

# National Research Survey Programme

## Lakes 2017

### Lough Leane

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Iascach Intíre Éireann  
Inland Fisheries Ireland



Inland Fisheries Ireland

National Research Survey Programme

**Fish Stock Survey of Lough Leane,  
September 2017**

Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

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Cover photo: Netting survey on Lough Derravaragh © Inland Fisheries Ireland

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## 1.1 Introduction

Lough Leane forms part of the Killarney National Park, Macgillicuddy's Reeks and Caragh River catchment candidate Special Area of Conservation (Plate 1.1a, Plate 1.1b and Fig. 1.1). This is a large area that encompasses a wide variety of habitats designated under Annex I of the EU Habitats Directive, including blanket bog, alluvial woodlands, alpine heath and both upland and lowland oligotrophic lakes. The site has also been selected for the following species, Killarney fern, slender naiad, freshwater pearl mussel, Kerry slug, marsh fritillary, Killarney shad, Atlantic salmon, brook lamprey, river lamprey, sea lamprey, lesser horseshoe bat and otter; all species listed on Annex II of the EU Habitats Directive (NPWS, 2005).

Lough Leane itself is the largest of the Killarney lakes, with a surface area of 1,978ha, a mean depth of 13m and a maximum depth of 66m. The lake is categorised as typology class 8 (as designated by the EPA for the Water Framework Directive), i.e. deep (mean depth >4m), greater than 50ha and moderate alkalinity (20-100mg/l CaCO<sub>3</sub>).

A decline in water quality in the Lough Leane catchment has been evident throughout the past 40 years and in 1997 Lough Leane was classified as hypertrophic (Coillte 2010; Killarney National Park, 2010). This decline in water quality was principally attributed to increased levels of nutrients, most significantly phosphorus, being transported via the rivers to the lakes, which has led to eutrophication in the past (Coillte, 2010; Killarney National Park, 2010). A number of algal blooms were noticed in Lough Leane during the summer of 1997 and this event resulted from excessive phosphorus levels within the lake and had the potential to cause significant damage to the ecology of the lake (Anon, 2009). In response to this, Kerry County Council set up the Lough Leane Working Group to co-ordinate efforts to monitor and manage water quality within the catchment between 1998 and 2001 (Coillte, 2010). This monitoring and management programme was a catchment wide initiative, aimed at stopping the eutrophication process and restoring the rivers and lakes to a satisfactory state by reducing phosphorus inputs from all sources. The project also aimed to identify and quantify all significant point and diffuse sources of pollution input, in particular those inputs from local authority activities, agriculture, forestry and septic tanks.

Lough Leane contains a variety of fish species, including brown trout, sea trout, ferox trout, salmon, perch, flounder, eel, tench and Arctic char. A landlocked sub-species of the twaite shad known as the Killarney shad (*Alosa fallax killarnensis*) is also present and is unique to this lake (Plate 1.2). The



Killarney shad are listed in Annex II of the EU Habitats Directive. Lough Leane is famous for its free rising trout and good salmon fishing (O' Reilly, 2007), with hundreds of spring salmon and grilse being caught on the troll every year. Brown trout in the lake average 0.23kg; however, a specimen ferox trout was caught in 2005 weighing nearly 8kg (O' Reilly, 2007).

Inland Fisheries Ireland (previously the Central Fisheries Board) has undertaken a number of fish stock surveys on Lough Leane. Two surveys were undertaken in 2001 and 2003 to assess the status of the Killarney shad population (Roche and Rosell, 2003). The Killarney shad population size at the time was estimated to be in excess of 20,000 individuals of 1+ and older fish (Roche and Rosell, 2003). A small number of Arctic char were also recorded during the 2003 survey. In 2002, the Irish Char Conservation Group carried out fish surveys on all three Killarney Lakes and brown trout were recorded in all. Muckcross (Middle) lake was the only lake in which Arctic char were captured, with the population in Lough Leane believed to be extinct due to the eutrophication of the lake (Igoe, *pers. comm.*). Arctic char were not recorded in Upper Lake; however there are reports from anglers that Arctic char have been caught and released there.

Lough Leane was more recently surveyed in 2008, 2011 and 2014 as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al.*, 2009, Kelly *et al.*, 2012a and Kelly *et al.*, 2015a and 2015b). During the 2014 survey, perch were found to be the dominant species present in the lake. Salmon, brown trout, Arctic char, Killarney shad, flounder, rudd, tench and eels were also captured during the survey.

This report summarises the results of the 2017 fish stock survey carried out on the lake. In addition to the routine fish stock survey results the report includes results from a parallel hydroacoustic and pelagic gill netting survey. The latter survey aimed to incorporate hydroacoustic technology into the existing standard sampling protocols used to assign ecological and conservation status for the Water Framework and Habitats Directive for conservation and endangered fish species. The hydroacoustic survey concentrated on the deeper sections of the lake (depth >9m) and covered *circa* 31km of hydroacoustic transects.

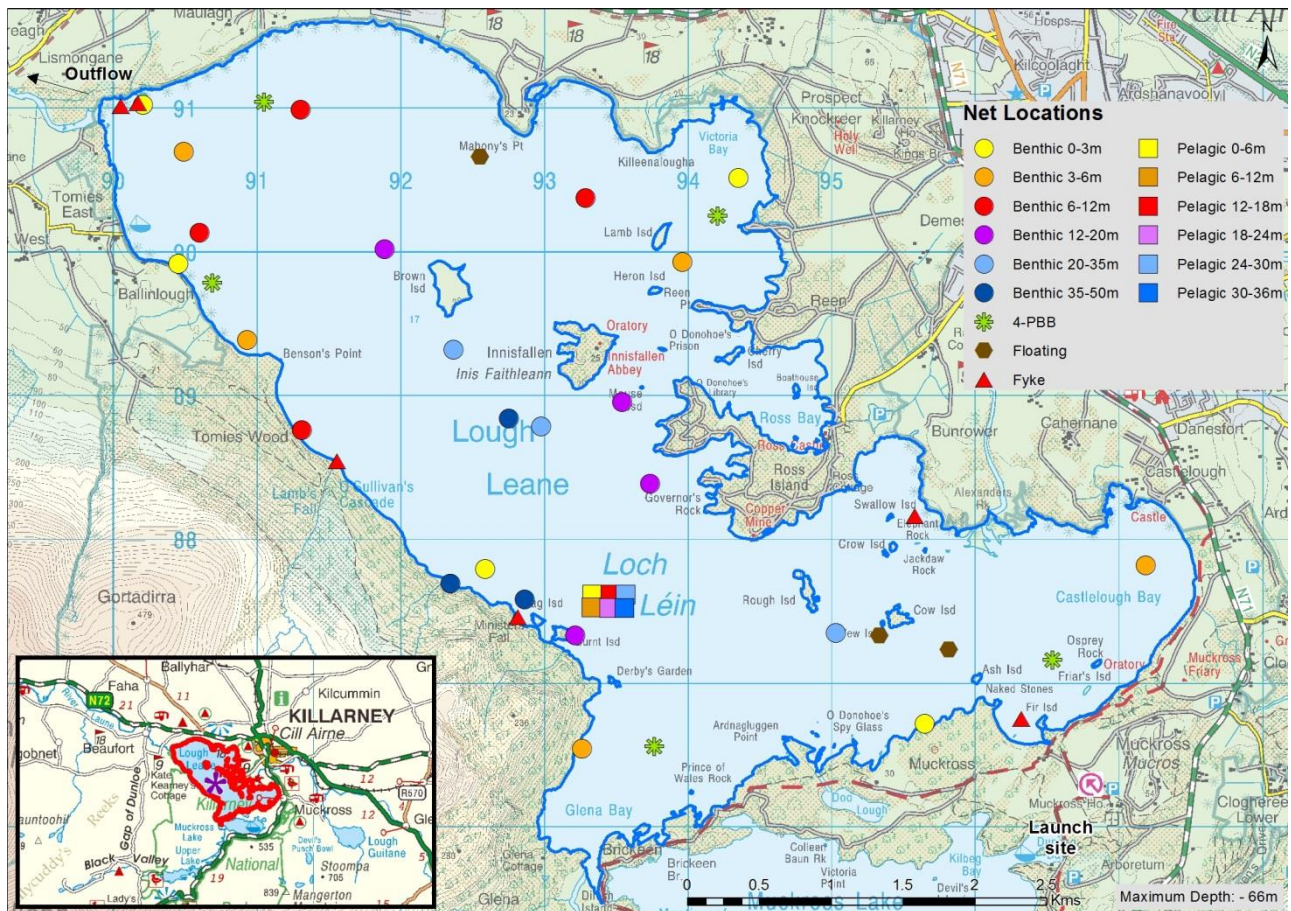




**Plate 1.1a. Lough Leane**



**Plate 1.1b. Lough Leane**



**Fig. 1.1 Location map of Lough Leane showing locations and depths of each net (outflow is indicated on map)**



## 1.2 Methods

### 1.2.1 Netting methods

Lough Leane was surveyed over three nights from the 11<sup>th</sup> to the 14<sup>th</sup> of September 2017. A total of six sets of Dutch fyke nets (Fyke), 24 benthic monofilament multi-mesh (BM CEN) (12 panel, 5-55mm mesh size) CEN standard survey gill nets (6 @ 0-2.9m, 4 @ 3-5.9m, 4 @ 6-11.9m, 4 @ 12-19.9m, 3 @ 20-34.9m and 3 @ 35-49.9m) and three floating monofilament multi-mesh (FM CEN) (12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed randomly in the lake (33 sites) (Fig. 1.1). In addition five four-panel benthic braided survey gill nets (4-PBB) were deployed in the lake. The four-panel nets are composed of four 27.5m long panels each a different mesh size (55mm, 60mm, 70mm and 90mm), tied together randomly. The site locations for the benthic monofilament multi-mesh gill nets (BM CEN) and the four-panel benthic braided survey gill nets (4-PBB) were chosen randomly within fixed depth zones (0-2.9m, 3-5.9m, 6-11.9m, 12-19.9m and 20-34.9m). Six pelagic multi-mesh (12 panel, 6.25-55mm mesh size) 30m x 6m CEN standard survey gill nets were set (PM CEN) and systematically sampled the pelagic from 0-36m (Fig.1.1). The remaining pelagic depth 36-66m was not sampled due to the weather conditions deteriorating during the latter part of the survey.

A handheld GPS was used to mark the precise location of each net. The angle of each gill net in relation to the shoreline was also randomised.

All fish apart from perch were measured (fork length) and weighed on site and scales were removed from all brown trout, Killarney shad, salmon, Arctic char, rudd and tench. Live fish were returned to the water whenever possible (i.e. when the likelihood of their survival was considered to be good). Samples of fish were retained for further analysis.

### 1.2.2 Hydroacoustic survey of the pelagic zone

Killarney shad and Arctic char are of high conservation importance; therefore it is desirable to monitor them using minimum impact techniques such as hydroacoustic technology. Hydroacoustics (echo-sounding) technology sends a beam of sound into the water column and fish in the beam send back an echo. The location of the fish is determined by the time it takes for the echo to return and the size of the fish by how loud the returning echo is. Species specific hydroacoustic estimates require ground





truthing; this is normally undertaken using species proportions from survey gill nets with appropriate coverage of the acoustically sampled area.

A hydroacoustic survey was conducted on Lough Leane during the day between the hours of 09:12 and 12:54 on the days of the 12<sup>th</sup> and the 13<sup>th</sup> of September 2017. The survey in accordance with the European standard (CEN, 2015) followed a systematic parallel transect design, had a total track length of 30.9km and the degree of coverage had a co-efficient of variation (CV) of 0.10. Water temperature ranged from 15.5°C at the surface to 10.9°C at 50m with a mean temperature of 14.2°C. Mean water conductivity was 92µS/cm.

A SIMRAD EY60 scientific echosounder with a vertical split-beam circular transducer (200kHz) was deployed off the side of the boat at a depth of 0.5m. The transducer was calibrated using the appropriate standard copper sphere and the nominal 3dB beam angle of the transducers was 7°. Ping rate was set at 5 pings s<sup>-1</sup>, pulse duration was 0.256ms. A differential GPS connected to the echosounder recorded the location and reported an average sailing speed of 3.2km h<sup>-1</sup> or 0.9m s<sup>-1</sup>. Lake conditions in Lough Leane were calm during the hydroacoustic survey with little wave action. Range sampled was 80m; transmitted power was 90W.

Sonar5 Pro post-processing software (Balk and Lindem, 2017) was later used to analyse the hydroacoustic recordings, track counting with fish baskets *in situ* was the method applied. Base threshold for data conversion was -120dB. Amplitude echograms were converted to TVG 40logR. Single Echo Detection (SED) criteria were defined as follows; minimum echo length: 0.7, maximum echo length: 1.4, maximum phase deviation: 0.15, maximum gain compensation: 3dB (one-way), multi-peak suppression: medium. Dynamic sound profile was applied and minimum target strength (TS) for SED acceptance was set at -50dB which corresponded to a *circa* 5cm fish (Love, 1971). Love's equation provides estimates using total length. To simplify comparisons within this report total length was converted to fork length, using data from Roche and Rosell (2003) and all lengths reported here refer to fork length. The simple automatic function was used to track fish; min track length was 2 pings, max ping gap was 1 and gating range was set at 0.15m. Fish were tracked in two layers (1.5 to 45m and >45m) as echograms and gillnetting data indicated a shift in the species composition above and below 45m. Transects ranged in length from 277m to 3,187m with a mean length of 1,630m, transects >540m were divided into smaller elementary sampling units (ESU); mean length of ESU was 536m. Analysis detected fish in both layers and all echoes detected were divided into four acoustic size categories. The acoustic echoes were subsequently apportioned to individual fish species and size categories based on



their percentage occurrence in the pelagic survey gill nets and the benthic gill nets set at depths >45m (Fig. 1.1). The arithmetic mean of fish density and biomass were calculated from hydroacoustic data recorded. The relative abundance of Killarney shad and Arctic char in the 1.5-45m and >45m layers were estimated for four acoustic size categories; small (4.9 to 9.6cm), medium (9.7 to 19.6cm), large (19.7 to 31.9cm) and very large (32.0 to 119.3cm).

### **1.2.3 Fish diet**

Fish were frozen before being dissected for stomach content analysis in the IFI laboratory. Total stomach contents were inspected and individual items were counted and identified to the lowest taxonomic level possible. The percentage frequency occurrence (%FO) of prey items were then calculated to identify key prey items (Amundsen *et al.*, 1996).

$$\%FO_i = (N_i / N) \times 100$$

Where:

%FO<sub>i</sub> is the percentage frequency of prey item i,  
N<sub>i</sub> is the number of a particular species with prey i in their stomach,  
N is total number of a particular species with stomach contents.

### **1.2.4 Biosecurity - disinfection and decontamination procedures**

Procedures are required for disinfection of equipment in order to prevent dispersal of alien species and other organisms to uninfected waters. A standard operating procedure was compiled by Inland Fisheries Ireland for this purpose (Caffrey, 2010) and is followed by staff in IFI when moving between water bodies.



## 1.3 Results

### 1.3.1 Species Richness

A total of nine fish species were recorded on Lough Leane in September 2017, with 555 fish being captured. The number of each species captured by each gear type is shown in Table 1.1. Brown trout was the most common fish species recorded. Perch, rudd, Killarney shad, salmon, Arctic char, tench and eels were also recorded. During the previous surveys in 2008, 2011 and 2014 the same species composition was recorded with the exception of Arctic char which were not recorded in 2008 and sea trout which were only recorded in 2011 (Kelly *et al.*, 2009, Kelly *et al.*, 2012a and Kelly *et al.*, 2015a and 2015b).

**Table 1.1. Number of each fish species captured by each method during the survey on Lough Leane, September 2017**

Scientific name	Common name	Number of fish captured					
		BM CEN	FM CEN	4-panel	PM CEN	Fyke	Total
<i>Salmo trutta</i>	Brown trout	124	13	28	16	7	188
<i>Scardinius erythrophthalmus</i>	Rudd	135	1	0	0	4	140
<i>Perca fluviatilis</i>	Perch	118	0	1	0	1	120
<i>Alosa fallax killarnensis</i>	Killarney shad	0	3	2	48	0	53
<i>Salmo salar</i>	Salmon	6	0	17	2	0	25
<i>Platichthys flesus</i>	Flounder	3	0	4	0	1	8
<i>Salvelinus alpinus</i>	Arctic char	1	0	0	0	0	1
<i>Tinca tinca</i>	Tench	0	0	1	0	0	1
<i>Anguilla anguilla</i>	European eel	1	0	0	0	18	19

### 1.3.2 Fish abundance

Fish abundance (mean CPUE) and biomass (mean BPUE) were calculated as the mean number/weight (g) of fish caught per metre of net. For all fish species except eel, CPUE/BPUE is based on all nets, whereas eel CPUE/BPUE is based on fyke nets only. Mean CPUE and BPUE for all fish species captured in the 2017 survey are summarised in Table 1.2.

Brown trout was the dominant fish species in terms of abundance (CPUE) and salmon was the dominant fish species in terms of biomass (BPUE) captured during the 2017 survey (Table 1.2).



**Table 1.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Lough Leane, 2017**

Scientific name	Common name	Mean CPUE ( $\pm$ S.E) **
<i>Salmo trutta</i>	Brown trout	0.115 (0.025)
<i>Scardinius erythrophthalmus</i>	Rudd	0.105 (0.030)
<i>Perca fluviatilis</i>	Perch	0.090 (0.024)
<i>Alosa fallax killarnensis</i>	Killarney shad	0.012 (0.009)
<i>Salmo salar</i>	Salmon	0.009 (0.003)
<i>Platichthys flesus</i>	Flounder	0.003 (0.001)
<i>Salvelinus alpinus</i>	Arctic char	0.001 (0.001)
<i>Tinca tinca</i>	Tench	0.0002 (0.0002)
<i>Anguilla Anguilla</i> *	European eel*	0.050 (0.012)*
		<b>Mean BPUE (<math>\pm</math> S.E) **</b>
<i>Salmo trutta</i>	Brown trout	14.183 (3.203)
<i>Scardinius erythrophthalmus</i>	Rudd	11.754 (3.330)
<i>Perca fluviatilis</i>	Perch	6.082 (1.622)
<i>Alosa fallax killarnensis</i>	Killarney shad	1.002 (0.718)
<i>Salmo salar</i>	Salmon	24.871 (8.050)
<i>Platichthys flesus</i>	Flounder	0.798 (0.329)
<i>Salvelinus alpinus</i>	Arctic char	0.104 (0.104)
<i>Tinca tinca</i>	Tench	0.374 (0.374)
<i>Anguilla Anguilla</i> *	European eel*	6.419 (1.938)*

Note: On the rare occasion where biomass data was unavailable for an individual fish, this was determined from a length/weight regression for that species (Connor *et al.*, 2017).

\*Eel CPUE and BPUE based on fyke nets only

\*\*CPUE and BPUE data above for all fish species except eels are not comparable to earlier surveys as extra panels were added to the 1-PBB to provide additional information on large fish.

The mean CPUE and BPUE (excluding the 55mm, 70mm and 90mm mesh panel of each 4-PBB and the pelagic multi-mesh gill nets) for all species captured in the 2008, 2011, 2014 and 2017 surveys are illustrated for comparison purposes in Figures 1.2 and 1.3.

Although the mean brown trout and perch CPUE and BPUE fluctuated slightly over the four sampling occasions, these differences were not statistically significant (Fig 1.2 and 1.3). The only difference was in the rudd CPUE and BPUE which was significantly higher in 2017 than all other sampling years (Kruskal-Wallis  $H=15.37$ ,  $P<0.001$  and  $H=15.09$ ,  $P<0.001$ ).



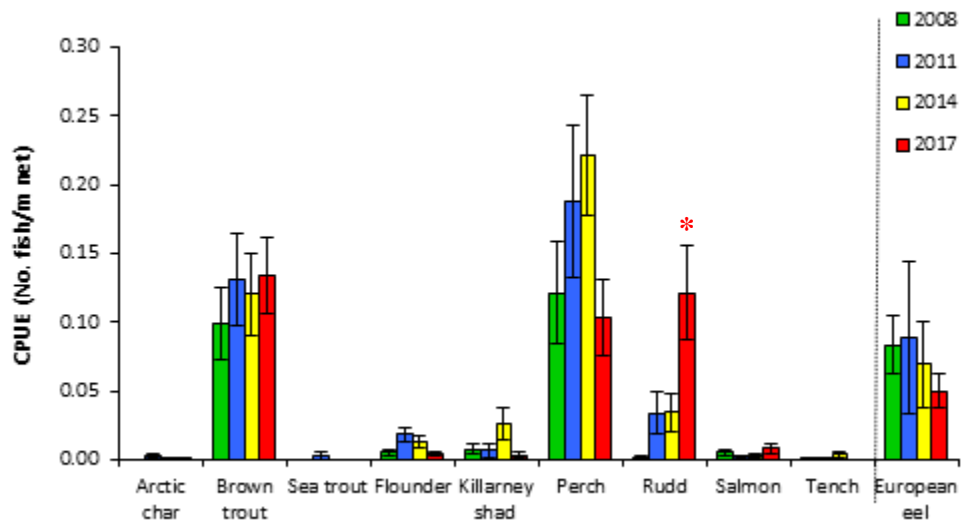


Fig. 1.2. Mean ( $\pm$ S.E.) CPUE for all fish species captured in Lough Leane (Eel CPUE based on fyke nets only), 2008, 2011, 2014 and 2017 (\* indicates a significant difference)

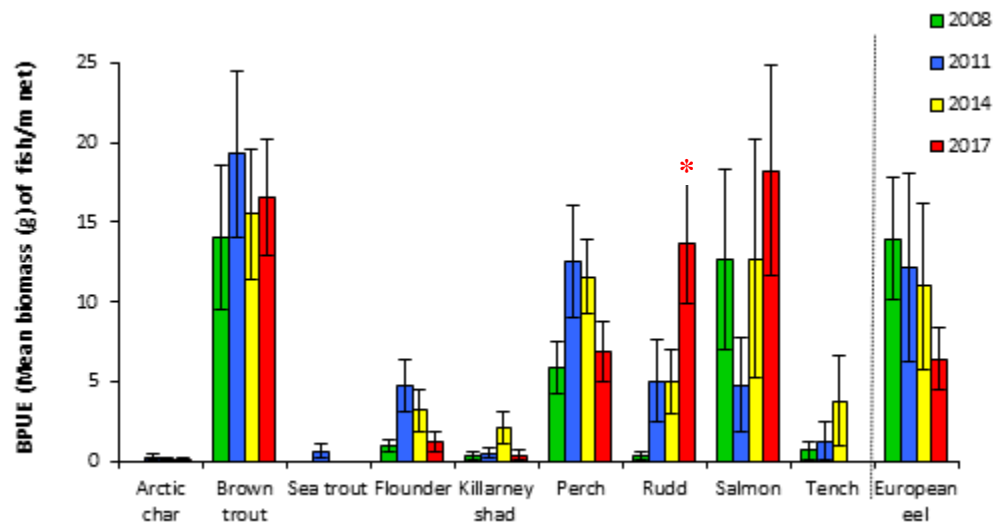
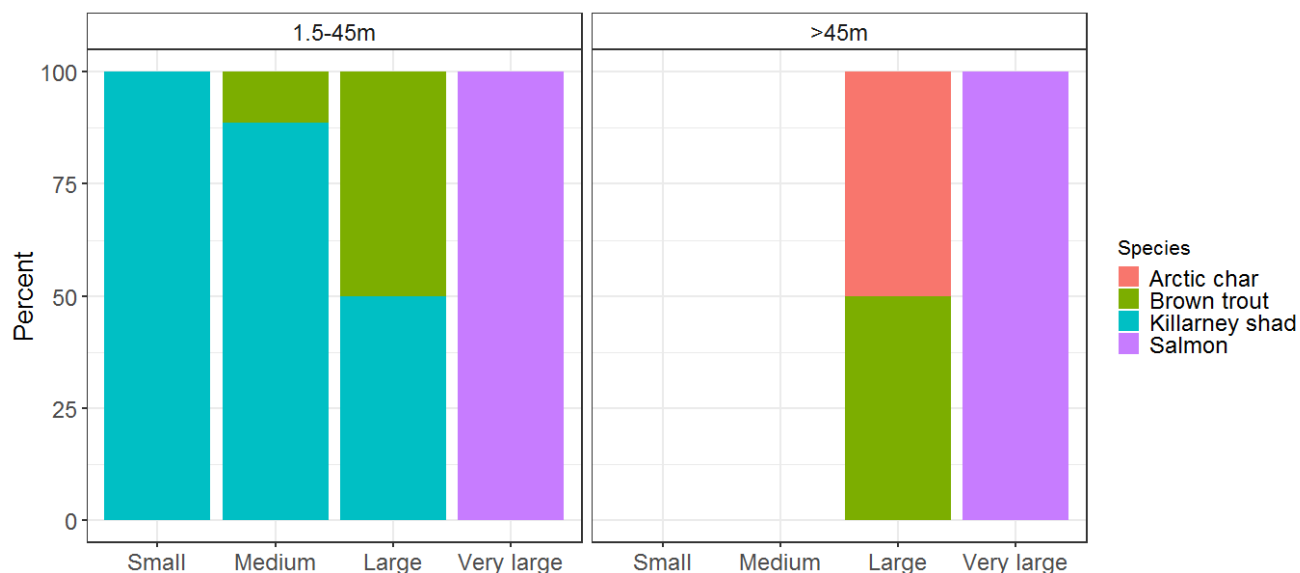


Fig. 1.3. Mean ( $\pm$ S.E.) BPUE for all fish species captured in Lough Leane (Eel BPUE based on fyke nets only), 2008, 2011, 2014 and 2017 (\* indicates a significant difference)

### 1.3.3 Percentage occurrence of fish species in the ground-truth netting

The percentage occurrence of Killarney shad for the small (4.9 to 9.6cm), medium (9.7 to 19.6cm), large (19.7 to 31.9cm) and very large (32.0 to 119.3) size classes was calculated to be 100%, 88.6%, 50% and 0%, respectively in the 1.5-45m depth layer (Fig. 1.4). No Killarney shad were observed below 45m. The percentage occurrence of Arctic char for the small, medium, large and very large size classes respectively was calculated to be 0%, 0%, 50% and 0%, respectively in the >45m depth layer (Fig. 1.4). No Arctic char were observed above 45m during the survey.



**Fig. 1.4. The percentage occurrence of selected fish species captured in two depth layers (1.5-45m & >45m) (includes all survey gill nets) used to ground-truth acoustic estimates**

### 1.3.4 Acoustic abundance of fish and conservation species in the pelagic zone

The total abundance of fish in the 1.5-45m and >45m depth layers were estimated as 20.20 fish ha<sup>-1</sup> and 4.14 fish ha<sup>-1</sup> respectively (Table 1.3). The apportionment of echoes to species using percentage occurrence data (Fig 1.4) resulted in a total abundance estimate of 18.60 Killarney shad ha<sup>-1</sup> and 0.04 Arctic char ha<sup>-1</sup> in the pelagic zone of Lough Leane (Tables 1.4 and 1.5).



**Table 1.3. Arithmetic mean acoustic total fish abundance (fish ha<sup>-1</sup>) and biomass (g ha<sup>-1</sup>) for four fish sizes and total fish in the pelagic zone of Lough Leane, September 2017**

Layer	Size category dB Range Size class (cm)	Small -50 to -45dB 4.9 to 9.6	Medium -44 to -39 dB 9.7 to 19.6	Large -39 to -35dB 19.7 to 31.9	Very Large -34 to -23dB 32.0 to 119.3	Total -50 to -23dB 4.9 to 119.3
<b>Abundance (fish ha<sup>-1</sup>)</b>						
1.5-45m		10.99	8.07	0.92	0.22	20.20
>45m		3.24	0.82	0.09	0	4.15
<b>Total</b>		<b>14.23</b>	<b>8.89</b>	<b>1.01</b>	<b>0.22</b>	<b>24.26</b>
<b>Biomass (g ha<sup>-1</sup>)</b>						
1.5-45m		82.99	529.68	215.30	221.36	1049.33
>45m		21.30	72.62	15.17	0	109.09
<b>Total</b>		<b>104.29</b>	<b>602.30</b>	<b>230.47</b>	<b>221.36</b>	<b>1158.42</b>

**Table 1.4. Arithmetic mean acoustic total Killarney shad abundance (Killarney shad ha<sup>-1</sup>) and biomass (g ha<sup>-1</sup>) for four fish sizes and total in the pelagic zone of Lough Leane, September 2017**

Layer	Size category dB Range Size class (cm)	Small -50 to -45dB 4.9 to 9.6	Medium -44 to -39 dB 9.7 to 19.6	Large -39 to -35dB 19.7 to 31.9	Very Large -34 to -23dB 32.0 to 119.3	Total -50 to -23dB 4.9 to 119.3
<b>Abundance (Killarney shad ha<sup>-1</sup>)</b>						
1.5-45m		10.99	7.15	0.46	0	18.60
>45m		0	0	0	0	0
<b>Total</b>		<b>10.99</b>	<b>7.15</b>	<b>0.46</b>	<b>0</b>	<b>18.60</b>
<b>Biomass (g ha<sup>-1</sup>)</b>						
1.5-45m		82.99	469.28	107.65	0	659.94
>45m		0	0	0	0	0
<b>Total</b>		<b>82.99</b>	<b>469.28</b>	<b>107.65</b>	<b>0</b>	<b>659.94</b>

**Table 1.5. Arithmetic mean acoustic total Arctic char abundance (Arctic char ha<sup>-1</sup>) and biomass (g ha<sup>-1</sup>) for four fish sizes and total in the pelagic zone of Lough Leane, September 2017**

Layer	Size category dB Range Size class (cm)	Small -50 to -45dB 4.9 to 9.6	Medium -44 to -39 dB 9.7 to 19.6	Large -39 to -35dB 19.7 to 31.9	Very Large -34 to -23dB 32.0 to 119.3	Total -50 to -23dB 4.9 to 119.3
<b>Abundance (Arctic char ha<sup>-1</sup>)</b>						
1.5-45m		0	0	0	0	0
>45m		0	0	0.04	0	0.04
<b>Total</b>		<b>0</b>	<b>0</b>	<b>0.04</b>	<b>0</b>	<b>0.04</b>
<b>Biomass (g ha<sup>-1</sup>)</b>						
1.5-45m		0	0	0	0	0
>45m		0	0	7.58	0	7.58
<b>Total</b>		<b>0</b>	<b>0</b>	<b>7.58</b>	<b>0</b>	<b>7.58</b>

#### **Total Killarney shad acoustic abundance**

The arithmetic mean acoustic abundance estimates were multiplied by area of the lake greater than 9m (866.66ha) to calculate population estimates for Killarney shad in Lough Leane (Table 1.4). An estimated 17,478 Killarney shad, 10,326 of which were juveniles (0+ and 1+) occurred in the 1.5-45m layer of the pelagic zone of Lough Leane and no Killarney shad were recorded in the >45m layer (Table 1.4).



Therefore the total Killarney shad population of Lough Leane was estimated to be 17,478, (59% juveniles) in September 2017 (Table 1.6).

#### **Total Arctic char acoustic abundance**

The arithmetic mean acoustic abundance estimates were multiplied by area of the lake greater than 45m (154.21ha) to calculate population estimates for Arctic char in Lough Leane (Table 1.5). An estimated seven Arctic char, none of which were juveniles (0+ and 1+) occurred in the >45m layer of the pelagic zone of Lough Leane. No Arctic char were captured in the 1.5-45m layer and therefore the total Arctic char population of Lough Leane was estimated to be seven individuals in the deep pelagic zone during September 2017 (Table 1.6).

**Table 1.6. Population estimates for Killarney shad and Arctic char in the pelagic zone of Lough Leane, September 2017**

Species	Juvenile (0+ and 1+)	Total
Killarney shad	10,326	17,478
Arctic char	0	7

#### ***1.3.5 Length frequency distributions and growth***

##### **Brown trout**

Brown trout captured during the 2017 survey ranged in length from 12.9cm to 36.6cm (mean 21.4cm) (Fig. 1.5). Seven age classes were present, ranging from 1+ to 7+, with a mean L1 of 6.5cm (Table 1.7). The dominant age class was 2+ (Fig. 1.5). Mean brown trout L4 in 2017 was 21.4cm indicating a very slow rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971) (Table 1.7). Brown trout captured during the 2008, 2011 and 2014 surveys had similar length and age ranges, with some smaller and larger fish recorded in the 2014 and 2017 surveys.



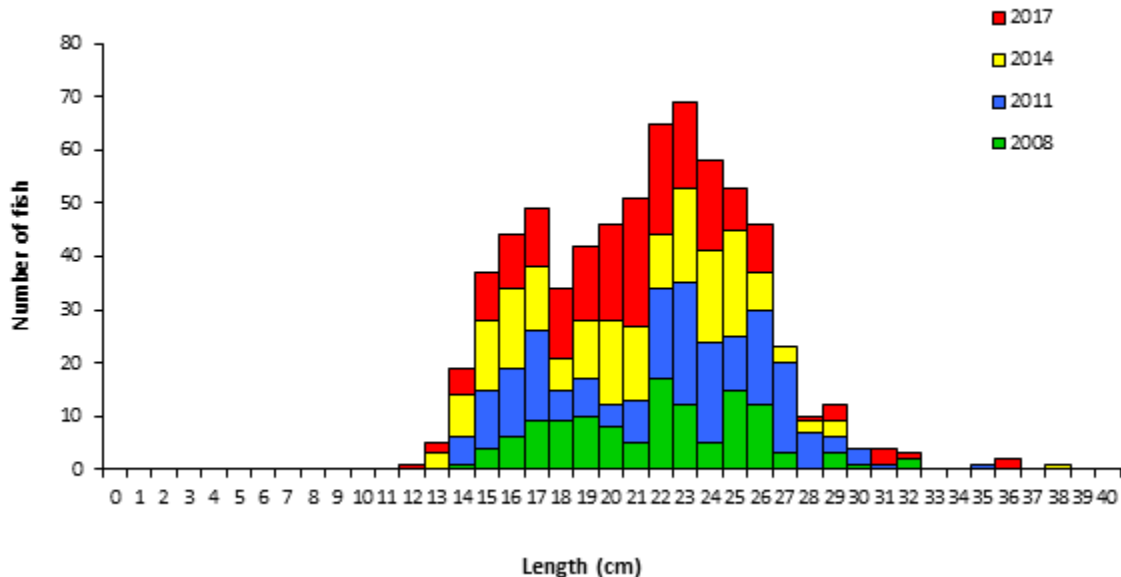


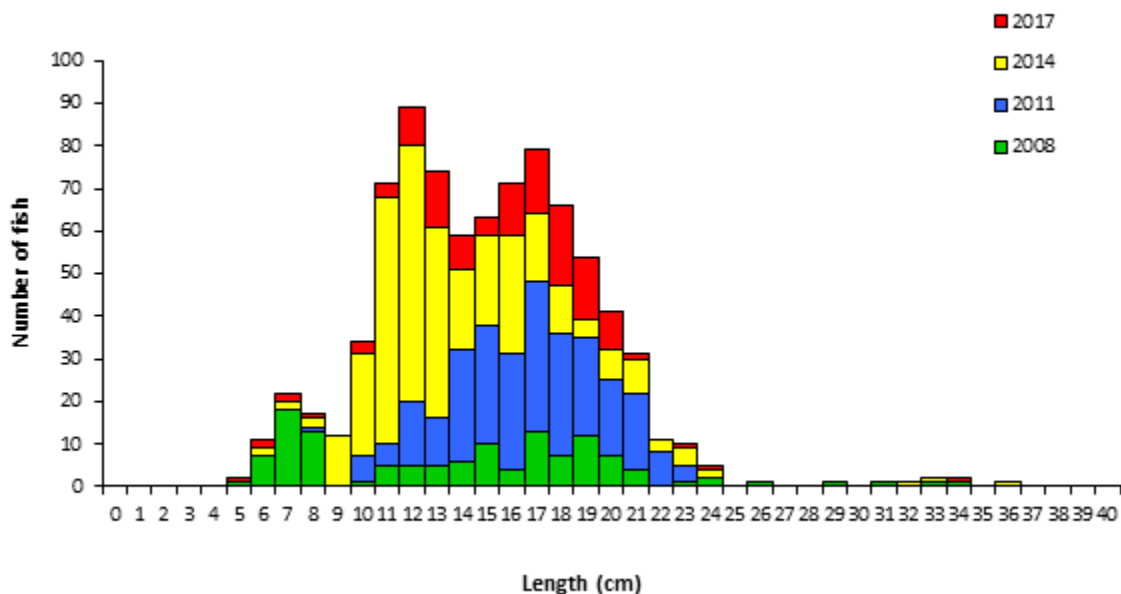
Fig. 1.5. Length frequency of brown trout captured on Lough Leane, 2008, 2011, 2014 and 2017

Table 1.7. Mean ( $\pm$ S.E.) brown trout length (cm) at age for Lough Leane, September 2017

	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	L <sub>4</sub>	L <sub>5</sub>	L <sub>6</sub>	L <sub>7</sub>	Growth Category
Mean ( $\pm$ S.E.)	6.5 (0.2)	13.6 (0.5)	18.0 (0.8)	21.5 (0.8)	25.1 (0.8)	28.5 (0.8)	32.5	Very slow
N	53	45	24	12	7	6	1	
Range	3.5-9.9	7.8-19.9	10.8-24.5	18.0-25.5	23.5-29.5	27.6-32.4	32.5-32.5	

## Perch

Perch captured during the 2017 survey ranged in length from 5.3cm to 34.4cm (mean = 16.3cm) (Fig.1.6) with eight age classes present, ranging from 0+ to 9+ with a mean L1 of 7.2cm (Table 1.8). The dominant age class was 4+ (Fig. 1.6). Perch captured during the 2008, 2011 and 2014 surveys had a similar length and age range with some smaller and larger fish recorded in 2008, 2014 and 2017 (Fig. 1.6).



**Fig. 1.6. Length frequency of perch captured on Lough Leane, 2008, 2011, 2014 and 2017**

**Table 1.8. Mean ( $\pm$ S.E.) perch length (cm) at age for Lough Leane, September 2017**

	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	L <sub>4</sub>	L <sub>5</sub>	L <sub>6</sub>	L <sub>7</sub>	L <sub>8</sub>	L <sub>9</sub>
Mean ( $\pm$ S.E.)	7.2 (0.3)	12.9 (0.4)	16.0 (0.4)	18.0 (0.4)	20.4 (0.9)	22.9 (0.8)	24.6 (2.1)	27.4 (4.4)	23.1
N	32	24	22	22	5	3	2	2	1
Range	4.3-10.1	7.4-16.1	10.9-18.8	14.9-21.8	18.4-23.5	21.2-23.9	22.5-26.8	22.9-31.8	23.1-23.1

### **Rudd**

Rudd captured during the 2017 survey ranged in length from 13.4cm to 26.6cm (mean = 18.4cm) (Fig.1.7) with seven age classes present, ranging from 3+ to 9+ with a mean L1 of 3.2cm (Table 1.9). The dominant age class was 4+ (Fig. 1.7). Rudd captured during the 2008, 2011 and 2014 surveys had a similar length and age range, with some smaller and larger fish recorded in 2014 (Fig. 1.9).

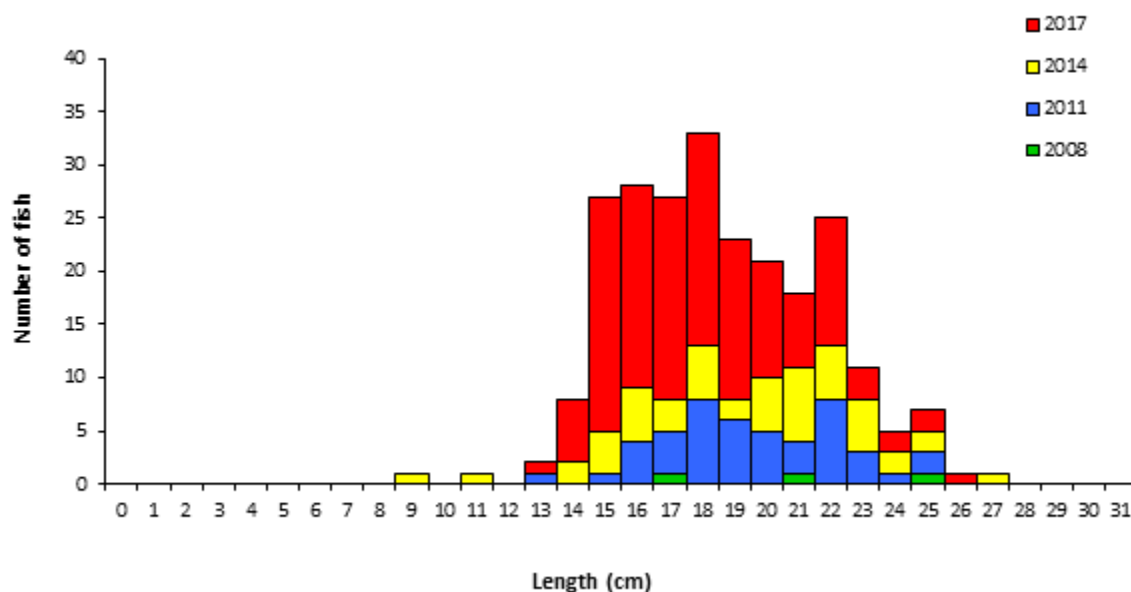


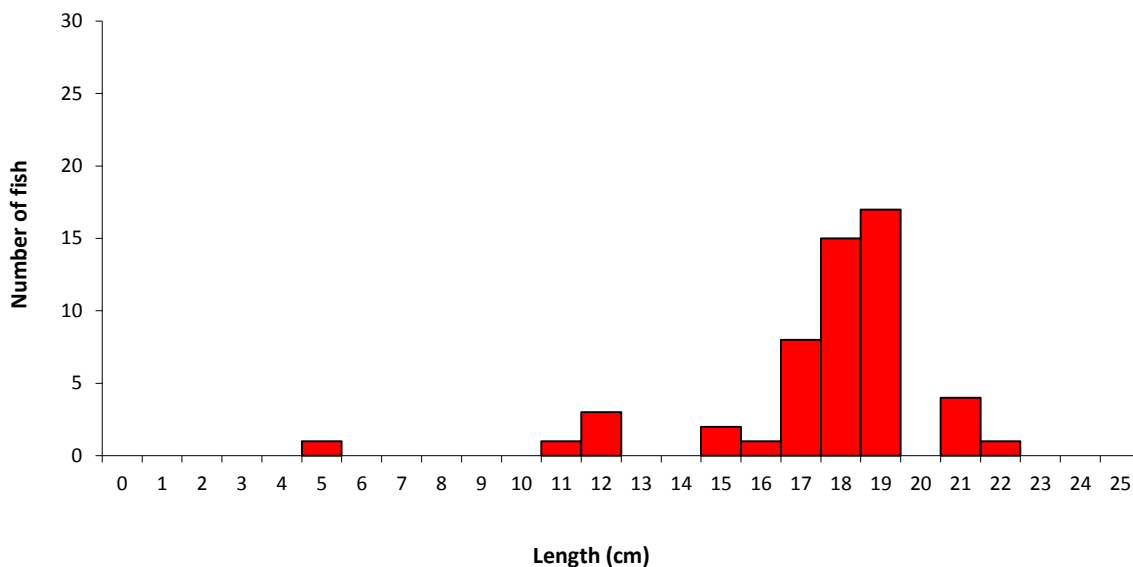
Fig. 1.7. Length frequency of rudd captured on Lough Leane, 2008, 2011, 2014 and 2017

Table 1.9. Mean ( $\pm$ S.E.) rudd length (cm) at age for Lough Leane, September 2017

	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	L <sub>4</sub>	L <sub>5</sub>	L <sub>6</sub>	L <sub>7</sub>	L <sub>8</sub>	L <sub>9</sub>
Mean ( $\pm$ S.E.)	3.3 (0.1)	8.5 (0.3)	13.5 (0.3)	16.7 (0.3)	19.5 (0.4)	21.1 (0.5)	22.6 (0.4)	23.7 (0.5)	26.0
N	32	32	32	29	17	11	8	6	1
Range	2.2-5.1	6.1-11.6	10.5-16.9	14.0-20.0	16.7-21.7	18.3-23.6	20.7-24.7	21.6-25.3	26.0-26.0

### Killarney shad

Killarney shad captured during the 2017 survey ranged in length from 5.0cm to 22.0cm (mean = 17.6cm) (Fig.1.8). Comparison with previously back-calculated length at age data suggests that individuals from 0+ to 8+ are present in the population (Roche and Rosell, 2003).



**Fig. 1.8. Length frequency of Killarney shad captured on Lough Leane, 2017**

### **Other fish**

Eels recorded during the 2017 survey ranged in length from 28.3cm to 61.0cm. One Arctic char was measured at 22.4cm and one tench at 46.8cm. Salmon ranged in length from 14.3cm to 90.0cm (aged from 1+ to 2.2+); flounder ranged from 23.0cm to 36.0cm.

### ***1.3.6 Stomach and diet analysis***

Dietary analysis studies provide a good indication of the availability of food items and the angling methods that are likely to be successful. However, the value of stomach content analysis is limited unless undertaken over a long period as diet may change on a daily basis depending on the availability of food items. The stomach contents of a subsample of brown trout and perch captured during the survey were examined and are presented below.

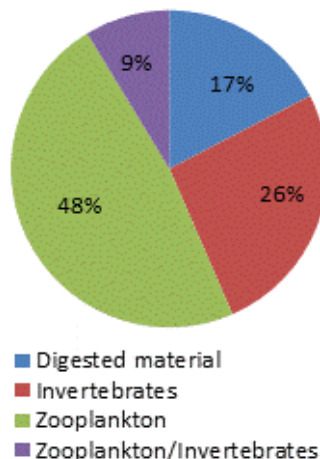
### **Brown trout**

Adult trout usually feed principally on crustaceans (*Asellus* sp. and *Gammarus* sp.), insects (principally chironomid larvae and pupae) and molluscs (snails) (Kennedy and Fitzmaurice, 1971, O'Grady, 1981). A





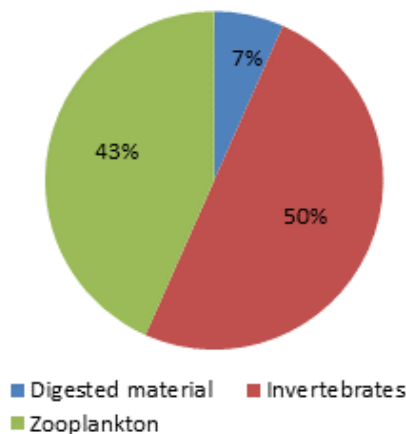
total of 60 trout stomachs were examined. Of these 37 were found to contain no prey items. Of the 23 stomachs containing food, 48% contained zooplankton, 26% invertebrates, 17% unidentified digested material and 9% zooplankton/invertebrates (Fig. 1.9).



**Fig 1.9. Diet of brown trout (n=23) captured on Lough Leane, September 2017 (% FO)**

### Perch

Perch initially start to feed on pelagic zooplankton. Once they reach an intermediate size they start feeding on benthic resources eventually moving on to feed on fish once they are large enough (Hjelm *et al.*, 2000). A total of 45 stomachs were examined. Of these 15 were found to contain no prey items. Of the remaining 30 stomachs containing food, 50% contained invertebrates, 43% zooplankton and 7% unidentified digested material (Fig. 1.10).



**Fig 1.10. Diet of perch (n=30) captured on Lough Leane, 2017 (% FO)**

### ***1.3.7 Conservation status of Killarney shad and Arctic char in Lough Leane***

Currently there are no formal conservation criteria for Killarney shad or Arctic char in Ireland. Therefore a provisional conservation status for the Lough Leane Killarney shad and Arctic char populations were assigned using expert opinion for Killarney shad and the UK favourable condition table (Joint Nature Conservation Committee, 2005) for Arctic char (Table 1.10).



**Plate 1.2 Killarney shad captured in Lough Leane, September 2017**

#### **Conservation status of Killarney shad**

Killarney shad were the dominant species in the pelagic zone and a full range of size classes that correspond with previously reported size distribution were captured (Roche and Rosell, 2003). Survey gill nets typically capture juvenile fish in lower proportions than their actual occurrence. Hydroacoustic analysis indicated that 68% of the Killarney shad population were juveniles, indicating recent successful recruitment. Indeed the length frequency of the Killarney shad captured in this survey indicates that there is continuous successful recruitment. Comparison with previously back-calculated length at age



suggests that individuals from 0+ to 8+ are present in the population (Roche and Rosell, 2003). In light of these findings the Killarney shad population are assigned a provisional conservation status of **Favourable – Stable**. However, the population remain vulnerable as they are confined to one lake, which increases the risk of extirpation.

### Conservation status of Arctic char

According to the Joint Nature Conservation Committee, favourable conservation status can be assigned when a healthy Arctic char population is present and spawning successfully. There should also be evidence of consistent recruitment and 70% of the population should be juveniles (0+/1+), etc. (Table 1.10).

**Table 1.10 Comparison of Lough Leane results to minimum criteria for assignment of favourable conservation status (JNCC) to Arctic char**

Minimum JNCC Criterion	Lough Leane
Consistent juvenile recruitment	No, Kelly <i>et al.</i> , 2009, 2012a & 2015b
4 or 5 age classes present	No
70% of population juveniles (0+/1+)	No
> 520 Arctic char ha <sup>-1</sup> (mesotrophic lakes)**	No, 0.03 Arctic char ha <sup>-1</sup> (pelagic zone only)**
pH > 5.5	Yes, 7.47 (N=89, 2017)*
Total Phosphorus (TP) (annual mean) ≤ 20µg l <sup>-1</sup>	Yes, 8µg l <sup>-1</sup> (N=89, 2017)*
***DO >4mg l <sup>-1</sup>	Yes, 13.38 mg l <sup>-1</sup> (N=89, 2017)*
***Natural hydrology (no barriers, etc.)	Yes, no modifications apparent
***Habitat composition (littoral & benthic habitats)	Yes, a few minor modifications apparent
***No introductions or translocations	Introduced species; perch, rudd, tench, Fringed water-lily ( <i>Nymphoides peltata</i> )

**Note:** \*Data from Environmental Protection Agency (2017, once per month Jan-Dec – All sites); \*\*geometric mean; \*\*\*Discretionary



The Arctic char population in Lough Leane do not comply with the minimum criteria as required for favourable conservation status (JNCC, 2005) and appear to be at critically low levels. In addition, fish species that may have negative effects on Arctic char, such as perch, are present in the lake (Connor *et al.*, 2018). In contrast, several of the abiotic attributes were found to be favourable (1) pH, total phosphorous and dissolved oxygen (2) natural hydrology of the lake and (3) habitat composition. Nevertheless, juvenile Arctic char appear to be absent from the Lough Leane population indicating that the population may depend upon neighbouring Muckcross Lake for Arctic char recruitment.

Therefore the Arctic char population has been assigned a provisional conservation status of **Unfavourable – Bad**.



#### 1.4 Summary and ecological status

A total of nine fish species were recorded on Lough Leane in the September 2017 fish stock survey. Brown trout was the dominant fish species in terms of abundance (CPUE) and salmon was the dominant fish species in terms of biomass (BPUE) captured in the survey gill nets during the 2017 survey. The total Killarney shad population of Lough Leane was estimated to be 17,478, (59% juveniles) using scientific hydroacoustic survey equipment. An estimated seven Arctic char, none of which were juveniles (0+ and 1+) occurred in the >45m layer of the pelagic zone of Lough Leane.

Brown trout ranged in length from 12.9cm to 36.0cm with seven age classes present, ranging from 1+ to 7+, indicating reproductive success in seven of the previous eight years. The dominant age class was 2+. Length at age analyses revealed that brown trout in the lake exhibit a very slow rate of growth according to the classification scheme of Kennedy and Fitzmaurice (1971).

Perch ranged in length from 5.3cm to 34.4cm and ranged in age from 0+ to 9+, indicating reproductive success in eight of the previous ten years. The dominant age class was 4+.

Rudd ranged in length from 13.4cm to 26.6cm and ranged in age from 3+ to 9+, indicating reproductive success in seven of the previous ten years. The dominant age class was 4+.

Although the mean brown trout and perch CPUE and BPUE fluctuated slightly over the four sampling occasions, these differences were not statistically significant. However, both rudd CPUE and BPUE were significantly higher in 2017 than all other sampling years.

Classification and assigning lakes with an ecological status is a critical part of the WFD monitoring programme. It allows River Basin District managers to identify and prioritise lakes that currently fall short of the minimum “Good Ecological Status” that is required if Ireland is not to incur penalties. A multimetric fish ecological classification tool (Fish in Lakes – ‘FIL’) was developed for the island of Ireland (Ecoregion 17) using IFI and Agri-Food and Biosciences Institute Northern Ireland (AFBINI) data generated during the NSSHARE Fish in Lakes project (Kelly *et al.*, 2008). This tool was further developed during 2010 (FIL2) in order to make it fully WFD compliant, including producing EQR values for each lake and associated confidence in classification (Kelly *et al.*, 2012b). Using the FIL2 classification tool, Lough Leane has been assigned an ecological status of Good for 2017 based on the fish populations present. In previous years the lake was also assigned a fish status of Good in 2008, 2011 and 2014. In the 2010 to



2015 surveillance monitoring reporting period, the EPA assigned Lough Leane an overall ecological status of Good.

The Killarney shad population were assigned a provisional conservation status of Favourable – Stable; however the population remain vulnerable. While the Arctic char populations were assigned a provisional conservation status of Unfavourable - Bad.



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