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Assessment of fish
stocks in Lower
Lough Erne 1992 –
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Further information

Freshwater Fisheries
Fisheries & Aquatic Ecosystems Branch
Newforge Lane
Belfast
BT9 5PX

Tel: +44 (0)28 9025 5506

Email: freshwater.fisheries@afbini.gov.uk

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Assessment of fish stocks in Lower Lough

Erne: 1992 - 2022

Contents

Executive Summary.....	4
Introduction	6
Fish Community	7
Invasive Species	8
Methods.....	10
Sampling Equipment.....	10
Multi Panel / Survey Nets	10
Fixed Mesh Nets.....	11
Survey methodology	12
Results and discussion	14
Stock status.....	14
Change in most abundant species in Lower Lough Erne	17
Bream and Roach-Bream Hybrids	19
Pike.....	21
Brown Trout	21
Conclusion.....	24
Future recommendations	25
Reference List.....	26

Executive Summary

Fish stocks in Lower Lough Erne have been systematically monitored at three-to-five-year intervals since 1992 using monofilament multi-mesh gill nets in margin habitats from July to September. These surveys provide a longitudinal index of fish stock status over a 30-year period.

Based on the finding from the most recent survey undertaken by AFBI in 2022, non-native roach (*Rutilus rutilus*) and perch (*Perca fluviatilis*) continue to dominate the fish community in terms of both abundance and biomass. A significant long-term shift over 20 years, from roach to perch as the most prevalent species has been observed, consistent with patterns seen in other aquatic systems post-colonisation by the invasive zebra mussel (*Dreissena polymorpha*) which were first observed in the Erne system in 1996. Perch populations currently outnumber roach by a factor of two, though they contribute a smaller percentage of the total biomass.

There has been a notable decline in bream (*Abramis brama*) stocks over the past 30 years. An increasing trend in roach x bream hybrid stocks was observed until 2019. This is likely influenced by factors such as climate change and narrower spawning seasons, which may facilitate the fertilisation of bream eggs by roach. However, this trend did not persist, and a decline in hybrid numbers was noted in 2022. It is important to note that most hybrids are typically sterile or have reduced fertility and do not produce offspring. Nevertheless, roach x bream hybrids exhibit greater longevity compared to their parent species and may persist in the lake for several years.

Numbers of brown trout (*Salmo trutta*) caught in 2022 were higher than in previous surveys, although it remains unclear whether this increase accurately reflects the true status of the brown trout population in the lake. Brown trout numbers had been steadily declining since 2010, likely due to behavioural

changes in response to multiple high-impact invasive species. Future targeted surveys are required to further investigate this issue.

The 2022 summer survey revealed a slight decrease in the pike (*Esox lucius*) population compared to those present during the survey undertaken in 2019.

Introduction

Lower Lough Erne is the fourth largest Irish lake, with a surface area of approximately 110 km². The deepest point in the lake is approximately 66 m, and it has a mean depth of 12 m. In deep areas of Lower Lough Erne, thermal stratification can occur from June onwards throughout the summer season (Gibson, 1998). The Lower Lough has become increasingly enriched over the last century (Rosell, 1997) with a mean annual Total Phosphorus (TP) concentration of 59 µg L⁻¹ (McElarney et al., 2015). Due to the presence of flow regulation and hydropower stations on its exit river the lake is designated as a heavily modified waterbody under the Water Framework Directive (WFD) (NIEA, 2009).

Lough Erne is of important socio-economic importance: hire boat cruising is a significant tourist activity in the area, together with other businesses that contribute to the tourist industry including recreational fishing (Rosell, 2001). Until 2009, Lough Erne also supported a commercial eel fishery with between 10 and 16 commercial fishing licences issued annually between 2007 and 2009 (DCAL, 2014). Eel fishing was banned on Lough Erne in 2010 due to a pan-European decline in eel abundance and a need for conservation led management. Currently the only commercial fisheries are a small pike fishery (up to 10 tonnes / annum) consisting of two to five active fishermen, and a conservation eel fishery capturing migrating silver eels which are then transported past two hydro-electric power stations on the efferent River Erne.

The Lough Erne catchment extends to 4,306 km² with 44% of the catchment in Northern Ireland and 56% in the Republic of Ireland. In 2010 the population density was 0.34 people per hectare. The catchment land use is mostly agricultural (70% of the catchment), forest cover makes up 14.8% of the catchment and urban cover is low at 1.9% (McElarney et al., 2015). The catchment is delineated into 13 river catchments (Figure 1).

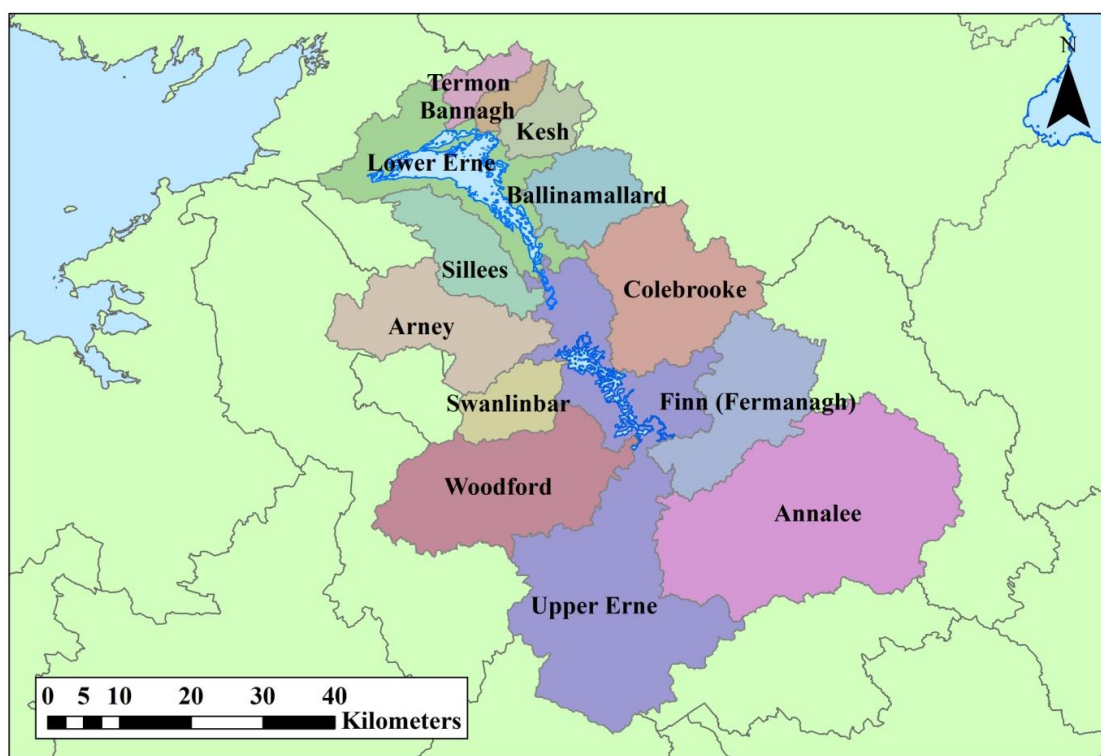


Figure 1. Lough Erne and surrounding river catchments (taken from McElarney et al. (2015)).

Fish Community

The fish community of Lower Lough Erne is renowned by anglers and naturalists for its trout, pike and coarse fish. Lower Lough Erne is currently dominated by the non-native species perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*). Pike are the dominant predatory fish species in Lough Erne, though their native / non-native status is uncertain (Ensing, 2015, Pedreschi et al., 2014, Pedreschi and Mariani, 2015), and larger specimens of perch and trout also exhibit some piscivorous behaviour. Pollan a species endemic to Ireland and of conservation importance are also present in Lower Lough Erne (AFBI, 2024a). Pike, perch and roach are considered keystone species in European lakes, as they have been shown to affect ecosystem function and/or population structure depending on conditions, e.g. by predation on other species (pike), grazing on phytoplankton (roach), and in changing the ratio between species associated with the impact of the zebra mussel (perch and roach) resulting in an

apparent shift in expression of lake trophic condition (Brabrand et al., 1986, Kurmayer and Wanzenböck, 1996).

Roach are unusual in the context of European freshwater fish as they are generalist omnivores throughout their lifecycle. They switch from a juvenile diet of zooplankton to a diet dominated by macroinvertebrates as they enter sexual maturity. The generalist diet, efficient zoo planktivory and rapid recruitment are all perceived factors in the capacity of this species to succeed in lakes outside of their natural distribution (Fitzmaurice, 1981, Rask et al., 2000), typically through competitive superiority over native or other resident fishes (Bergstrand, 1990, Persson and Greenberg, 1990, Persson, 1991).

Invasive Species

The earliest discovered specimens of the invasive non-native bivalve *Dreissena polymorpha*, also known as the zebra mussel, in Lower Lough Erne date from circa 1996 (Rosell et al., 1998) and since then its coverage has expanded. Hard structures throughout the lake have now been colonised to all available depths. This has impacted the ecological processes within this system (Rosell, 2014). The bloody-red shrimp, *Hemimysis anomala*, a crustacean originating from the Ponto–Caspian region, was discovered in Lough Derg in the Shannon River Basin District in the Republic of Ireland during 2008 and subsequently in Lough Ree, within the same river system (Minchin and Boelens, 2010). The species is a small (Borcherding et al., 2007, Ketelaars et al., 1999), opportunistic omnivore (Mauchline, 1980, Salemaa and Hietalahti, 1993) that inhabits deep to sublittoral zones. It aggregates and swarms in shaded locations during the day and disperses during the night in the pelagic zone (Salemaa and Hietalahti, 1993). This species' path of spread has been identical to that of the zebra mussel and it has now been identified throughout the Shannon system and through the Shannon-Erne canal into the Erne system (Gallagher et al., 2015a). An earlier study (Dick et al., 2013) concluded that *H. anomala* showed

dramatically higher predatory functional responses (feeding quantity and rate) than native ecological equivalents when presented with zooplankter prey items over a range of sizes. Furthermore, *H. anomala* has also been shown to prey directly on pollan eggs and larvae under experimental conditions (Gallagher, 2017), raising significant concerns about the potential negative impacts of this species on pollan and other lake spawning fish species.

The Department of Environment, Agriculture and Rural Affairs Inland Fisheries Branch commissioned AFBI to undertake triannual multi-species surveys within Lower Lough Erne and produce a stock status report on the fish stocks of Lower Lough Erne to provide scientific advice to support management decisions for fish and fisheries within Lough Erne. This report summarises the results of the surveys undertaken by AFBI between the years 1992 and 2022.

Methods

Sampling Equipment

Two different types of net were utilised during the AFBI fish stock assessments within Lower Lough Erne. These were:

- 1) a CEN (2005) compliant multi panel monofilament gillnet, and
- 2) a braided fixed mesh 50mm gill net (Figure 2).

The combination of these two net types ensures a robust and balanced assessment of the fish stock, capturing a comprehensive range of species and size classes. This dual method approach also enhances the accuracy of the survey.

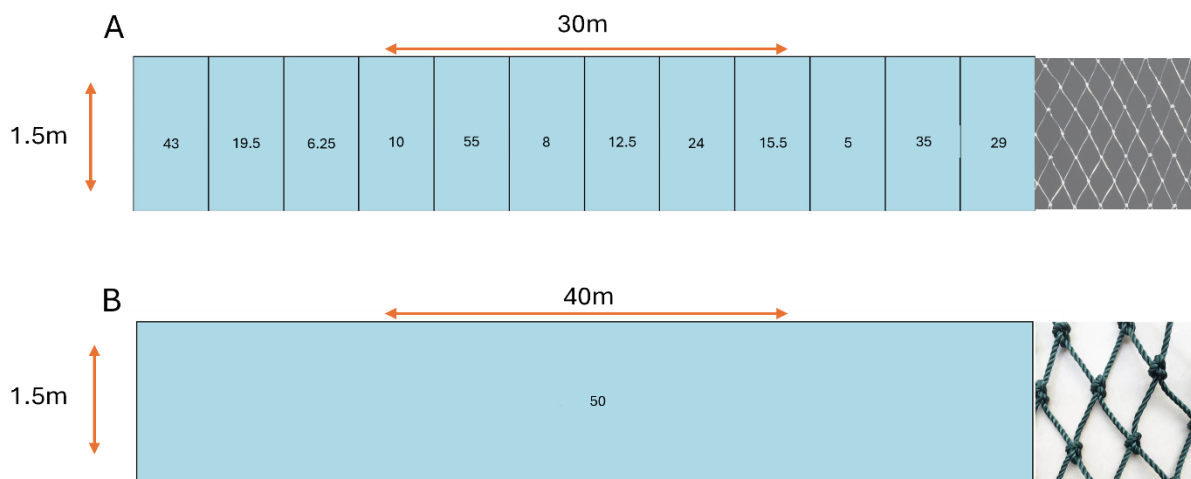


Figure 2: Diagram of the two types of nets used in the survey a) CEN monofilament floating net with a length of 30m, depth of 1.5m and 12 panels of varying mesh (5 to 55mm), b) a fixed mesh braided net with a length of 40m, depth of 1.5m and a uniform 50mm mesh. NB numbers inset represent mesh size in millimetres.

Multi Panel CEN Nets

These nets consist of a number of panels of varying mesh sizes in one single net (Figure 2a). This design is intended to catch a broadly representative sample of fish of all age classes and species present. Over time the catches from these nets give an index of the overall fish population. When surveys began in Lower Lough Erne in the 1990s, 6 panel nets of meshes ranging from 12.5 to 46 mm were used.

However changes in net material availability and standardisation of methods have over time forced several changes in net design (including the implementation of the EU WFD (2000)). In 2004 the 6-panel net design was replaced with a 12 panel Baltic net with meshes in an incremental progression (mesh sizes increasing in even intervals) from 8 to 50mm. A further change in standard available survey nets came in with the EU WFD (2000) compliant CEN net of 5 to 55 mm meshes in a randomised geometric progression (CEN, 2005). Before any changes in the type of nets used were implemented, the proposed new set up was trialled in parallel, with the existing configuration for a minimum of one survey to inter-calibrate the results and create a basis for a standard time series. In 2019 AFBI moved to full CEN standard survey gill nets (as described above) as opposed to the now obsolete Baltic nets. This move may have resulted in some minor distortion to the true trend gained by previous Baltic net surveys, the most obvious trend shift noted from inter-calibration surveys in this lough and others is the ability of the new CEN standard net to sample young of year perch more effectively. Going forward the widespread change of net type to a standard CEN provides greater clarity when comparing Erne stock assessment results against other European lakes and allows for comparison between lakes, nationally and internationally.

Fixed Mesh Nets

These are nets of a single mesh size (Figure 2b). They are selective for a particular size range of each particular species. To adequately sample larger individuals, two fixed mesh nets with a mesh size of 50 mm are set at each of the sampling stations within Lower Lough Erne. This is particularly useful for catching trout above 30 cm and gives an indication of the population of adults of these species. Larger roach, bream and cyprinid hybrids are also caught within these nets.

Survey methodology

Thirty sampling sites have traditionally been surveyed within Lower Lough Erne during AFBI fish stock assessment surveys. Figure 3 shows the location of these sites. During the AFBI 2022 survey, three nets were set at each of 30 samplings sites from mid-July to mid-August. These nets included:

- 1 x CEN (2005) Net measuring 30 m x 1.5 m
- 2 x 50 mm Fixed Mesh Nets measuring 40 m x 1.5 m

Nets were deployed with a soakage interval of approximately 18 hours. Nets were deployed around the margins of Lower Lough Erne and in the “Back Lough” north of Boa Island at a standard set of 30 sites (Figure 3) representing a range of habitats, shore slopes and water depths down to a depth of approximately 8 m. Nets were set at right angles to the shore at the nearest safe location to a set grid reference. The netting team had discretion to move a net up to 100 m to adjust for conditions (e.g. wind direction, moving to the lee of an island, avoiding water sports or boating activity, variation in water levels). Nets were set to cover one dusk and one dawn fish peak activity period and marked with regulation (Erne navigation bye-law compliant) labelled yellow floats at each end.

After retrieving nets, all samples were sorted, counted and the date, location, and net type recorded. Samples from each net were stored separately. Fish were frozen (-18° C) in bags and later transferred frozen to the AFBI laboratory at Newforge Lane, Belfast for further analysis. For each sampling day, a record was made of the nets utilised and catches at the level of number of individuals of each species for each net. This data was forwarded to the laboratory team in preparation of lab analyses.

All samples were analysed as per AFBI SOP FRW20 (2024b). Each individual fish was measured (fork length \pm 1mm) weighed, (blotted wet mass \pm 0.1g), and its sex determined (male, female, immature). Tissue samples were also removed for future analysis.

Details of length of net set were used to calculate standardised catch per unit effort (CPUE): Recorded as number or biomass (weight) per unit metre (BPUE) of net per night. As the 50mm fixed mesh net catches less fish this data is presented as number of fish per net.

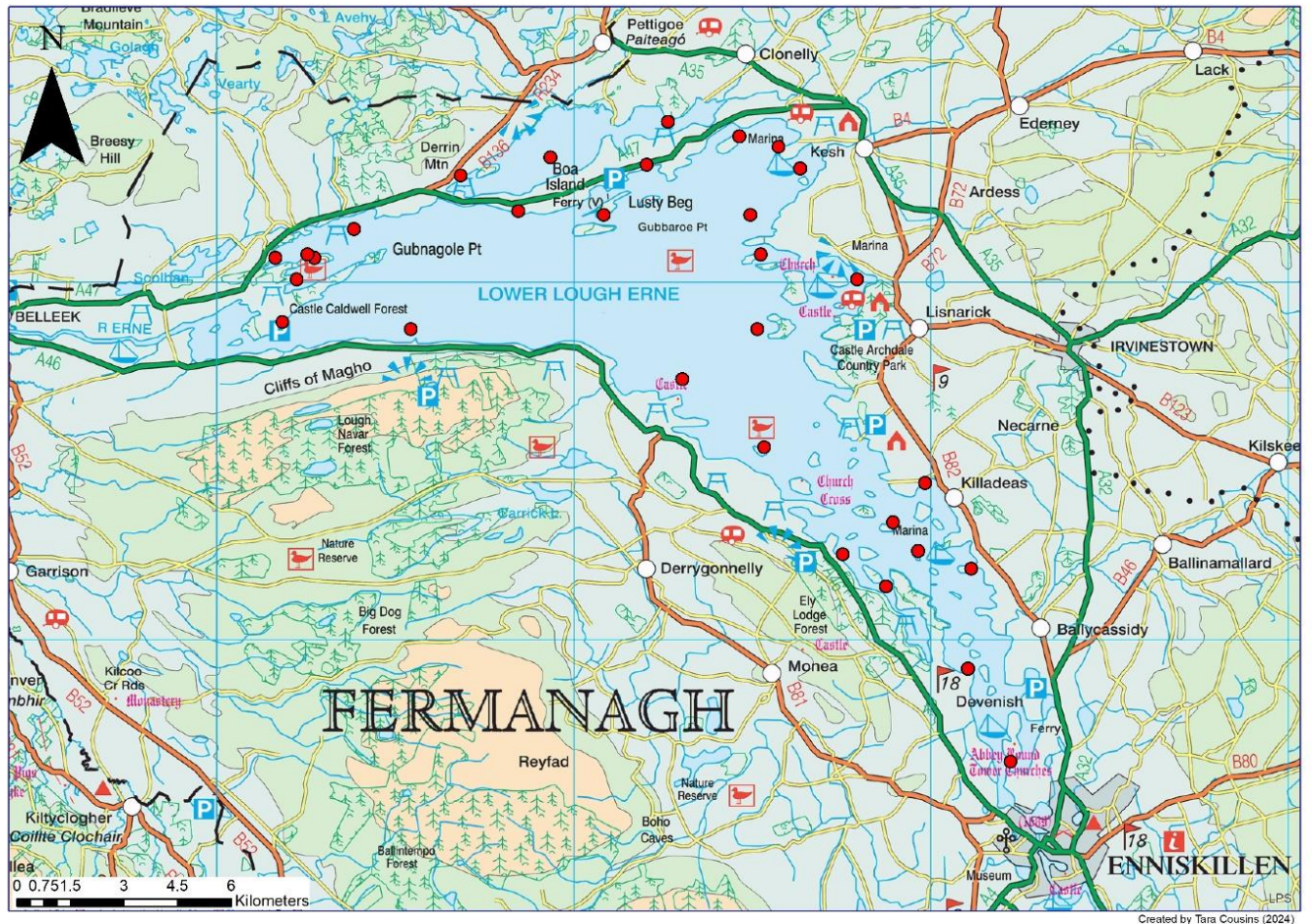


Figure 3- Fish survey sites within Lower Lough Erne sampled between 1991 – 2013.

Results and discussion

Stock status

Trends in population change are assessed through catch per unit effort of individual species from CEN survey nets. The most abundant species' within Lower Lough Erne in terms of both number (Table 1 & Figure 4) and biomass (Table 2 & Figure 5) remain roach and perch. The number of fish captured in the 50mm nets is detailed in Table 3.

*Table 1: Temporal variation in Catch per Unit Effort (mean number of fish per metre of survey net per net night from 1992 to 2022. *Denotes Roach – Bream Hybrids. †Note gear change from Baltic to CEN in 2019.*

Year	Pike	Perch	Roach	Bream	Hybrids*	Trout
1992	0.025	0.596	1.220	0.047	0.032	0.015
1996	0.027	0.473	0.916	0.024	0.037	0.014
2000	0.006	0.844	0.690	0.012	0.046	0.014
2002	0.009	0.640	0.626	0.009	0.048	0.009
2004	0.013	1.047	1.001	0.011	0.076	0.016
2007	0.012	1.032	1.008	0.007	0.130	0.014
2010	0.007	1.300	0.633	0.001	0.026	0.005
2013	0.007	1.516	0.546	0.001	0.041	0.004
2016	0.008	1.284	0.696	0.001	0.053	0.003
2019[†]	0.014	1.090	0.518	0.000	0.062	0.002
2022	0.01	1.691	0.611	0.000	0.031	0.007

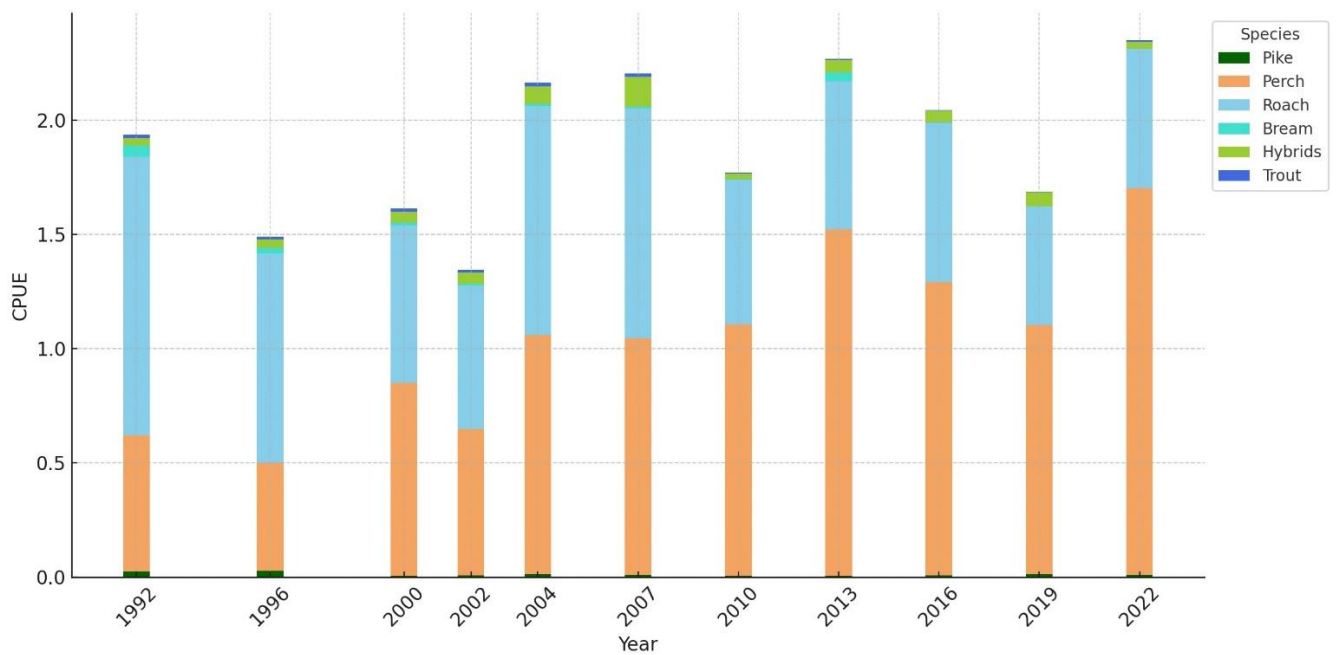


Figure 4: Graph showing the temporal variation in Catch per Unit Effort (mean number of fish per metre of survey net per net night from 1992 to 2022. *Denotes Roach – Bream Hybrids. †Note gear change from Baltic to CEN in 2019

Table 2: Temporal variation in Biomass per Unit Effort (mean weight of fish per metre of survey net per net night from 1992 to 2022. *Denotes Roach – Bream Hybrids. †Note gear change from Baltic to CEN in 2019.

Year	Pike	Perch	Roach	Bream	Hybrids	Trout
1992	10.963	40.667	192.111	18.926	7.074	5.370
1996	15.854	36.471	96.361	5.659	6.649	6.391
2000	8.275	65.344	127.319	2.979	13.139	5.973
2002	8.960	47.960	120.212	3.893	12.963	3.160
2004	12.215	56.334	159.910	9.852	23.516	3.253
2007	5.468	70.634	281.936	4.762	69.260	3.630
2010	6.012	67.165	96.734	0.525	10.336	1.754
2013	3.966	88.073	95.033	0.902	18.446	0.360
2016	9.117	83.459	112.164	0.049	24.504	0.380
2019 [†]	8.101	18.709	78.238	0.000	36.890	0.726
2022	4.371	34.898	97.8	0.000	20.227	0.751

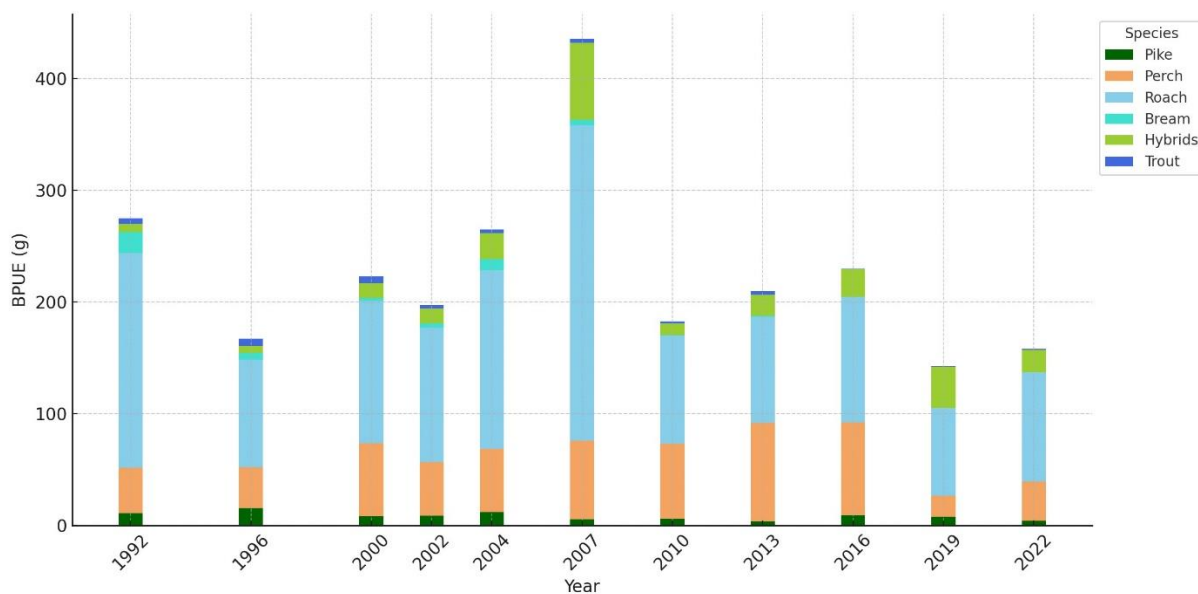


Figure 5: Graph showing the temporal variation in Biomass per Unit Effort (mean weight of fish per metre of survey net per net night from 1992 to 2022). *Denotes Roach – Bream Hybrids. †Note gear change from Baltic to CEN in 2019.

Table 3: Variation in mean number of fish per 50 mm fixed mesh net from 1992 to 2022. *Hybrids denotes Roach –Bream hybrids. †Note gear change from Baltic to CEN in 2019.

Year	Pike	Perch	Roach	Bream	Hybrids*	Trout	Tench
1992	0.7	0.2	2.08	1.43	0.82	0.107	0
1996	0.52	0.25	4.19	0.63	0.33	0.23	0
2000	0.52	0	4.43	1.09	2.39	0.51	0
2002	0.5	0.019	1.52	0.38	1.55	0.259	0
2004	0.08	0.167	6.45	1.27	3.49	0.2	0
2007	0.03	0.2	8.63	0.11	2.93	0.121	0
2010	0.41	1.27	9.2	0.07	4.3	0.433	0
2016	0.3	2.7	3.87	0.05	3.88	0.13	0
2019	0.46665	0.2331	5.7	0.19998	11.466	0.011	0.1
2022	0.43333	0.6333	9.8333	0.1	13.2667	0.233	0.033

Change in most abundant species in Lower Lough Erne

Non-native invasive species are often considered to be the drivers of ecological change in freshwater systems (Didham et al., 2005, MacDougall and Turkington, 2005). There are a series of potential ecological interactions between roach and perch (both of which are non-native within Lower Lough Erne) that under certain conditions (including those posed by invasive species) can result in competitive asymmetries between the two species (Persson, 1986, Persson, 1987, Persson and Greenberg, 1990, Persson, 1990, Persson, 1991, Persson et al., 1991, Persson and Eklov, 1995). A significant change in relative abundance of roach and perch has been observed and documented in Lower Lough Erne (Rosell, 2012, Rosell, 2014) since the introduction of the invasive zebra mussel in the late 1990's (Rosell et al., 1998). Throughout the current time series, and particularly since the introduction of several high impact invasive species such as the zebra mussel and the bloody-red shrimp, perch abundance has increased whilst roach abundance has decreased. This is likely due to increased predatory success of perch in clearer water (Figure 6).

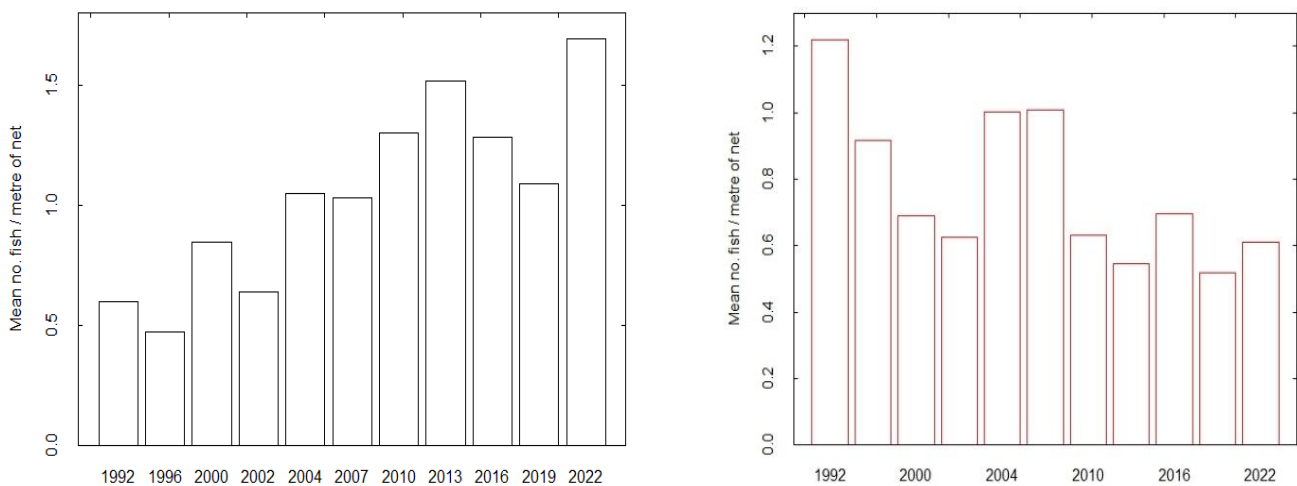


Figure 6: CPUE of perch (left) and roach (right) from surveys of Lower Lough Erne from 1992-2022.

In 2022 roach and perch combined (by number) contributed to 98% of the entire survey catch, this has been a consistent finding since 2016 (Gallagher and Rosell, 2019). As mentioned previously, the high

contribution of these two non-native species is likely a product of the introduction and proliferation of the zebra mussel and may have also been exacerbated by the introduction of a second high impact invasive species the bloody red shrimp to the catchment in 2013 (Gallagher et al., 2015b, Gallagher, 2017). As can be seen in Figure 7, perch overtook roach as the most abundant species caught within surveys in Lower Lough Erne from 2010.

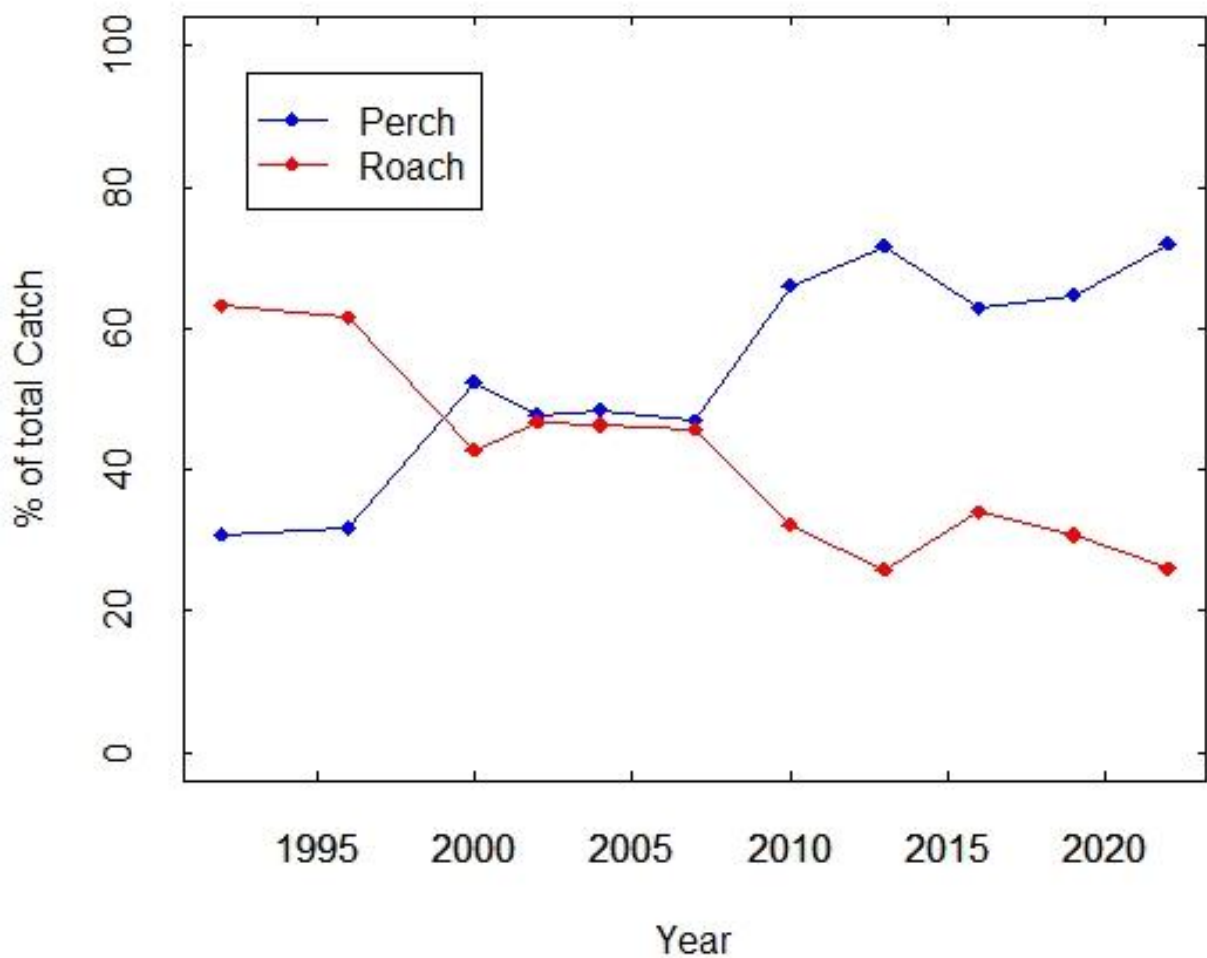


Figure 7: Percentage contribution of Roach and Perch in survey net catches from 1992 – 2022.

Bream and Roach-Bream Hybrids

Numbers of bream have fallen in the most recent AFBI surveys of Lower Lough Erne (Figure 8). Small bream have always been scarce in Lower Lough Erne surveys and it has previously been suggested that the population relied on movement of shoals from further afield including Upper Lough Erne (Rosell, 2014). However an AFBI led survey of Upper Lough Erne in 2013 failed to catch any Bream within this area (Gallagher et al., 2015b). The current low population size of bream within Lower Lough Erne gives rise to concerns for the future of bream in the system given the lack of recruitment. This is not unique to Lower Lough Erne as similar situations are observed within most catchments throughout Ireland.

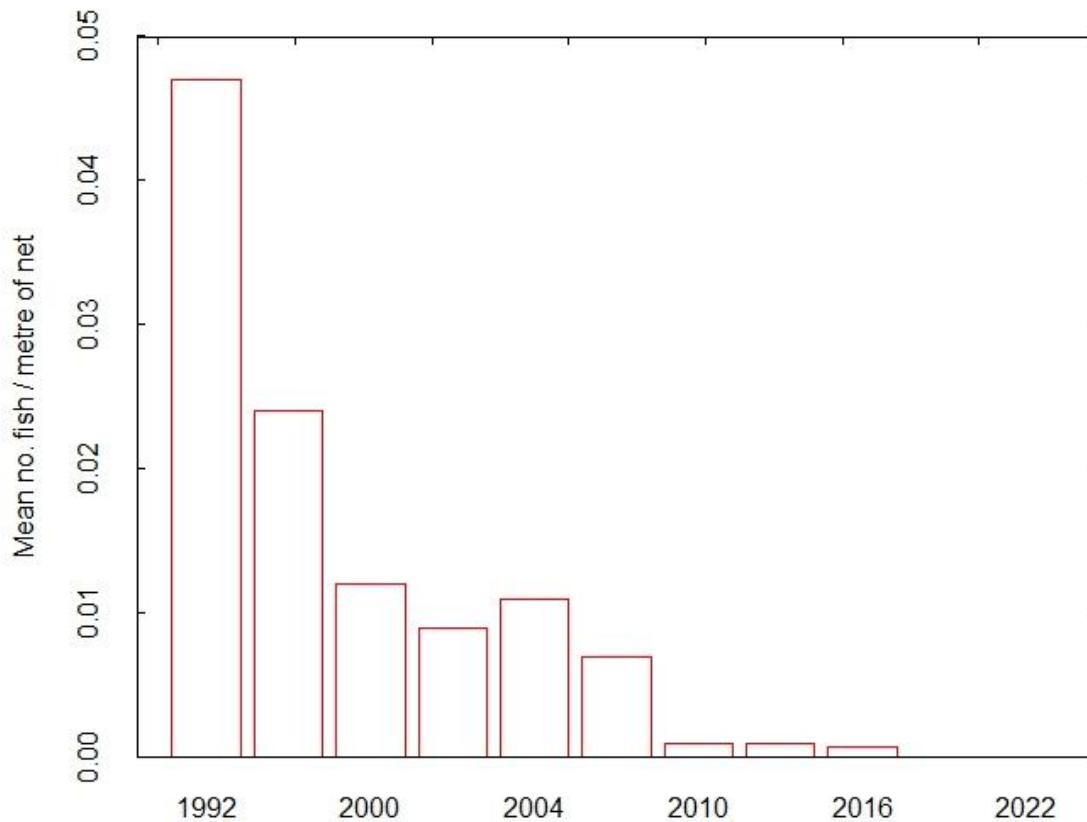


Figure 8: CPUE of Bream in survey nets from Lower Lough Erne 1992-2022.

Following a spike in the population in 2007, the abundance of the Roach-Bream hybrids in Lower Lough Erne decreased in 2010 and numbers have remained similar to pre-2007 levels until the most recent survey which indicated a subsequent further decrease in their population density (Figure 9). A detailed examination of the hybrids following each survey reveals that hybrids live to a greater age than either parental species (bream / roach) and can persist long after the parents have been lost to natural mortality. As such, if hybridisation with roach at shared spawning locations is the cause of the decline of bream, this explains the outnumbering of bream by hybrids. Eventually, if the decline in bream persists, the occurrence of hybrids will likely continue to decline as natural mortality removes the last fecund bream and the remaining cohorts of hybrids.

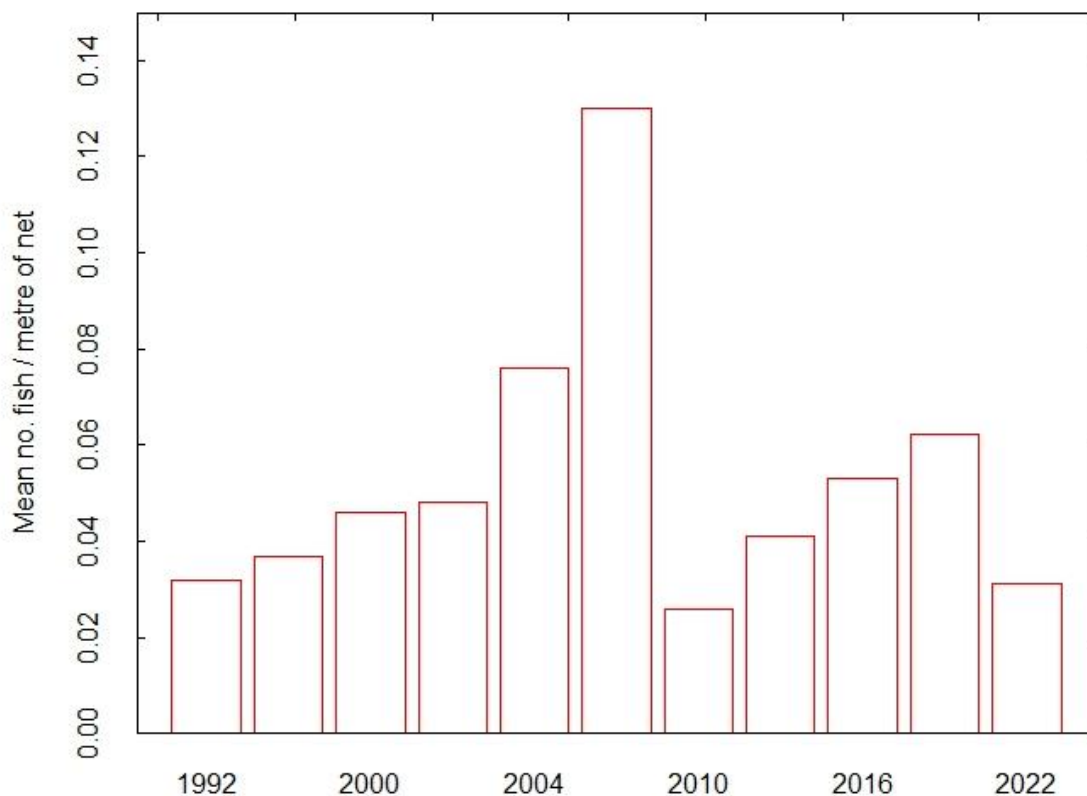


Figure 9: CPUE of Roach - Bream Hybrids in survey nets from 1992 - 2022.

Pike

The data indicates a sharp decline in pike numbers in 2000, followed by subsequent fluctuations thereafter (Figure 10). The mean number of pike per meter of net in 2022 showed an increase compared to the early 2000s but a decrease from the 2019 survey, indicating a relatively stable but fluctuating trend in recent years. These fluctuations are potentially coupled with commercial pressures and variations in water levels. Should commercial fishing effort decrease, the pike population should be closely monitored.

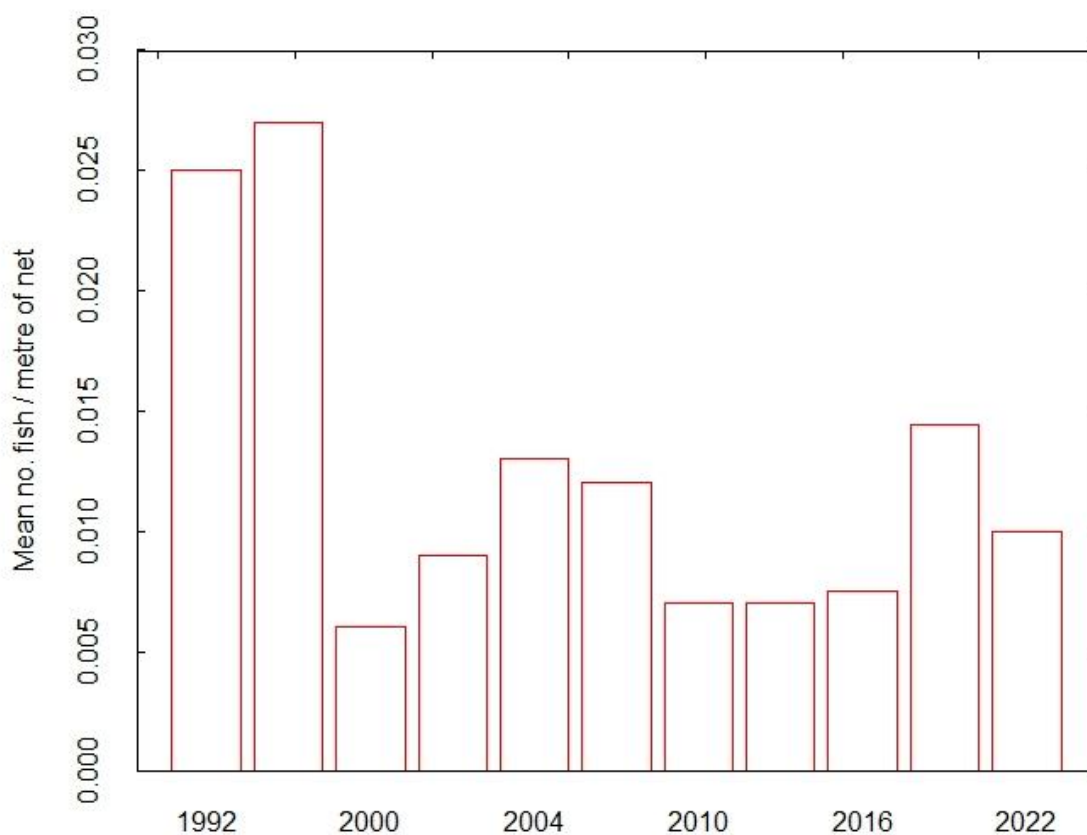


Figure 10: CPUE of Pike in survey nets from Lower Lough Erne 1992 - 2022.

Brown Trout

The multi mesh CEN survey net is designed to catch trout of a size ranging from juvenile fry up to approximately 40 cm although the majority of fish caught in these nets are below the 30 cm threshold

required for recreational harvest. It is noteworthy that brown trout catches in these nets have been low since the zebra mussel invasion (Figure 11). However, trout numbers recorded from multi mesh nets in the most recent survey (2022) have more than tripled in comparison to the previous survey in 2019 (Figure 11).

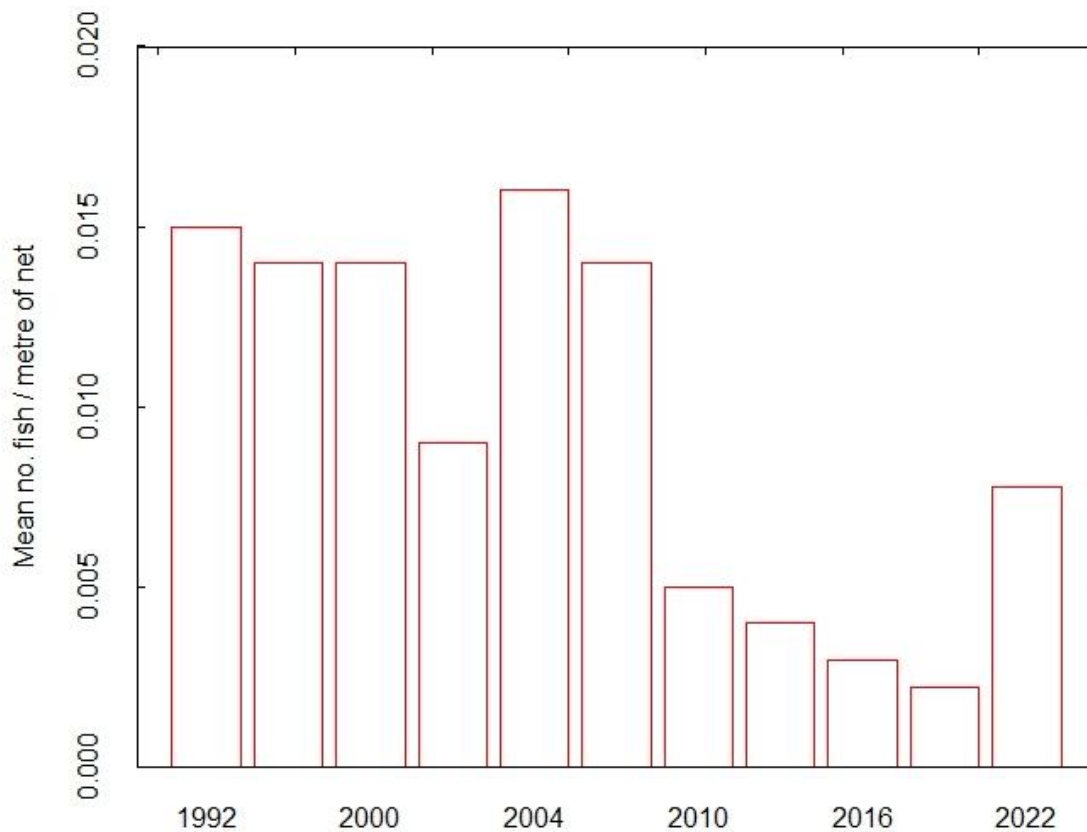


Figure 11: CPUE of brown trout in multi mesh survey nets from Lower Lough Erne 1992-2022.

The 50mm fixed mesh net is primarily used in our surveys to catch trout above statutory minimum landing size (30cm). Catches of Brown Trout from 50 mm fixed mesh nets reached their lowest point in the time series in 2019 however, as was the case with the multi mesh survey net, numbers have increased in the 2022 survey.

These changes may be the result of changing ecology within the Lough following the zebra mussel invasion. Our surveys may not be detecting inter survey population changes but rather an adaptation in

fish behaviour due to predator – prey interactions, competitive asymmetries or the intermittent avoidance of warm shallow waters. In addition, responses to invasive species can affect the catch efficiency of sampling gear.

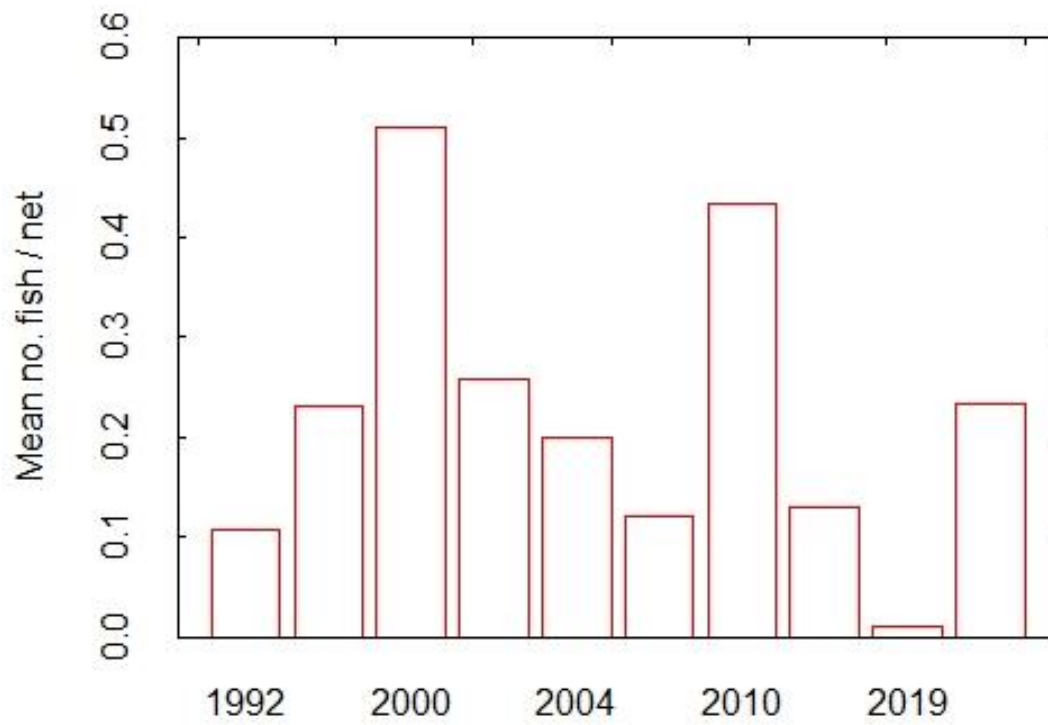


Figure 12: Number of Brown Trout in 50 mm fixed mesh nets from Lower Lough Erne 1992 - 2022.

Conclusion

- The results of the 2022 survey, and in particular the switching from roach to perch dominance, generally follow the trends described in 2019 (Gallagher and Rosell, 2019) and are typical of a fish community in an ecosystem undergoing colonisation from Ponto – Caspian invaders (zebra mussel and bloody red shrimp).
- There has been a continuous decline in the bream stock in recent years. This issue is common in many lakes across the island and the causes may be multifaceted. The presence of roach in the same ecosystem as bream can exert significant ecological pressures potentially leading to declines in bream populations; through competition for food and habitat. Introgressive hybridisation between roach and bream is another significant pressure which has ecological consequences including a reduction or extirpation of a bream stock.
- An increase in brown trout captured during the 2022 survey may indicate a strengthening population which could have previously decreased due to factors including invasion. Future surveys will provide a greater insight into this.

A caveat to the results outlined above is that the change from a Baltic net to a CEN net in 2019 may have introduced a slight variation in the data, which should be taken into account when interpreting long term trends. Method standardisation in future surveys will augment the data series. It should be considered how the current monitoring methodology could be improved upon to enable assessments of potential behavioural changes of fish in response to invasion. This would require setting additional nets in the deep navigable channel, hydroacoustic surveys and an assessment of angler provided data.

Future recommendations

- Conservation and Research Proposals
 - A robust mechanism to collect and analyse catch-per-unit-effort (CPUE) data for rod-caught fish should be established.
 - Data from deep-water sites should be incorporated into stock assessments to enhance accuracy and reliability.
 - Research should be expanded to facilitate the capture of targeted information on brown trout and bream populations to further inform stock management and conservation strategies.

- Incorporate Open Water Survey Techniques
 - Modern survey methodologies, such as sonar and hydro-acoustics, should be implemented to assess navigated channels and open-water habitats. These non-invasive techniques minimise disruptions to tourist boating activities while improving the precision of ecological data collection.

- Updated Assessment on Invasive Species.
 - Surveys to map the spread of key invasive species, including zebra mussels, quagga mussels, and *Hemimysis anomala* should be conducted. These surveys are essential to accurately assess the current distribution, population dynamics, and ecological impacts of these species. Additionally, incorporate advanced screening protocols to manage risks and prevent further spread, safeguarding native ecosystems.

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