Report of the Technical Expert Group on Salmon to the North-South Standing Scientific Committee for Inland Fisheries

The Status of Irish Salmon Stocks in 2022 with Catch Advice for 2023

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Citation

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1 Executive summary

The Technical Expert Group on Salmon (TEGOS) advises that in 2023:

- 48 rivers have an advised harvestable surplus as they are exceeding their conservation limits (CLs).
- A further 20 rivers below their CL are advised to be opened on a catch and release-only basis, based on having a high probability of achieving at least 65% of their conservation limit (CL) or exceeding the qualifying fry threshold of ≥17 fry (0+ salmon) per 5 minute electrofishing (multiple site catchment average).
- In addition, 76 rivers are (a) failing to meet at least 65% of their CL or (b) lacking recent data to determine their CL attainment status. Therefore, it is advised that these rivers should be closed for fishing. Where there is a lack of data, or where catchment-wide electro-fishing surveys indicate juvenile abundance below the fry threshold, the TEGOS assumes that these rivers are failing to meet CL.

There are 16 rivers for which there are significant fisheries on the multi-sea-winter (MSW) component of the stock and thus a separate assessment is made. Of these:

- 11 have an advised harvestable surplus as they are exceeding their CL.
- 4 rivers below their CL are advised to be opened on a catch and release-only basis as they have a high probability of achieving at least 65% of their CL or exceed the catchment-wide electro-fishing minimum mean fry threshold (≥17 fry).
- In addition, 1 river is advised for closure as it is failing to meet 65% of its CL and is below the catchment-wide electro-fishing mean fry threshold (≥17 fry).

There are currently 40 rivers or river tributaries of the 144 salmon rivers assessed in Special Areas of Conservation (SACs) where salmon have a qualifying interest under the EU Habitats Directive. Of these, only 22 are above their CL.

2 Introduction

The North-South Standing Scientific Committee for Inland Fisheries (NSSSCIF) was formed in early 2018 to support the provision of scientific advice relating to the conservation and sustainable exploitation of the inland fisheries resource with advice provided in response to requests from the Department of the Environment, Climate and Communications (DECC) and its agency Inland Fisheries Ireland (IFI) from Ireland (IRL), the Department of Agriculture, Environment and Rural Affairs (DAERA) from Northern Ireland (NI) and the Loughs Agency (LA) a North-South Implementation Body. This group was also tasked to give consideration to the co-ordination and effective use of scientific resources for data collection and research projects linked to the above. The NSSSCIF Terms of Reference (ToRs) facilitates the formation of Expert Groups drawn from within the membership of the Committee, or additional invitees as required, to advise and contribute on any particular species, aquatic habitat or biosecurity issues. To this end, the NSSSCIF has established an expert group to provide scientific advice to guide the NSSSCIF and IFI management in decisions and policy development relating to salmon.

2.1 Terms of reference for the operation of the Technical Expert Group on Salmon (TEGOS)

This document outlines the ToRs for the establishment of a Technical Expert Group on Salmon (TEGOS) to support the NSSSCIF with scientific advice on salmon stock status to support IFI with the management of salmon stocks.

Purpose

The NSSSCIF requests the TEGOS to provide an annual report on the status of salmon stocks, as outlined in Appendix A, for the purpose of advising the NSSSCIF on the sustainable management of Irish salmon stocks. The NSSSCIF may also request the TEGOS to offer scientific advice on the implications of proposed management decisions or policies on salmon or seek advice on scientific matters in relation to salmon. All scientific advice provided by TEGOS will be considered by the NSSSCIF and presented as independent advice.

Appendix A:

For the purpose of advising the NSSSCIF, the TEGOS shall estimate the overall abundance of salmon returning to rivers in the State with reference to river-specific conservations limits (CLs). The TEGOS shall carry out an assessment of salmon stocks using internationally accepted best scientific practice which should demonstrate whether:

a. conservation limits are being or likely to be attained on an individual river basis; and
b. favourable conservation status is being attained within Special Areas of Conservation (SACs) and nationally as required under the Habitats Directive or otherwise.

The assessment shall take account of mixed-stock fishing on salmon stocks including the potential effects on freshwater salmon populations from rivers other than those targeted. In cases where stocks are determined to be below CLs, the TEGOS shall advise the level to which catches should be reduced or other measures adopted on a fishery basis in order to ensure a high degree of probability of meeting the CLs. The TEGOS shall respond to the NSSSCIF relating to specific requests for scientific advice using best international practice. The TEGOS shall provide the NSSSCIF with an independent annual report, which contains the following information:

a. an annual overview of the status of Irish salmon stocks on an individual river basis.
b. catch advice with an assessment of risks associated with the objective of meeting conservation limits in all rivers.
c. upon request an evaluation of the effects on salmon stocks and fisheries of management measures or policies.
d. upon request from the NSSSCIF, report on specific scientific advice relating to salmon conservation.

3 The status of Irish salmon stocks in 2022 with catch advice for 2023

The conservation limit (CL) applied by the Technical Expert Group on Salmon (TEGOS) to establish the status of individual stocks is the "maximum sustainable yield" (MSY) also known as the stock level that maximises the long-term average surplus, as defined and used by the International Council for the Exploration of the Sea (ICES) and the North Atlantic Salmon Conservation Organisation (NASCO). The methodology for establishing CLs was modified for the 2013 catch advice by the former Standing Scientific Committee on Salmon (SSCS) by deriving new estimates of fecundity, average weights, sex and age ratio for Irish index rivers. Similarly, new wetted areas were derived based on a more robust statistical approach and these were also incorporated into the assessment for 2013. Therefore, on the basis of these modifications and the best information available on catches, counts or other estimates and application of a forecast model to these data, the TEGOS advises that in 2023:

- 48 rivers have an advised harvestable surplus as they are exceeding their CLs (Figure 1).
- A further 20 rivers below their CL are advised to be opened on a catch and release-only (C&R-only) basis, based on having a high probability of achieving at least 65% of their conservation limit (CL) or exceeding the qualifying fry threshold of ≥17 fry (0+ salmon) per 5 minute electrofishing (multiple site catchment average).
- In addition, 76 rivers are (a) failing to meet at least 65% of their CL or (b) lacking recent data to determine their CL attainment status. Therefore, it is advised that these rivers should be closed for fishing. Where there is a lack of data, or where catchment-wide electro-fishing surveys indicate juvenile abundance below the fry threshold, the TEGOS assumes that these rivers are failing to meet CL.

There are 16 rivers for which there are significant fisheries on the multi-sea-winter (MSW) component of the stock and thus a separate assessment is made. Of these:

- 11 have an advised harvestable surplus as they are exceeding their CLs.
- 4 rivers below their CL are advised to be opened on a C&R-only basis as they have a high probability of achieving at least 65% of their CL or exceed the catchment-wide electro-fishing minimum mean fry threshold (≥17 fry).
- In addition, 1 river is advised for closure as it is failing to meet 65% of its CL and is below the catchment-wide electro-fishing lower mean fry threshold (≥17 fry).

Amongst the stocks being assessed are 62 river stocks where no rod catch data is available and the annual average rod catch in the most recent five-year period has been less than 10 salmon, making a direct assessment difficult. Although the vast majority of these are insignificant fisheries, their stocks are important as spawning populations in their own right, which must be maintained as constituent elements of biodiversity, as required under the EU Habitats Directive. Because there is no recent means of direct salmon stock assessment on these rivers, the TEGOS have not provided an assessment of CL attainment on these rivers for the 2023 advice. The TEGOS advise that these rivers remain closed until additional information is made available to assess stock status relative to their CLs or catchment-wide electrofishing data indicates they can be opened for C&R-only fishing. In effect, this means that stocks in 82 salmon rivers are assessed for the 2023 advice.

Despite the considerable reductions in commercial catches, following the closure of the mixed-stock fishery at sea in 2007, only 59% of Ireland's assessed salmon rivers are currently estimated to be exceeding biologically-based CLs. While 20 more rivers under CL have been advised to open for C&R-only angling, as assessments indicate relatively high juvenile abundances or the stocks are meeting ≥65% of CL, it is clear the overall proportion of Irish rivers with a good population status is low.

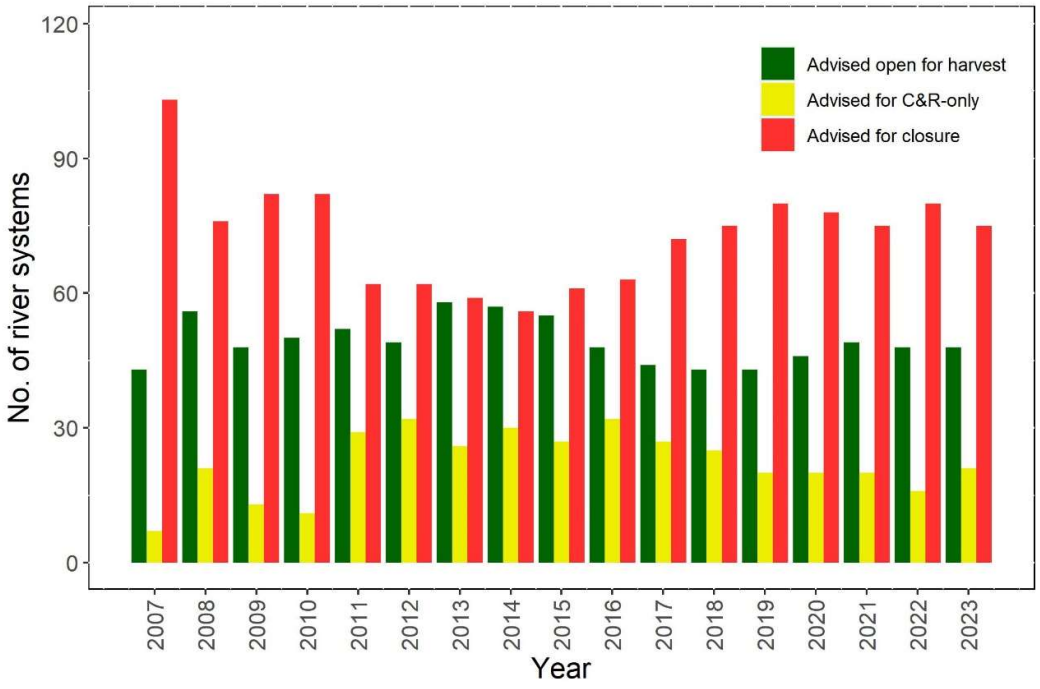

Figure 1 Summary of status of stocks and scientific catch advice provided between 2007 and 2023.

Of the 144 rivers being assessed, there are currently 40 rivers or river tributaries in SACs where salmon have a qualifying interest under the EU Habitats Directive. Of these, only 22 are above their CL (Appendix II Table 10). In addition, there are stocks in four major rivers used for hydro-power which have been assessed as being below their CLs above the impoundments *i.e.* Upper Liffey (Dublin), Upper Lee (Cork), Upper Shannon (Limerick) and the River Erne (Table 6) and following the scientific advice already provided for other rivers, there should be no harvest fisheries on wild salmon in these specific rivers until such time as significant improvements to the generation of self-sustaining runs of salmon above these impoundments has been made within the context of agreed restoration plans.

3.1 Assessment methodology for 2023 catch advice

There was no change in principle to the methodology used to provide catch advice in 2022 for the 2023 season. A summary of the approach is shown below in Figure 2. In-river or estuarine measures of abundance are used (*i.e.* fish counter data and rod/net catch data) to provide a primary measure of spawning stocks and attainment of CLs. For the 2012 analyses for 2013 advice, river-specific CLs were updated and these updated CLs have been applied to date. Any other updates are detailed in the relevant sections below.

With the operation of fisheries restricted to estuaries and rivers since 2007, the assessment is now focused primarily on estimating individual river returns from catch data, counter data (if available), and ranges of rod catch exploitation rates derived from observed values in Irish rivers.

A more comprehensive description of the data used and of the assessment in 2022 for the 2023 fishery is provided in the relevant sections below. Every effort is made to obtain relevant data and monitor the performance of stocks (attainment of CL) at the river level and consequently to assess the status of individual riverine stocks. Several sources of information are used in this process.

3.1.1 Commercial catch data

Despite the cessation of the coastal mixed-stock fisheries, the catch statistics derived from operational estuarine commercial fisheries (draft nets & snap nets) will remain an important source of quantitative information, particularly in determining the overall size of the returning stock and the attainment of river CLs. Following implementation of the wild salmon and sea trout tagging scheme which commenced in 2001 (Ó

Maoiléidigh *et al.,* 2001; Anon 2004), the catch data are derived from the logbook returns of commercial fishers. Reporting rates are at 100% from this fishery.

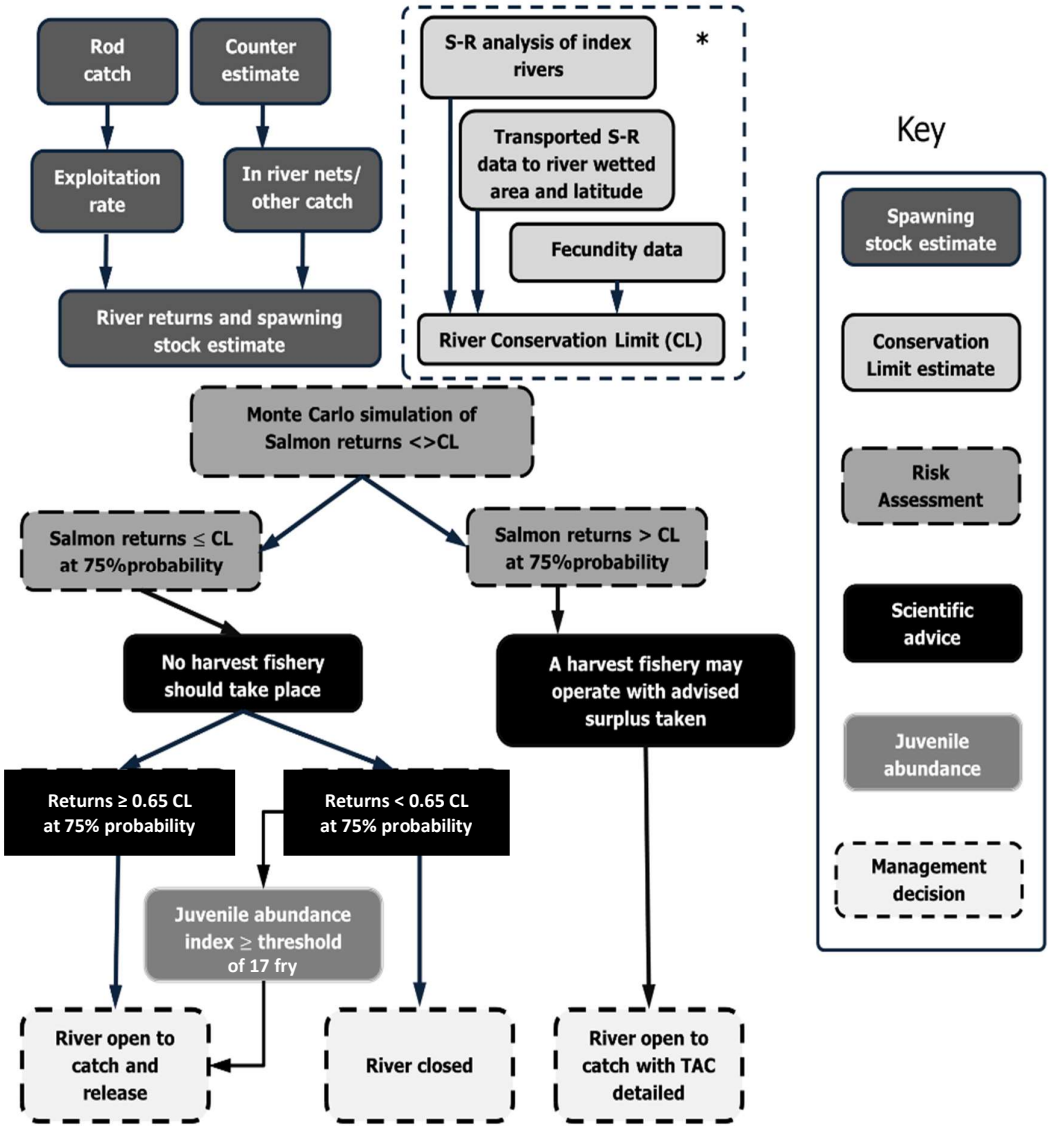

Figure 2 The scientific process for catch advice from 2006 to present (note: since 2018 the management decision thresholds for C&R-only angling are 50% CL or a juvenile abundance CWEF index of 15 in rivers below CL).

3.1.2 Rod catch data

The reported rod catch from the wild salmon and sea trout tagging scheme was adjusted to take into account the numbers of fish that have been caught by anglers who have not returned their logbook. The adjustment follows Small (1991). In some

instances, directly reported rod catches from IFI Regional Fisheries officers or rod catch data from managed fisheries (private owners who maintain reliable records), provided these have been vouched for by IFI officers, have also been used. Angling logbook returns had seen a steady return rate averaging around 70% up until 2017. However, since 2018 logbook returns have dipped to just under 60%.

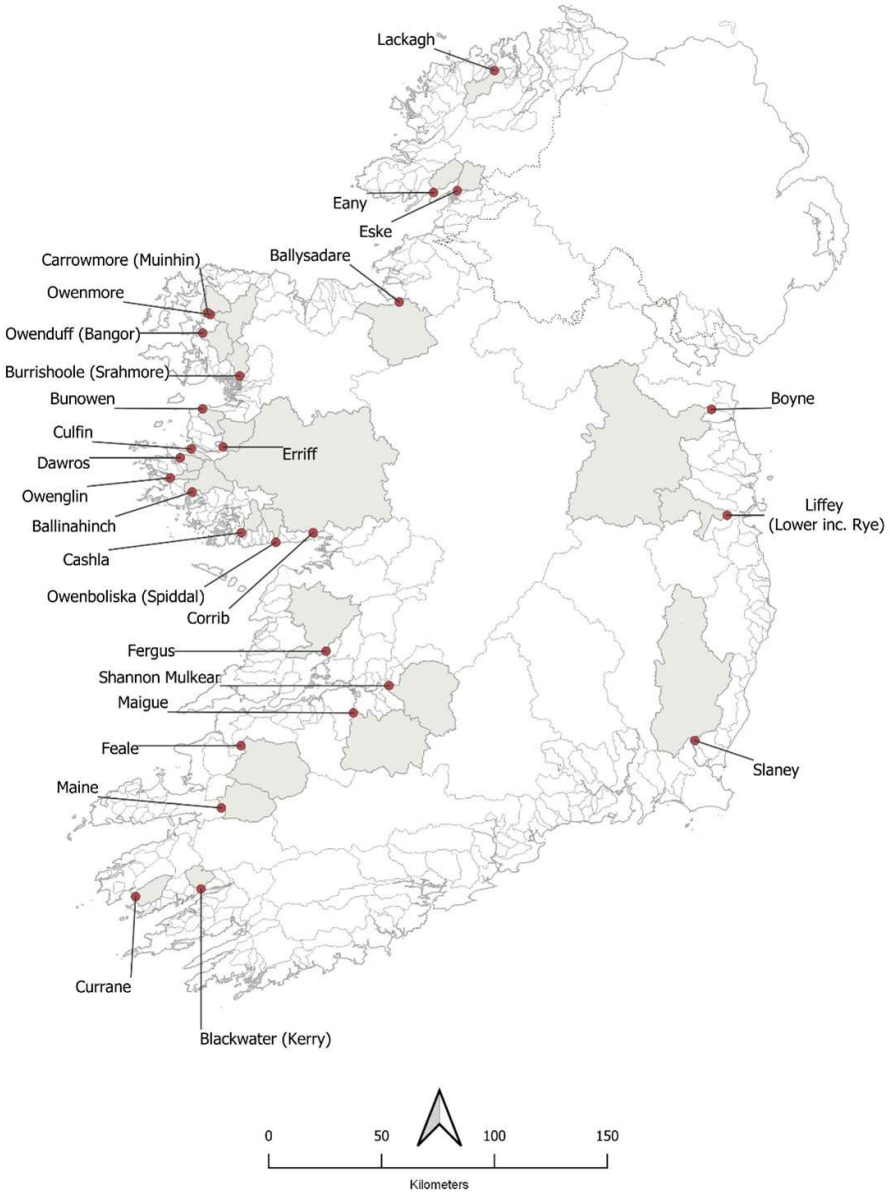

Figure 3 Fish counters used in the stock assessment for the 2023 advice.

3.1.3 Total traps and counters

Data are available from 25 fish counters (see below) and two salmon traps (Burrishoole River, Bangor District and Erriff River, Ballinakill District). Values for October to December in the most recent year were extrapolated from the mean of the previous five years where appropriate. Any further information received which indicated changes to previous catch or counter estimates were incorporated where indicated by IFI.

Fish counter data are provided by IFI and the Marine Institute and some private fishery owners. In total, counts from 27 fish counters and traps were used in the 2022 assessments for the 2023 advice (Figure 3). These are the: *Boyne (Drogheda District); Lower Liffey (Dublin District); Slaney (Wexford District); Kerry Blackwater, Waterville/Currane and Maine (Kerry District); Feale, Fergus, Mulkear and Maigue (Limerick District); Corrib (Galway District); Owenboliska, Casla and Ballynahinch (Connemara District); Owenglin, Dawros, Culfin, Erriff trap and Bunowen (Ballinakill District); Burrishoole trap, Owenduff, Owenmore and Carrowmore (Bangor District); Ballysadare (Sligo District); Eske and Eany (Ballyshannon District); and Lackagh (Letterkenny District)*.

The following approach has been adopted in interpreting the count data and utilising these to measure the attainment of CL:

- Fish are initially separated into salmon and sea trout by signal strength generated by the fish passing the counting electrodes and video images.
- A process of validation of the numbers of salmon and sea trout is carried out during the year whereby a proportion of the counter data (usually a minimum of 15%) is examined in relation to contemporaneous video footage (resistivity counters) or self-generated infra-red images (infra-red counters).
- The initial numbers of salmon and sea trout are corrected after video verification and this correction factor is applied to the remainder of the data.
- It is assumed that all of the downstream counts up to the end of May represent out-migrating kelts *i.e.* fish ascending the river in the previous year (except for the Corrib, Erriff, Lee, Shannon and Erne counters where downstream counts are not available).
- The downstream count from June to December is then subtracted from the upstream count in the same period, correcting for fish counted upstream but which may then come back downstream.

- The estimated upstream run of fish from the counter is corrected to include salmon caught and killed downstream of the counter and excludes salmon caught and killed above the counter.
- Raising factors may be applied to those counters where the possibility of fish moving over the weir without being counted has been reported. The recorded count is raised by a further percentage depending on observations. However, it is essential that these observations are based on assessments carried out by local fisheries authorities or the agencies involved in salmon stock assessment. The Dee, Boyne, Corrib and Slaney counts are raised by a factor of two to allow for the partial nature of these counts (angling catch was used in recent assessments for the Dee (as the counter was not operational in 2018 and 2019).
- In the case of the River Slaney where the proportion of MSW salmon to grilse is much higher than most other rivers in Ireland, a specific analysis was carried out which allows the numbers of grilse and MSW salmon to be allocated over the season with greater precision than in previous assessments based on scale analyses.
- Where counters are used, the CL relates to the area above the counter.

3.1.4 National Coded-wire Tagging and Tag Recovery Programme

This programme provides an index of marine survival over a long time period and information on exploitation rates in marine and freshwater fisheries. Despite the cessation of the mixed-stock fisheries since 2007, information from this programme will continue to inform on marine survival rates and exploitation in some estuarine and rod fisheries and more importantly indicates whether fluctuations in the numbers of returning adults are as a result of management measures or changes in factors occurring outside of management control *i.e.* environmental/climate changes. The most recent trends in marine survival are shown in Section 7.2.1.

3.1.5 Catchment-wide electro-fishing

Information on juvenile salmon abundance indices derived from catchment-wide electro-fishing surveys carried out annually by IFI are examined to indicate stock status. This information is used primarily where new information has not been available for rod catches. A summary of the 2022 programme is provided in Appendix III.

3.2 Status of individual rivers relative to conservation limits

In line with international advice on salmon stocks, the TEGOS advise that the best way to meet national and international objectives of conserving salmon stocks in all salmon rivers is to primarily allow fisheries only in rivers or the estuary of that river, where

there is a greater probability of targeting only the stocks originating from these rivers (*i.e.* single stock fisheries). The TEGOS also advise that fisheries should take place only on stocks that are shown to be meeting their CL with the catch restricted to the estimated surplus above CL. This advice follows from international best practice as advised by ICES and NASCO.

The main objective of the scientific advice therefore, is to ensure that there are sufficient spawning salmon remaining after commercial and recreational fisheries to meet the required CL for that river. In order to do this, the number of salmon which will be available before the fishery takes place must be "forecast" for each river annually, based on the average returns in recent years (usually the most recent five years provided sufficient information is available). The information required for this forecast is derived from commercial catch data, from extrapolation of rod catch information using exploitation rates or from estimates based on fish counter information.

3.2.1 Estimating the total catch in each river

As stated previously the catch data for draft nets, other commercial engines (snap nets) and rods, derive from mandatory fishing logbooks or from vouched information supplied to IFI directly. The forecast model requires the inclusion of the fish taken by the commercial fisheries in the estuaries of each river if present.

3.2.2 Estimating the returns of adult salmon in each river using rod exploitation rates

Rod exploitation rates derive from observed exploitation rate values from fish counters or traps on Irish rivers and are supported by information from the scientific literature and the National Coded-wire Tagging and Tag Recovery Programme. Exploitation by angling on grilse stocks varies but is generally between 10% and 30% of the total river stock available (Milner *et al.*, 2001). These authors quote mean values of 19% for UK rivers, while values for specific Irish grilse (1SW salmon) fisheries have been estimated for the River Erriff at 19% between 1986 and 2000 (Gargan *et al.*, 2001), and 15% for the Burrishoole between 1970 and 2000 (Whelan *et al.*, 2001). Estimates of angling exploitation on multi-sea-winter stocks are generally higher than those reported for grilse (Solomon and Potter 1992) and this has also been observed from Irish rivers with associated fish counter data (Millane *et al.*, 2017). In 2008, the SSCS evaluated all existing information on individual rod fisheries made available by IFI, including field observations of fisheries which have known high or low intensity, to derive more precise estimates of the likely rod exploitation rate on a river by river basis. An extensive review of salmon exploitation rates in Irish rivers (Millane *et al.*, 2017) using rod catch and fish counter data was published in 2017 but has not yet been

incorporated into estimates of adult salmon returns and further work in this regard is required.

Provided the catch in a river is known, in simple terms, the total stock can be estimated by extrapolation using an appropriate exploitation rate in the fishery *e.g.*:

> *If the rod catch of salmon was 150 fish and the exploitation rate in the fishery was 10%, then the total stock of salmon available to generate this catch would be estimated as the catch raised by the exploitation rate:*
>
> *Catch / Exploitation rate * 100*
>
> *In this case 150 / 10 * 100 = 1,500 salmon.*

For most rivers, the specific exploitation rates are not known and therefore a range of values is applied within which the true value is expected to be. Furthermore, as specific rod exploitation data for Irish rivers with fish counters is available, it has been possible to allocate all rivers into specific groups representing heavily fished (higher exploitation rate) and medium fished (medium exploitation rate) to lightly fished rivers (low exploitation rate) based on field observations (Table 1). This restricts the overall range of values being used to a more likely range rather than applying the entire range of values observed.

Table 1 Standard exploitation rates applied in the stock assessment

Fishing intensity	**Total and 1SW (%)**	**MSW (%)**
Low	5 (1–12)	12 (6–27)
Medium	15 (7–35)	
High	33 (10–50)	31(15–46)

Table 9 presents the exploitation rates used for each river for the 2023 advice. Because of the extended drought in summer 2018, the average angling exploitation rates were generally reduced by 50% to account for lower fishing activity. In addition, angling exploitation rates in general were reduced by 20% for years 2020 and 2021 to account for a reduced exploitation rate because of COVID-19 restrictions on movement unless Fisheries Inspector reports indicated otherwise or if the rod catch was greater than twice the five-year average then no such reductions were applied. In addition, the following decision framework was used to revise angling exploitation rates to account for periods of drought affecting angling in summer 2022.

- No further reduction was made to rivers that already had a low exploitation rate assigned.
- No change to the MSW exploitation rates where MSW stocks were separately assessed as these comprise the spring period pre-drought.
- No changes were made where no indication was given by the Fisheries Inspectors that angling catches were affected.
- For rivers with a medium exploitation rate and where the Fisheries Inspectors indicated that low water levels affected angling, the rate was reduced to either low or drought medium to reflect lower angling activity due to low water levels as follows:
    - Munster Blackwater medium reduced to 80% of its standard value;
    - Easky and Drowes reduced to drought medium; and
    - Fane, Gweebarra, Leannan, Owenea & Owentocker, Suir and Tullaghobegly reduced to low.

It is important to note that 2022 angling catches are estimated and the corresponding exploitation rates will further be reviewed for the 2024 advice once official catches are received.

3.3 Provision of harvest guidelines

Once estimates of average returns, average catch, and river-specific CLs have been derived, harvest options are provided with the associated probability of meeting CLs. Where estimates were available for both a counter or trap and a rod catch, the values for the counter or trap are used.

Following the procedure used by ICES for the provision of catch advice for West Greenland, the harvest option that provides a 0.75 probability level (or 75% chance) of meeting the CL for a given stock is recommended. Where there is no harvest option which will provide a 75% chance of meeting the CL, then there is no surplus of fish to support a harvest (commercial or rod).

Given the uncertainty in the data and the use of a risk analysis to allow for some of this uncertainty, a further precautionary limitation on forecast surplus is applied based on the recruit per spawner index of each river. A maximum of three recruits per spawner value is applied to the abundance outputs derived from the risk assessment *i.e.* for every one spawner three recruits may be produced. This is considered to reflect better the overall status of salmon stocks both nationally and internationally.

An objective of the catch advice is to ensure that harvest fisheries only take place on river stocks meeting and exceeding CLs. The means to achieve this objective is to primarily allow only harvest fisheries, which can specifically target single stocks, which are meeting their CLs. Where a fishery comprises of more than one stock, the risk analysis is based on the simultaneous attainment of CL for all contributing stocks. For the 2023 advice, Killary Harbour (Bundorragha and Erriff stocks), the Owenmore Estuary (Carrowmore Lake and Owenmore), Tullaghan Ferry and the Castlemaine Harbour area (Maine, Laune and Caragh river stocks) were considered as true mixed-stock fisheries.

Mixed-stock fisheries will always present greater risks than when stocks are exploited separately however, because of uncertainties or variability in the proportion of the catch originating from the weaker of the stocks. This is particularly true when there are large differences in the relative numbers of fish in each stock as it may be difficult to estimate the impacts on the smaller stocks. Therefore, to avoid intercepting fish from other rivers, particularly those which are not meeting CLs, the advice is to operate all fisheries within the estuary of the river stock for which the catch advice is being given and not a common bay or estuary where several rivers stocks may be present. Careful consideration must be made of local topography, fishing practices, number of contributing stocks and their status and the ability to discriminate the contributing stocks and manage the fishery effectively.

In a number of rivers the CL will be achieved by the contributions of both 1SW (grilse) and MSW (multi-sea-winter) fish. There is conservation of biodiversity and fisheries development value in identifying and protecting both life history types. It is important for fisheries management to be able to determine how much of the CL is likely to be met by either MSW or 1SW fish and to regulate fisheries for both components separately. More information is required on the proportions of each component of the stock being exploited and the timing of their entry into estuaries and freshwater. Advice has been provided on 1SW and MSW separately where a significant early run component has been identified and can be managed separately on the assumption that all fish counted or caught before 31st May are considered to be MSW fish (except for the Slaney where data are available on the typical proportions of 1SW and MSW salmon encountered through the run).

4 Overview of status of stocks and precautionary catch advice for 2023

Although new CLs were applied in 2013 and the basis for the risk assessment was modified, few changes applied to the actual catch advice procedure for the 2023 season. The present system of updating catch data from the previous year to reflect official logbook returns was maintained (unless indicated otherwise by local Fisheries Inspectors), while the catch data for the most recent year was based on local Fisheries Inspectors estimates. Data from fish counters and traps were updated for the previous year to include October to December values if available, while provisional counts for the current year were compiled to the end of September. In addition, respective counter values for October to December in the current year were extrapolated from the mean of the previous five years where appropriate. Any further information received, which indicated changes to previous catch or counter estimates, were incorporated where indicated by IFI.

Overal, catch advice for the 2023 season is provided for 144 salmon stocks. In addtion, separate assessments are made for 16 rivers which are considered to have a significant MSW stock component.

Details of the catch advice for 2023 provided by the TEGOS are given in Table 2 through to Table 7:

Generally, the TEGOS advises that:

- Harvest of salmon should only be allowed on stocks from rivers where a surplus above their CL is identified and that no more than this surplus should be harvested *i.e.* those rivers detailed in Table 2 and Table 3. (Note: in some rivers where the available surplus is minor and impractical to manage, management may decide to operate such fisheries as C&R-only).
- Harvest fisheries should not take place on stocks from rivers without an identifiable surplus above the CL *i.e.* those rivers identified in Table 4 to Table 7. C&R-only angling is advised on rivers where stocks under CL are meeting at least 65% of CL or the juvenile fry index is at least 17 (Table 7).
- No harvest fisheries should take place on those stocks from 62 rivers where insufficient rod catch data is available to assess salmon stock status (Table 8). The TEGOS advise that these rivers remain closed to harvest until such time as additional information becomes available to assess the status of these stocks relative to their CLs.

Owing to the different status of individual stocks within the stock complex, mixed-stock fisheries present particular threats to stock status (ICES 2014). The objective of the catch advice is to ensure that harvest fisheries only take place on river stocks meeting and exceeding CLs. The means to achieve this objective is to primarily allow only harvest fisheries which can specifically target single stocks which are meeting their CLs. The TEGOS strongly advise that all fisheries should operate only on the target stock as close to the river mouth or within the river to achieve this.

Even where all exploited stocks in a common estuary are meeting their CLs, mixed-stock fisheries introduce greater uncertainty into predicting the effects of management measures and pose a greater threat to small stocks or populations, especially if these are of low relative productivity and/or subject to high exploitation. As the number of stocks (or populations) increases, the number of fish that must escape from such the fisheries in order to meet CLs must also increase. When the number of populations is too large, it may be impossible to ensure a high probability of the simultaneous achievement of spawner requirements in each individual unit. The overall objective should be to achieve a flexible but sustainable fishery without compromising conservation goals by ideally fishing only single stock salmon stocks which are shown to have a harvestable surplus over the CL. The best way to achieve this is to fish within the river or as close to the river as possible (*i.e.* the estuary of that river).

Table 2 Rivers meeting conservation limits with a forecasted surplus above the required conservation limit for 2023 advice. This is the catch option which provides a 75% chance that the CL will be met. (Note: 1SW and 2SW combined unless otherwise noted).

District	River	CL	Deficit/ surplus	Prop. CL achieved
Dundalk	Fane	1173	102	1.09
Lismore	Blackwater, Glenshelane, Finisk	15217	4448	1.29
Cork	Lower Lee (Cork)	1896	759	1.40
Cork	Bandon	2058	842	1.41
Cork	1SW Ilen	679	414	1.61
Cork	Mealagh	96	164	2.71
Cork	Owvane	372	208	1.56
Cork	Coomhola	309	112	1.36
Cork	Glengarriff	166	182	2.09
Kerry	Croanshagh	274	147	1.54
Kerry	Sheen	623	421	1.68
Kerry	Roughty	1538	306	1.20
Kerry	Sneem	347	664	2.92
Kerry	1SW Waterville	119	237	3.00
Kerry	Inney	630	236	1.38
Kerry	Ferta	224	63	1.28
Kerry	1SW Caragh	395	791	3.95
Kerry	1SW Laune and Cottoners	2071	4027	2.95
Kerry	Maine	1186	424	1.36
Kerry	Owenmore	105	210	3.00
Limerick	1SW Feale, Galey and Brick	2859	132	1.05
Galway	Corrib	7551	3331	1.44
Connemara	Cashla	419	159	1.38
Connemara	Ballynahinch	834	64	1.08
Ballinakill	Owenglin	422	93	1.22
Ballinakill	Dawros	495	742	2.50
Ballinakill	Culfin	136	270	3.00
Ballinakill	Erriff	1381	461	1.33
Ballinakill	1SW Bundorragha	95	190	3.00
Ballinakill	Carrownisky	365	52	1.14
Ballinakill	Bunowen	460	215	1.47
Bangor	1 SW Newport R. (Lough Beltra)	507	184	1.36
Bangor	1SW Owenduff (Glenamong)	711	364	1.51
Bangor	Owenmore	2073	434	1.21
Bangor	1SW Carrowmore	231	241	2.04
Bangor	Glenamoy	622	32	1.05
Ballina	Moy	16736	12159	1.73
Ballina	Easky	1400	188	1.13
Sligo	Ballysadare	6372	894	1.14
Sligo	Drumcliff	511	185	1.36

District	River	CL	Deficit/ surplus	Prop. CL achieved
Ballyshannon	1 SW Drowes	1064	2024	3.00
Ballyshannon	Owenwee (Yellow R)	183	95	1.52
Letterkenny	Owenea and Owentocker	1684	283	1.17
Letterkenny	1SW Gweebarra	611	157	1.26
Letterkenny	Gweedore (Crolly R.)	342	313	1.92
Letterkenny	Clady	345	80	1.23
Letterkenny	Tullaghobegly	223	74	1.33
Letterkenny	Crana	1072	221	1.21

Table 3 MSW river stocks meeting conservation limits with a forecasted surplus above the required conservation limit for 2023 advice. This is the catch option which provides a 75% chance that the CL will be met.

District	River	CL	Surplus	Prop. CL achieved
Cork	2SW Ilen	212	181	1.85
Kerry	2SW Waterville	83	83	1.98
Kerry	2SW Caragh	280	252	1.90
Kerry	2SW Laune	815	446	1.55
Limerick	2SW Feale, Galey and Brick	864	46	1.05
Ballinakill	2SW Bundorragha	70	17	1.24
Bangor	2SW Newport R. (Lough Beltra)	366	88	1.24
Bangor	2SW Owenduff (Glenamong)	402	196	1.49
Bangor	2SW Carrowmore	122	244	3.00
Ballyshannon	2SW Drowes	426	262	1.62
Letterkenny	2SW Gweebarra	116	22	1.19

Table 4 Assessed rivers below conservation limits for 2023 advice and the estimated deficits and proportion of CL achieved for 1SW and MSW stocks combined unless otherwise indicated. Catchment-wide electrofishing (CWEF) mean value (salmon fry/ 5 min) is also presented.

District	River	CL	Deficit	Prop. CL achieved	CEF mean value
Dundalk	Castletown	1447	-1334	0.08	14.1
Dundalk	Glyde	1852	-711	0.62	12.9
Dundalk	1SW Dee	945	-602.00	0.36	15.4
Drogheda	Boyne	10242	-7988	0.22	15.9
Dublin	Lower Liffey Inc Rye	1705	-1526	0.10	15.6
Dublin	Upper Liffey US Lexlip	5373	-5213	0.03	8.3
Wexford	1SW Slaney	915	-721	0.21	17.5
Waterford	Barrow and Pollmounty	11738	-10120	0.14	16.9
Waterford	Nore	10420	-2642	0.75	15.8
Waterford	Suir, Clodiagh, Lingaun, Blackwater	14055	-4315	0.69	13.3
Lismore	Bride	1569	-517	0.67	16.3
Cork	Upper Lee	2789	-2277	0.18	0.3
Cork	Argideen	467	-235	0.50	22.3
Kerry	Blackwater	438	-21	0.95	25.0
Kerry	Owenascaul	180	-143	0.20	19.3
Limerick	Maigue	4642	-4112	0.11	15.0
Limerick	Mulkear	4222	-1321	0.69	
Limerick	Fergus	1187	-845	0.29	6.5
Limerick	Doonbeg	526	0	1.00	16.8
Galway	Owenboliska R (Spiddal)	592	-478	0.20	5.5
Connemara	Screebe	151	-53	0.65	11.1
Ballinakill	Owenwee (Belclare)	375	-74	0.80	8.9
Bangor	Srahmore (Burrishoole)	617	-344	0.44	
Sligo	1 SW Garvogue (Bonnet)	2545	-807	0.684	14.6
Ballyshannon	Duff	1065	-664	0.38	18.1
Ballyshannon	Erne	16506	-14772	0.11	0.4
Ballyshannon	Eske	729	-372	0.49	14.2
Ballyshannon	Eany	1464	-1039	0.29	19.6
Ballyshannon	Oily	628	-510	0.19	19.6
Ballyshannon	Bungosteen	373	-303	0.19	15.4
Ballyshannon	Glen	1196	-305	0.75	17.2
Letterkenny	Ray	435	-82	0.81	11.1
Letterkenny	1SW Lackagh	235	-50	0.79	19.9
Letterkenny	1SW Leannan	517	-222	0.57	18.6

Table 5 Rivers below conservation limits and estimated deficits and proportion of CL achieved for MSW stocks only for 2023 advice. (Total deficit for these rivers = 1SW & MSW deficits combined). Catchment-wide electrofishing (CWEF) mean value (salmon fry/ 5 min) is also presented.

District	River	CL	Deficit	Prop. CL achieved	CEF mean value
Dundalk	2SW Dee	715	-739	0.00	15.4
Wexford	2SW Slaney Counter	2749	-2495	0.09	17.5
Sligo	2SW Garvogue (Bonnet)	289	-88	0.69	14.6
Letterkenny	2SW Lackagh	278	-269	0.03	19.9
Letterkenny	2SW Leannan	1199	-1302	0.00	18.6

Table 6 Status of salmon stocks above rivers impounded for hydro-electric schemes.

River	Wetted area u/s of hydro station m²	CL	Average salmon count (most recent five-year data)	Prop. CL achieved
Erne	6,457,264	16,586	2198	11%
Upper Shannon (above Parteen)	30,895,619	49,638	1439	5%
Upper Lee	2,370,000	2,789	512	18%
Upper Liffey	2,308,361	5,389	243	3%

Table 7 Rivers advised to be open for catch & release-only fishing for 2023 based on meeting ≥65% CL threshold or meeting catchment-wide electrofishing (CWEF) minimum mean threshold of ≥17 salmon fry/ 5 min.

District	River	CL	Deficit	Prop. CL achieved	CWEF mean value
Wexford	1SW Slaney	915	-721	0.21	17.5
Waterford	Nore	10420	-2642	0.75	15.8
Waterford	Suir, Clodiagh, Lingaun, Blackwater	14055	-4315	0.69	13.3
Lismore	Bride	1569	-517	0.67	16.3
Cork	Argideen	467	-235	0.50	22.3
Kerry	Cloonee	61	-49	0.20	25.0
Kerry	Blackwater	438	-21	0.95	19.3
Limerick	Lower Shannon	4205			32.3
Limerick	Mulkear	4222	-1321	0.69	
Limerick	Doonbeg	526	0	1.00	16.8
Connemara	Screebe	151	-53	0.65	11.1
Ballinakill	Owenwee (Belclare)	375	-74	0.80	8.9
Sligo	1 SW Garvogue (Bonnet)	2545	-807	0.684	14.6
Ballyshannon	Duff	1065	-664	0.38	18.1
Ballyshannon	Eany	1464	-1039	0.29	19.6
Ballyshannon	Oily	628	-510	0.19	19.6
Ballyshannon	Glen	1196	-305	0.75	17.2
Letterkenny	Ray	435	-82	0.81	11.1
Letterkenny	1SW Lackagh	235	-50	0.79	19.9
Letterkenny	1SW Leannan	517	-222	0.57	18.6
Wexford	2SW Slaney Counter	2749	-2495	0.09	17.46
Sligo	2SW Garvogue (Bonnet)	289	-88	0.69	14.6
Letterkenny	2SW Lackagh	278	-269	0.03	19.9
Letterkenny	2SW Leannan	1199	-1302	0.00	18.6

Table 8 Rivers where no or insufficient rod catch data available, with catchment-wide electro-fishing (CWEF) value indicated and whether river is meeting CWEF mean minimum threshold of ≥17 salmon fry/ 5 min.

District	River	CL	Meeting CWEF threshold (value)
Dundalk	Flurry	427	No (9.3)
Dublin	Dargle	734	No (3.33)
Dublin	Vartry	274	No (6.9)
Wexford	Avoca	3945	No (7)
Wexford	Owenavorragh	944	No (6.6)
Waterford	Colligan	422	No (11.8)
Waterford	Corock R	836	No (11.1)
Waterford	Mahon	443	No (6.3)
Waterford	Owenduff	300	No (6.2)
Waterford	Tay	319	No (5.5)
Lismore	Lickey	148	No (12.8)
Lismore	Tourig	118	No (10.3)
Lismore	Womanagh	368	No (5.74)
Cork	Adrigole	167	No (7)
Cork	Owenacurra	293	No (15.6)
Kerry	Behy	176	No (6.5)
Kerry	Carhan	88	No (11)
Kerry	Cloonee	61	No (7)
Kerry	Emlagh	137	No (4.6)
Kerry	Emlaghmore	68	No (3.1)
Kerry	Feohanagh	161	No (11.4)
Kerry	Finnihy	143	No (2.5)
Kerry	Kealincha	128	No (0.0)
Kerry	Lee	507	No (0.5)
Kerry	Lough Fada	88	No (1.6)
Kerry	Milltown	87	No (15.0)
Kerry	Owenreagh	87	No (5.6)
Kerry	Owenshagh	304	No (10.8)
Limerick	Annageeragh	321	No (3.9)
Limerick	Aughyvackeen	223	No (1.7)
Limerick	Deel	2823	No (1)
Limerick	Inagh	1096	No (5.5)
Limerick	Owenagarney	630	No (9.8)
Limerick	Shannon(Lower)	4205	Yes (32.3)
Limerick	Shannon (Upper)	49638	No data
Limerick	Skivaleen	458	No (12.3)
Galway	Aille (Galway)	105	No data
Galway	Clarinbridge	487	No (4.5)
Galway	Kilcolgan (Dunkellin)	2070	No (7.23)

District	River	CL	Meeting CWEF threshold (value)
Galway	Knock	132	No (14.7)
Connemara	L. Na Furnace	71	No (0.0)
Bangor	Muingnabo	336	No (1.0)
Bangor	Owengarve	227	No (6.4)
Ballina	Ballinglen	411	No (9.6)
Ballina	Brusna	1096	No (11.2)
Ballina	Cloonaghmore	1323	No (15.4)
Ballina	Leaffony	241	No (3.9)
Sligo	Grange	339	No (4.4)
Ballyshannon	Abbey	333	No (28.1)*
Ballyshannon	Ballintra (Murvagh R).	548	No (11.7)
Ballyshannon	Erne	16586	No (0.4)
Ballyshannon	Laghy	448	No (9.6)
Letterkenny	Bracky	200	No (12.5)
Letterkenny	Clonmany	443	No (9.2)
Letterkenny	Culoort	252	No (7.7)
Letterkenny	Donagh	429	No (3.1)
Letterkenny	Glenagannon	377	No (7.3)
Letterkenny	Glenna	215	No (8.8)
Letterkenny	Isle (Burn)	521	No (1.1)
Letterkenny	Mill	312	No (0.0)
Letterkenny	Owenamarve	205	No (4.5)
Letterkenny	Straid	184	No (0.1)
Letterkenny	Swilly	1105	No (11.4)

*only 1 valid survey

Table 9 River rod catch exploitation rates applied for 2023 advice.

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Dundalk	Castletown	2022		NA				
Dundalk	Castletown	2021		NA				
Dundalk	Castletown	2020	0.07	0.15	0.35			
Dundalk	Castletown	2019	0.01	0.05	0.12			
Dundalk	Castletown	2018	0.01	0.025	0.06			
Dundalk	Dee	2022	0.01	0.05	0.12	0.06	0.12	0.27
Dundalk	Dee	2020-2021	0.01	0.04	0.1	0.06	0.12	0.27
Dundalk	Dee	2019	0.01	0.05	0.12	0.06	0.12	0.27
Dundalk	Dee	2018	0.01	0.025	0.06	0.06	0.12	0.27
Dundalk	Fane	2022	0.01	0.05	0.12	0.06	0.12	0.27
Dundalk	Fane	2020-2021	0.01	0.04	0.1	0.06	0.12	0.27
Dundalk	Fane	2019	0.01	0.05	0.12	0.06	0.12	0.27
Dundalk	Fane	2018	0.01	0.05	0.12	0.06	0.12	0.27
Dundalk	Glyde	2022	0.01	0.05	0.12	0.06	0.1	0.22
Dundalk	Glyde	2021	0.01	0.05	0.12	0.06	0.1	0.22
Dundalk	Glyde	2020	0.07	0.12	0.28	0.06	0.1	0.22
Dundalk	Glyde	2019	0.01	0.05	0.12	0.06	0.12	0.27
Dundalk	Glyde	2018	0.01	0.025	0.06	0.06	0.12	0.27
Waterford	Barrow and Pollmounty	2022	0.01	0.05	0.12	0.06	0.12	0.27
Waterford	Barrow and Pollmounty	2020-2021	0.01	0.04	0.1	0.06	0.12	0.27
Waterford	Barrow and Pollmounty	2019	0.01	0.05	0.12	0.06	0.12	0.27
Waterford	Barrow and Pollmounty	2018	0.01	0.025	0.06	0.06	0.12	0.27
Waterford	Nore	2022	0.01	0.05	0.12	0.06	0.12	0.27
Waterford	Nore	2020-2021	0.01	0.04	0.1	0.06	0.12	0.27
Waterford	Nore	2019	0.01	0.05	0.12	0.06	0.12	0.27
Waterford	Nore	2018	0.01	0.025	0.06	0.06	0.12	0.27
Waterford	Suir, Clodiagh, Lingaun	2022	0.01	0.05	0.12	0.06	0.12	0.27
Waterford	Suir, Clodiagh, Lingaun	2020-2021	0.07	0.15	0.35	0.06	0.12	0.27
Waterford	Suir, Clodiagh, Lingaun	2018-2019	0.01	0.05	0.12	0.06	0.12	0.27
Lismore	Blackwater, Glenshelane, Finisk	2022	0.1	0.15	0.2			
Lismore	Blackwater, Glenshelane, Finisk	2021	0.067	0.1	0.14			
Lismore	Blackwater, Glenshelane, Finisk	2020	0.1	0.15	0.2			

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Lismore	Blackwater, Glenshelane, Finisk	2019	0.12	0.18	0.26			
Lismore	Blackwater, Glenshelane, Finisk	2018	0.09	0.14	0.19			
Lismore	Bride	2022	0.01	0.05	0.12			
Lismore	Bride	2021	0.07	0.15	0.35			
Lismore	Bride	2019-2020	0.01	0.05	0.12			
Lismore	Bride	2018	0.01	0.025	0.06			
Cork	Argideen	2022	0.01	0.05	0.12			
Cork	Argideen	2020-2021	0.01	0.04	0.1			
Cork	Argideen	2019	0.01	0.05	0.12			
Cork	Argideen	2018	0.01	0.025	0.06			
Cork	Bandon	2022	0.07	0.15	0.35	0.6	0.12	0.27
Cork	Bandon	2020-2021	0.07	0.12	0.28	0.06	0.1	0.22
Cork	Bandon	2019	0.07	0.15	0.35	0.6	0.12	0.27
Cork	Bandon	2018	0.065	0.14	0.212	0.13	0.281	0.423
Cork	Coomhola	2019-2022	0.07	0.15	0.35			
Cork	Coomhola	2018	0.035	0.075	0.175			
Cork	Glengarriff	2022	0.07	0.15	0.35			
Cork	Glengarriff	2020-2021	0.01	0.04	0.1			
Cork	Glengarriff	2019	0.01	0.05	0.12			
Cork	Glengarriff	2018	0.01	0.025	0.06			
Cork	Ilen	2019-2022	0.07	0.15	0.35	0.06	0.12	0.27
Cork	Ilen	2018	0.035	0.075	0.175	0.06	0.12	0.27
Cork	Lower Lee (Cork)	2022	0.07	0.15	0.35	0.06	0.12	0.27
Cork	Lower Lee (Cork)	2020-2021	0.07	0.12	0.28	0.06	0.1	0.22
Cork	Lower Lee (Cork)	2019	0.07	0.15	0.35	0.06	0.12	0.27
Cork	Lower Lee (Cork)	2018	0.035	0.075	0.175	0.06	0.12	0.27
Cork	Mealagh	2022	0.07	0.15	0.35			
Cork	Mealagh	2021	0.01	0.05	0.12			
Cork	Mealagh	2020	0.01	0.04	0.1			
Cork	Mealagh	2019	0.01	0.05	0.12			
Cork	Mealagh	2018	0.01	0.025	0.06			
Cork	Owvane	2022	0.07	0.15	0.35			
Cork	Owvane	2021	0.01	0.04	0.1			

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Cork	Owvane	2019-2020	0.01	0.05	0.12			
Cork	Owvane	2018	0.01	0.025	0.06			
Kerry	Caragh	2022	0.07	0.15	0.35	0.15	0.31	0.46
Kerry	Caragh	2020-2021	0.07	0.12	0.28	0.15	0.31	0.46
Kerry	Caragh	2019	0.07	0.15	0.35	0.15	0.31	0.46
Kerry	Caragh	2018	0.035	0.075	0.175	0.15	0.31	0.46
Kerry	Croanshagh	2022	0.07	0.15	0.35			
Kerry	Croanshagh	2019-2021	0.01	0.05	0.12			
Kerry	Croanshagh	2018	0.01	0.025	0.06			
Kerry	Ferta	2020-2022	0.07	0.15	0.35			
Kerry	Ferta	2019	0.01	0.05	0.12			
Kerry	Ferta	2018	0.01	0.025	0.06			
Kerry	Inney	2019-2022	0.07	0.15	0.35			
Kerry	Inney	2018	0.035	0.075	0.175			
Kerry	Laune and Cottoners	2022	0.07	0.15	0.35	0.15	0.31	0.46
Kerry	Laune and Cottoners	2020-2021	0.07	0.12	0.28	0.15	0.25	0.37
Kerry	Laune and Cottoners	2019	0.07	0.15	0.35	0.15	0.31	0.46
Kerry	Laune and Cottoners	2018	0.035	0.075	0.175	0.15	0.31	0.46
Kerry	Owenascaul	2021-2022	0.01	0.05	0.12			
Kerry	Owenascaul	2020	0.01	0.04	0.1			
Kerry	Owenascaul	2019	0.01	0.05	0.12			
Kerry	Owenascaul	2018	0.01	0.025	0.06			
Kerry	Owenmore	2022	0.07	0.15	0.35			
Kerry	Owenmore	2020-2021	0.01	0.04	0.1			
Kerry	Owenmore	2019	0.01	0.05	0.12			
Kerry	Owenmore	2018	0.01	0.025	0.06			
Kerry	Roughty	2019-2022	0.07	0.15	0.35			
Kerry	Roughty	2018	0.05	0.1	0.15			
Kerry	Sheen	2020-2022	0.07	0.15	0.35			
Kerry	Sheen	2019	0.01	0.04	0.1			
Kerry	Sheen	2018	0.01	0.02	0.05			
Kerry	Sneem	2021-2022	0.07	0.15	0.35			
Kerry	Sneem	2019-2020	0.01	0.05	0.12			

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Kerry	Sneem	2018	0.01	0.025	0.06			
Limerick	Doonbeg	2019-2022	0.01	0.05	0.12			
Connemara	Screebe	2022	0.07	0.15	0.35			
Connemara	Screebe	2021	0.07	0.15	0.35			
Connemara	Screebe	2020	0.07	0.12	0.28			
Connemara	Screebe	2019	0.07	0.15	0.35			
Connemara	Screebe	2018	0.01	0.025	0.06			
Ballinakill	Bundorragha	2022	0.07	0.15	0.35	0.15	0.31	0.46
Ballinakill	Bundorragha	2020-2021	0.07	0.12	0.28	0.06	0.12	0.27
Ballinakill	Bundorragha	2019	0.07	0.15	0.35	0.15	0.31	0.46
Ballinakill	Bundorragha	2018	0.035	0.075	0.175	0.15	0.31	0.46
Ballinakill	Carrownisky	2021-2022	0.01	0.05	0.12			
Ballinakill	Carrownisky	2020	0.01	0.04	0.1			
Ballinakill	Carrownisky	2019	0.01	0.05	0.12			
Ballinakill	Carrownisky	2018	0.01	0.025	0.06			
Ballinakill	Owenwee (Belclare)	2021-2022	0.01	0.05	0.12			
Ballinakill	Owenwee (Belclare)	2020	0.01	0.04	0.1			
Ballinakill	Owenwee (Belclare)	2019	0.01	0.05	0.12			
Ballinakill	Owenwee (Belclare)	2018	0.01	0.025	0.06			
Bangor	Glenamoy	2022	0.07	0.15	0.35			
Bangor	Glenamoy	2019-2021	0.01	0.05	0.12			
Bangor	Glenamoy	2018	0.01	0.025	0.06			
Bangor	Newport R. (Lough Beltra)	2022	0.05	0.1	0.15	NA	NA	NA
Bangor	Newport R. (Lough Beltra)	2020-2021	0.05	0.08	0.12	0.06	0.1	0.22
Bangor	Newport R. (Lough Beltra)	2019	0.05	0.1	0.15	0.06	0.12	0.27
Bangor	Newport R. (Lough Beltra)	2018	0.025	0.05	0.075	0.06	0.12	0.27
Ballina	Easky	2022	0.035	0.075	0.175			
Ballina	Easky	2021	0.01	0.05	0.12			
Ballina	Easky	2019-2020	0.07	0.15	0.35			
Ballina	Easky	2018	0.035	0.075	0.175			
Ballina	Moy	2022	0.07	0.15	0.35	0.15	0.31	0.46
Ballina	Moy	2021	0.1	0.33	0.50	0.15	0.31	0.46
Ballina	Moy	2020	0.07	0.12	0.28	0.15	0.25	0.37

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Ballina	Moy	2019	0.07	0.15	0.35	0.15	0.31	0.46
Ballina	Moy	2018	0.035	0.075	0.175	0.15	0.31	0.46
Sligo	Drumcliff	2022	0.07	0.15	0.35			
Sligo	Drumcliff	2021	0.07	0.12	0.28			
Sligo	Drumcliff	2019-2020	0.07	0.15	0.35			
Sligo	Drumcliff	2018	0.035	0.075	0.175			
Sligo	Garvogue (Bonnet)	2022	0.01	0.05	0.12	NA	NA	NA
Sligo	Garvogue (Bonnet)	2020-2021	0.01	0.04	0.1	0.06	0.1	0.22
Sligo	Garvogue (Bonnet)	2019	0.01	0.05	0.12	0.06	0.12	0.27
Sligo	Garvogue (Bonnet)	2018	0.01	0.025	0.06	0.06	0.12	0.27
Ballyshannon	Bungosteen	2022	0.01	0.05	0.12			
Ballyshannon	Bungosteen	2020-2021	0.01	0.04	0.1			
Ballyshannon	Bungosteen	2019	0.01	0.05	0.12			
Ballyshannon	Bungosteen	2018	0.01	0.025	0.06			
Ballyshannon	Drowes	2022	0.035	0.075	0.175	0.15	0.31	0.46
Ballyshannon	Drowes	2020-2021	0.07	0.15	0.35	0.06	0.12	0.27
Ballyshannon	Drowes	2019	0.07	0.15	0.35	0.15	0.31	0.46
Ballyshannon	Drowes	2018	0.035	0.075	0.175	0.15	0.31	0.46
Ballyshannon	Duff	2022	0.01	0.05	0.12			
Ballyshannon	Duff	2020-2021	0.01	0.04	0.1			
Ballyshannon	Duff	2016-2019	No exploitation					
Ballyshannon	Duff	(2014–2015)	0.07	0.15	0.35			
Ballyshannon	Glen	2022	0.01	0.05	0.12			
Ballyshannon	Glen	2021	0.01	0.05	0.12			
Ballyshannon	Glen	2019-2020	0.07	0.15	0.35			
Ballyshannon	Glen	2018	0.035	0.075	0.175			
Ballyshannon	Oily	2022	0.01	0.05	0.12			
Ballyshannon	Oily	2020-2021	0.01	0.04	0.1			
Ballyshannon	Oily	2019	0.01	0.05	0.12			
Ballyshannon	Oily	2018	0.01	0.025	0.06			
Ballyshannon	Owenwee (Yellow)	2022	0.01	0.05	0.12			
Ballyshannon	Owenwee (Yellow)	2021	0.01	0.04	0.1			
Ballyshannon	Owenwee (Yellow)	2020	0.07	0.15	0.35			

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Ballyshannon	Owenwee (Yellow)	2019	0.01	0.05	0.12			
Ballyshannon	Owenwee (Yellow)	2018	0.01	0.025	0.06			
Letterkenny	Clady	2022	0.07	0.15	0.35			
Letterkenny	Clady	2021	0.07	0.12	0.28			
Letterkenny	Clady	2020	0.07	0.15	0.35			
Letterkenny	Clady	2019	0.07	0.15	0.35			
Letterkenny	Clady	2018	0.035	0.075	0.175			
Letterkenny	Crana	2022	0.01	0.05	0.12			
Letterkenny	Crana	2021	0.01	0.05	0.12			
Letterkenny	Crana	2020	0.07	0.15	0.35			
Letterkenny	Crana	2019	0.01	0.05	0.12			
Letterkenny	Crana	2018	0.01	0.025	0.06			
Letterkenny	Gweebara	2022	0.01	0.05	0.12	0.06	0.12	0.27
Letterkenny	Gweebara	2020-2021	0.07	0.12	0.38	0.06	0.1	0.22
Letterkenny	Gweebara	2019	0.07	0.15	0.35	0.06	0.12	0.27
Letterkenny	Gweebara	2018	0.035	0.075	0.175	0.06	0.12	0.27
Letterkenny	Gweedore (Crolly R.)	2022	0.01	0.05	0.12			
Letterkenny	Gweedore (Crolly R.)	2019-2021	0.01	0.05	0.12			
Letterkenny	Gweedore (Crolly R.)	2018	0.01	0.025	0.06			
Letterkenny	Leannan	2022	0.01	0.05	0.12	0.06	0.12	0.27
Letterkenny	Leannan	2020-2021	0.07	0.12	0.28	0.06	0.1	0.22
Letterkenny	Leannan	2019	0.07	0.15	0.35	0.06	0.12	0.27
Letterkenny	Leannan	2018	0.035	0.075	0.175	0.06	0.12	0.27
Letterkenny	Owenea and Owentocker	2022	0.01	0.05	0.12			
Letterkenny	Owenea and Owentocker	2021	0.07	0.12	0.28			
Letterkenny	Owenea and Owentocker	2018-2020	0.07	0.15	0.35			
Letterkenny	Ray	2022	0.01	0.05	0.12			
Letterkenny	Ray	2020-2021	0.01	0.04	0.1			
Letterkenny	Ray	2019	0.01	0.05	0.12			
Letterkenny	Ray	2018	No exploitation					
Letterkenny	Ray	(2015, 2017)	0.01	0.05	0.12			
Letterkenny	Tullaghobegly	2022	0.01	0.05	0.12			
Letterkenny	Tullaghobegly	2021	0.07	0.12	0.28			

District	River	Year	Total or 1SW exploitation rate			MSW exploitation rate		
			Min.	Likely	Max.	Min.	Likely	Max.
Letterkenny	Tullaghobegly	2020	0.07	0.15	0.35			
Letterkenny	Tullaghobegly	2019	0.07	0.15	0.35			
Letterkenny	Tullaghobegly	2018	0.01	0.05	0.12			

5 Mixed-stock commercial fisheries advice

The objective of the catch advice is to ensure that harvest fisheries operate only in estuaries where stocks in contributing systems meet and exceed CLs. There are potentially four mixed-stock commercial fisheries operating in estuaries.

5.1 Killary Harbour

In the case of the Killary Harbour (Ballinakill District) fishery, there are two contributing stocks (Delphi and Erriff) both of which are meeting and exceeding their CLs in the 2023 advice (Table 2). The TEGOS provide advice on the Killary common embayment based on the CL being met on both rivers simultaneously. If a mixed-stock draft-net fishery is to operate in Killary Harbour in 2023, then a mixed-stock common estuary surplus applies which raises the CL for both rivers to ensure they simultaneously meet CL. The common estuary surplus for Killary Harbour is 568 fish for 2023. This surplus applies to the recreational fisheries operating in the River Erriff, the 1SW stock in the Bundorragha River and the draft-net fishery operatring in Killary Harbour and can be allocated accordingly between them. The 2SW Bundorragha stock has a separate surplus.

5.2 The Owenmore Estuary and Tullaghan Ferry

The Owenmore Estuary and the relatively minor Tullaghan Ferry mixed-stock fisheries formerly comprised the Tullaghan Bay mixed-stock fishery which operated until 2013. The operation of the Tullaghan Bay mixed-stock fishery was reviewed in 2012 and it was noted that the fisheries are mostly confined to the immediate vicinity of the Carrowmore/Owenmore and Owenduff river mouths with only a relatively small mixed-stock fishery in the bay (Ferry). Therefore, it was advised that it was more appropriate to apply a specific risk analysis for Owenmore Estuary (which exploits stocks from the Carrowmore and Owenmore rivers). This results in a higher requirement for spawners for this mixed-stock fishery than simply combining the CLs for the two contributory rivers which ensures a simultaneous attainment of CLs is required to advise this fishery to operate. As such the draft net and rod angling fisheries for the Owenmore and Carrowmore 1SW must be taken from this reduced surplus if available. In addition, a small TAC is assigned to the relatively minor Tullaghan Ferry mixed-stock fishery (which potentially exploits stocks from the Carrowmore/Owenmore and Ownduff rivers). This TAC is allocated from a percentage of the Owenmore Estuary surplus and the Owenduff surplus when available. Neither the Owenmore Estuary or Tullaghan Ferry mixed-stock fishery was advised for operation until 2021 as one of the three contributary stocks, the Owenmore River, was below CL. As all three rivers were assessed as exceeding CL in 2023, both mixed-stock fisheries are advised a suplus for operation. The Owenduff River has had a substantial surplus and a TAC has been allocated to the Owenduff Estuary since 2015.

The TEGOS advice for 2023 is that the Owenmore has a 1SW surplus of 434 fish while the Carrowmore has a 1SW surplus of 241 fish (Table 2). If a mixed-stock draft-net fishery is to operate in the Owenmore estuary in 2023, then a mixed-stock common estuary surplus applies which raises the CL for both rivers to ensure they simultaneously meet CL. The common estuary surplus advised for 1SW fish for the Owenmore estuary is 445 fish for 2023. This surplus applies to all relevant commercial and recreational fisheries operating in the Owemore and Carrowmore rivers and Owenmore Estuary and can be allocated accordingly between them. The 2SW Carrowmore stock has a separate surplus. If the Tullaghan Ferry commercial fishery is operated, the TAC should be allocated in part from the 1SW Owenduff surplus and in part from the Common Estuary Owenmore surplus.

5.3 Castlemaine Harbour

In 2010, the Minister of State at the Department of Communications, Energy & Natural Resources requested advice on how a commercial salmon fishery could be operated on stocks in Castlemaine Harbour in a sustainable manner, maximising the opportunities for commercial fishing whilst ensuring that stocks are not overexploited. In this context, a pilot fishery was operated in Castlemaine Harbour in 2010 to determine the composition of the various stocks in the fishery. The results indicated that at least 94% of the catch in the fishery comprised salmon stocks from rivers entering Castlemaine Harbour (Laune, Caragh and Maine). All three rivers have been above CL since 2011 and a mixed-stock fishery has operated since that time. Advice is provided annually on this common embayment fishery based on all three rivers simultaneously achieving their CLs. If a mixed-stock draft-net fishery is to operate in Castlemaine in 2023, then a mixed-stock common estuary surplus applies which raises the CL for constituent rivers to ensure they simultaneously meet CL. The common estuary surplus for Castlemaine is 4395 fish for 2023. This surplus applies to all relevant commercial and recreational fisheries and can be allocated accordingly between them. The 2SW Laune and 2SW Caragh have a separate surplus.

6 Recent trends in salmon stock status

Since 2007, scientific advice has been provided on an individual river basis regarding salmon stock status. While scientific advice will continue to be presented on an individual river basis, data from fish counters, where reliable long-term data is available, has been combined (Figure 4) in order to provide an overview of trends in salmon stock status nationally.

6.1 Fish counter time series

The number of counters installed and used in stock assessments has increased since river-specific advice began in 2007. The analysis is based on data from 9 to a maximum of 31 fish counters with a reasonable time series of data. The counter time series runs from 2002 to the most recent full year. Corrected average yearly fish counts can be calculated using a generalised linear model (GLM) to show the overall annual trend across the available counters. This provides a benchmarked comparison of how annual salmon returns have varied in this time period. Figure 4 shows variation in the mean values for numbers of salmon counted through counters from 2002 to 2022, peaking in 2007 which coincided with the cessation of offshore drift netting.

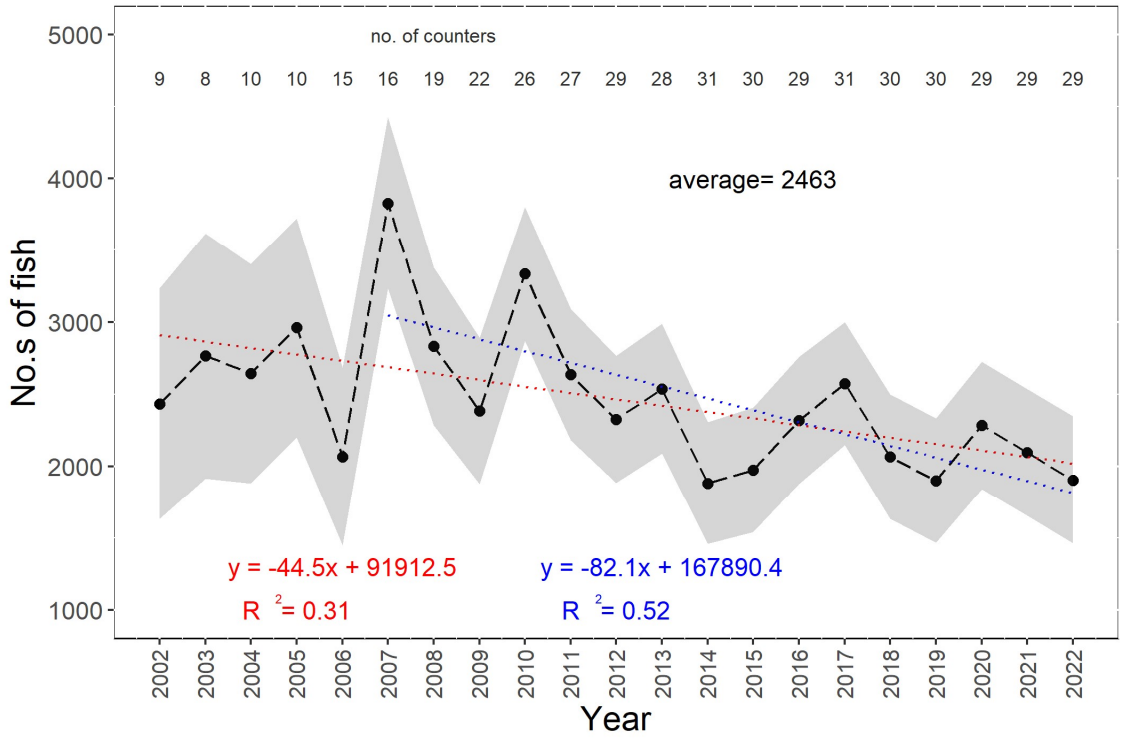

Figure 4 Marginal GLM Least Squares-mean standardised number of salmon counted through counters operated between 2002 and 2022 (± 95% confidence intervals – grey band). The number of counters is shown at the top. The linear trend over the full time period (red dashed line), and between 2007 and the present (blue dashed line) are also indicated. Note that the drift net fishery ceased at the end of the 2006 season.

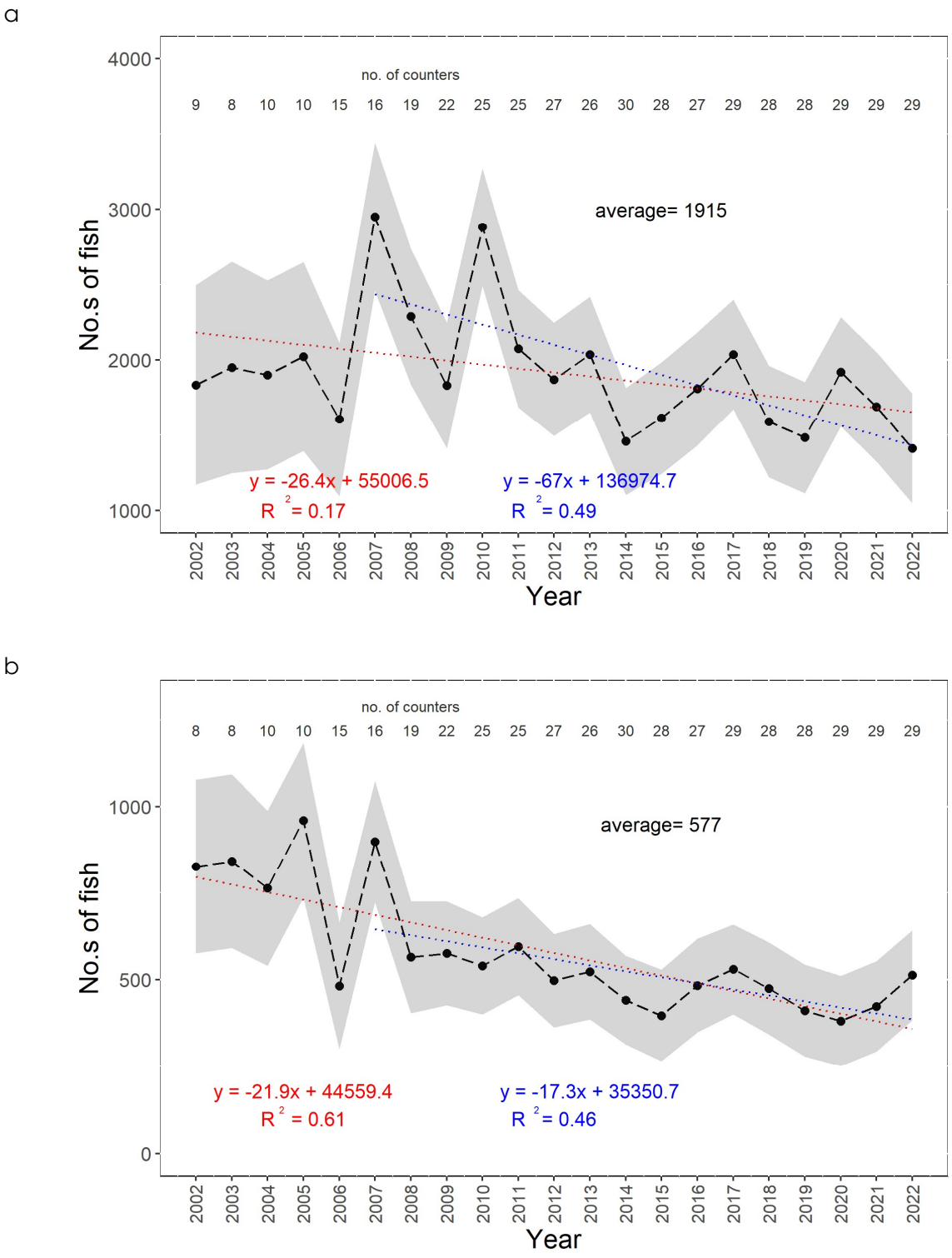

Figure 5 Marginal GLM LS-mean standardised number of (a) 1SW grilse and (b) MSW counted through counters operated between 2002 and 2022 (± 95% confidence intervals – grey band). The linear trend over the full time period (red dashed line), and between 2007 and the present (blue dashed line) are also indicated.

The overall linear trend of the fish counter time series indicates a moderate decline in mean abundance which has become more marked since 2007. A minor upturn was evident from the series low of 2014 until 2017 with mean abundance in 2020 an upturn on the preceding two years which has not continued since 2021. Figure 5a shows trends in returns of one-sea-winter (1SW) grilse. As 1SW grilse constitute the majority of the overall salmon stock in Ireland, it is unsurprising that the overall trend and year to year variations in mean stock abundance are similar as was observed for the total salmon stock (Figure 4). Figure 5b presents trends in returning multi-sea-winter (MSW) salmon, including spring salmon which predominantly return from January to May inclusive. A moderately declining trend is evident in this stock component over the time series. However, since 2020, a minor upward trend is evident and this reflects anecdotal reports from across the country in 2022 that MSW fish were a more notable feature of overall returns in 2022.

Overall, 21 of the 29 counter estimates are below their mean counts from preceding years (Figure 6).

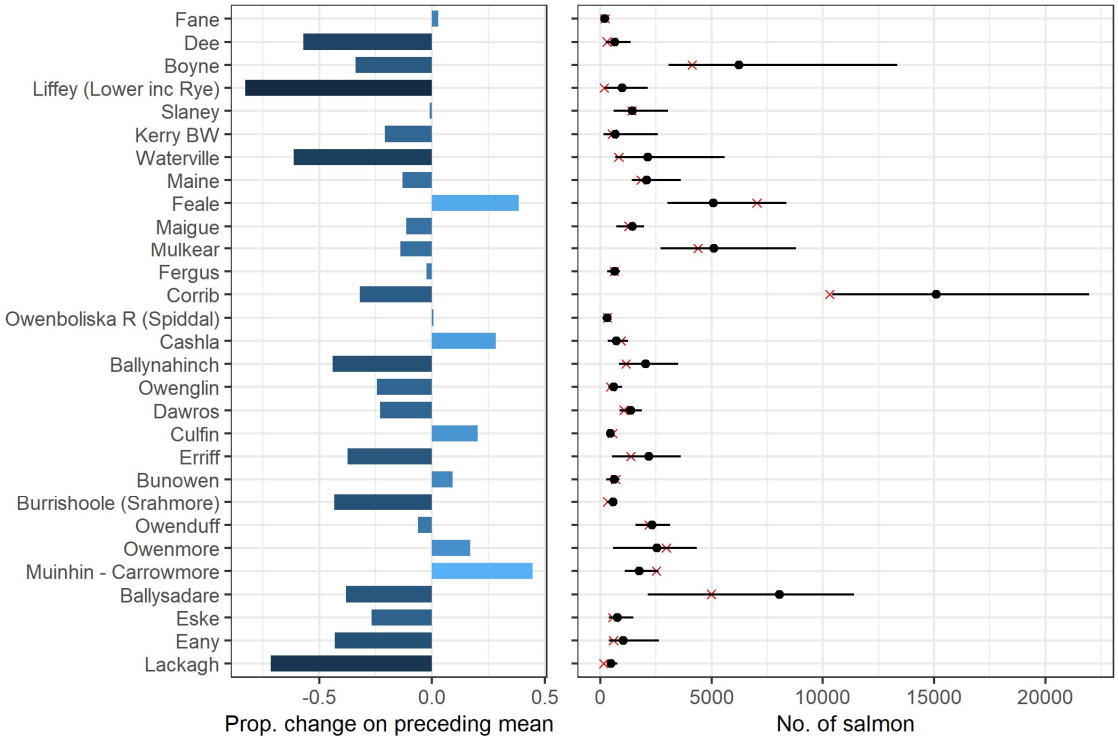

Figure 6 The proportional change in the salmon count in 2022 compared to the preceding multi-annual mean count per fish counter (left panel); Mean salmon count and associated range (min, max) of the preceding time series (indicated by black circle and bar, respectively) in comparison to the most recent year's count (indicated by red X) (right panel).

6.2 National returns and estimates of spawners relative to CL attainment

The ICES Working Group on North Atlantic Salmon (WGNAS) provides annual scientific advice to the inter-governmental body NASCO for the management of fisheries in the North Atlantic. In this advice, Irish wild salmon stocks are included as part of the southern complex in the North-east Atlantic region, along with French, south-west Icelandic and UK stocks. As part of the ICES advice process, for the southern stock complex and its constituent jurisdictions, annual stock assessments and periodic stock forecasts (every one to three years) are undertaken (ICES 2018, 2019, 2020, 2021). As the ICES WGNAS did not convene in 2022, no such annual assessment of stock status was undertaken for 2022.

For the ICES WGNAS assessments, stocks are divided into *maturing 1SW* i.e. grilse fish who spend a single winter at sea before returning to Ireland; and *non-maturing 1SW* i.e. multi-sea winter fish who spend, typically two, or more years at sea before returning to Ireland. The following stock statuses are considered:

- PFA (*Pre-fisheries abundance*): Abundance of maturing 1SW and non-maturing 1SW in the ocean before any fisheries or natural mortality on their return migration takes place.
- CL (*conservation limit*). This is the sum of the conservation limits of all Irish salmon rivers.
- SER (*Spawner escapement reserve*). This level on the graph indicates the minimum amount of fish that are required in the PFA phase to meet the national CL set for each stock component. The SER accounts for the natural mortality that occurs between the PFA stage and the return of fish to home-waters. It is derived from the national CL by accounting for the natural mortality and distant water fisheries that occur during the fish's residence at sea.
- 1SW / MSW returns: number of fish returning to the Irish coast after high seas fisheries and taking account natural mortality rates while at sea.
- 1SW / MSW spawners: number of spawning fish in Irish rivers.

6.2.1 One-sea-winter returns and spawners

Based on ICES advice, 1SW returns to Ireland before fisheries take place were above CL from 1971 to 2008 and 2010 to 2012, below CL in 2009 and since 2013. (Figure 7). However, following exploitation, spawners have been at or below CL for 23 of the 49 years in the time series. In the most recent years, post the cessation of the drift net fishery, the national CL has been exceeded only in five years (2007, 2008, 2010, 2011 and 2012) (ICES 2021).

6.2.2 Multi-sea-winter returns and spawners

National MSW returns to Ireland exceeded CL until 1990 after which values fluctuated around the CL until 2005. Since then, returns of MSW fish have been well below CL (Figure 7). While the management aim is to ensure that MSW spawners are above CL after any fishery takes place, this has only been achieved three times since 1988 and not since 2003 (ICES 2021).

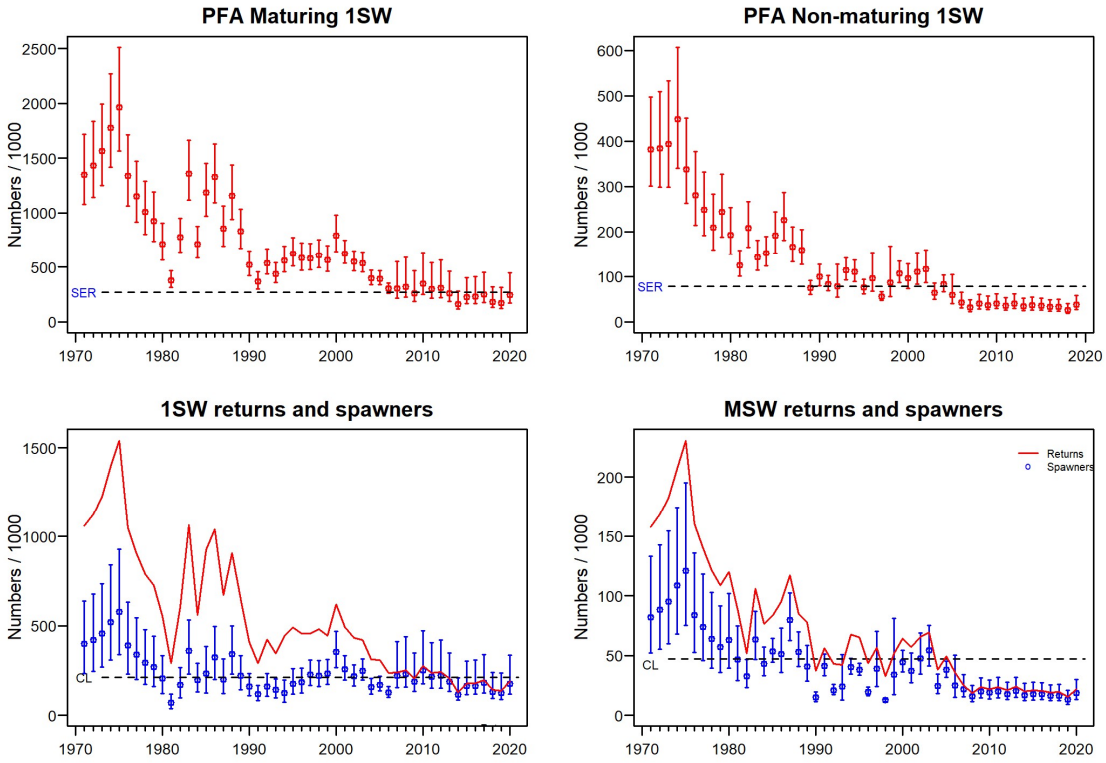

Figure 7 Top panels: Pre-Fisheries Abundance of Irish 1SW and MSW salmon stocks (red points with 95% confidence intervals) with respective Spawner Escapement Reserve indicated (dashed line). Bottom panels: Estimated return of 1SW and MSW salmon to Ireland prior to homewater fisheries (solid red line) and spawners (blue points with 95% confidence intervals) relative to national CL (dashed line). (source: ICES 2021).

6.2.3 Stock forecast (2020 to 2024)

For the southern North-east Atlantic stock complex (2020 to 2024), of which Ireland is a constituent jurisdiction, for maturing (1SW) stocks the PFA is forecast to fall below the SER in 2022 and 2023. The forecast for the non-maturing (MSW) PFA remains above SER in the period 2020-2024. However, for both maturing and non-maturing Irish stocks, the median PFA is forecast to be below the SER for all forecasted years (2020-2024). This modelled projection essentially predicts that there will not be enough Irish one-sea-winter or multi-sea-winter salmon present in the ocean to meet our national CL during this period (ICES 2021).

7 Advice for stock rebuilding

7.1 International guidance on stock rebuilding

The terms of reference of the TEGOS are outlined earlier in this report. One of these relates to salmon stocks below CL.

> *"In cases where stocks are determined to be below the conservation limits the TEGOS shall advise the level to which catches should be reduced or other measures adopted on a fishery basis in order to ensure a high degree of probability of meeting the conservation limits".*

Other measures to be adopted can relate to stock rebuilding programmes for salmon stocks below CL. In 1998, NASCO adopted the "precautionary approach" to fisheries management. The NASCO *Agreement on the Adoption of the Precautionary Approach* states, that:

'*an objective for the management of salmon fisheries is to provide the diversity and abundance of salmon stocks*'

or in other words to maintain both the productive capacity and diversity of salmon stocks. NASCO provides an interpretation of how this is to be achieved. Management measures should be aimed at maintaining all stocks above their CLs by the use of management targets. The precautionary approach is an integrated approach that requires, *inter alia*, that stock rebuilding programmes (including as appropriate, fishery management actions, habitat improvements and stock enhancement) be developed for stocks that are below CLs.

NASCO developed *Guidelines on the Use of Stock Rebuilding Programmes (SRP) in the Context of the Precautionary Management of Salmon Stocks* in 2004, CNL(04)55. An SRP is an array of management measures, possibly including habitat restoration/improvement, exploitation control and stocking, which is designed to restore a salmon stock above its CL. The nature and extent of the programme will depend upon the status of the stock and the pressures that it is facing. NASCO guidelines on stock rebuilding programmes notes, that while the short-term response to a stock failing to exceed its CL may be to reduce or eliminate exploitation, there will generally be a need to develop a programme to evaluate and address the causes of the stock decline. In more serious situations, there may be a need for a comprehensive programme of research and management, involving a wide range of management actions undertaken by a number of user groups.

NASCO's SRP guidelines were developed to *inter alia* provide a link between several other guidance documents developed by NASCO in relation to the application of the Precautionary Approach, including the *Decision Structure for the Management of Salmon Fisheries*, and the *Plan of Action for the Protection and Restoration of Atlantic Salmon Habitats*. Since the SRP guidelines were adopted, NASCO has adopted *Guidelines for the Management of Salmon Fisheries*, CNL(09)43, *Guidelines for the Protection, Restoration and Enhancement of Salmon Habitat*, CNL(10)51, and *Guidance on Best Management Practices to Address Impacts of Sea Lice and Escaped Farmed Salmon on Wild Salmon Stocks*, SLG(09)5, which contain elements relevant to stock rebuilding.

Ireland was required to submit an Implementation Plan (IP) to NASCO covering the period 2019–2024 to demonstrate what actions are being taken to implement NASCO resolutions, agreements and guidelines. Among the information provided are the main threats to wild salmon and challenges for management in relation to fisheries, to estuarine and freshwater habitat, and to aquaculture, introductions and transfers, and transgenics. The IP sets out what actions are planned to address each of the above threats and challenges in the five-year period to 2024.

Each year Ireland is required to submit an Annual Progress Report (APR) to NASCO providing information on progress against actions in Ireland's IP relating to management of salmon fisheries, habitat protection and restoration and aquaculture and related activities as well as available information on monitoring the effectiveness of those actions and their enforcement. In addition, details of any significant changes to the status of stocks and any changes to the IP are included in the report. The IP sets out how actions are proposed to address stock rebuilding of salmon stocks below CL and the APR details progress being made to achieve these objectives.

ICES is also addressing the issue of stock rebuilding of salmon across all North Atlantic salmon countries. The ICES Working Group on Effectiveness of Recovery Actions for Atlantic Salmon (WGERAAS) reported in 2015, and reviewed and evaluated the effectiveness of the many salmon recovery and rebuilding programmes that have been implemented in the past. This investigation will enable successful approaches, and their situations, to be highlighted and recommendations based upon this for future works to be made.

The group has four Terms of Reference, to:

- develop a classification system for recovery / re-building programs for Atlantic salmon, including threats to populations, population status, life history attributes, actions taken to re-build populations, program goals, and metrics for evaluating the success of re-building programs;
- populate the system by collecting data on recovery / re-building programs for Atlantic salmon populations from around the North Atlantic;
- summarise the resulting data set to determine the conditions under which various recovery / re-building actions are successful and when they are not; and
- provide recommendations on appropriate recovery / rebuilding actions for Atlantic salmon given threats to populations, status and life history.

The findings of this group were reported to NASCO in 2016. (ICES 2017).

7.2 Factors affecting stock rebuilding programmes for Irish salmon stocks

Closure of marine mixed-stock fisheries for salmon and even complete closure of some salmon rivers to harvest fisheries may not ensure that all rivers will meet or exceed CLs in the short term. There are several identifiable problems militating against immediate recovery and this must be taken into account for future management over and above management of fisheries (Thorstad *et al*., 2021). In some instances, such as climate changes leading to poorer marine survival of salmon, it may not be possible to tackle the specific problems directly. Some of these specific problems related to marine survival are outlined below.

7.2.1 Marine survival

Marine survival of Irish salmon has declined from 15% to 20% of juveniles returning as adults to Irish rivers in the 1970s and 1980s to a current level which fluctuates around the 5% level (Figure 8). Decreased survival rate in the marine environment, rather than in natal rivers, seems to explain the current poor state of many salmon populations (ICES 2016). Marine survival can be partitioned into coastal (transitional and inshore waters) and oceanic (offshore and open ocean) components. The coastal component operates during the first migration of juvenile salmon (smolts) out of their natal river. Events during such early life stages can have an impact on subsequent marine survival of salmon. Coastal pressures include local pollution, predation, and increased rates of sea lice infestation associated with salmon aquaculture. In the ocean, salmon respond to large-scale climate forcing (ICES 2016) by the North Atlantic Oscillation (NAO) and the Atlantic Multi-decadal Oscillation (AMO) that drive

sea surface temperature (SST) and thus salmon thermal habitat (Friedland *et al*., 1993; Friedland *et al*., 2003; Jonsson & Jonsson 2004; Mills *et al*., 2013) and associated prey dynamics (Beaugrand & Reid 2012; Defriez *et al*., 2016; Vollset *et al*., 2022). Recent studies suggest that ocean warming has had a negative impact on oceanic growth and survival of Atlantic salmon (Todd *et al*., 2008; McCarthy *et al*., 2008; Friedland *et al*., 2009). The exact mechanisms at play leading to reduced marine survival are poorly understood but changes in primary production at sea leading to changes in prey distribution, abundance and energetic content are being investigated. Other areas of investigation include direct mortality impacts related to predator abundance and distribution (seabirds/mammals) and by-catch in pelagic fisheries. Food availability leading to impacts on salmon growth and energetic storage, resulting in a change in maturation and hence survival at sea are also being investigated as the main drivers of reduced marine survival of salmon (Figure 9).

Current estimates of marine survival are amongst the lowest in the time series and suggest that based on recent years just over 5% of the wild smolts that go to sea from Irish rivers are surviving (*i.e.* 5 adults returning for every 100 smolts migrating). Survival rates from hatchery fish are lower than for wild fish. The decline in hatchery salmon survival has become more apparent since 2004 and recent values are the lowest in the time series. IFI are currently developing two wild salmon marine survival indices using PIT tag technology, in the River Erriff (National Salmonid Index Catchment) and River Corrib systems. These indicate respective provisional mean survival estimates of less than 3% since 2020.

7.2.2 Freshwater

Within river systems, the principal threats to the sustainability of salmon stocks include:

- water quality issues from agriculture, domestic waste-water treatment and forestry; and urban waste-water pressures;
- over-exploitation of stocks and illegal fishing;
- hydromorphological pressures relating to physical modification or damage to habitat and natural river/lake processes including migration barriers;
- climate change stressors; and
- invasive alien species, heightened predation pressures and disease.

These may act at local and regional scales and individual stocks may be synergistically affected by multiple such stressors. Addressing such anthropogenic pressures is key to facilitating the natural recovery of vulnerable stocks through increasing freshwater production potential to ultimately maximise adult returns.

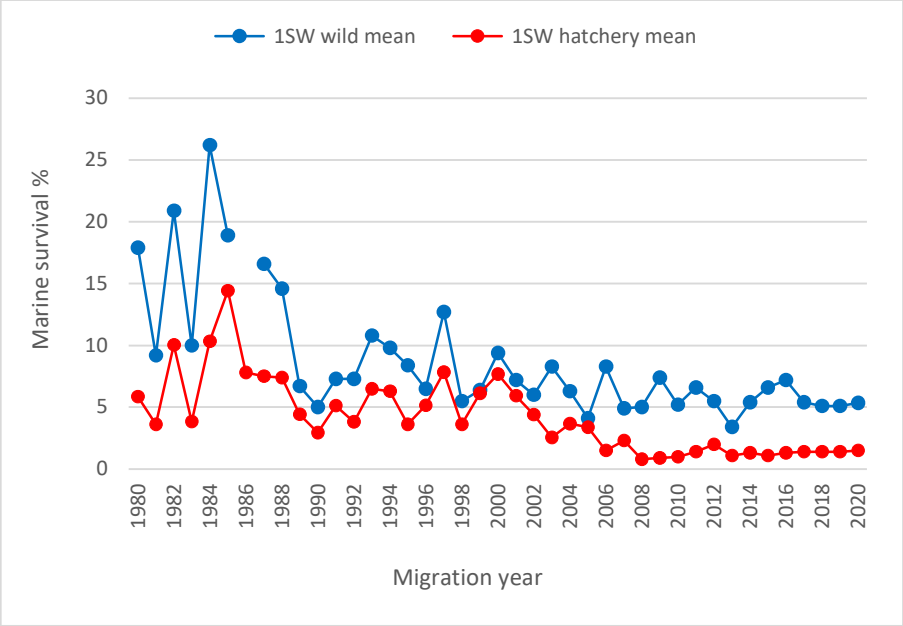

Figure 8 Marine survival (from smolt release to return to the Irish coast) for wild and hatchery salmon (2022 returns not yet available).

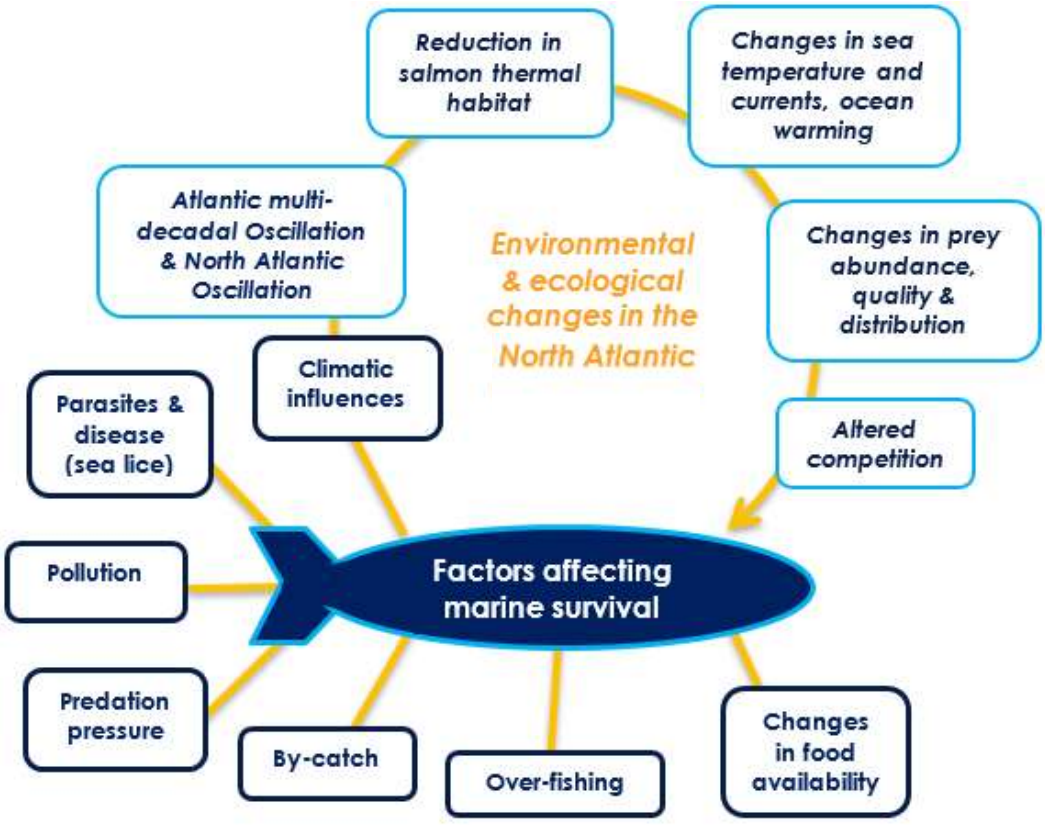

Figure 9 The factors which individually and synergistically affect the marine survival of salmon and which cause significant changes to life history responses such as population structure, fitness and size.

8 Changes to assessments in future years

Until such time as new methods become available, the existing forecast model based on fisheries data or count data will be applied using the currently derived CL. Data will continue to be updated and where appropriate, improved to provide catch advice.

The TEGOS examined rod exploitation rates on rivers with counters in 2008 to derive estimates of the likely range of exploitation by anglers on salmon stocks. Since then, new counters have been installed on many rivers and a time series of rod exploitation has been generated on a range of rivers nationally. An extensive review of salmon exploitation rates in Irish rivers (Millane *et al*., 2017) using rod catch and fish counter data was published in 2017 but has not yet been incorporated into estimates of adult salmon return. It is envisaged that this work will be revised to include more recent data as well as investigating if climatic influences and river characteristics can be incorporated into exploitation rates. As such, TEGOS intend to further develop this data to refine the rod exploitation rates currently being used to provide estimates of salmon stock status.

9 Conclusions

Despite the considerable reductions in catches, following the closure of the mixed-stock fishery at sea in 2007, only 59% (n=48) of Ireland's assessed salmon rivers are currently estimated to be exceeding biologically-based CLs. While 20 more rivers are advised to open for C&R-only angling as assessments indicate relatively high juvenile densities or the stocks are meeting ≥65% of CL, it is clear the overall proportion of rivers with good population status is low. Fish counters and traps provide the most direct assessment of salmon stock status in rivers. The number installed and used in stock assessments has increased from 9 in 2002 to a maximum of 31 in recent years. There has been variation in the mean count since 2002, with highest numbers recorded in 2007 coinciding with the cessation of offshore drift netting. However, there has been a marked decline in salmon counts subsequently. A minor upturn was evident from the time series low of 2014 until 2017 with mean abundance in 2020 an upturn on the preceding two years. However, this upturn appears not to have continued since that time for the stock as a whole. As regards the MSW component, since 2020, a minor upward trend is evident and this reflects anecdotal reports from across the country in 2022 that MSW fish were a more notable feature of overall returns in 2022. These counter data can be considered as an index for other rivers nationally and likely reflect the national trend.

Marine survival values in the past five years are amongst the lowest recorded since the coded-wire tagging programme commenced in 1980. Changes in oceanic conditions leading to poor recruitment of salmon have been implicated by NASCO following international investigations into the decline of salmon stocks (e.g. SALSEA Merge). Recent stock forecasts from ICES for Irish stocks in the southern range of the North-east Atlantic, indicate that this low stock situation will prevail at least until 2024. Given the current poor survival, the expectation of large catches is unrealistic at present and priority should be given to conservation objectives rather than catch increases until there is a noticeable improvement in stock abundance.

In this regard, the ongoing management policy of adopting the scientific advice to only allow exploitation on stocks above CL is central to aid the recovery of salmon stocks nationally. With this policy in place, any improvement in marine survival would be reflected in greater numbers of rivers achieving CL. This will contribute to complying with ICES & NASCO advice of providing for the diversity and abundance of salmon stocks.

10 References

Beaugrand, G. and Reid, P.C. (2012). Relationships between North Atlantic salmon, plankton, and hydroclimatic change in the Northeast Atlantic. *ICES Journal of Marine Science* 69:1549-1562.

Crozier, W.W. and Kennedy G.J.A (1994). Application of semi-quantitative electro-fishing to juvenile salmonid stock surveys. *Journal of Fish Biology* 45:159-164.

Defriez, E.J., Sheppard, L.W., Reid, P.C. and Reuman, D.C. (2016). Climate change-related regime shifts have altered spatial synchrony of plankton dynamics in the North Sea. *Global Change Biology* 22:2069-2080.

Friedland, K.D., MacLean, J.C., Hansen, L.P., Peyronnet, A.J., Karlsson, L., Reddin, D.G., Ó Maoiléidigh, N. and McCarthy, J.L. (2009). The recruitment of Atlantic salmon in Europe. *ICES J Mar Sci* 66:289-304.

Friedland, K.D., Reddin, D.G. and Castonguay, M. (2003). Ocean thermal conditions in the post-smolt nursery of North American Atlantic salmon. *ICES Journal of Marine Science* 60:343-355.

Friedland, K.D., Reddin, D.G. and Kocik, J.F. (1993). Marine survival of North American and European Atlantic salmon: effects of growth and environment. *ICES Journal of Marine Science* 50:481-492.

Gargan, P., Roche, W., Keane, S. and Stafford, T. (2008). Catchment-wide electrofishing Report. Central Fisheries Board, Mobhi Boreen, Dublin 9.

Gargan. P., Stafford, J. and Ó Maoiléidigh, N. (2001). The relationship between salmon rod catch, stock size, rod exploitation and rod effort on the Erriff fishery, Western Ireland (pp. 68-75). In R. Shelton (Ed.) *The interpretation of rod and net catch data*. *Proceedings of a Workshop held at the Centre for Environment, Fisheries and Aquaculture Science, Lowestoft.* 6-7 November. Atlantic Salmon Trust, Moulin, Pitlochry, Scotland.

ICES (2017). Report of the Working Group on Effectiveness of Recovery Actions for Atlantic Salmon (WGERAAS), 9–13 November 2015, ICES Headquarters, Copenhagen, Denmark. ICES CM 2015/SSGEPD:03. 115 pp.

ICES (2018). Report of the Working Group on North Atlantic Salmon (WGNAS), 4–13 April 2018, Woods Hole, MA, USA. ICES CM 2018/ACOM:21. 386 pp.

ICES (2019). Report of the Working Group on North Atlantic Salmon (WGNAS), 25 March–4 April 2019, Bergen, Norway. ICES Scientific Reports 1:16. 368 pp.

ICES (2020). Report of the Working Group on North Atlantic Salmon (WGNAS). ICES Scientific Reports. 2:21. 358 pp.

ICES (2021). Report of the Working Group on North Atlantic Salmon (WGNAS). ICES Scientific Reports. 3:29. 407 pp.

Jonsson, B. and Jonsson, N. (2004). Factors affecting marine production of Atlantic salmon (*Salmo salar*). *Can J Fish Aquat Sci* 61:2369-2383

McCarthy, J.L., Friedland, K.D. and Hansen, L.P. (2008). Monthly indices of the post-smolt growth of Atlantic salmon from the Drammen River, Norway. *Journal of Fish Biology* 72:1572-1588.

Millane, M., Shephard, S., White, J., Ó Maoiléidigh, N., O'Higgins, K., O'Malley, P., Roche, W., Poole, R., Rogan, G., Bond, N. and Gargan, P. (2017). Estimating salmonid angling exploitation rates from systems monitored by fish counters, and potential application to fisheries management in Ireland (pp. 167-184). In G. Harris (Ed.) *Sea Trout: Science & Management. Proceedings of the 2nd International Sea Trout Symposium*.

Milner N.J., Davidson, R.E., Evans, R.E., Locke, V. and Wyatt, R.J. (2001). The use of rod catches to estimate salmon runs in England and Wales (pp. 463–67). In R. Shelton (Ed.) *The interpretation of rod and net catch data*. *Proceedings of a Workshop held at the Centre for Environment, Fisheries and Aquaculture Science, Lowestoft*. *6-7 November*. Atlantic Salmon Trust, Moulin, Pitlochry, Scotland.

Mills, K.E., Pershing, A.J., Sheehan, T.F. and Mountain, D. (2013). Climate and ecosystem linkages explain widespread declines in North American Atlantic salmon populations. *Global Change Biology* 19:3046-3061.

Ó Maoiléidigh, N., McLaughlin, D., Cullen, A., McDermott, T. and Bond, N. (2001). Carcass tags and logbooks for managing Irish salmon stocks (pp. 40–48). In C. Moriarty (Ed.) *Catchment Management – Proceedings of the 31st Annual Study Course of the Institute of Fisheries Management* Trinity College, Dublin. 129 pp.

Small, I. (1991). Exploring data provided by angling for salmonids in the British Isles. In I.G. Cowx (Ed.) *Catch Effort sampling Strategies – their application in Freshwater Fisheries Management*. Blackwell Scientific Publications Ltd.

Thorstad, E.B., Bliss, D., Breau, C., Damon-Randall, K., Sundt-Hansen, L.E., Hatfield, E.M.C. *et al*. (2021). Atlantic salmon in a rapidly changing environment—Facing the challenges of reduced marine survival and climate change. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31:2654–2665.

Todd, C.D., Hughes, S.L., Marshall, C., MacLean, J.C., Lonergan, M.E. and Biuw, E. (2008). Detrimental effects of recent ocean surface warming on growth condition of Atlantic salmon. *Global Change Biology* 14:958-970.

Vollset *et al*., (2022). Ecological regime shift in the Northeast Atlantic Ocean revealed from the unprecedented reduction in marine growth of Atlantic salmon. Science Advances 8: eabk2542.

Whelan, K.F., Whelan, B.J. and Rogan, G. (2001). Catch as a predictor of salmon stock in the Burrishoole fishery, Co. Mayo, Western Ireland (pp. 76-84). In R. Shelton (Ed.) *The interpretation of rod and net catch data*. *Proceedings of a Workshop held at the Centre for Environment, Fisheries and Aquaculture Science, Lowestoft*. 6-7 November. Atlantic Salmon Trust, Moulin, Pitlochry, Scotland.

11 Appendices

Appendix I. Members of the The Technical Expert Group on Salmon (TEGOS) 2022/2023

Dr Michael Millane (Chair) – Inland Fisheries Ireland

Dr James Barry – Inland Fisheries Ireland (October 2022)

Dr Colm Fitzgerald – Inland Fisheries Ireland

Dr Paddy Gargan – Inland Fisheries Ireland (until May 2022)

Dr Richard Kennedy – AFBI Northern Ireland

Mr Hugo Maxwell – Marine Institute

Dr Sarah McLean – Loughs Agency

Appendix II. Rivers assessed where salmon have a qualifying interest in Special Areas of Conservation and status relative to CL for the 2023 advice.

Table 10 Rivers assessed where salmon have a qualifying interest in Special Areas of Conservation (EU Habitats Directive) and status relative to conservation limit for the 2023 advice.

District	River	Above CL for 2023 advice	SAC
Ballina	Moy	Above	RIVER MOY SAC
Ballinakill	Bundorragh	Above	MWEELREA/SHEEFFRY/ERRIFF COMPLEX SAC
Ballinakill	Bunowen	Above	MWEELREA/SHEEFFRY/ERRIFF COMPLEX SAC
Ballinakill	Carrownisky	Above	MWEELREA/SHEEFFRY/ERRIFF COMPLEX SAC
Ballinakill	Culfin	Above	THE TWELVE BENS/GARRAUN COMPLEX SAC
Ballinakill	Dawros	Above	THE TWELVE BENS/GARRAUN COMPLEX SAC
Ballinakill	Erriff	Above	MWEELREA/SHEEFFRY/ERRIFF COMPLEX SAC
Ballyshannon	Drowes	Above	LOUGH MELVIN SAC
Ballyshannon	Eske	Below	LOUGH ESKE AND ARDNAMONA WOOD SAC
Ballyshannon	Glen	Below	SLIEVE TOOEY/TORMORE ISLAND/LOUGHROS BEG BAY SAC
Bangor	Glenamoy	Above	GLENAMOY BOG COMPLEX SAC
Bangor	Muingnabo	Below	GLENAMOY BOG COMPLEX SAC
Bangor	Newport	Above	NEWPORT RIVER SAC
Bangor	Owenduff	Above	MWEELREA/SHEEFFRY/ERRIFF COMPLEX SAC
Bangor	Owenmore	Above	MWEELREA/SHEEFFRY/ERRIFF COMPLEX SAC
Bangor	Srahmore	Below	OWENDUFF/NEPHIN COMPLEX SAC
Connemara	Cashla	Above	CONNEMARA BOG COMPLEX SAC
Drogheda	Boyne	Below	RIVER BOYNE AND RIVER BLACKWATER SAC
Galway	Corrib	Above	LOUGH CORRIB SAC / Maumturk Mountains
Galway	Owenboliska	Below	CONNEMARA BOG COMPLEX SAC
Kerry	Caragh	Above	KILLARNEY NAT PARK, MACGILLYCUDDY'S REEKS & CARAGH R CAT SAC

District	River	Above CL for 2023 advice	SAC
Kerry	Emlagh	Below	CASTLEMAINE HARBOUR SAC
Kerry	Ferta	Above	KILLARNEY NAT PARK, MACGILLYCUDDY'S REEKS & CARAGH R CAT SAC
Kerry	Kerry Blackwater	Below	BLACKWATER RIVER (KERRY) SAC
Kerry	Mealagh	Above	KILLARNEY NAT PARK, MACGILLYCUDDY'S REEKS & CARAGH R. CAT SAC
Kerry	Owenascaul	Below	CASTLEMAINE HARBOUR SAC
Kerry	Owenreagh	Below	KILLARNEY NAT PARK, MACGILLYCUDDY'S REEKS & CARAGH R CAT SAC
Letterkenny	Clady	Above	LOUGH ESKE AND ARDNAMONA WOOD SAC
Letterkenny	Gweebarra	Above	WEST OF ARDARA/MAAS ROAD SAC
Letterkenny	Leannan	Below	LEANNAN RIVER SAC
Letterkenny	Owenea	Above	WEST OF ARDARA/MAAS ROAD SAC
Letterkenny	Owennamarve	Below	CLOGHERNAGORE BOG AND GLENVEAGH NATIONAL PARK SAC
Limerick	Shannon	Below	LOWER RIVER SHANNON SAC
Lismore	Blackwater	Above	BLACKWATER RIVER (CORK/WATERFORD) SAC
Sligo	Ballysadare	Above	UNSHIN RIVER SAC
Sligo	Garavogue	Below	LOUGH GILL SAC
Waterford	Barrow	Below	RIVER BARROW AND RIVER NORE SAC
Waterford	Nore	Below	RIVER BARROW AND RIVER NORE SAC
Waterford	Suir	Below	LOWER RIVER SUIR SAC
Wexford	Slaney	Below	SLANEY RIVER VALLEY SAC

Appendix III. Summary results from the catchment-wide electro-fishing programme in 2022

Analysis of salmon fry index

In cases where the scientific forecast of returning salmon recruits to a river provides a catch option resulting in less than a 75% chance of the river meeting its conservation limit (CL), the scientific advice recommends that the river is closed for fishing. As a separate recommendation, TEGOS advise that if a river is meeting 65% or more of its CL the river can open for catch and release-only (C&R-only) angling. There are many rivers where a direct assessment is not possible due to a very low or inconsistent reported angling catch (*i.e.* less than 10 on average annually). Therefore, advised closures of rivers with very low rod catches, or which have been closed over a period due to the absence of new and alternative information (e.g. fish counter information) poses a problem for assessing the status of the rivers salmon population and CL attainment over time as there are no new data for updating the forecast and risk analysis method currently employed by the TEGOS.

A relative index of fry abundance based on a semi-quantitative electrofishing technique (Crozier and Kennedy 1994; and Gargan *et al*. 2008) was developed in 2009 and 2010 to provide an alternative method for assessing CL attainment in rivers closed for angling or where there was no counting facility. Electrofishing of juveniles presents an alternative (and fisheries independent) source of population information as the numbers of juveniles should be a good reflection of the number of adults which produced them and the relative productive capacity of that river. This method is based on a relationship between fry abundance (which may be measurable annually) and adult returns for rivers with information on rod catches or counters over a number of years was available. The scientific advice is that assessments should preferentially be based on a recent five-year average of available data. Some catchment-wide electro-fishing data are based on less than five data points, however, it is expected that more robust assessments can be made over the coming years as more surveys are carried out.

The method is primarily used for rivers where there is no other index of stock. Some catchments are electro-fished annually as index catchments. Until the 2018 advice, an index of at least 17 salmon fry per 5 minute standardised electro-fishing has been used as the cut-off between rivers below this threshold where the stock is clearly below CL and those rivers above the threshold where it is more likely that the stock is meeting CL. If the fry index is above the threshold, C&R-only fishing in the following

year is advised. This provides a safeguard against opening a river prematurely, while still allowing some fishery activity and the subsequent collection of catch data.

Catchment-wide electro-fishing is also important in providing managers with information on the distribution and abundance of salmon fry and to identify management issues in a catchment or tributary. The absence or low density of salmon fry may be related to water quality issues, obstructions, or habitat damage and areas of low abundance can be investigated.

During 2022, catchment-wide electro-fishing was undertaken in 50 catchments or sub-catchments to assess the abundance and distribution of salmon fry. Forty-seven catchments (Figure 10), as were planned surveys of the old River Shannon main channel below the Parteen weir; the Owentaraglin, Farahy and Owenaskirtaun rivers in the Munster Blackwater; the Aghacashlaun, Yellow, Termon and Ominey sub-catchments on the Erne. A total of 1095 sites were visited. Salmon fry abundance for this year alone ranged from an average of 0 fry/5min on the Finglas (Camp), Lee (Kerry), Aille, Leaffony, Erne, Mill (Letterkenny) and Straid to a catchment average of 43.19 fry/5 min on the Owenea river. The Owenea, Erriff, Crana, Shannon Old Main Channel, Owenglin, Carrownisky, Slaney, Owentocker, Inny, Owennacurra, Gweebarra, Owenalondrig, Doonbeg and Carhan all recorded an annual catchment wide average of >17 fry in 2022.

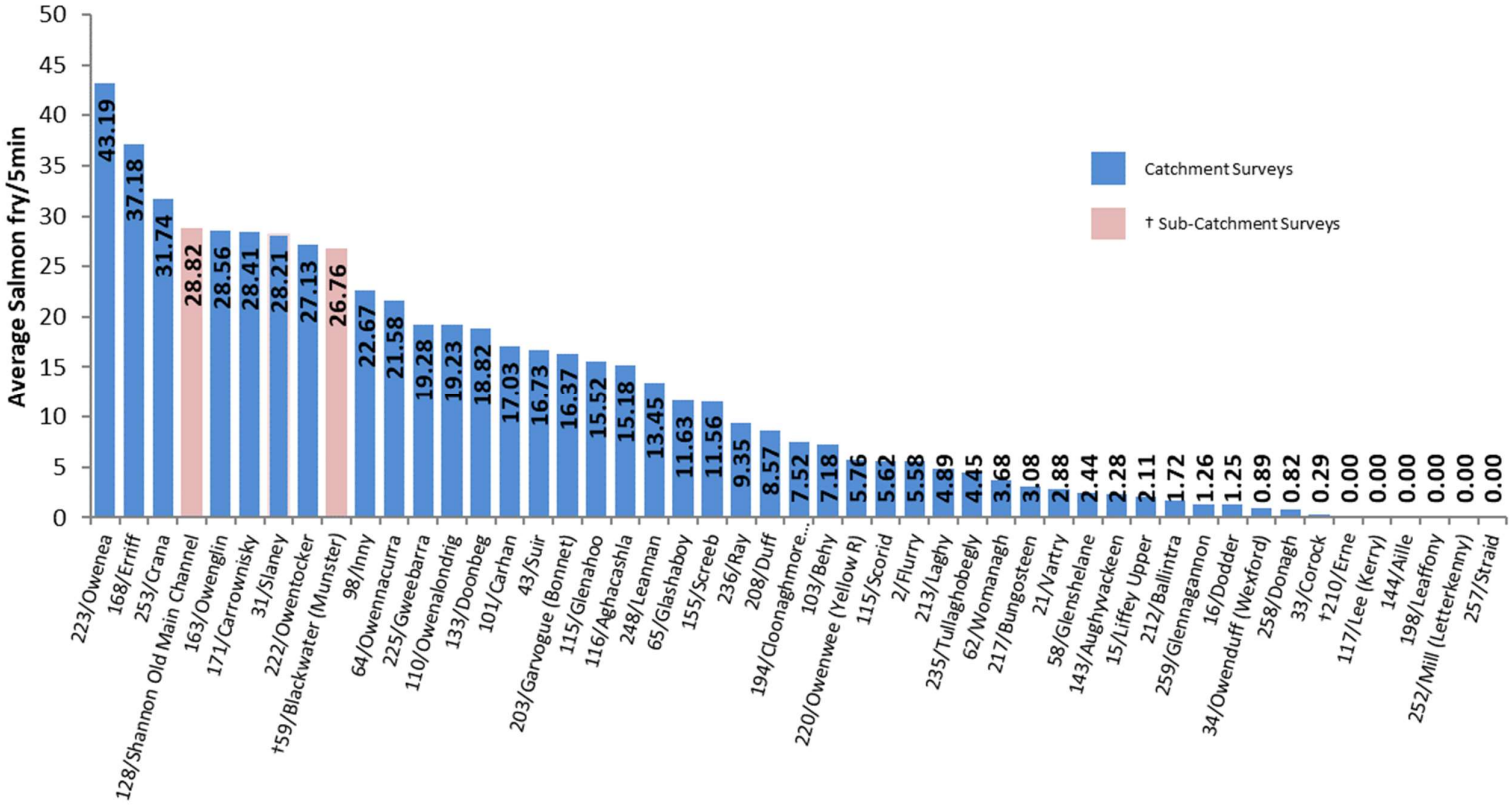

Figure 10 Results of catchment wide electro-fishing undertaken in 2022.