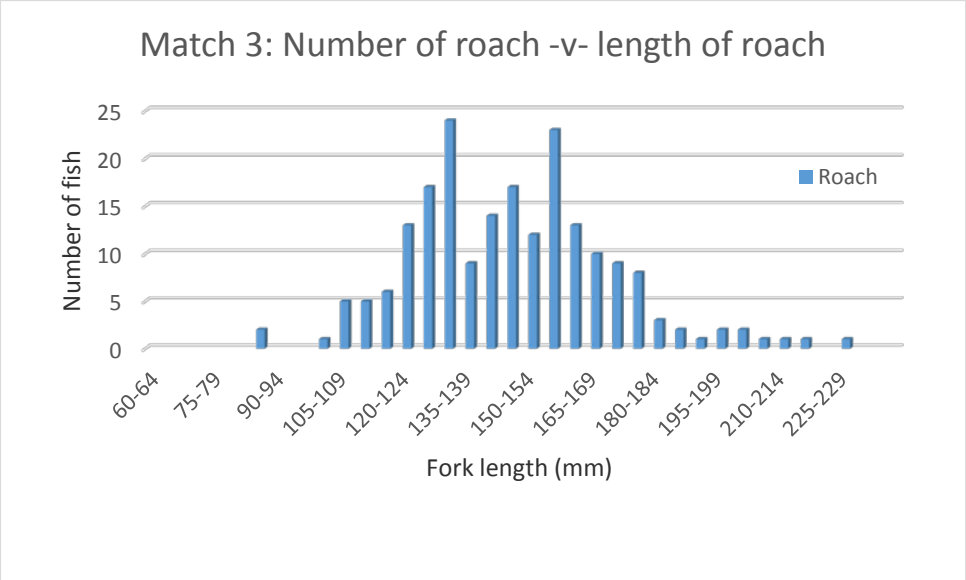
Length samples ranged by species as follows – bream 14-32cm (Graph 22); roach 8-23cm (Graph 23); perch 9-28cm; dace 10-22cm; ruff 6-11 cm (Graph 24).



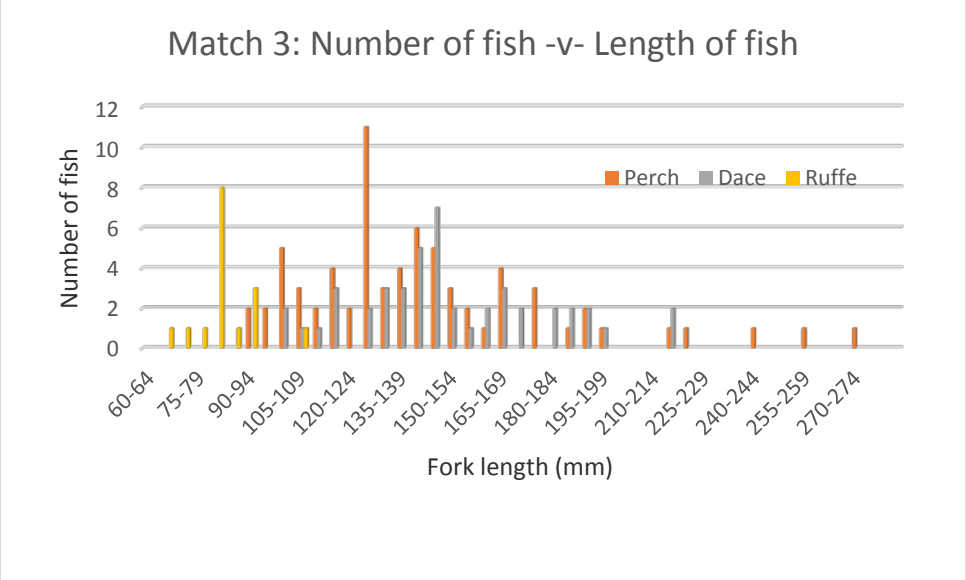
Graph 21: Total fish captured in match 3 shown as number of fish where length (and a proportion of weight and scale) sampling was completed and numbers of fish where only a count of individuals was taken



Graph 22: Length histogram of bream sampled during match 3



Graph 23: Length histogram of roach sampled during match 2



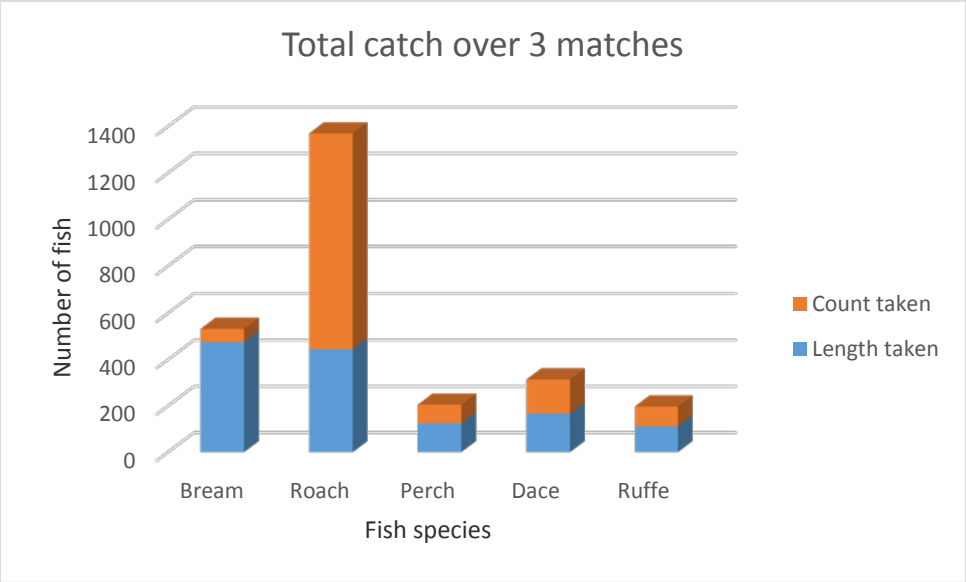
Graph 24: Length histogram of perch, dace and ruffe sampled during match 2

3.5.2 Further analysis of match data

3.5.2.1 Overall Species Composition

The total count of each fish species caught during the three matches is shown in *Graph 25.*

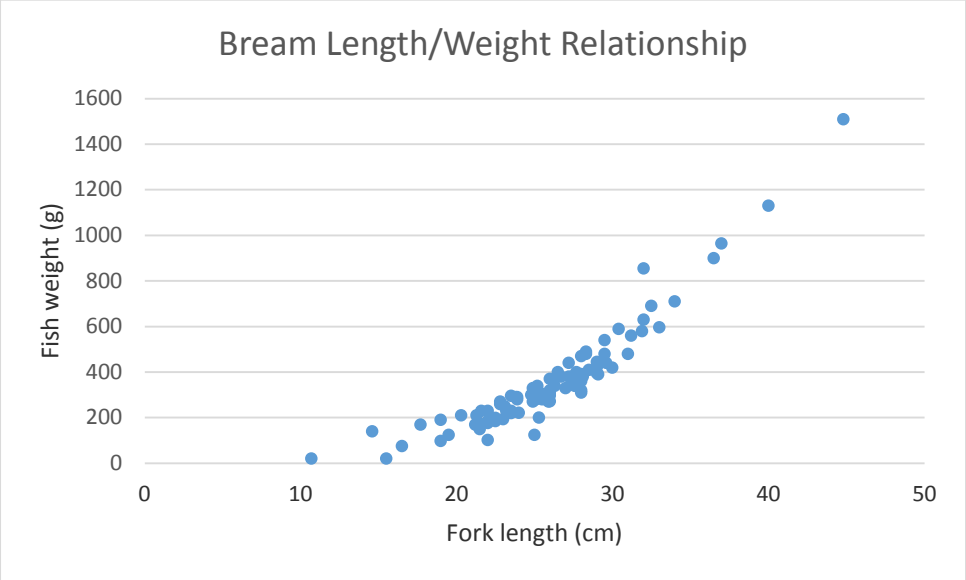
The total count over the three matches was 2618 fish. Within this figure, bream accounted for 532 fish (475 sampled and 57 counted, >20% of total)); roach, 1370 fish (444 sampled and 926 counted, >52% of total)); perch, 205 fish (124 sampled and 81 counted, <8% of total)); dace, 314 fish (166 sampled and 148 counted, 12% of total); and ruffe, 197 fish (111 sampled and 86 counted, >7% of total) (see *Graph 25).*



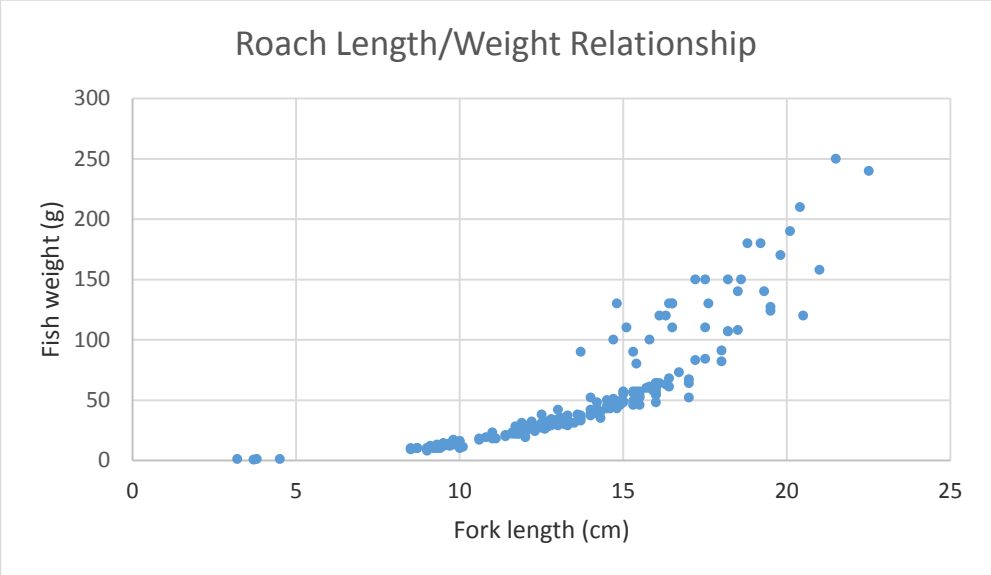
Graph 25: Total fish caught across the three matches displayed as individual species

3.5.2.2 Length to weight conversion charts

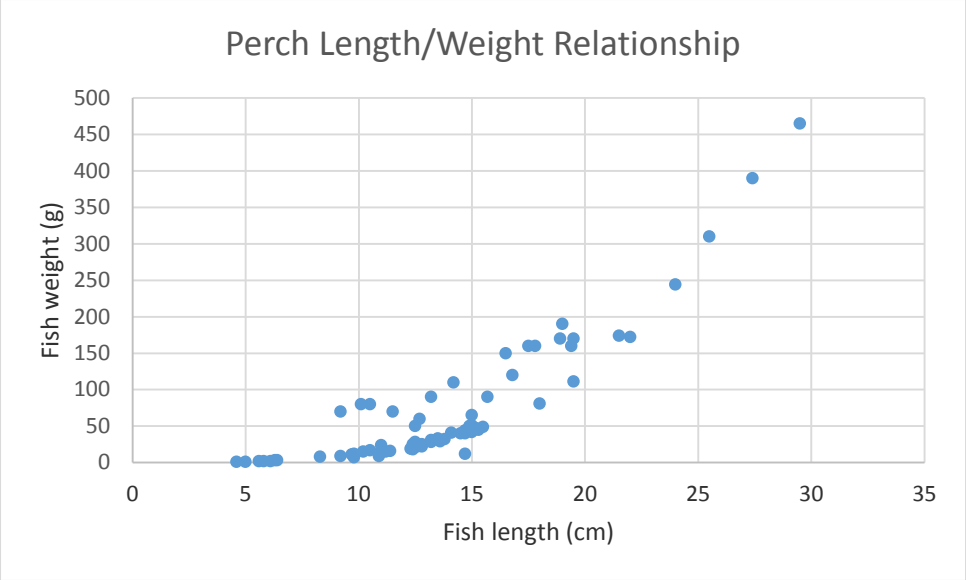
For each fish species, length to weight conversion charts were generated using data collected during matches 2 and 3 (*Graph 26 to Graph 30*).



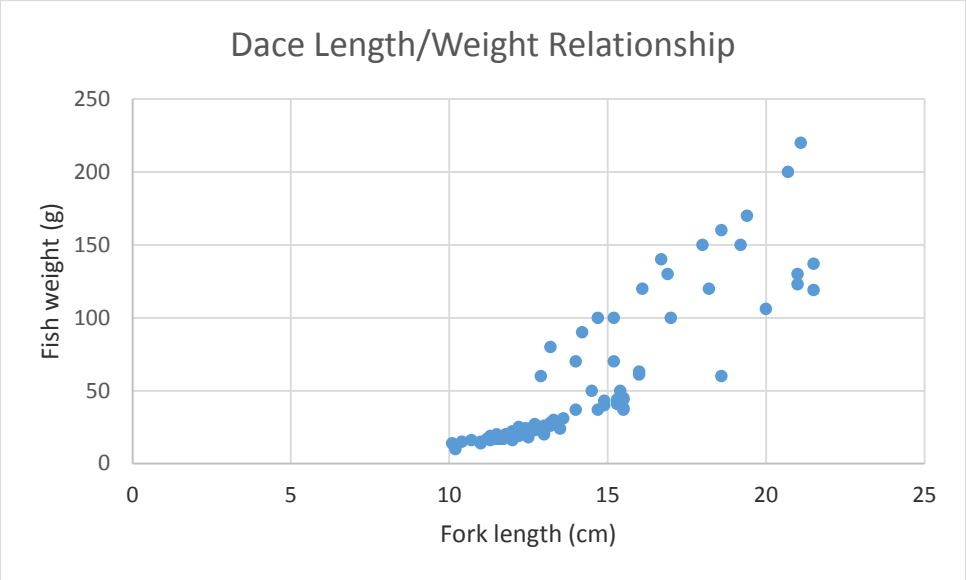
Graph 26: Length to weight conversion chart for bream



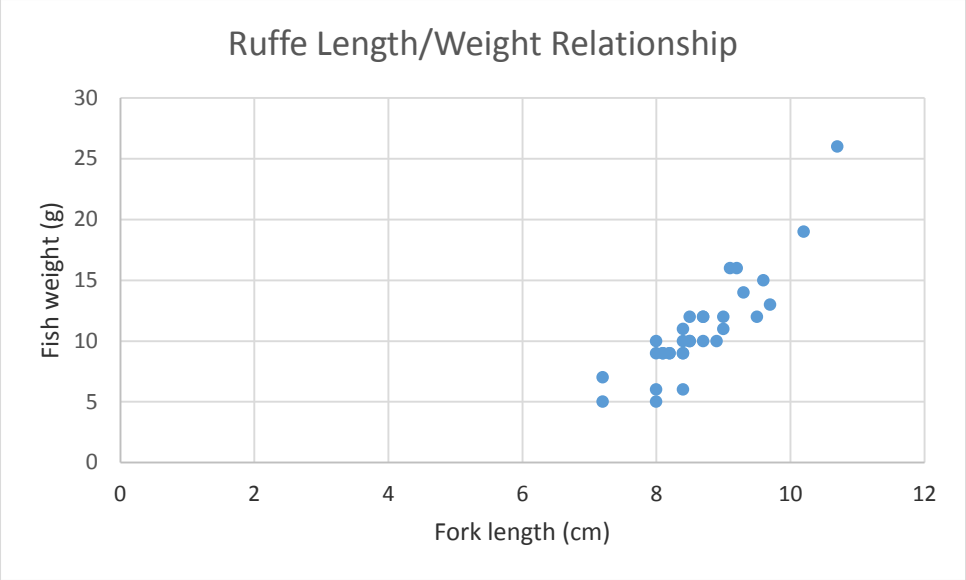
Graph 27: Length to weight conversion chart for roach



Graph 28: Length to weight conversion chart for perch



Graph 29: Length to weight conversion chart for dace



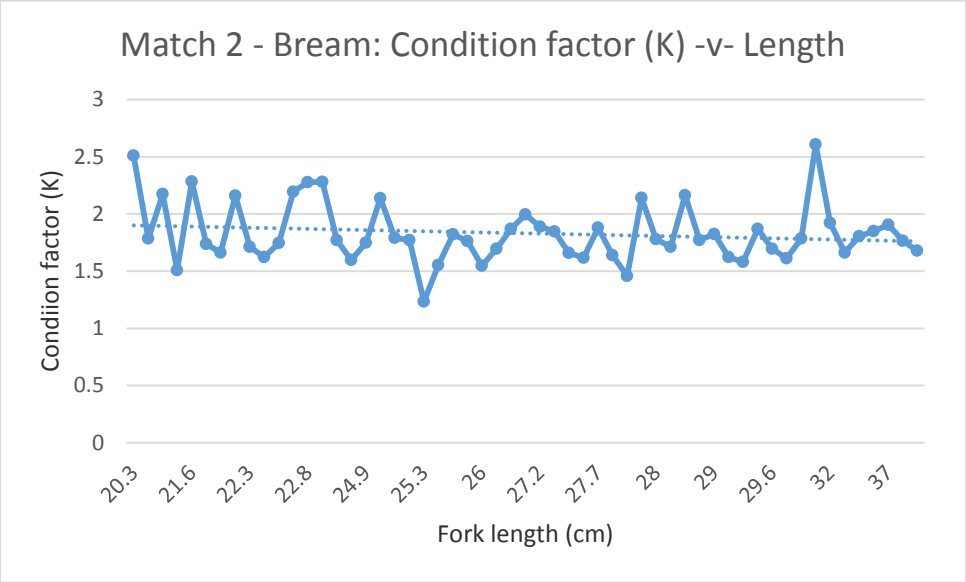
Graph 30: Length to weight conversion chart for ruffe

3.5.2.3 Fulton's Condition Factor

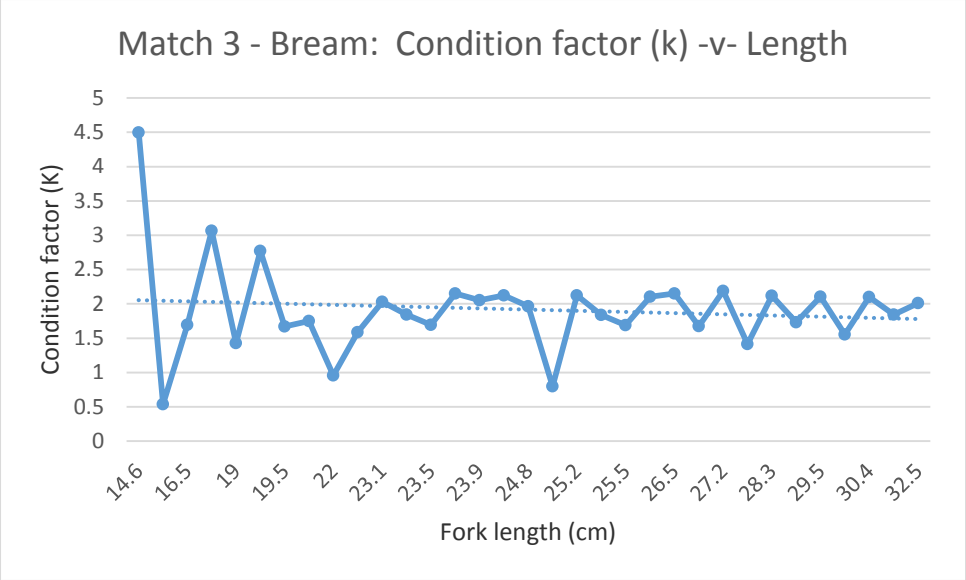
Length and weight data from each fish species was then used to calculate to 'Fulton's Condition Factor' in a similar fashion to the seine netting data (see section 3.4). Individual fish species graphs of conversion factor can be seen in *Graph 31 – Graph 40.*

A line of best fit has been plotted across the range of fish lengths recorded.

Condition factors for data gathered during match 2 and match 3 were kept separately to account for changes in body mass resulting from spawning activity completed by many species (in particular the perch) between the two matches.

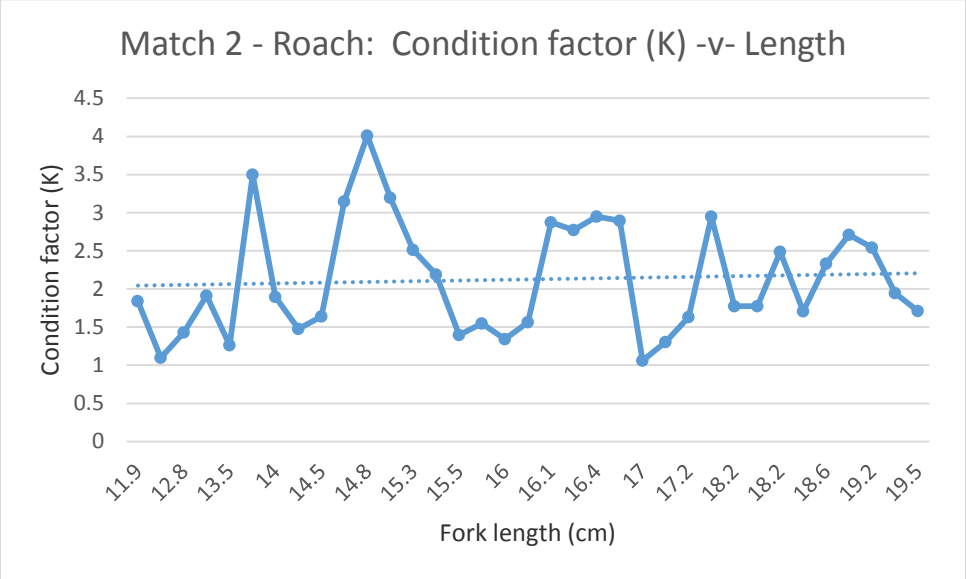


Graph 31: *Condition factor of bream sampled during match 2*

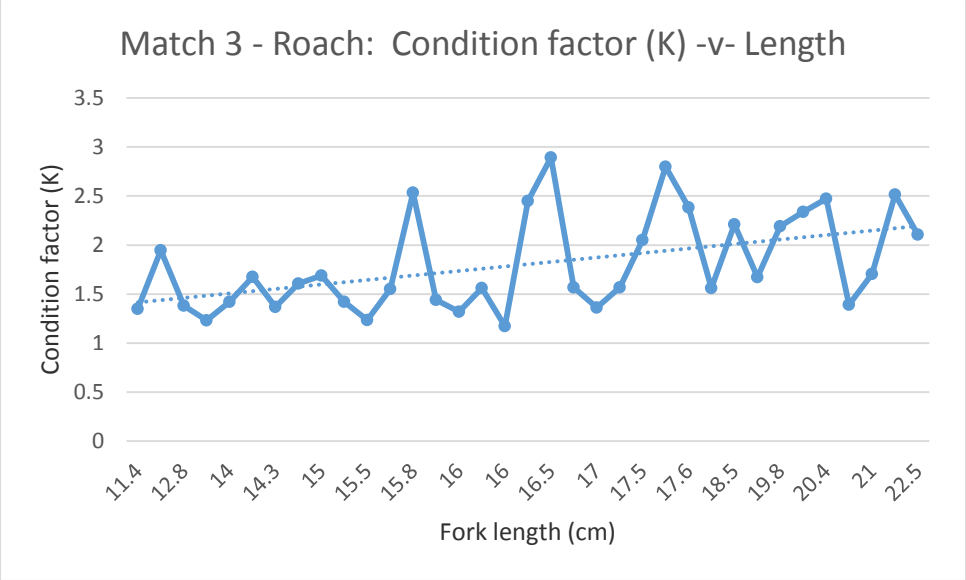


Graph 32: *Condition factor of bream sampled during match and 3*

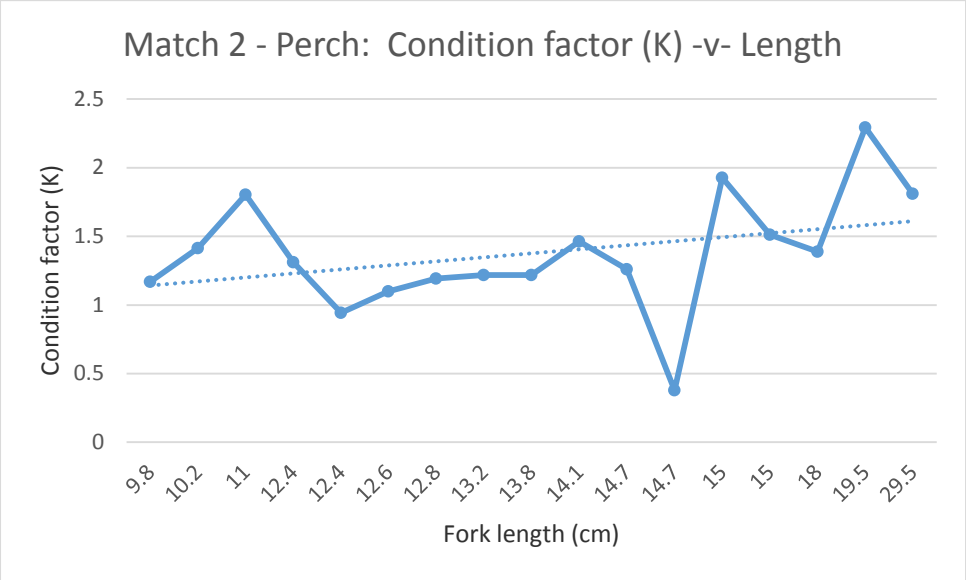
Condition factor of bream was found to be >1 in all fish sampled during match 2. In only three fish sampled during match 3 did condition factor fall to <1.



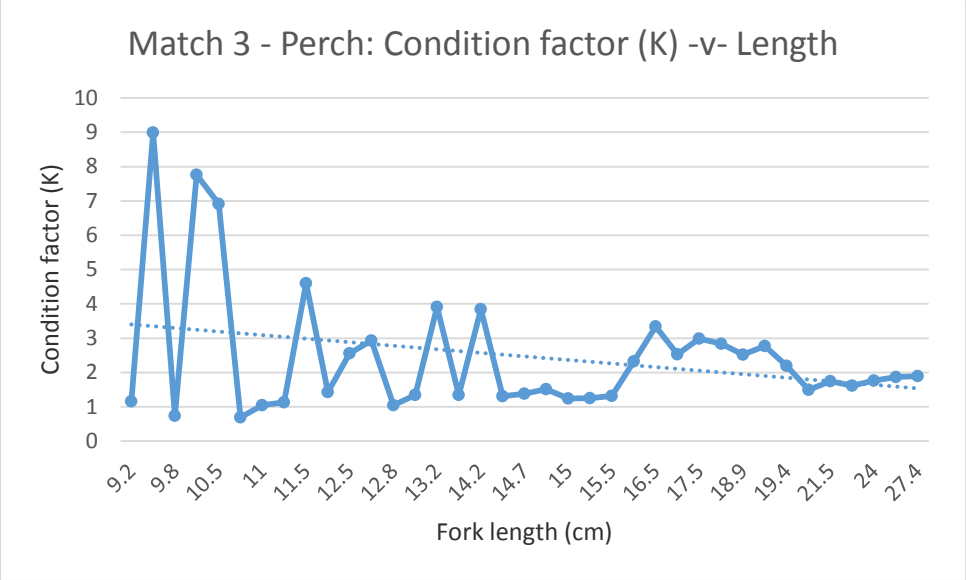
Graph 33: *Condition factor of roach sampled during match 2*



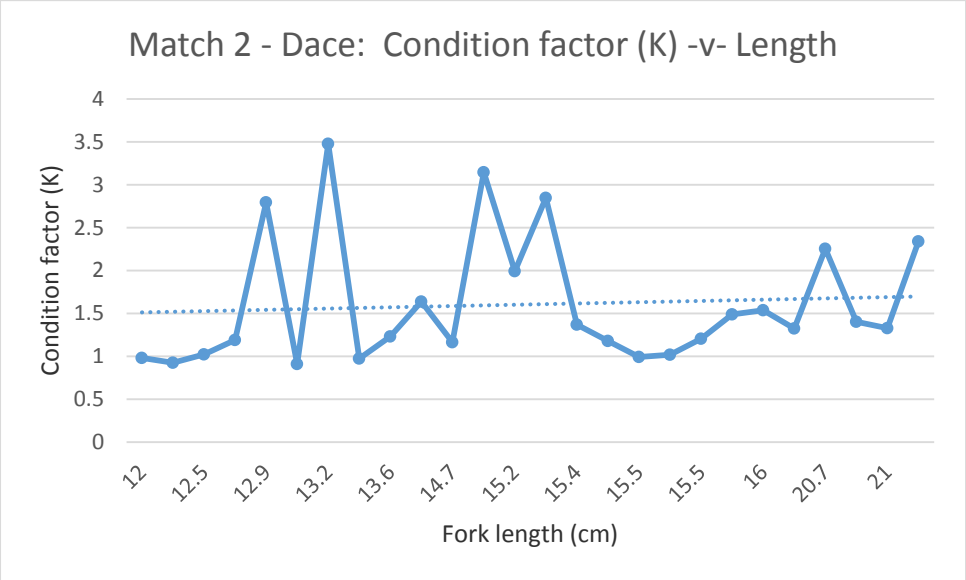
Graph 34: *Condition factor of roach sampled during match 3*



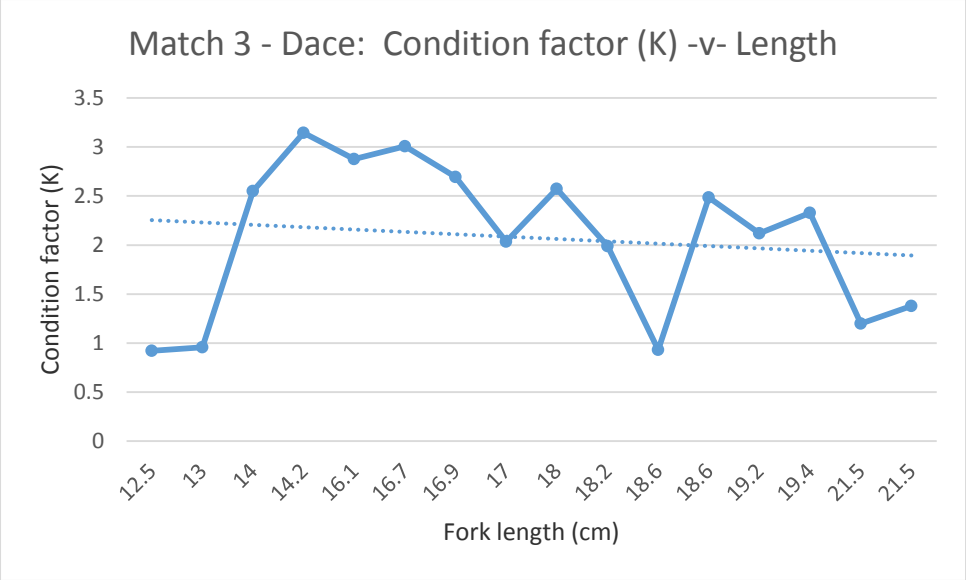
Graph 35: *Condition factor of perch sampled during match 2*



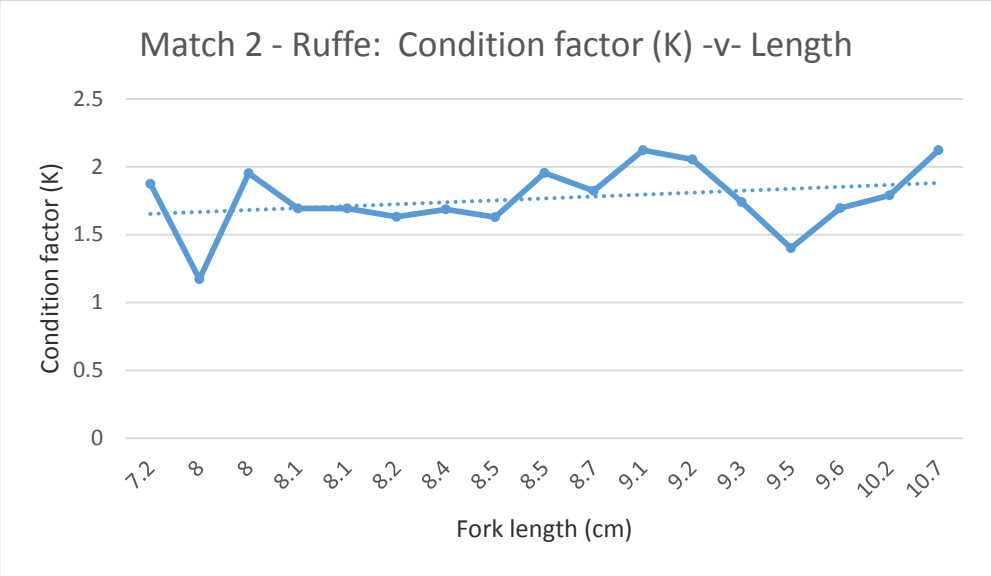
Graph 36: *Condition factor of perch sampled during match 3*



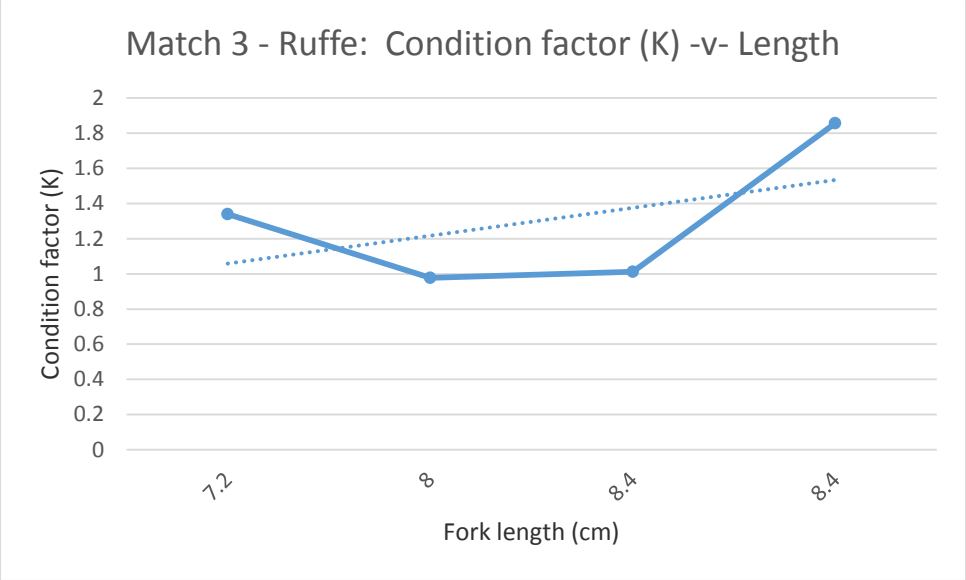
Graph 37: *Condition factor of dace sampled during match 2*



Graph 38: *Condition factor of dace sampled during match 3*



Graph 39: *Condition factor of ruffe sampled during match 2*



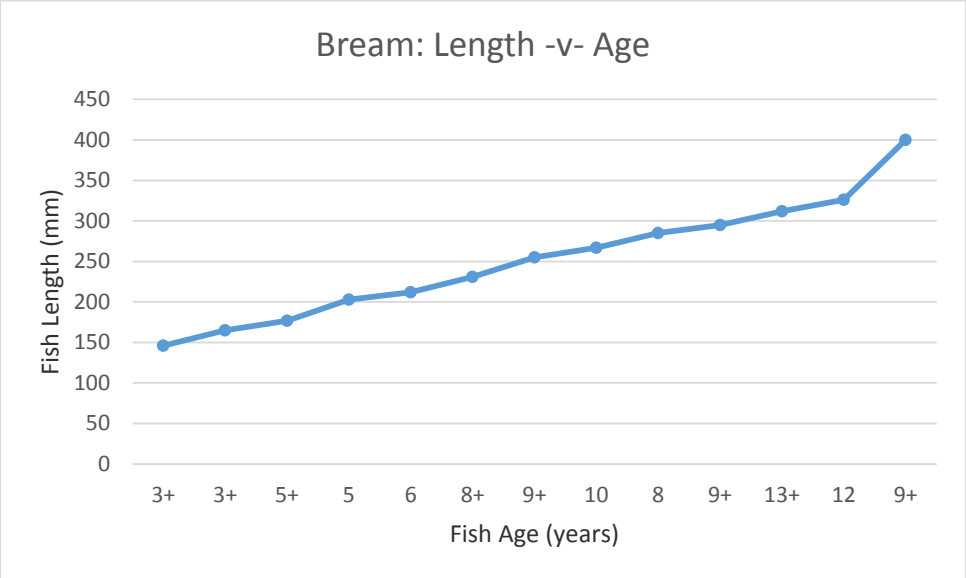
Graph 40: *Condition factor of ruffe sampled during match 3*

3.5.2.4 Fish Scale Analysis

To assess the age structure of the coarse fish communities of Loch Ken, scale samples were collected primarily during fish sampling at matches 2 and 3.

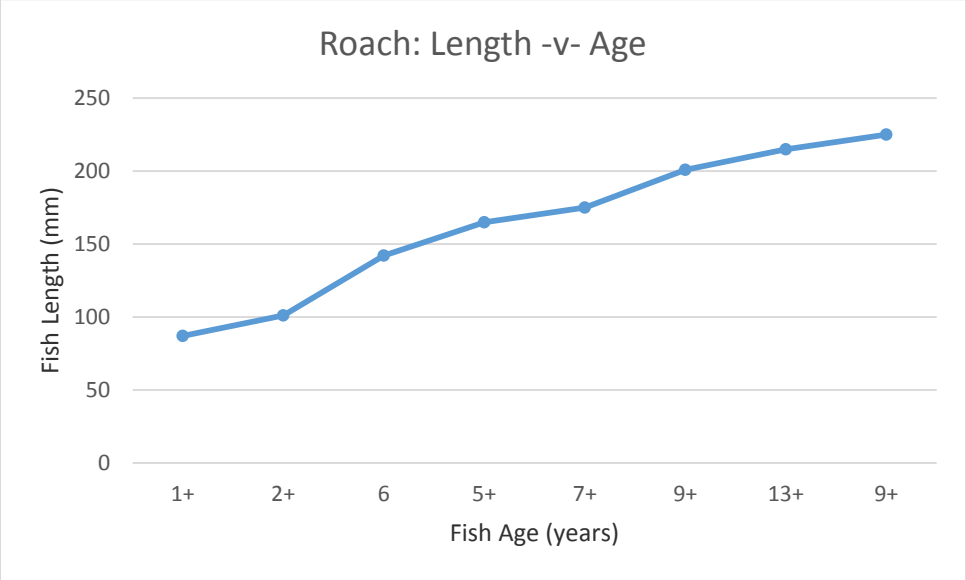
Having selected scale samples that best represented the variation in individual fish species sizes sampled 13 bream, 8 roach, 14 perch, 8 dace, and 9 pike scale samples were examined by the Environment Agency (EA) (as they have significant experience in coarse fish scale analysis).

Graphs 41 – 45 show how fish growth changes with age in five coarse fish species commonly caught on Loch Ken.



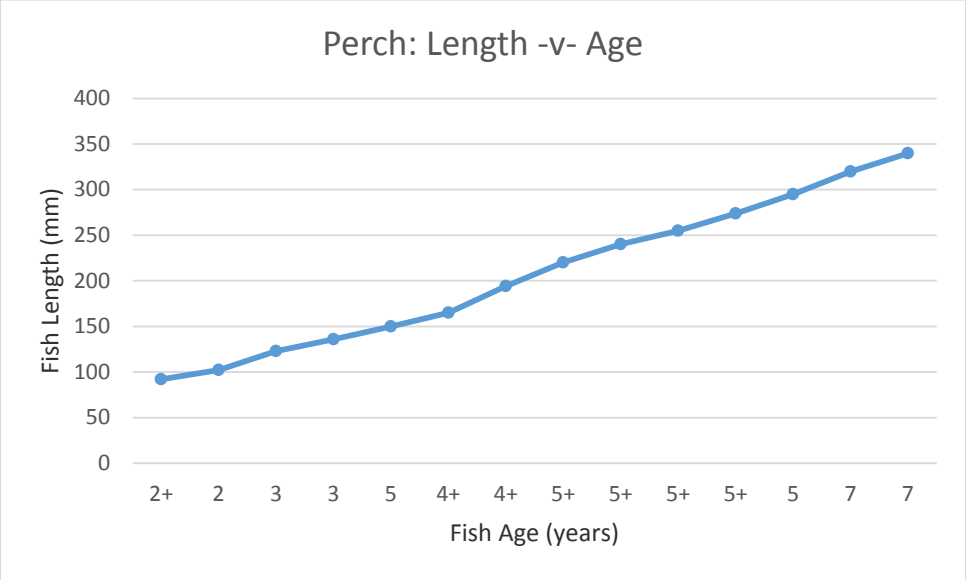
Graph 41: How growth changes with age in common bream found within Loch Ken

Common bream scale analysis found fish ages between 3+ and 13+ years relating to fish lengths ranging from 146 - 400 mm.



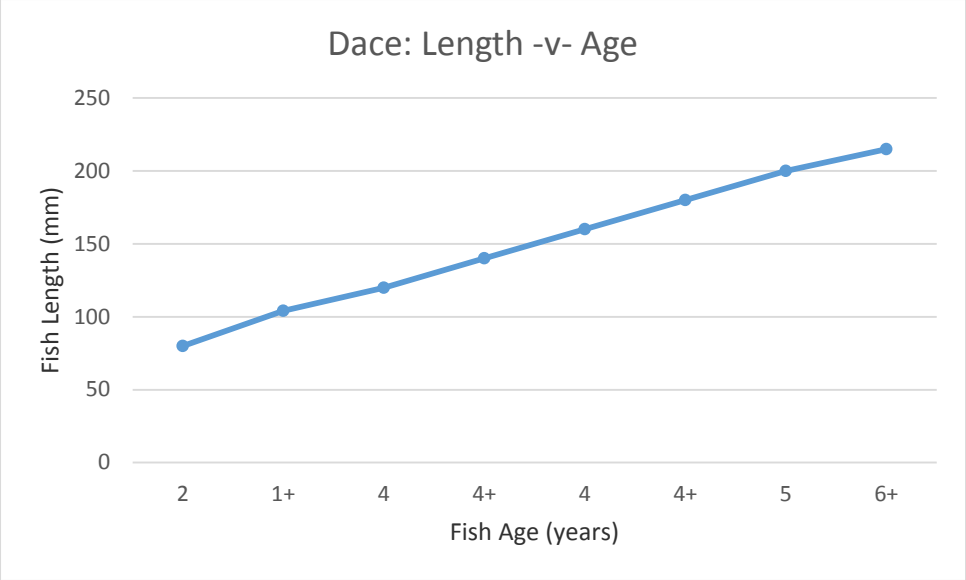
Graph 42: How growth changes with age in roach found within Loch Ken

Scale samples analysed from roach were found to be from fish between the ages of 1+ and 13+ years relating to fish lengths ranging from 87 - 225 mm.



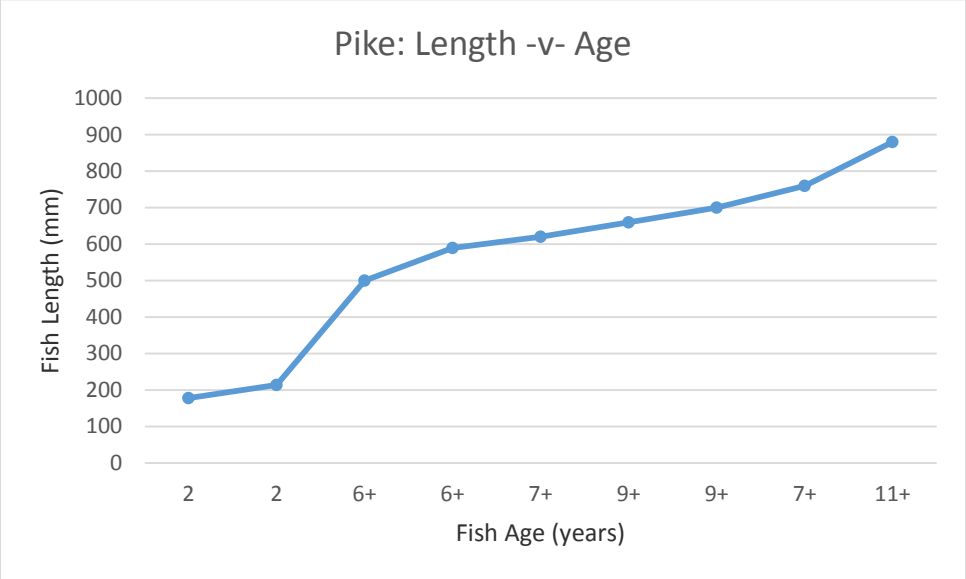
Graph 43: How growth changes with age in perch found within Loch Ken

Scale samples analysed from perch were found to be from fish between the ages of 2+ and 7 years of age, taken from fish which ranging in length from 92 - 340 mm.



Graph 44: How growth changes with age in dace found within Loch Ken

Scale samples analysed from dace were found to be from fish between the ages of 1+ and 6+ years of age, taken from fish ranging in length from 80 - 215 mm.



Graph 45: How growth changes with age in pike found within Loch Ken

Scale samples analysed from pike were found to be from fish between the ages of 2 and 11+ years of age, taken from fish which ranging in length from 178 mm - 880 mm.

3.5.3 Bag weights of coarse fish captured during matches on Loch Ken

Coarse fish data collected during Loch Ken angling matches can be extremely useful for year to year comparison in general coarse fish species biomass within the fishery. However, historically this data has been limited to total bag weight of fish captured with no record taken of individual fish species composition within each bag.

The following section reviews bag weights sampled during Loch Ken matches attended within this study and best bag weights recorded over the last year at most matches recorded on Loch Ken through the Facebook page 'Loch Ken Match Banter'.

3.5.3.1 Data from attended matches

For future comparison with current data, the total bag weights of fish caught at each peg during the three matches attended in this study are shown in Table 7 below.

Table 7: Bag weights of coarse fish captured upon individual Loch Ken angling pegs during the three matches attended in this study

Section Name	Peg # Match 1	Bag Weight (lb/oz)	Peg # Match 2	Bag Weight (lb/oz)	Peg # Match 3	Bag Weight (lb/oz)
West Bank						
Twin Bridges	14	2lb 14oz	N/A		B6	1lb 10oz
	15	0lb 3oz			B7	6lb 4oz
	16	0lb 6oz			B8	9lb 6oz
	17	4lb 12oz			B9	4lb 6oz
					B10	5lb 14oz
Robins	18	3lb 4oz	1	0lb 1oz	B11	2lb 6oz
	19	1lb 2oz	2	2lb 12oz	B12	2lb 12oz
	20	7lb	3	14lb 12oz	B13	2lb 12oz
	21	1lb 2oz	4	2lb 6oz	B14	2lb 6oz
	22	2lb 15oz			B15	4lb 2oz
Birches	23	6lb 4oz	5	9lb 02oz	C1	9lb 4oz
	24	1lb 14oz	6	2lb 6oz	C2	8lb
	25	7lb 12oz	7	6lb 10oz	C3	9oz
	26	2lb 2oz	8	3lb 8oz	C4	4lb 12oz
	27	3lb 2oz	9	3lb 6oz	C5	3lb 6oz
Boulders	28	18lb	10	3lb 14oz	C6	4lb 10oz
	29	15lb 2oz	11	10lb 04oz	C7	2lb 14oz
	30	14lb 8oz	12	5lb 10oz	C8	1lb 10oz
	31	2lb 8oz	13	N/A	C9	10oz
	32	8lb	14	4lb 04oz	C10	4lb 10oz
Shaley Bank	33	0lb 8oz	N/A		C11	2lb 10oz
	34	16lb 14oz			C12	8lb
	35	0lb 4oz			C13	1lb 4oz
	36	1lb 9oz			C14	4lb 8oz
					C15	1lb 4oz
East Bank						
Deeps	13	2lb	N/A		B5	1lb 8oz

	12	0lb 2oz			B4	4lb 6oz
	11	2lb			B3	2lb 12oz
	10	0lb 1oz			B2	1lb 10oz
	9	9lb 12oz			B1	9oz
				9lb		
Big Point	8	5lb	14	10oz	A15	4lb 12oz
	7	6lb 14oz	13	7lb	A14	5lb 14oz
	6	1lb 15oz	12	N/A	A13	1lb 10oz
	5	3lb 10oz	11	N/A	A12	6lb 8oz
					A11	5lb
Little Point	4	6lb	10	11lb	A10	3lb 4oz
				11lb		
	3	2lb 12oz	9	12oz	A9	8lb 4oz
				19lb		
	2	3lb 6oz	8	2oz	A8	5lb 6oz
	1	5lb 8oz	7	18lb	A7	1lb 12oz
			6	18lb	A6	6lb 8oz
Shallows	N/A		5	8lb 2oz	A5	1lb 14oz
			4	9lb 2oz	A4	7lb 2oz
			3	5lb 4oz	A3	8lb 4oz
			2	7lb	A2	4lb 8oz
				7lb		
			1	14oz	A1	8lb 2oz

The best bag recorded at match 1 (04/12/2016) weighed 18lb and came from Boulders section on the West Bank. During match 2 on day 1 (31/03/2017) the best bag was recorded at Little Point weighing 19 lb 2 oz. At the third match attended (14/04/2017), the best bag weighed 9 lb 6 oz and was recorded at Twin Bridges on the West Bank.

It was felt by anglers fishing match 3 that many fish were spawning (and therefore unattainable) and this was evident in the amount of gravid and spawned fish sampled. Disturbance by pike was also noted by anglers as problematic to coarse fish returns during this match.

3.5.3.2 Loch Ken Match Calendar

To provide further context and information over a year's worth of basic details on most Loch Ken matches was gathered from the 'Loch Ken Match Banter' Facebook page. Details including date and duration of match, angler attendance and weight of best bag by section name were regularly recorded. These details are shown in Table 8 below.

Table 8: Basic details of most Loch Ken Matches held between the 12/03/2016 and 23/04/2017

Date	**Duration (Days)**	**Match Name**	**No. anglers**	**Match Best Bag (lb/oz)**	**Section Name**
12/03/2016	2	Loch Ken Open	19-25	38lb 04oz	Robins
18/03/2016	3		27	37lb 8oz	Robins
25/03/2016	3	Easter Festival	46	34lb 8oz	Robins
28/05/2016	3		18-27	31lbs	Twin Bridges

17/07/2016	1	Loch Ken Sweep	7	17lbs 4oz	Boulders
23/07/2016	2		32	75lb	
05/08/2016	3	LK Mini Festival	11	85lb 12oz	Birches
27/08/2016	3	August Bank Holiday	38	46lb 2oz	Robins
21/09/2016	3		30	40lb 5oz	Robins
24/09/2016	2	Silverfest			
08/10/2016	1	Loch Ken Sweep	7		
09/10/2016	1	SFCA	21	24lb 4oz	Robins
15/10/2016	2		30	34lb 4oz	Twin Bridges
30/10/2016	1	Loch Ken Sweep	6		
06/11/2016	1	Loch Ken Sweep			
20/11/2016	1	Loch Ken Sweep	10		
03/12/2016	2	Christmas Fishing Festival	36	21lb 4oz	Boulders
18/12/2016	1	Loch Ken Sweep	6 or 7		
28/12/2016	1	Loch Ken Sweep	6 or 7		
15/01/2017	1	Loch Ken Sweep	7		
22/01/2017	1	Loch Ken Sweep	7		
29/01/2017	1	Loch Ken Sweep	7		
12/02/2017	1	Loch Ken Sweep	7	20lb 8oz	Big Point
18/02/2017	2		38	40lb 2oz	Robins
04/03/2017	2	Loch Ken Ashes	42	33lb 8oz	Little Point
12/03/2017	1	Loch Ken Sweep	6		
19/03/2017	1	Loch Ken Sweep	5	9lb	Boulders
26/03/2017	1	Loch Ken Sweep	3	15lb 4oz	Little Point
31/03/2017	3		28	19lb 2oz	Little Point
09/04/2017	1	Loch Ken Sweep	3		
14/04/2017	3	Easter Festival	45	19lb 04oz	Little Point
23/04/2017	1	SFCA	8	9lb 10oz	Little Point

From the information available, it can be seen that between the two Easter festivals hosted on Loch Ken (2016 and 2017), 28 further matches have been held on the loch. These include twelve 2 or 3-day matches and sixteen 1-day matches. The largest bag recorded (85 lb 12oz) was taken during a three-day match on 05/08/2016 at Birches (West Bank). Elsewhere, of the 20 best bag weights that could be identified bag weights of >20 lb accounted for 14 (70%) of 20 weights recorded.

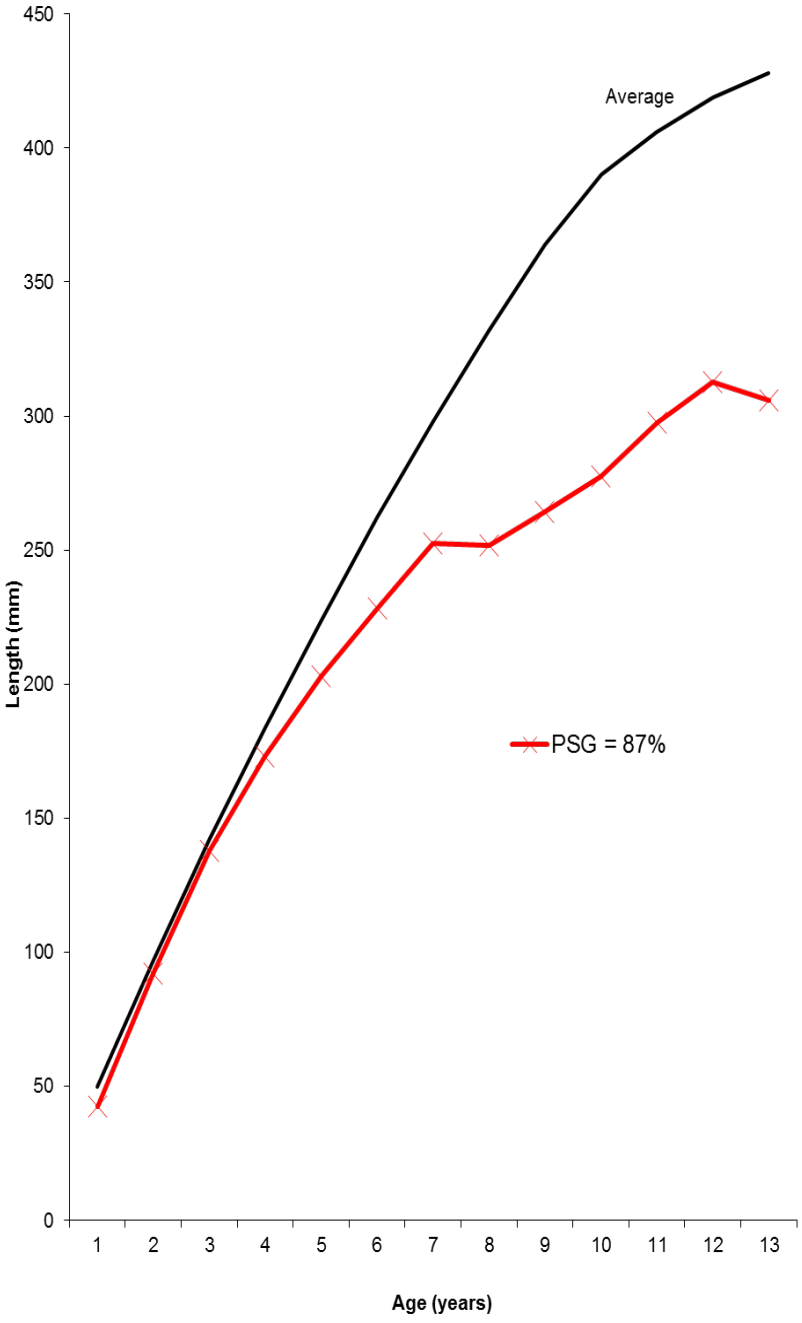
3.6 Fish scale data

In total, scales from 52 fish were aged covering a range of fish species and lengths. The scale reading was undertaken by the EA. For those sampled in winter (October - March), the fish were aged using the edge of the scale as the last complete year. For fish sampled during the summer growth season (April - Sept) the fish were aged using a plus (+) notation. The maximum ages for each species analysed were 13+ in common bream, 6+ in dace, 7 years in perch, 11+ in pike and 13+ in roach.

Fish were sampled from a number of sites and sample sizes were low. There is significant variance in growth rates within specific age classes and mean growth data should be interpreted with care due to the limited number of fish within each age class. It should also be

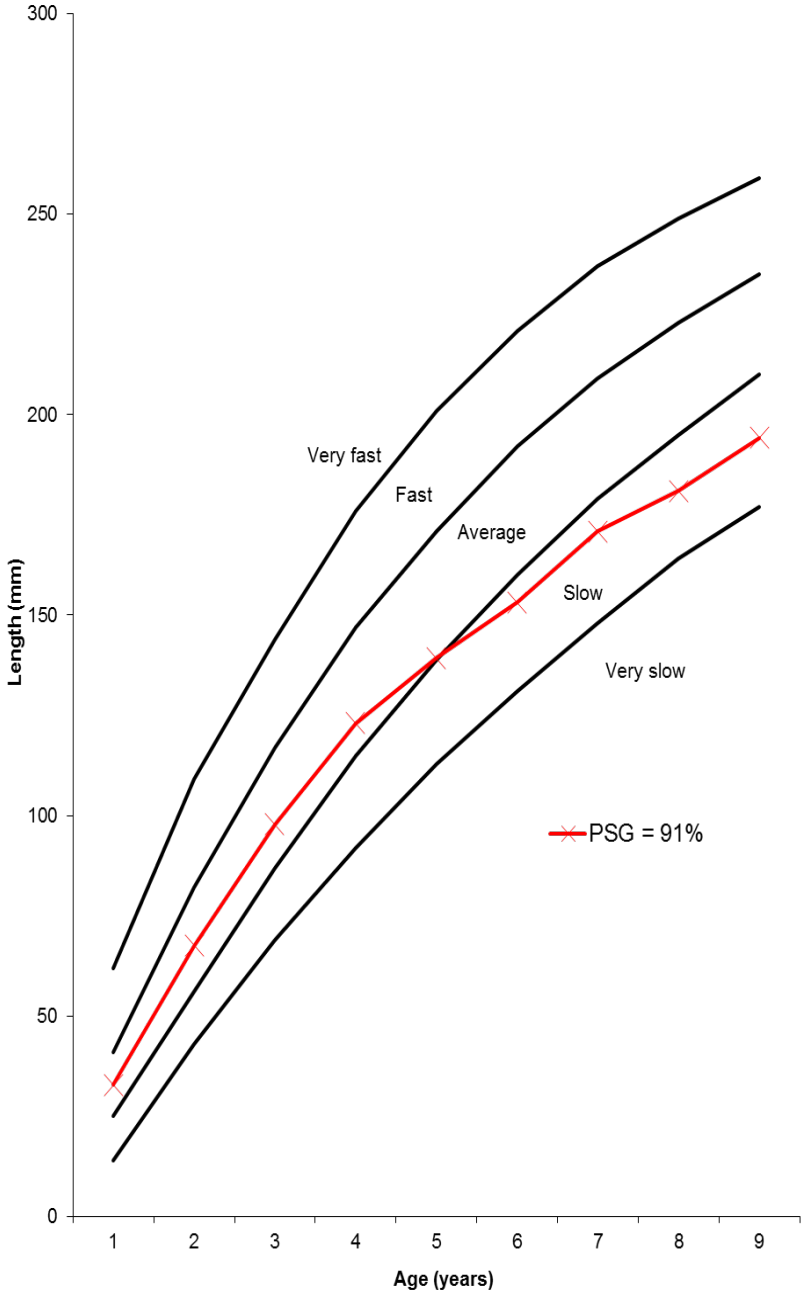
noted that the growth standards used are calibrated for rivers in England where there is a greater volume of data and study to generate these standards than in Scotland.

The age data for each fish species is graphed below against 'species standards for Northern English rivers' for roach and dace, and against 'National growth standards' for pike, bream and perch.



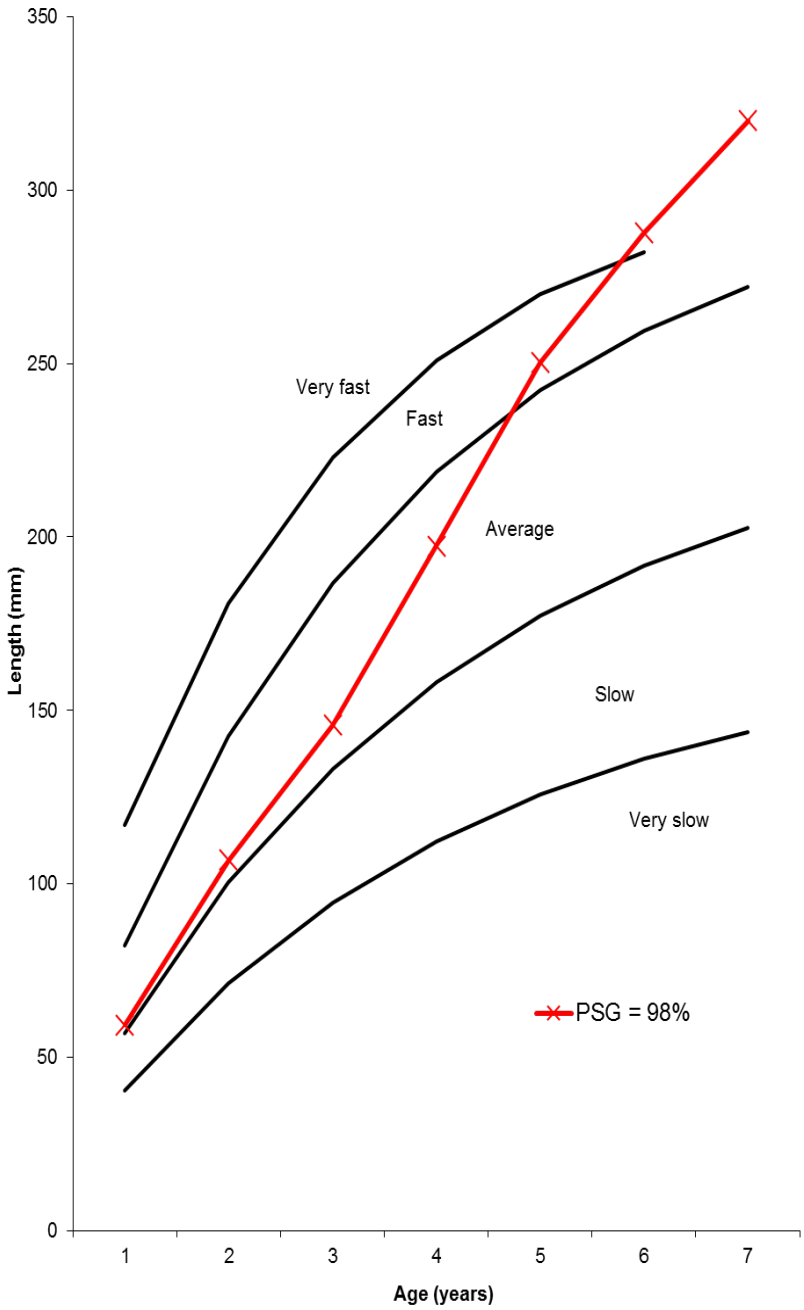
Graph 46: Growth of common bream in Loch Ken compared to the standard growth of common bream in rivers (Hickley and Dexter, 1979)

Common bream showed average growth until about six years old and then growth fell (percentage standard growth (PSG) of 87%) compared to standard growth data from across England (Graph 46).



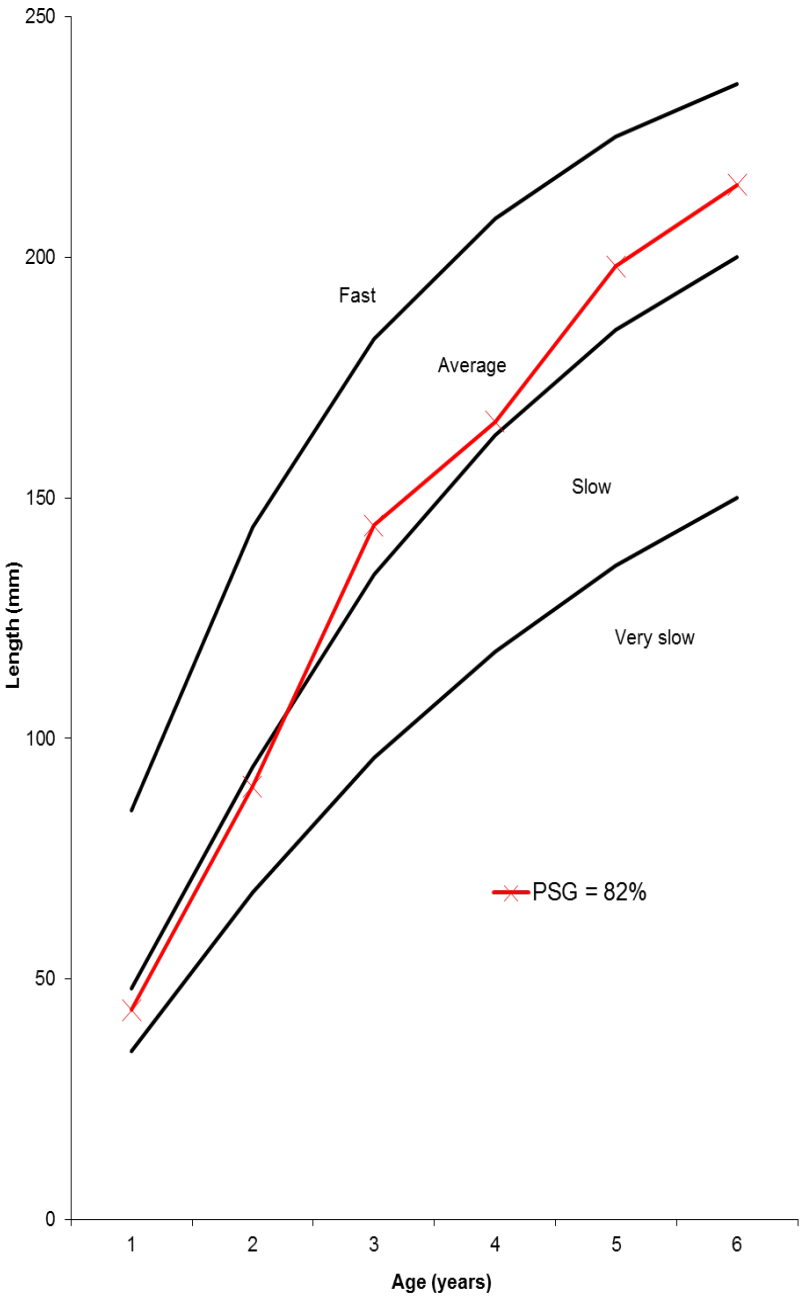
Graph 47: Growth of roach in Loch Ken compared to the standard growth of roach in Northern rivers (National Fisheries Services unpublished data)

The roach were found to have average growth rates (with a PSG of 91%) when compared to species standards from Northern English rivers (Graph 47).



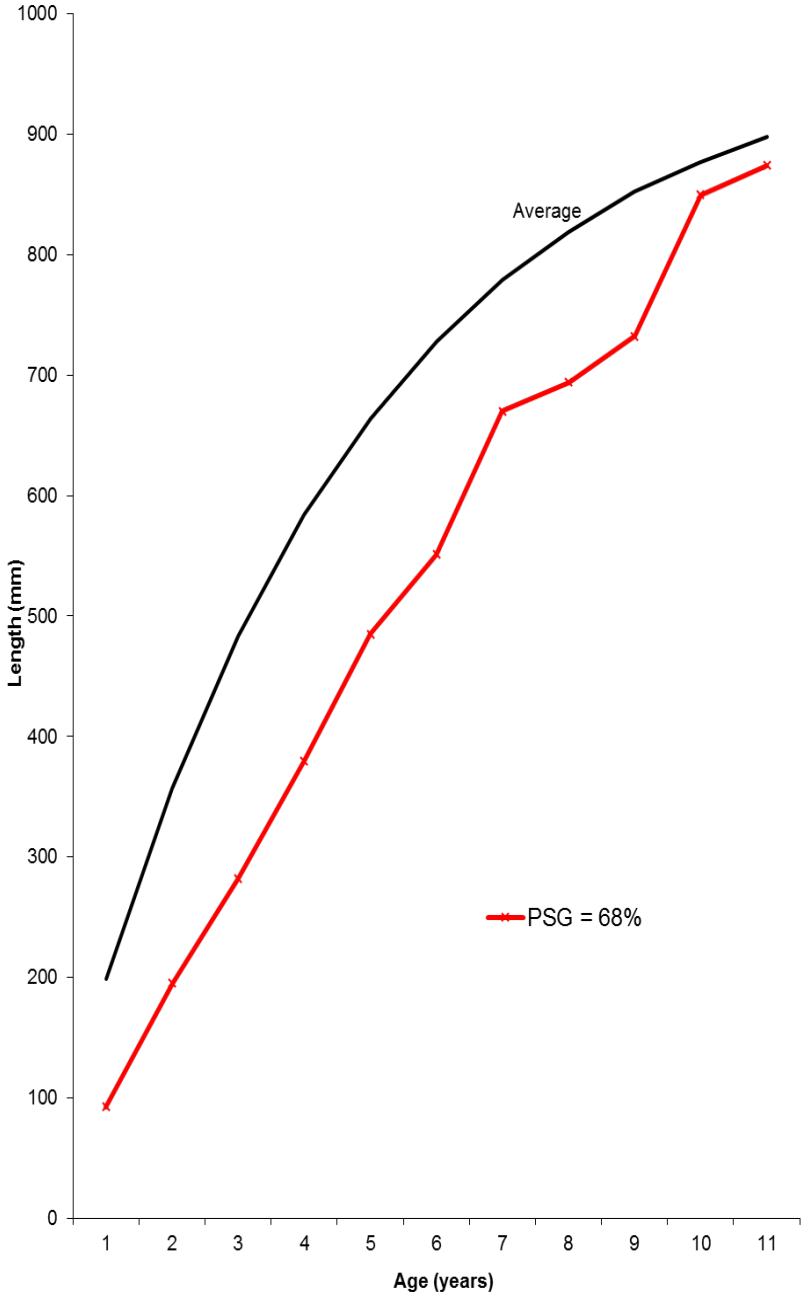
Graph 48: Growth of perch in Loch Ken compared to the standard growth of perch in rivers (National Fisheries Services unpublished data)

The perch from Loch Ken showed normal growth (with a PSG of 98%) up to 4 years old but then growth rates became 'fast' before becoming 'very fast' when aged 6 and 7, when compared to national growth standards (Graph 48).



Graph 49: Growth of dace in Loch Ken compared to the standard growth of dace in Northern rivers (National Fisheries Services unpublished data)

The dace growth rates were found to be close to 'average' (with a PSG of 82%) when compared to species standards from Northern English rivers (Graph 49).



Graph 50: Growth of pike in Loch Ken compared to the standard growth of pike in rivers (Hickley & Sutton, 1984)

Loch Ken pike growth rates (PSG of 68%) when compared to national growth standards from Northern English rivers were low especially for the younger age classes (Graph 50).

4. DISCUSSION

4.1 Public engagement

Two public engagement events were held which were well attended by a range of stakeholders and angling interests. These meetings helped to launch the study and encouraged engagement in the project. A lot of useful information and opinions on a range of issues was collected. Subsequent to the events many of the attendees contacted GFT to provide further material which was of interest to the study. It was very clear that many attendees are interested to be involved in the management of the Loch Ken fishery.

Many of the anglers reported that over time the fishery has changed. Historically Loch Ken was renowned as a roach fishery but bream catches started to increase in the early 2000s and now dominate the overall catch during most angling matches. Ruffe and dace are two fish species which have become established in the loch in recent years. Dace now appear to be one of the most abundant fish within Loch Ken but were rarely reported in angler catches before 2010. Many of the fishers targeting perch consider that since signal crayfish became established within the loch that larger specimen perch are more abundant and have increased in size due to them predating on juvenile crayfish. It would be expected that the fish populations within the loch would change over time as many fish species are known to show natural fluctuations in their annual recruitment and from interactions between the various fish species due to limited resources such as food, spawning habitat or predation. The introduction of various fish species over the years, many which are not considered native to Scotland, and the establishment of a large signal crayfish population has changed the environment and composition of the overall fish population in the loch. Although these reported changes originate from the anecdotal records of anglers there is no reason to doubt their authenticity.

Attendees of the events raised the need to improve access at existing angling areas. It was reported that many of the popular angling points are not suitable for infirm anglers. Scrub encroachment was also mentioned by anglers as limiting access at some locations although this is usually managed by angling interests themselves.

4.1.1 Fishery and fish protection, legal access and the right to fish

The concerns and confusion regarding the policing of fisheries legislation across Loch Ken was also raised by a number of attendees. Many reported having seen activity they considered to be illegal including setting of signal crayfish traps, killing of pike and fishing without permits. This is an important issue for consideration as there is presently no clear lead organisation policing fisheries legislation across Loch Ken.

The various organisations with a potential role to play in the policing of the Loch are detailed below:

- Dumfries and Galloway Council (Council Ranger) – in the last few years the Council has reduced the number of rangers they employ from four down to one. This has reduced the ranger presence at the loch. Policing of angling at Loch Ken has never been a responsibility of the ranger post but has been assumed by many to be so.
- DDSFB – their bailiff undertakes some patrols and ticket checking around Loch Ken but the powers of the bailiff, and funding for the post, are related and limited by legislation to salmon and sea trout.
- NGAA – the club has a trained up member to police their waters which include Loch Ken.
- Police Scotland – have a role to enforce the law.

While it is clearly understood that angling from the shore requires permission, usually addressed by purchasing a permit, there is widespread confusion regarding angling on Loch Ken while afloat on a boat or kayak. It appears that few of these anglers are buying a permit.

To police the Loch Ken fishery effectively it is essential that all relevant parties understand the legal situation with regard to angling on Loch Ken. Legal advice was sought from Robert Younger, Solicitor at Fish Legal Scotland who confirmed the following:

- As Loch Ken is part of the Kirkcudbrightshire Dee which flows into the Solway Firth it is covered by s26 of the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003.

- Under s26(1) of the Salmon Act 2003 anyone fishing without legal right, or without permission of a person having such a right takes or fishes for any fish other than salmon in any stream or other watercourses running into the Solway shall be guilty of an offence.

- Fishery owners around Loch Ken have the right to fish from their banks and also enjoy a 'common fishing right' with other owners over the whole of Loch Ken to be exercised by boat.

- Thus anyone fishing by boat or kayak on Loch Ken will be in breach of s26(1) unless they can show that they had permission from any riparian owner.

This interpretation confirms that anyone fishing Loch Ken, either from the bank or on the loch from a boat or kayak, must be able to show they have permission to fish otherwise they are committing a criminal offense. This permission does not have to be in writing.

Another important misunderstanding highlighted at the events was that the killing of pike by anglers is illegal. It is not a criminal offence in Scotland to kill coarse fish. However, the owners of fishing can set conditions on their ‘permission to fish’ which if not followed would be a breach of their permission to fish.

4.2 Loch Ken angling record

The data collected from this source was useful but the actual number of returned forms in relation to the number of forms distributed was disappointing. It is also important to note that 78% of the forms came from anglers fishing Loch Ken during matches and very few were from boat anglers.

Some key findings regarding the anglers who completed the records were:

- 65% of anglers were aged between 45 – 64 years old.
- Only 17% of the anglers were from Dumfries and Galloway Region.
- Most anglers (61%) were from England.
- 25% of the anglers said they did not have a permit to fish.
- About a third of the anglers reported using fishing techniques to avoid contact with signal crayfish.

The records also provided important information on the issue of biosecurity and showed anglers do have an understanding of measures they should be undertaking and 54% of respondents said they would use disinfectant equipment if it was available at Loch Ken. Despite this awareness and the presence of signal crayfish in the loch only just over a third of anglers (35%) reported actually and actively undertaking biosecurity actions at present. These included a range of recognised measures including checking / cleaning boats and equipment,

visual checks of equipment, only using certain equipment on Loch Ken and drying out equipment after use.

The angling catch information was useful but as many weights and sizes were estimated it was limited how much interpretation of the data could be undertaken. It did help to further the understanding of the level of angling success on the Loch and how many anglers landed signal crayfish. In the 'total bag' records it suggested that out of the 55 records submitted, 30 caught signal crayfish and 25 did not. The highest number of crayfish caught by an angler in a day was reported as being 50 individuals.

4.3 Loch Ken creel record

The Loch Ken creel surveys were useful in providing a profile of the anglers using Loch Ken who are not involved with angling matches. This differs from the angling records which came mostly from match anglers. Numbers of anglers on the loch varied considerably with few fishing during periods of poor weather, ice on the loch or when the fish were likely to be spawning. Again the participants were mostly anglers fishing from the shore of the Loch and boat anglers were poorly represented. Interestingly a wider age range of anglers was noted when compared to the data collected using the angling records. In particular more young anglers were recorded (<25 years old).

Again only low numbers (13%) of the anglers lived in Dumfries and Galloway, with the majority from England (58%). These visiting anglers are important to the local economy with 70% staying at least one night locally. The majority of anglers (73%) stayed for more than two nights. Approximately 66% of these anglers had to pay for their accommodation with the remainder wild camping, sleeping on a boat or staying with friends.

Anglers seemed positive about their angling experience on Loch Ken with 91% of anglers being satisfied or very satisfied with their angling experience. Most of the anglers (82%) had fished previously on Loch Ken. When asked for comments on any negative feedback experienced during their angling trip the answers included the need to review the overall management of the water, limited access for elderly anglers, poor fishing, litter and the killing of fish. Some pike fishermen also raised concerns that increased angling activity could be detrimental to the pike fishery.

Only 50% of anglers said they had a fishing permit to fish on Loch Ken.

Very little fish data was collected by GFT staff during these surveys as few anglers retained their fish in keep nets after capturing them. Pike anglers were found to keep accurate weights of their catches and this data was useful for the study. Actual sampling of pike and large perch was not very successful in the overall study as anglers do not typically retain these fish in keep nets or collect any data on the fish apart from weight. To understand the growth rates and health of these fish it would have been useful to have collected more scale samples from them.

Throughout the current study anglers have regularly raised concerns that there is limited policing or fishery protection undertaken on the loch and that certain fish species are being killed and removed by a minority of anglers for consumption, particularly pike. Pike are the apex predator in Loch Ken and an intentional cull of significant scale, especially if it targeted large pike, would be expected to impact negatively on the overall pike fishery. It is recognised that historically the DDSFB has itself undertaken a pike cull on the loch and this may, to some degree, influence the thinking of some that the pike is less valuable to the loch.

With regard to biosecurity, 89% of anglers were aware of INNS particularly signal crayfish. 58% said that signal crayfish had affected their 'fishing experience' on the loch. Many anglers (64%) deployed fishing techniques to help avoid signal crayfish. 65% of anglers do undertake

biosecurity measures on their fishing tackle. It was difficult to get an explanation from the anglers who did not undertake any biosecurity and answers given included lack of disinfectant facilities, inconvenient and not knowing what to do. It was disappointing to note that only 22% of anglers stated they had heard of the 'Check Clean Dry' campaign. When asked what measures would encourage them to undertake biosecurity there was a strong preference for providing information on permits and signage and little support for running events or the production of a leaflet. There was strong support for providing disinfection stations at Loch Ken with 89% of anglers saying they would use them if provided. With regard to the positioning of any disinfection stations, there was strong support for them to be close to Loch by the main angling areas.

As part of the creel surveys anglers were asked how to improve the fishing / fishery experience on the loch and the most popular suggestions were associated with signal crayfish (control or make a crayfish plan), improving access for anglers, undertake bankside management, construct a fishery plan and dealing with litter. Many anglers replied to say they did not think any improvements were required and were happy with the fishery as it was.

4.4 Seine netting

The seine netting was undertaken with the particular focus of catching juvenile fish living in the shallow weedy waters near Mains of Duchrae. There are still lessons being learnt regarding the netting and catches have not been as high as previous envisaged. Between the initial trial work in 2016 and 2017 there appears to have been some changes at the netting site with some snags (woody debris) washed into the bay and greater levels of silt present. It can be seen that catches improved as the snags were removed and the areas to avoid netting were better identified.

One of the main benefits of the netting is to remove the potential that angling may bias the fish sampled during the data collection in the rest of the project. There is also the potential that other fish species may be present in the loch that are not susceptible to angling but could be an important component of the overall fish populations in the loch.

The netting to date has caught the same fish species which have been sampled through the angling methods. This gives confidence that the angling records, creel records and match catches are representative of the fish populations in Loch Ken.

The fish sampled through the netting cannot be used to calculate the numbers of fish present within the loch. If similar netting locations and effort (including season of netting) were used annually then the catch could be used to indicate general annual trends in fish populations present.

As each fish was accurately sampled for weight and length then the health of these juvenile fish can be assessed by calculating their condition factor. There are many variables that can affect growth rates in different waters. Low growth rate can be an entirely natural phenomenon of for example, nutrient poor, high altitude or northerly waters and is not necessary a concern. It is important to compare sampled growth rates with an appropriate model or comparator rate. As there is limited or no availability of growth rates calculated specifically for or from Scottish coarse fish populations' annual comparisons from within the loch or against English growth rates may be all that is currently possible. However, it will be useful in the future to be able to monitor the health of the fish population by comparing annual condition factors over the years if the netting was to be continued. In isolation the condition factor data from 2017 tell you very little about the health of the Loch Ken fish stocks as there is no historic or Scottish baseline data to compare it to.

4.5 Angling matches

The collection of fish data from the catches at angling matches has been very successful with 2618 fish sampled from three matches. Species identification of all the fish and the sampling of weights and lengths from a sub-sample was completed. Scale samples were also collected to represent a range of sizes across each of the fish species.

This data has identified which key fish species are important for the angling matches. In terms of numbers, roach were the most abundant fish caught, followed by bream, then dace, followed by perch and finally ruffe.

It is not possible to calculate the overall size of the fish populations from the data collected but the information does provide an important baseline to compare future data to if the sampling was to continue. The condition factor of these fish can be calculated but as mentioned in Section 4.4, it would only be if the data collection was to continue that trends in fish growth and health could be considered.

Working closely with the match organisers and consulting with match participants also provided additional useful information regarding how Loch Ken is considered as a location for angling matches. In recent years the ongoing reporting of good fish catches by anglers has helped to encourage anglers back to the fishery following negative publicity about signal crayfish in the angling press. Currently Loch Ken is the most popular venue for angling matches in Scotland (Mark Trueman, personal communication) - believed to be due to affordable ticket costs, consistently good and reliable catches, quality and affordability of accommodation, active match organisers, positive publicity and promotion of the events and their fish catches and proximity to England where most match anglers are travelling from. It was reported that English match anglers are favouring 'wild fish' angling venues over stocked fisheries, making Loch Ken more popular as a location able to offer this experience when compared with many English waters.

On the west bank of Loch Ken the water managed by NGAA is popular for fishing by club members, day tickets and match anglers. Car parking facilities are available close to the water at eight parking locations but access to the loch from the car parking is difficult for the infirm. Anglers have confirmed that access difficulties limits angler participation at angling matches.

While it is known that 20+ angling matches are held annually on the Loch (most are run over at least two days and can be attended by up to 30 – 40 anglers), additional new matches have been trialled during winter 2016 and spring 2017. These new matches appear to have been successful and well attended. Match organisers report there is a need to increase angling capacity to meet angling demand – in many matches anglers are turned away as there is not enough suitable angling pegs. If further expansion of matches is to take place then it is important to consider that different areas of the loch may need to be fished due to seasonal fish movements.

Over 85% of the anglers attending matches come from out with Dumfries and Galloway, including significant numbers from England. Typically each match angler stays for a minimum of two nights in local accommodation and they estimate that each will spend £200 - £500 locally at every match attended. Therefore, there are likely to be significant and direct economic benefits to the area if capacity for additional match anglers could be provided. For example, if 15 new fishing pegs could be created and used for 10 matches per year this would provide an additional 150 match angler days. The potential local spend from these anglers would be £30,000 - £75,000 annually based upon an individual angler spend of £200-£500. New pegs could also be utilised by day anglers out with match days.

4.6 Fish scale data

By collecting scales and lengths of individual fish from across the different species it was possible to graph the growth rates of each fish species. This is a useful data set to start to monitor the health of the Loch Ken fishery. It is possible to compare the fish growth rates in Loch Ken against other standard growth rates from across a range of waters. The comparable data is mostly available from England due to the greater levels of research and coarse fish data collection compared to Scotland. Again it is important to note that the information collected in this project is important baseline data which will give a greater understanding of future trends and changes in the Loch Ken fish populations if the surveys continue. Slow growth rates are not necessary a concern and can be due to a range of natural issues or complex relationships between species. It is fair to assume though that if a fish species has a slow growth rate compared to other waters then it is unlikely that those fish will attain a particularly large size for the species. No particular concerns were identified when considering the growth rates of the fish collected in 2017.

Roach are targeted by many anglers particularly during matches where they appear to make up about half of the total fish caught and are an important element of the overall fishery. Examination of the condition factor of roach found them to be healthy and growth rates, when considered against EA bandings from England, are comparable until the fish are around five years old after which time growth rate is slower than those typically found in England. Similarly common bream are an important fish species for the overall fishery. They also showed average growth rates, when compared to English standards, until they reached six years old and then growth rates fell well below the average. It is not clear why this occurring.

Loch Ken was known historically as a fishery for large pike with some very large specimen fish reported by anglers. The techniques used in the present study did not collect data from significant numbers of pike due to them not being targeted in matches and not being retained by individual anglers to allow sampling. The data from the sample available suggested relatively slow growth rates compared to those from England. However, as growth rates of many fish species in Scotland would be anticipated to be lower than England, typically due to lower water temperatures and nutrient levels, this is not unexpected. Loch Ken was and is one of the top venues in Scotland for large pike and holds abundant prey species to sustain this fishery.

The dynamics of the perch population is interesting. Large perch are particularly targeted by many anglers on Loch Ken and the loch is recognised for specimen fish. Whilst growth rates of small perch are comparable with those from English waters when the fish reach over four years old their growth rates increase and are considered ‘fast’ to ‘very fast’ under the same comparison. There is some evidence that this may be due to them becoming large enough to exploit juvenile crayfish as a food source at this age and growing more rapidly from this dietary preference.

The dace has more recently become established in Loch Ken and the population may not yet have stabilised within the overall ecology of the system. Growth rates, however, are similar or a little lower than that typically found in England throughout all ages of dace sampled.

4.7 Conclusions

4.7.1

Loch Ken continues to support both a healthy fish population and is a popular coarse fishery destination, particularly for visiting anglers who reside outside Dumfries and Galloway. This is despite the presence of a significant signal crayfish population and the negative publicity generated around this issue. It is recognised that the fishery has changed over time – for a number of reasons not just because of the presence of the crayfish. At times it is the limited

access to the loch which restricts the use of the fishery rather than any other factor. Therefor there would appear to be potential to increase access and angling opportunities on the loch and to better promote the fishery to anglers and, with these actions, to increase the economic benefits derived from anglers and angling to the surrounding area.

4.7.2

The fish populations appears to be coping with the pressures that signal crayfish are exerting upon them e.g. predation of eggs, competition for food and grazing of aquatic weeds (which can be important fish spawning and nursery areas for young fish). There is no indication, based on the limited data collected and collated, that any component of the fish community is unhealthy or under identifiable stress. No concerns were currently identified regarding recruitment of any of the fish species in Loch Ken.

4.7.3

The monitoring and sampling confirmed that the main species targeted by anglers are bream, roach, pike, perch and to a lesser extent dace and ruffe. The bream population makes up a significant portion of the overall catch of match anglers. While the bags of bream caught are highly rated by anglers during good fishing conditions the maximum sizes of bream are not particularly notable. Growth rates of bream in Loch Ken are below the average found in data collected from England but are still healthy. Loch Ken is highly rated as a perch fishery with large specimen perch regularly reported.

4.7.4

Most anglers are ‘satisfied’ or ‘very satisfied’ with the fishing on Loch Ken, although there are concerns over the management of the fishery.

4.7.5

Most anglers are aware of the need for biosecurity and the problems associated with invasive species. Many anglers do undertake some biosecurity measures when fishing on Loch Ken. There was strong support for providing further biosecurity facilities at Loch Ken and a willingness to use them if available.

4.7.6

It is important to note that these conclusions are based on data collected in this study alone (2016 and 2017), which has focussed on coarse fish and coarse angling, and on-going monitoring should be undertaken to assess and understand the situation in the future. Future monitoring should also recognise the presence of the important trout and salmon populations in the catchment whilst retaining a focus of monitoring of the coarse fish community within the loch

5. RECOMMENDATIONS

Listed below are recommendations for projects which could be included in the Galloway Glens Partnership Project (Stage 2) application and / or delivered in the future as part of an overall management strategy for the Loch Ken Fishery.

These project proposals have been developed from information provided following various consultations and discussions undertaken as part of the overall study including the public events, 'creel survey' questionnaires and meetings.

5.1 Monitoring of Loch Ken fish populations

It is advised that a programme of surveys to monitor the fisheries resource within Loch Ken is undertaken over a further five year period based on the techniques used in this study. These surveys would provide information on the health of the overall fish population and help to understand annual fluctuations in fish recruitment and growth rates. It is important to ensure that any increased angling pressure which may result from the overall project is undertaken in a sustainable manner. There may be opportunities for education institutions to assist in the recommended monitoring work or undertake associated research (see section 5.6).

It is recommended that the following surveys and activities are undertaken annually:

- Catches from two angling matches, in March and September, should be surveyed following the protocol of the present study. These matches should provide up to 500 fish each for sampling.

- Two seine nettings should be undertaken during the summer months, July and September. The protocol of the present study should be followed. This survey will target the juvenile life stages of fish.

- 12 Creel surveys should be undertaken annually to target anglers fishing for pike and larger sized perch anglers. Keep nets should be made available to these anglers to retain fish until data can be collected. Most of the anglers which are targeting large perch do so from boats or kayaks.

- There should be engagement with academic institutes to develop projects and studies suitable for undergraduate and postgraduate students on an ongoing basis. These studies could supplement ongoing monitoring work, undertake additional or more extensive analysis of this work, initiate new studies on, for example species interactions (including with signal crayfish) and do this on a cost effective basis whilst adding to the body of knowledge of the loch.

5.2 Governance, Management and Planning of the fishery

It is clear that improved governance is required to ensure the long term sustainable development and marketing of the loch fishery and to address some of the minor disagreements that occur at times between the different angling interests.

It is recommended that:

- Formation of a Loch Ken Fisheries Management Group (LKFMG) - as a sub-group to the present Loch Ken Advisory Management Committee. The group would require a clear purpose and ability to protect and improve the fishery. It is important that 'terms of reference' are agreed and that administrative support is provided to facilitate meetings. Group membership would need to be diverse to represent the range of

angling stakeholders and interested parties. The group would become an important local consultative group and forum on issues such as planning or development associated with the loch.

Regular events could be organised for the members of the group to increase their knowledge and understanding of the different angling interests and a range of fishery management issues such as fish sampling techniques and habitat enhancement.

- Production of a 5 year Loch Ken Fishery Management Plan - to assist the LKFMG in their new role. This plan would provide background information, describe the fishery resource, identify limiting factors and set out potential solutions and achievable actions which could be undertaken. The plan would assist with the planning of resources and securing of funds. The LKFMG would be directly involved in the production of the plan so as to utilise their knowledge and expertise and to ensure their 'buy in' and support. The plan would require revision and updating on a 5 year cycle.

  Much of the information required for the plan will have been collected for the present Loch Ken study. It will be important that the plan production involves adequate consultation with all interested parties.

5.3 Fishery Protection, Access and Local Management Capacity

Earlier in the report (section 4.1.1) the complexity of the fisheries protection and access legislation is explained which needs to be enforced effectively across Loch Ken. There is a need to develop a common understanding of the responsibilities, legalities and legislation to build capacity and improve the overall protection of the fishery. The proposed LKFMG (outlined in section 5.2) should play an important role in co-ordinating the required actions.

It is recommended that:

- The writing of a general set of fishing rules for Loch Ken and organising sign up by all those involved in the issuing of permission to fish on the loch. It is important that these rules cover boat and kayak fishing due to the present confusion regarding their need to have permission to fish on the loch.

- A wildlife crime event is organised annually for all interested parties. The event would be aimed at encouraging closer co-ordinated working, increasing knowledge, capacity building, protection of natural heritage, identifying shortcomings in the present enforcement arrangements and to clarify the various relevant wildlife and fisheries legislation.

- Improve co-ordination between existing individuals and groups involved presently in fishery protection on the loch and clarity of their roles. The possible enhanced roles of volunteers in assisting in the protection of the fishery should be explored.

5.4 Development: Promotion and increasing accessibility

From the public engagement work and information collected from the loch users it is clear that improving accessibility would allow more anglers to fish and increase the angling experience that the loch offers. This can be achieved through a combination of actions and projects which are set out below.

It is recommended that:

Initially, improved access at two existing angling areas for infirm anglers through the construction of ramps and steps is considered. Suitable locations were highlighted during the project along the West bank (at GR: NX 64584 74195 & GR: NX 65104 73390). These locations had available safe car parking, access at the loch edge, space and angling opportunities. Other suitable locations requiring improvement may be available at other fisheries around the loch.
To progress this recommendation, there will need to be support from the relevant land owner and planning permission / detailed engineer designs will be required for gaining accurate costings.

Creation of 10 – 20 new fishing pegs to allow the expansion of angling matches (both in number of attendees and number of matches). The exact locations for this work will need carefully consideration to address when there is a limitation in pegs. Three possible locations for new pegs were identified with match organisers which require further investigation:

- Loch access along the road to Ringour and around Ged Point (west bank)
- Loch edge accessed through Shirmers Wood (east bank)
- Upstream of the Glenlochar Barrage (west bank)

Creation of an 'Angling Passport Scheme' - it should be investigated whether there would be interest amongst owners of fishing rights around the loch to set up an 'angling passport system' to assist in selling angling tickets. These schemes cover a number of fisheries which are then marketed and promoted collectively through scheme literature and websites. In England there are eight main schemes and one in Scotland (Annan). These schemes appear to be popular with and informative for anglers, and have opened up many fisheries which otherwise may not have offered angling. These schemes also minimise administrative burdens and costs to fishery owners. For information on how passport schemes work on West Country Trust waters and on the River Annan see relevant website links in references.

A Loch Ken passport system would require buy-in and support from enough owners of fishings and land owners to be viable and it is unclear at this stage, and without further discussion, whether this would be forthcoming or not. However, such a scheme could provide an effective way of providing additional angling opportunity around the loch to a common set of rules and standards whilst generating modest angling related revenues to fishery owners with limited ongoing input from these owners.

Improved marketing using websites and social media – although individual fisheries around the loch are well publicised on the internet, it is recommended that Loch Ken as a high quality location for coarse angling, should be given greater prominence in future promotion of the area particularly through the wider Galloway Glens project. There may also be opportunities to utilise the local Fish Pal website (link provided in reference section) which could be used to provide on-line booking facilities for selling tickets around Loch Ken to the benefit of participating fisheries. Elsewhere, Fish Pal partners have used the booking system to generate income to support local management – this may be possible for the fisheries of Loch Ken.

5.5 Biosecurity

Throughout this project it has been found that anglers fishing on Loch Ken were aware that INNS were harmful, particularly signal crayfish, but not many were actively undertaking biosecurity measures to minimise the risk of further introductions or transfer of species to the loch especially. Reciprocally, and equally important, there was little evidence of biosecurity measures being implemented to prevent the spread of crayfish to other waters from Loch Ken. Given the prominence of the crayfish issue on the loch and the impacts and disruption caused by this it is important that the loch is not inadvertently the source of new crayfish introductions by angler (or other water user) transfers.

There is currently little information regarding INNS or biosecurity available around Loch Ken or on angling permits.

An effective and co-ordinated biosecurity programme is required for Loch Ken to provide improved information to Loch users and the necessary infrastructure / facilities to disinfect equipment.

It is recommended that:

- Standard wording should be produced for all angling tickets, boat registrations, etc which describes the harm of INNS in general, what to do with signal crayfish when caught and reinforces the need to practice effective biosecurity.

- Improved signage around the loch to promote the Check-Clean-Dry national campaign, explain the legal situation regarding signal crayfish, and how to undertake effective biosecurity measures. Specific posters for Loch Ken should be produced for use in noticeboards currently located around the loch at the main car parking points where many anglers and other users access the loch.

- Provision of two fixed disinfectant stations to encourage all anglers to disinfect their equipment before and after fishing on Loch Ken. Disinfectant stations are designed to make it easy for anglers to disinfect their equipment and clothing and contain suitable disinfectant and brushes within a plastic storage container. On-going maintenance is required to top up disinfectant, replace brushes, etc. A static disinfectant station could be fitted on each bank of the loch; one at the public boat slip way near the viaduct and the other at the recently constructed car parking near Ringour. These locations are near popular angling locations and are easily accessible. A mobile biosecurity station should also be purchased and made available to event organisers for angling matches and water based events.

- A dedicated staff resource is required to support and organise the biosecurity work detailed above, including the promotion of bio-security issues for all loch users.

5.6 Education and Research Opportunities

Loch Ken is well suited to offer a wide range of educational and research opportunities which would be of national interest. Of particularly interest would be work associated with the signal crayfish population and how it is interacting with the ecology of the loch. Loch Ken also offers a wonderful opportunity to study the various coarse fish species present.

It is recommended that:

- Discussions are held with school, higher and tertiary education institutions to explore possible opportunities to study Loch Ken and its ecology. Possible projects could suit a range of interests and levels, from primary and secondary school projects to undergraduate to postgraduate levels.

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The Angling Trust; Your story matters: UK angling movement survey www.anglingtrust.net/invasivesurvey

The Broads invasive species survey: http://www.broads-authority.gov.uk/__data/assets/pdf_file/0018/405342/Invasive_species_survey_report.pdf

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ANNEX 1: LOCH KEN ANGLING RECORD

Loch Ken Fisheries Study: **Angling Record** *Key:*		*insert text or cross (**X**) box that applies*

Your details	Name					Age		
	Address or residential town/region							
	Phone No.							
	Email							
Your fishing trip	Date			Time at start of fishing (00:00)				
	Duration	Less than 1/2 day		Half Day		Full Day		
	Permit			Yes		No		
		If 'yes' - please detail permit issuer						
Your fishing	Location	Bankside		Boat				
	Grid ref	or circle within map overleaf						
	Target Species (cross all that apply)	Pike	Bream	Roach	Perch	Trout	Other	
	No. rods							
	Angling method	Bait:		Lure:		Fly		
		Float		*Spinner*				
		Ledger/feeder		*Spoon*				
				Crankbait				
		Other						
	Are you using a particular method to avoid signal crayfish?					Yes	No	
	If 'Yes' - describe method?							
Catch	Did you catch anything?			Yes		No		
	Species	Pike	Bream	Roach	Perch	Trout	Other	

Bag weights	Species	Total weight lb oz	Estimate Yes	No	Photo

Individual fish Species	Length (cm)	Weight (lb/oz)	Photo* (Y/N)	Comments (distinguishing features)

*If you would be happy to supply these via email, please include email contact above

Biosecurity

Do you undertake any biosecurity measures, actions or precautions?

Yes ☐ No ☐

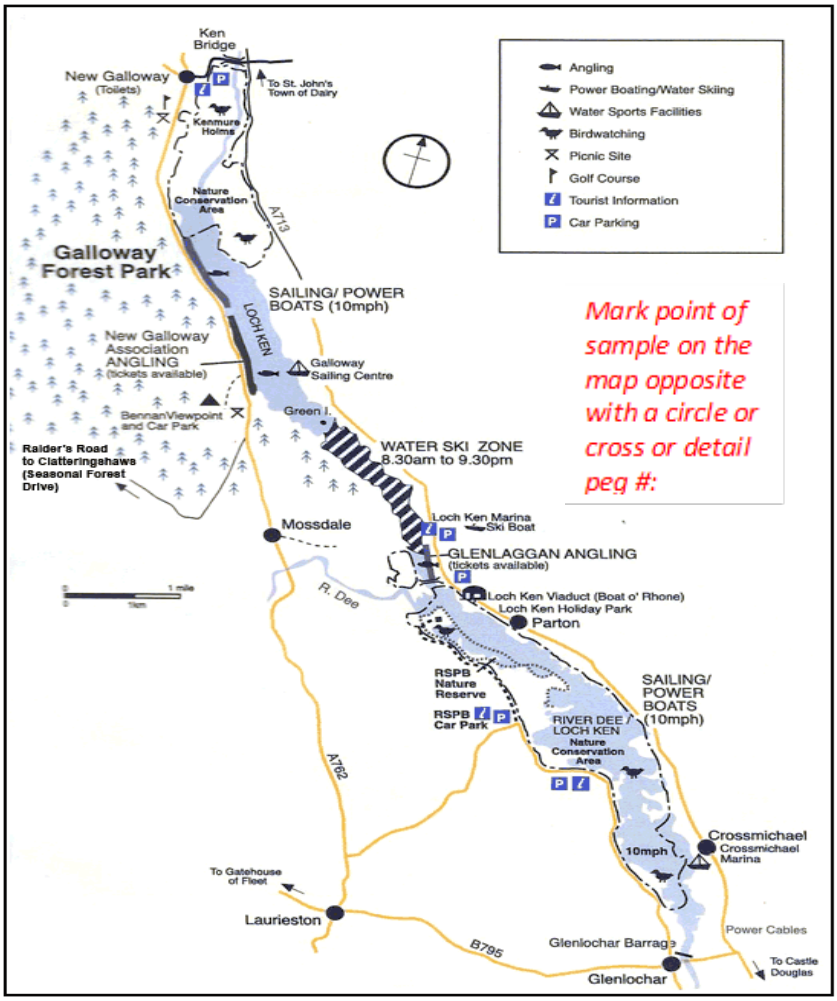
If 'Yes', what?

Would you use disinfection stations if these were available next to the loch with clear instructions for use? Yes ☐ No ☐

Please return your completed Loch Ken Angling Record to mail@gallowayfisheriestrust.org , a participating ticket outlet: Loch Ken Holiday Park (Parton), The Post Office & J R Hopkins Newsagents (New Galloway) or a match official

WIN A £50 ANGLING VOUCHER

Please remember to include contact details with your completed form to be in with a chance of winning a £50 angling voucher! A winner will be selected monthly between November 2016 & July 2017. Keep an eye on the Galloway Fisheries Trust Website and social media pages for more information on this project.



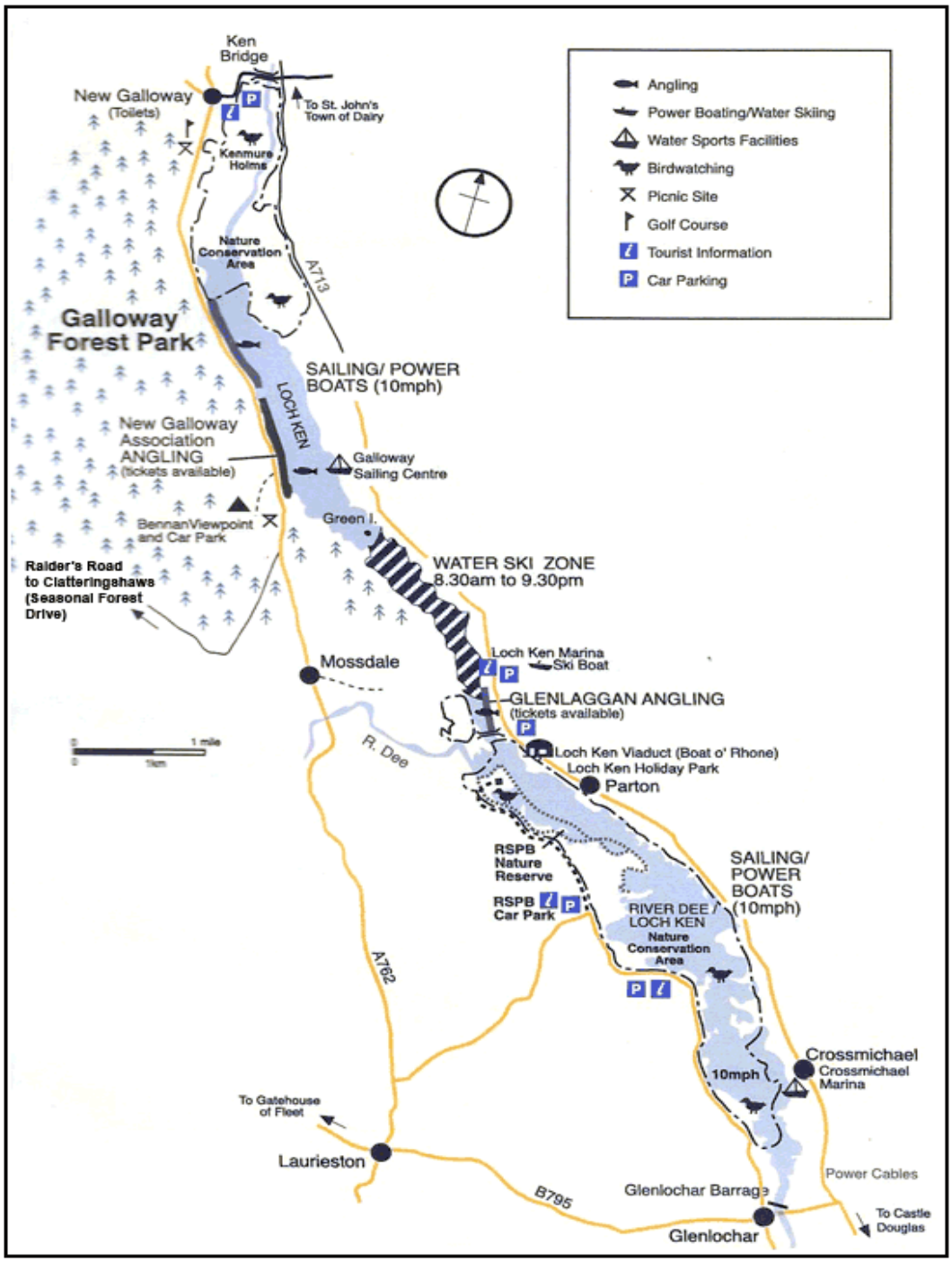
ANNEX 2: LOCH KEN CREEL RECORD

Loch Ken Creel Record				*Key:*		*insert text or cross (**X**) box that applies*	
Your details	Name						
	Address or residential town/region						
	Tel. No.			Email			
Your fishing trip	Date			Time at start of fishing (00:00)			
	Duration	Less than 1/2 day		Half day		Full Day	
	Permit			Yes		No	
		If 'yes' - please detail permit issuer					
Your fishing	Location	Bankside		Boat			
	Grid ref	or circle within map overleaf					
	Target Species	Pike	Bream	Roach	Perch	Trout	Other
	(cross all that apply)						
	No. rods		Method				
Sample Catch	Have you caught anything today?			Yes		No	
	If yes and returned - what was your catch?						
	Species						
	Estimate #/weight						
	If fish caught are present - ask to process individual fish						

Fish No.	Species	Length(cm)	Weight (lbs/oz)	Photo*	Comments (distinguishing features/scale sample taken)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

16					
17					
18					

*If angler has additional fish photos to share, please provide an email address above



Mark point of sample on the map above with a circle or cross

Angler profile	Angler sex				Male		Female
	Age	<18	18-24	25-34	35-44	45-54	55-64	65+
	Are you a Dumfries and Galloway resident?						Yes	No
	How far have you travelled to reach Loch Ken (miles)?				0 to 10	10 to 30	30 to 50	>50
	Is your visit:				Day		Overnight	
	If overnight, give stay duration					1 night	2 nights	>2 nights
	Accomodation type:	Wild camping			Campsite	Self cater	B&B	Hotel
	Is this your first fishing visit to loch ken?						Yes	No
	If no, how often do you visit annually?							
	Are you aware of any INNS species in/around Loch Ken?						Yes	No
Invasive Non-Native Species (INNS)	If 'Yes' - what?							
	Have you come across any invasive non-native species today?						Yes	No
	If 'Yes', what?							
	Do you undertake any biosecurity measures?						Yes	No
	If 'Yes': How often do you carry out biosecurity measures?							
	Always	Sometimes	Only if moving between waterbodies/catchments					
	If 'No': Why don't you carry out biosecurity every time you fish?							
	- No-one else does it so why should I?							
	- I don't believe it makes any difference							
	- I don't know what I'm supposed to do							
	- There were no facilities available for me to wash equipment							
	- I don't visit waters which have invasive species							
	- It's inconvenient/I don't have time							
	- Other (please specify)							
Bio-security	Are you aware of the Check, Clean, Dry Campaign?						Yes	No
	Provide Check, Clean, Dry Leaflet							
	How should we raise awareness of biosecurity at Loch Ken?							
	- provide basic information on permits							
	- run events for loch users to provide information							
	- distribute leaflets							
	- erect information panels							
	If there were disinfectant stations at Loch Ken - would you use them?						Yes	No
	If 'Yes' - where would you suggest they be positioned to encourage useage?							
	- On banksides, within 100m of popular fishing locations							
	- At ticket outlets							
	- In villages, e.g. New Galloway or at entry points to loch e.g. marina							
Angler	Are there any ways Loch Ken fishery and fishing experience could be improved?							

Feedback		
	No - leave water/fishery as it is	
	Yes - make a crayfish control plan	
	Yes - carry out predator control	
	Yes - construct a fishery management plan	
	Yes - run a hatchery programme *(please specify for what in comments)*	
	Yes - undertake bankside management	
	Yes - all 'Yes' suggestions above	

Comments:

Have ASC affected your fishing experience today?	Yes	No
Are you using a particular method to avoid signal crayfish?	Yes	No

If 'Yes' - describe method?

On a scale of 1-5, how satisfied are you with your fishing experience at Loch Ken?

1-very unhappy	
2-un-happy	
3-neither happy or unhappy	
4-happy	
5-very happy	

Please explain score with +ve/-ve aspects:

ANNEX 3: ANGLING MATCH STRATEGY

Galloway Fisheries Trust (GFT) have recognised that Loch Ken Coarse Fish Matches can provide a brilliant resource for sampling the coarse fish community within Loch Ken.
With a number of anglers fishing the loch at one time (40+), adopting very similar fishing methods, and for the same fishing duration - sampling fish on a match day will help GFT both identify the fish species most readily available to anglers fishing from the bankside and generate baseline data for future year's comparison on species length, weight and age class structures.

Developing an approach to fish sampling

GFT attended a match in December 2016 where many fish were captured by anglers. A total of 302 fish were length sampled (172 bream, 55 roach, 45 ruffe, 15 dace and 15 perch and a wide range of fish lengths recorded (172-400 mm bream, 93-200 mm roach, 92–160 mm perch, 110–210 mm dace and 68–105 mm ruffe). At this event it was clear that it was not likely to be possible to sample all fish from future matches given the time, staff and logistical constraints in doing so. Therefore, an approach to sampling has been prepared to ensure that representative samples of the range of fish captured are recorded to make best use of the staff resources available and the opportunity to gather valuable data.
We have investigated how age could be extrapolated from recorded fish length data using the Environment Agency document 'Fish Ageing Survey Report (2014)'. Using scale samples, the report confirmed that fish age structures in bream, roach and perch can be verified in relation to age classes predicted by length data.
Using the average length to age conversion table provided within the report, lengths of bream, roach and perch have been categorised into age classes by compartmentalising groups of lengths within a recording sheet (Appendix 1). Predicted age classes are shown as alternate shaded and clear bands in the length categories and these will be used to help guide scale sampling within these bands to verify predicted age class structures of bream, roach and perch caught at Loch Ken matches.
Weight information will also be collected from across the predicted age class bands to allow an assessment of condition factor to be determined by species and age.

It is proposed that the following general approach to sampling will be undertaken:

- All fish of all species will have individual lengths recorded
- For all species other than ruffe i.e. bream, perch, roach and dace, weights will be recorded and scale samples taken from every 10th fish not within the predicted 0+ age class
- A subset of these scale samples will be selected for reading and analysis with other samples archived for later use

It is noted that volume of fish captured in the match may prevent all fish being measured for length or limit the feasibility of collecting scales and weights from every 10th fish. In such circumstances GFT will determine how best to proceed to maximise the data collected at any match.

General methods

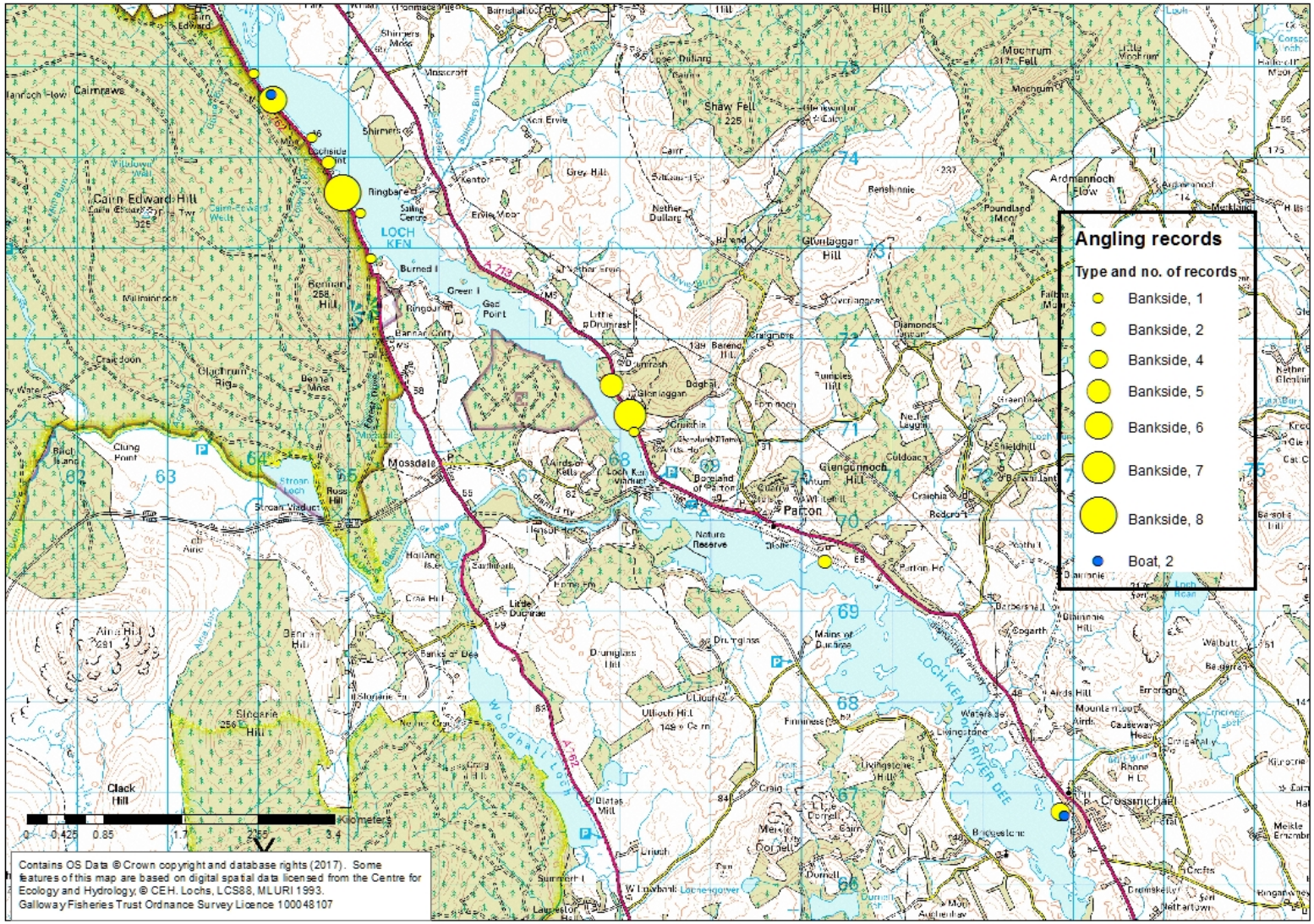
GFT will aim to sample between 200 and 300 fish during each Loch Ken match in cooperation with the anglers and match organisers. GFT will be present at the close of the match and follow the competition weigh-in and transfer anglers catches held in keep nets after weigh-in into GFT keep nets. Fish held in GFT keep nets will be secured in the water on each section of the competition until weigh-in has finished and processing can commence.
Fish will be processed from as wide a geographic range as the match competition is spaced (normally West Bank within NGAA section and East Bank on Glenlaggan). GFT will split into two teams to cover the East and West Bank.

Working in pairs, GFT will sample all (or most) fish for length data; weight and scale samples (not for ruffe) will be collected from every 10th fish of each species across a range of sizes.

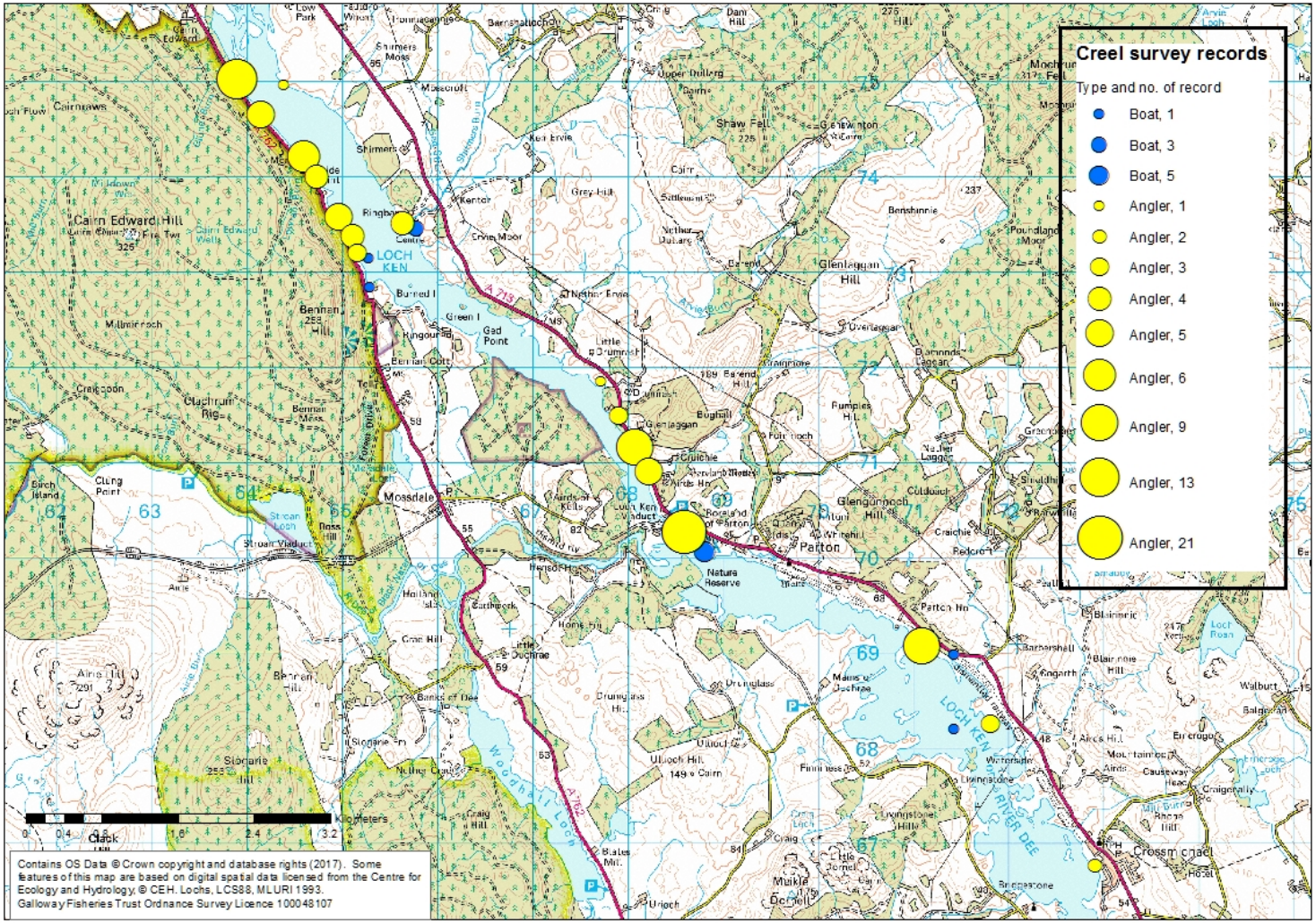
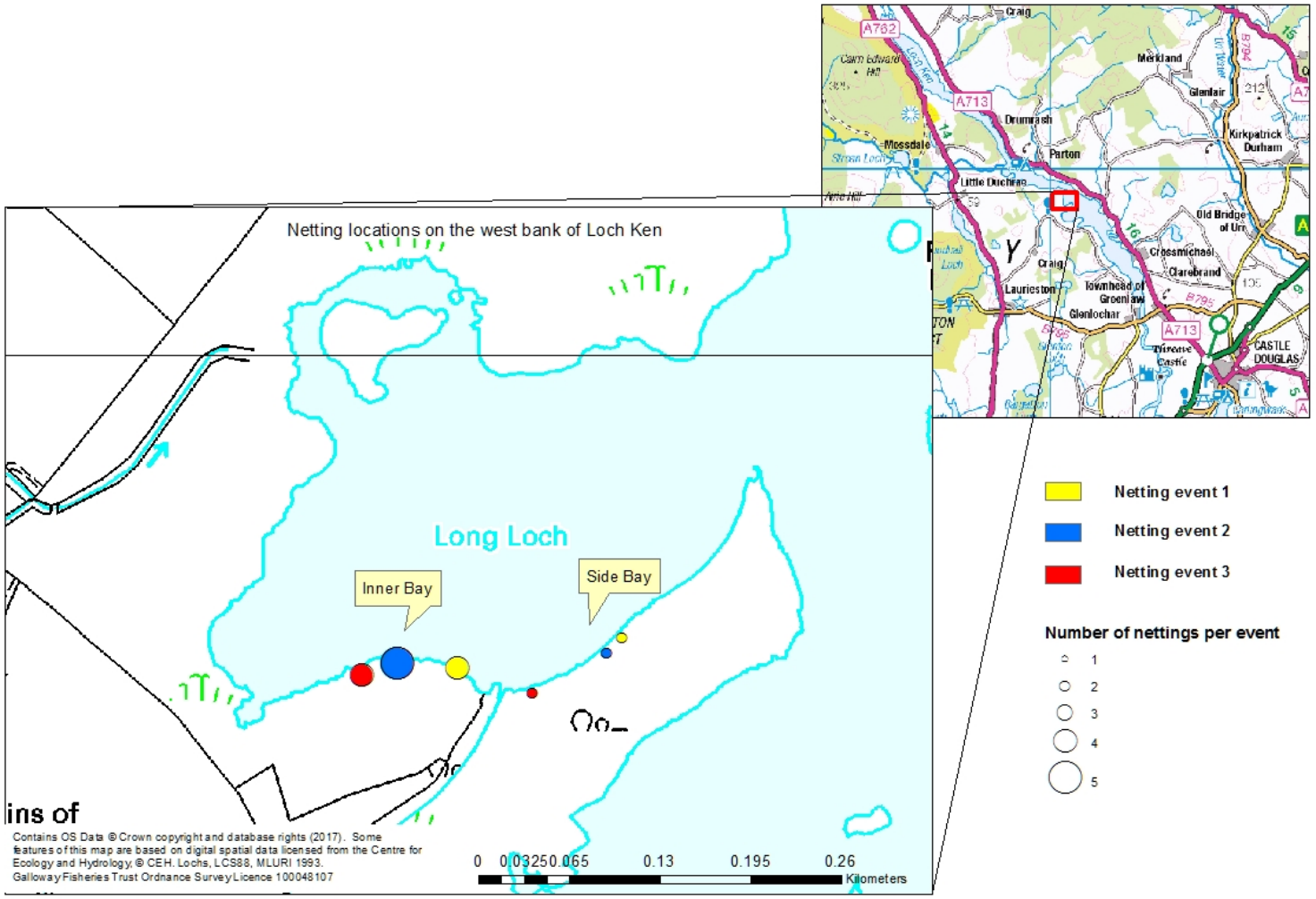
ANNEX 4: TABLE IDENTIFYING LOCATION BY SECTION NAME, PEG NUMBER AND GRID REFERENCE WHERE FISH WERE SAMPLED DURING THREE LOCH KEN MATCHES

Section Name	Peg # Match 1	GR Northing	GR Easting	Peg # Match 2	GR Northing	GR Easting	Peg # Match 3	GR Northing	GR Easting
West Bank									
Twin Bridges	14	264587	574224	N/A			B6	264565	574226
	to 17	264602	574200				B10	264600	574200
Robins	18	264731	573993	1	264738	573987	B11	264724	573996
	to 22	264766	573947	4	264770	573958	B15	264765	573951
Birches	23	264944	573602	5	264940	573607	C1	264940	573597
	to 27	264980	573563	9	264985	573557	C5	264978	573564
Boulders	28	265142	573254	10	265135	573258	C6	265140	573260
	to 32	265154	573215	14	265152	573203	C10	265158	573208
Shaley Bank	33	265186	573142	N/A			C11	265185	573138
	to 36	265203	573112				C15	265200	573110
East Bank									
Deeps	13	268011	571309	N/A			B5	268012	571314
	to 9	268042	571262				B1	268040	571272
Big Point	8	268071	571137	14	268078	571132	A15	268079	571135
	to 5	268097	571111	11	268094	571114	A11	268094	571112
Little Point	4	268144	571001	10	268148	571002	A10	268144	571014
	to 1	268157	570968	6	268166	570967	A6	268160	570962
Shallows	N/A			5	268200	570942	A5	268198	570938
				1	268241	570876	A1	268228	570886

ANNEX 5: MAP OF LOCATIONS WHERE ANGLER RECORDS WERE UNDERTAKEN ON LOCH KEN



ANNEX 6: MAP OF LOCATIONS WHERE CREEL SURVEYS WERE UNDERTAKEN ON LOCH KEN



ANNEX 7: MAP OF LOCATIONS WHERE SEINE NETTING SURVEYS WERE COMPLETED ON LOCH KEN