River Lune Net Limitation Order and Byelaw Review

February 2020

Table of Contents

List of Figures

List of Tables

Executive Summary

Over the ten year lifetime of the current Net Limitation Order and byelaws (2009 to 2019), the Lune salmon stock has declined markedly. This is reflected in reduced catches to the estuary nets, particularly during August; reduced catches to the rods, particularly during September and October; and also reflected in a reduced number of salmon crossing the resistivity fish counter at Forge Weir approximately 4km upstream of the tidal limit, particularly during September, October and November. There also appears to be a marked decrease in the distribution and abundance of juvenile salmon in the Lune catchment, with the 2019 survey data reflecting some of the poorest juvenile salmon abundance recorded from approximately 40 years of juvenile surveys. All these data support the observations of a widespread lack of grilse returning to the river in summer and autumn, in common with the situation across much of the North East Atlantic area.

Since 1999 the number of net licences issued has remained the same at 19, comprising 12 haaf nets in the inner estuary and 7 drift nets in the outer estuary. The net fishing season has remained unchanged since 1999. The 5-year average net catches of salmon have declined markedly from an average of 1126 for the period from 1999 to 2003, to an average of just 247 for the period from 2014 to 2018.

Declared rod catches have similarly declined since 1999, with 5-year average catches declining from 997 salmon per year for the period 1999 to 2003, down to 343 salmon per year for the period 2014 to 2018. The number of salmon killed by the rod fishery has declined from a 5-year average of 425 salmon killed per year over the period 1999 to 2003, to 85 salmon killed per year over the period 2014 to 2018. While the kill of salmon by the rod fishery has declined, this has coincided with both declining runs and increased rates of voluntary catch and release from around 60% ten years ago, to 86% in 2018. While the current byelaw for the rod fishery restricts the kill of salmon to four salmon per licencee per season, only 2 anglers reported killing this many salmon in the last 5 years (2014 to 2018). This compares with 8 anglers who reported killing this number of salmon in the 2009 season and 33 anglers killing this number in 1999.

The 5-year average count of salmon recorded at the Forge Weir fish counter for the period 1999 to 2003 was 6760 salmon per year but that has declined to an average count of 5380 salmon per year for the period 2010 to 2014, although a persistent decline from over 8300 in 2010 to over 3400 in 2014 is evident in this 5-year period. The salmon counts from 2012 to 2014 are the three lowest salmon counts on record.

The Lune salmon stock is now classified as “At Risk” of failing its conservation limit more than once in a 5-year period, based on the 2018 stock assessment, and is also predicted to remain At Risk in 5 years-time, given the prevailing strong downward trend in annual stock assessments. Our Decision Structure guidance directs us to reduce the exploitation of At Risk stocks to zero as quickly as possible.
A national byelaw introduced for the 2019 fishing season already prohibits the killing of salmon by the net fisheries for a ten year period. No change to that byelaw is recommended here given that this already achieves the zero exploitation guidance for the net fishery.
In terms of the number of net licences to be made available through Net Limitation Order, it is not proposed to change the previously available numbers of 12 haaf net licences and 7 drift net licences, in the event that potential stock recovery within the 10-year lifetime of the national byelaws, might permit a take of salmon by the net fishery in the future.

For the rod fishery, a new local byelaw is recommended to apply mandatory catch and release fishing for the 2020 season onwards in order to achieve the zero exploitation of salmon for this fishery.

The Lune sea trout stock is currently classified as “Probably Not At Risk” based on a relatively simplistic appraisal of the current performance of the fishery in relation to historic performance. While we would not wish to see any increase in the exploitation of sea trout at the present time we are not proposing to introduce any new regulations to limit or reduce the exploitation of sea trout at this time.

1. Introduction

This document describes the fisheries management principles and the recent status of salmon and sea trout stocks in the River Lune, to inform the review of the Net Limitation Order (2009), and time limited rod fishery byelaws that expired in November 2019.

1.1 Salmon Management

The Environment Agency has a statutory duty, defined in the Environment Act (1995), to “maintain, improve and develop fisheries”. In addition, we have a statutory duty to operate a licensing system for fishing under the Salmon and Freshwater Fisheries Act (1975). The powers to meet these duties are contained primarily in the Salmon and Freshwater Fisheries Act 1975 (including licensing of angling and net fishing), the Water Resources Act 1991 (including the powers to make byelaws to regulate fishing), the Eels (England and Wales) Regulations 2009 (including powers to facilitate eel passage) and the Keeping and Introduction of Fish Regulations 2015 (including regulating the movement and introduction of fish).

Salmon stocks in England are managed in line with the guiding principles that are set out by the North Atlantic Salmon Conservation Organisation[1] (NASCO). Further information on the NASCO guidelines relating to salmon fisheries management are available at: http://www.nasco.int/pdf/far_fisheries/Fisheries%20Guidelines%20Brochure.pdf

In brief, these guidelines indicate that conserving the productive capacity of individual river salmon stocks should be given priority over exploitation. The guidelines further state that fishing should not be permitted on stocks which are below their Conservation Limits[2]. However, if a decision is made to allow fishing on a stock which is below its Conservation Limit, on the basis of overriding socio-economic factors, fishing should clearly be limited to a level that will still permit stock recovery within a stated timeframe.

Encompassing this variety of duties and obligations in our fisheries strategy “Better sea trout and salmon fisheries – Our Strategy for 2008 – 2021”, we state that, **as a general principle, we want to reduce the exploitation of At-Risk stocks and will seek to agree voluntary constraints or use mandatory controls on fishing to ensure stocks are sustained whilst fishing opportunity is optimised.**

The status of stocks in the principal salmon rivers in England is assessed annually against the Conservation Limits and Management Targets[3] for these rivers, with the results used as a basis for assessing the need for management and conservation measures. The methods which are used are described in detail in Annex 7 to the Assessment of Salmon Stocks and Fisheries in England and Wales, and are reproduced in Appendix 1 of this document.
In summary, this method involves estimating the numbers of salmon returning to spawn in a river each year, and hence the number of eggs deposited, against the Conservation Limit.

[1] North Atlantic Salmon Conservation Organisation is an international organisation, established by an inter-governmental Convention in 1984. Their objective is to conserve, restore, enhance and rationally manage Atlantic salmon through international cooperation taking account of the best available scientific information.
[2] The Conservation Limit (CL) is the minimum spawning stock level below which stocks should not be allowed to fall. The CL for each river is set at a stock size (defined in terms of eggs deposited) below which further reductions in spawner numbers are likely to result in significant reductions in the number of juvenile fish produced in the next generation.
[3] The Management target (MT) is a spawning stock level for managers to aim at in order to meet the management objective. The ‘management objective’ used for each river in England is that the stock should be meeting or exceeding its CL in at least four years out of five (i.e. >80% of the time), on average.

The Conservation Limit is considered to be the **minimum safe level of spawning salmon** (described as the number of salmon eggs deposited) for each river. **By regularly failing to reach this limit, the risk of that river's salmon stock suffering serious decline greatly increases.**

Because salmon stocks naturally vary from year to year, the Environment Agency aims to ensure that **stocks meet the Conservation Limit in four out of five years on average; this is the Management Objective.** To meet this, the average level of a stock typically needs to be around 40% above the Conservation Limit (this higher level is termed the Management Target).

It is also important to look at the trend for a particular stock, whether it is stable, improving or deteriorating. Stocks are therefore classified according to whether, on the basis of the trend over the past 10 years, they are likely to meet the Management Objective in five years' time. This system is used because it gives an early warning of where a river's salmon stock will be, if current trends are maintained. On the basis of this annual compliance assessment, stocks are allocated to one of four categories based on the likelihood of meeting the Management Objective. These are set out in Table 1.

Table 1 Likelihood of meeting the Management Objective and the associated risk category

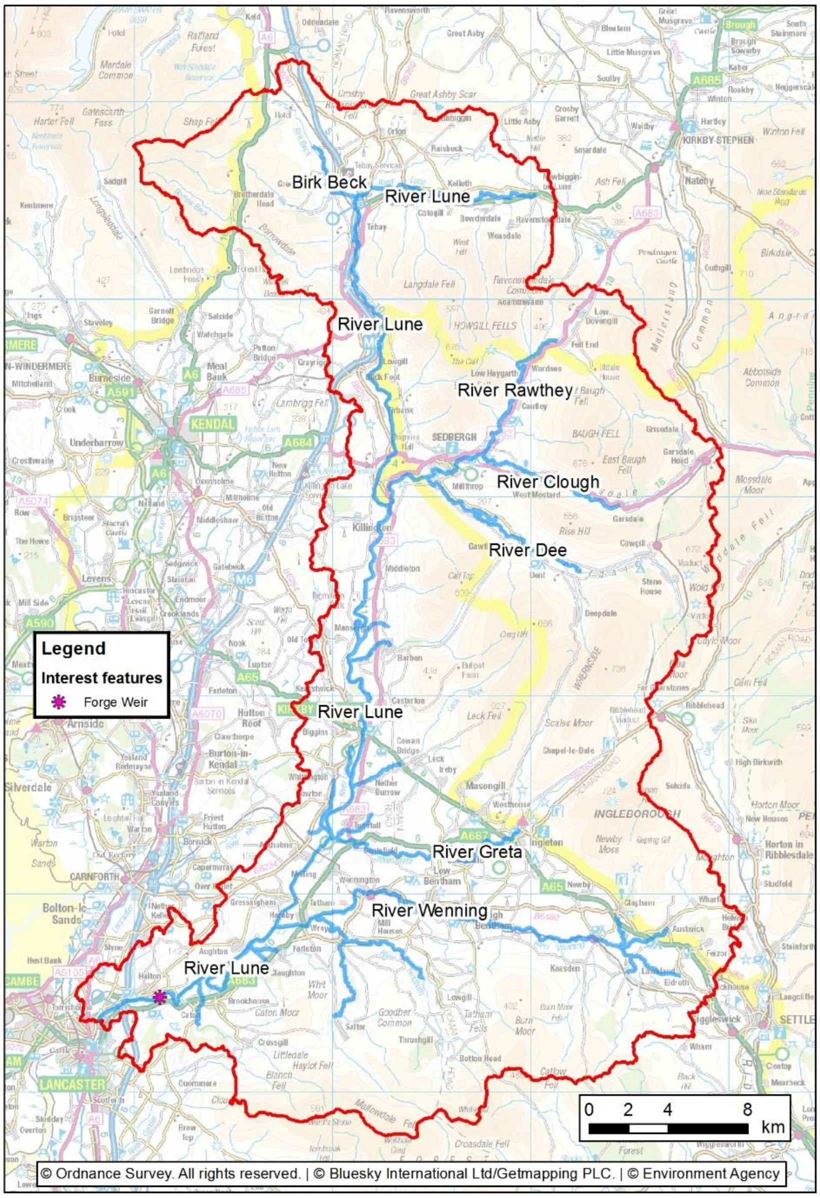
Likelihood of meeting the Management Objective	Less than 5%	Between 5% and less than 50%	Between 50% and less than 95%	95% and greater
Category name	At Risk (AR)	Probably at Risk (PaR)	Probably Not at Risk (PNaR)	Not at Risk (NaR)

To assist in determining the appropriate level of exploitation for a river's salmon stock, a salmon fishery management Decision Structure (Appendix 1) was established and has been in use since 2007. The Decision Structure helps to guide a consistent approach to the implementation of management measures and seeks to manage exploitation at a sustainable level that promotes stock recovery, whilst minimising the social and economic impacts of measures to control exploitation.

This approach has resulted in local based controls which typically seek to maintain an equitable balance between rod and net exploitation. Examples of this approach may include reductions in the number of licences for netsmen, changes in the netting season to reduce the salmon catch, or the introduction of 100% catch and release for the rod fishery to maximise the numbers of salmon available to spawn escapement.

1.2 River Lune catchment and fisheries

The River Lune rises on the slopes of Green Bell, on Ravenstonedale Common in the Howgill Fells (NGR NY 70100 01203), at an altitude of 540 metres. The river flows briefly north, then west from Newbiggin-on-Lune towards Tebay, then turns south entering Morecambe Bay to the south-west of the city of Lancaster, a total distance of 105 km from source to sea (Map 1). Main tributaries of the Lune include the Rivers Rawthey, Greta and Wenning.



Map 1 – Map of the river Lune catchment

Significant rod and line fisheries for salmon and sea trout operate throughout the main freshwater Lune.

The rod fishing season for salmon on the Lune runs from 1st February to 31st October each year, although the killing of salmon is prohibited prior to 16th June, by National Spring Salmon byelaws. These season and Spring salmon byelaws are not being reviewed here. A local time-limited byelaw restricting the kill of salmon to 4 salmon per angler per season on the Lune and its tributaries was also in place until recently, and this byelaw is being reviewed here. Rod fishing for sea trout is restricted to the season defined from 1st April to 30th September.

A drift net fishery for salmon and sea trout (7 available licences) operates in the outer Lune estuary, while a haaf net fishery for salmon and sea trout (12 available licences) operates in the inner estuary. The boundaries of these net fisheries are defined in local byelaws. Since 1999, these fisheries operate from 1st June to 31st August. The net fishery is also restricted by a local byelaw defining a weekly close time from 6am on Saturday to 6am the following Monday.

The current Net Limitation Order for the Lune Estuary defines a licence availability for 12 haaf net licences and 7 drift net licences each year. This number of licences has been maintained since 1999. Netting prior to 1st June is prohibited by National Spring Salmon byelaws that were first introduced in 1999, and were renewed in December 2018. New National byelaws were also introduced in December 2018 to prevent the killing of salmon by nets in a number of named rivers, including the Lune. These National byelaws are not being reviewed here.

In the last 20 years, the Lune Rivers Trust has developed significantly, undertaking numerous and widespread habitat improvement projects across the catchment for the benefit of all species, including improvement of riparian habitat and removal of weirs and barriers to fish migration.
A relatively small hatchery has been operated by Lune Hatchery Group volunteers for most of the last twenty years, switching stocking from an initial focus on pre-smolts (~20,000) and autumn parr (~20,000), to around 35,000 eyed eggs more recently, although broodstock capture has become increasingly difficult in recent years because of the declining runs of returning adult salmon.

Water is abstracted from the lower Lune by United Utilities for public water supply at two sites, including at Caton for local supply and at Halton for transfer to the neighbouring Wyre catchment. The latter abstraction has been utilised on a very limited basis in the last ten years.

The last ten years has seen some growth in the installation of low head hydropower schemes at a number of sites across the Lune catchment. While several small installations have been sited on small tributaries beyond the range of migratory salmon and sea trout, two larger schemes have been commissioned on the main river at Broadraine weir on the middle/upper river and at Forge weir (also referred to as Halton weir) on the lower river. All schemes have had to incorporate appropriate fish passage improvements, including permitted operational flows to not impede the flows through the fish passes. The Halton hydro scheme was constructed at the opposite end of Forge weir to the existing EA fish counter, so was required to include a fish trap and counter within it's fish pass to allow the ongoing monitoring of salmon and sea trout runs at this site. Unfortunately a variety of technical problems have affected one or other fish counter since that new fish pass was commissioned in 2015, so no complete counts of salmon and sea trout have been available since that time.

2. River Lune salmon stock

2.1 Net catches

The numbers of salmon caught in the Lune estuary net fishery from 1951 to 2018 are presented in figure 2.1 below. Catches have evidently been quite variable ranging from highs in excess of 3000 salmon per year through the mid to late 1960's, to the consistently low catches of less than 300 salmon per year in the last 10 years. Prior to 1999, the fishery supported at least 37 licencees, fishing over a five month fishing season (April to August, inclusive). Since 1999, 19 licences have been issued annually with the fishing season reduced to 1st June to 31st August. The drift net fishery tends to account for between two thirds and three quarters of the total annual net catch of salmon. The seine net licence was last issued in 2008. Seine net catches accounted for a relatively small proportion of the total annual net catch prior to that.

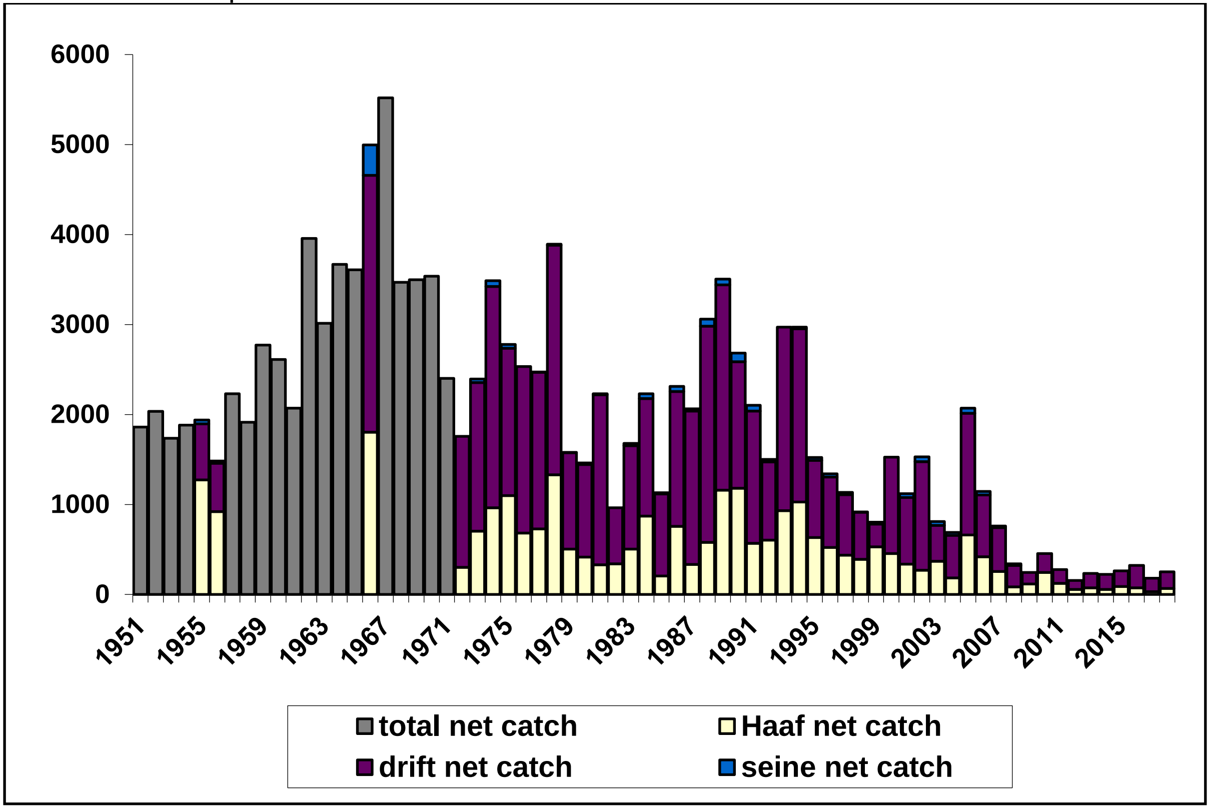


Figure 2.1 – Lune estuary net catch of salmon 1951 to 2018. Total net catches are presented in years where the catch by method is not defined.

Prior to 1980, when up to 61 net licences were issued annually (46 haaf, 12 drift, up to 3 seines), the average total annual net catch was over 2795 salmon per year with a notable peak in catches through the 1960's. From 1980 to 1999, the average total annual catch was 1928 salmon per year, with 37 net licences issued annually (26 haafs, 10 drifts, 1 seine). From 2000 to 2018 inclusive, the net fishing season has been reduced to 1st June to 31st August and 12 haaf net licences and 7 drift net licences have been issued each year. The average total annual catch for 1999 to 2003 was 1126 salmon. The average total annual catch for the most recent 5-year period, 2014 to 2018, was 247 salmon. The net fishery was prohibited from killing salmon in the 2019 season by National Byelaws, therefore resulting in zero kill of salmon to this fishery in this year and until 2028 inclusive.

Monthly salmon net catches are presented in figure 2.2 below. The drift nets have generally tended to account for more salmon caught than the haaf nets for all months. Catches tend to increase as the season progresses, being relatively low in June, averaging less than 20 for the haaf nets and just under 30 for the drift nets over this period. July catches tend to be higher than June catches for both methods and a decline in July catches is apparent. The five-year mean haaf net catch in July from 1999 to 2003 was 130 salmon, but from 2014 to 2018 was just 26 salmon. Similarly the five-year mean drift net catch in July from 1999 to 2003 was 207 salmon and from 2014 to 2018 was 86 salmon. August catches have shown a strong decline for both methods. The average haaf net salmon catch for August from 1999 to 2003 was 228 salmon, but from 2014 to 2018 was 18 salmon. More markedly, the average drift net salmon catch for August from 1999 to 2003 was 506 salmon, and has declined to an average of just 50 salmon for the most recent five-year period (2014 to 2018).

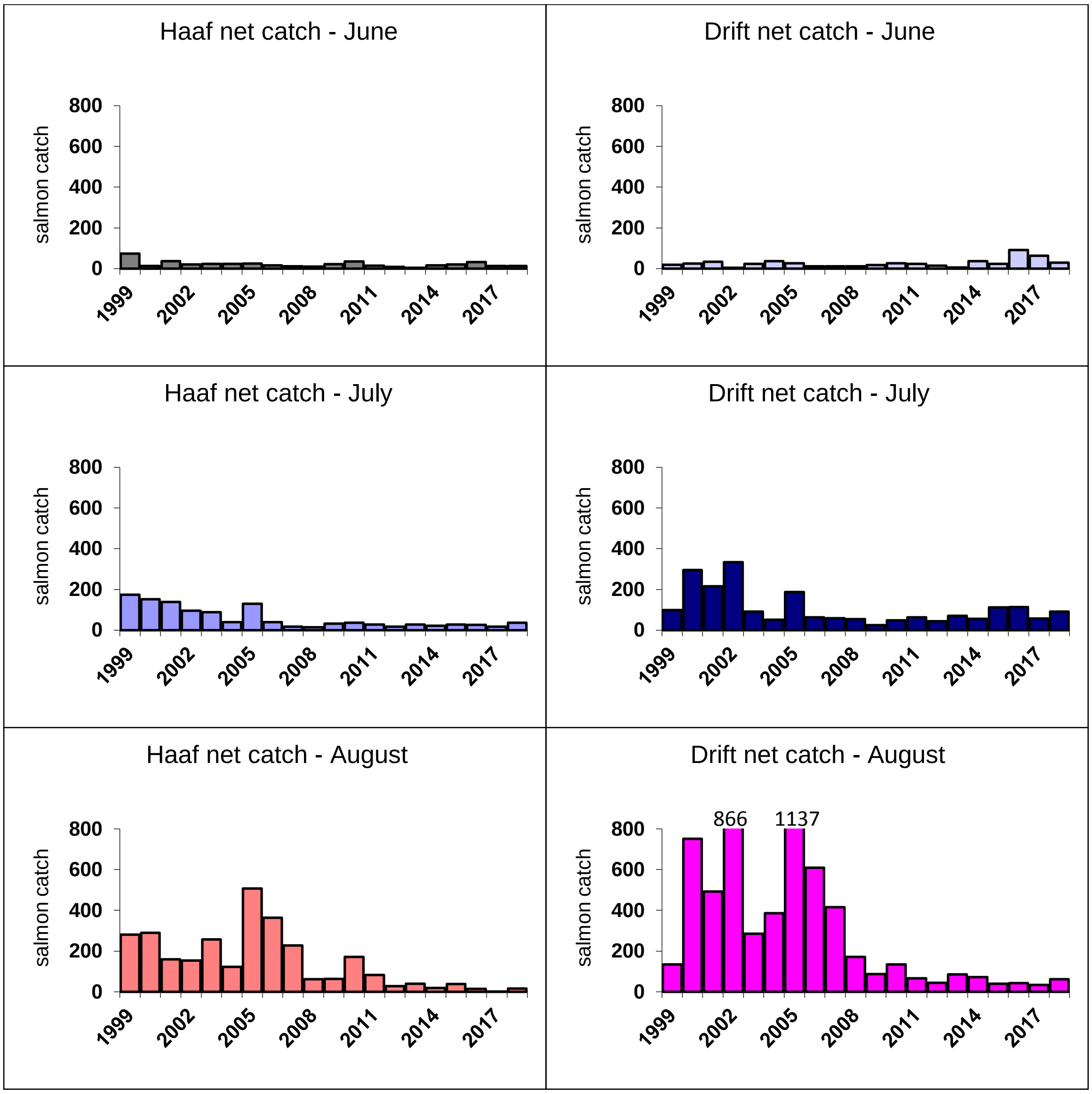


Figure 2.2 – Monthly net catches of salmon in the Lune Estuary net fishery, 1999 to 2018.

The number of tides fished and the catch of salmon in the net fishery expressed as the catch per tide fished is presented in figure 2.3 below. The haaf net fishery utilises more of the available tides than the drift net fishery in each respective month, but the catch of salmon per tide is lower in the haaf net fishery than in the drift fishery. (Refer to Figure 3.3 for sea trout catch per tide data).The catch of salmon per tide is generally progressively higher in each subsequent month for both fisheries. While the catch of salmon per tide in August is generally the highest of the fishing season, this has clearly declined in both fisheries over the period – likely reflecting the lack of returning grilse. The catch per tide in the drift net fishery in June appears to have increased slightly in recent years, possibly reflecting the slightly increased abundance of early multi sea-winter salmon.

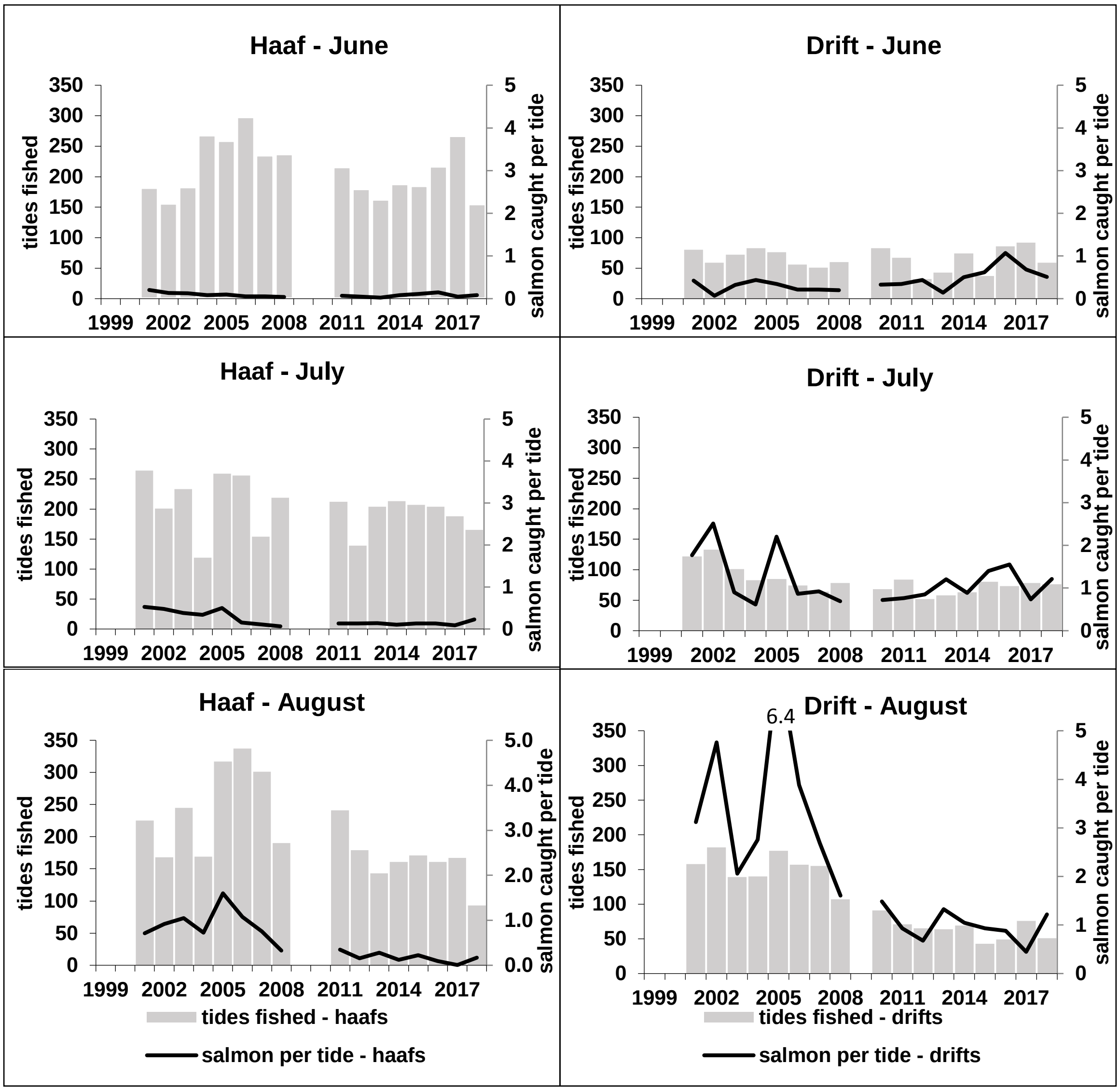


Figure 2.3 – Lune estuary haaf and drift net fisheries, monthly tides fished and salmon catch per tide 1999 to 2018. Effort data is incomplete for 1999, 2000, 2009 and 2010 (haaf only) and is therefore not included here.

In summary, net catches of salmon have declined markedly through the June to August netting season over the last 20 years, while there have been no changes to the allowable net fishing season, nor major changes in the fishing effort utilised. This decline primarily reflects a genuine decline in the abundance of returning adult salmon during the June to August netting season.

2.2 Rod catches

The number of salmon caught by the Lune rod fisheries between 1951 and 2018 is presented in Figure 2.4 below.

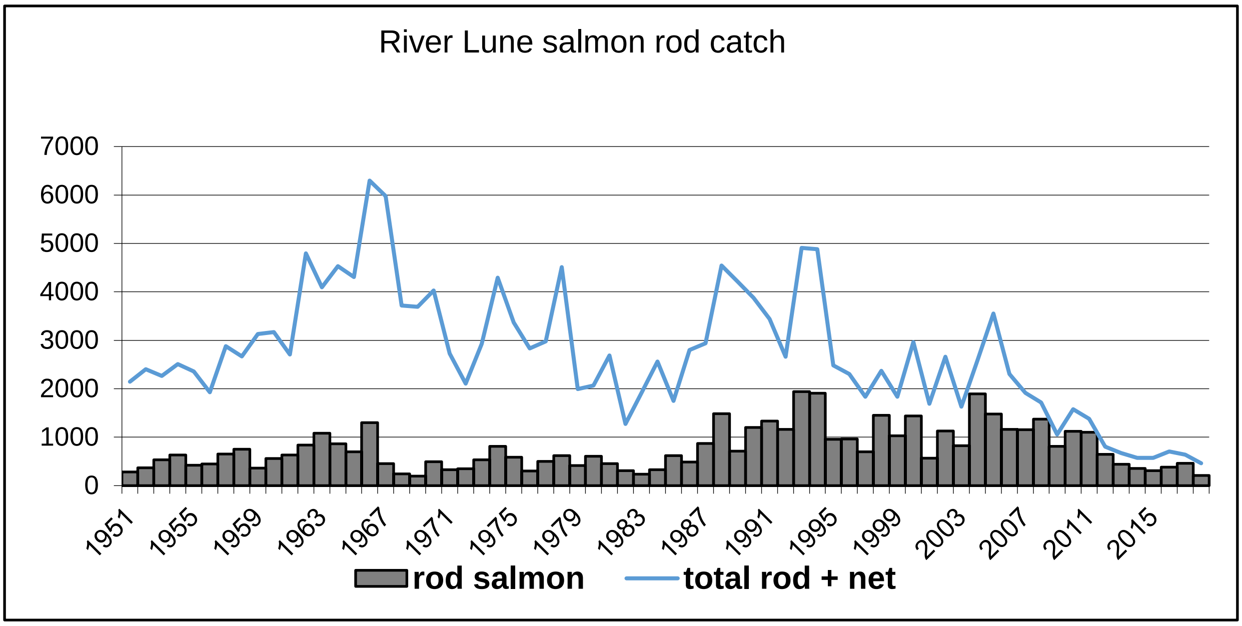


Figure 2.4 – River Lune annual salmon rod catch, 1951 – 2018.

Rod catch statistics are broadly characterised in three phases. From 1951 to 1987 the total annual rod catch averaged 545 salmon per year. From 1988 to 2011, the rod catch averaged 1204 salmon per year. Since 2012, the rod catch has averaged 431 salmon per year. Notably, the pattern of catches since the recent peak of 2004 has shown a marked decline, with the seven annual catches reported since 2012 being the lowest seven catches since 1986, (barring 2001 when foot and mouth disease imposed widespread access restrictions through the majority of the fishing season). While the current low levels of rod catches (<500 per season) have also occurred in the past, such as in the early 1950's, late 1960's and early 1980's, net catches at those times were relatively high, indicating good overall abundance of returning adult salmon. Total rod and net catches averaged over 2300 salmon in the early 1950's, over 4000 salmon per year through the late 1960's and over 2000 salmon per year through the early 1980's. Importantly, through the last twenty year period when the same fishing restrictions have applied, the total catches have declined from an average of 2156 salmon per year (1999 to 2003) to 590 salmon per year (2014 to 2018) demonstrating a clear and substantial decline in abundance.

The pattern of monthly catches since 1999 is presented in Figure 2.5 below. Catches during February (not included), March, April and May have only rarely exceeded 10 salmon per month in any year. Catches during June have generally not exceeded 20 salmon and catches during July have generally not exceeded 50 salmon. As is the case for the June drift net catch (fig 2.2, page 11), the June rod catch seems to have increased slightly in recent years, albeit from a relatively low initial level. Total annual catches have been dominated by catches recorded in September and October every year, with these two months' catches typically comprising around 80% of the annual totals. However it is noticeable that the catches recorded in these two months, and especially for October, have declined markedly in recent years – coinciding with the observation of reduced runs and catches of summer and autumn grilse. While it is recognised that unseasonably dry weather conditions have presented very poor angling opportunities in September and October in recent years (2014 to 2018), the recent reduced catches do reflect a genuine lack of salmon, rather than just a delayed run, coming after the end of the angling season at the end of October.

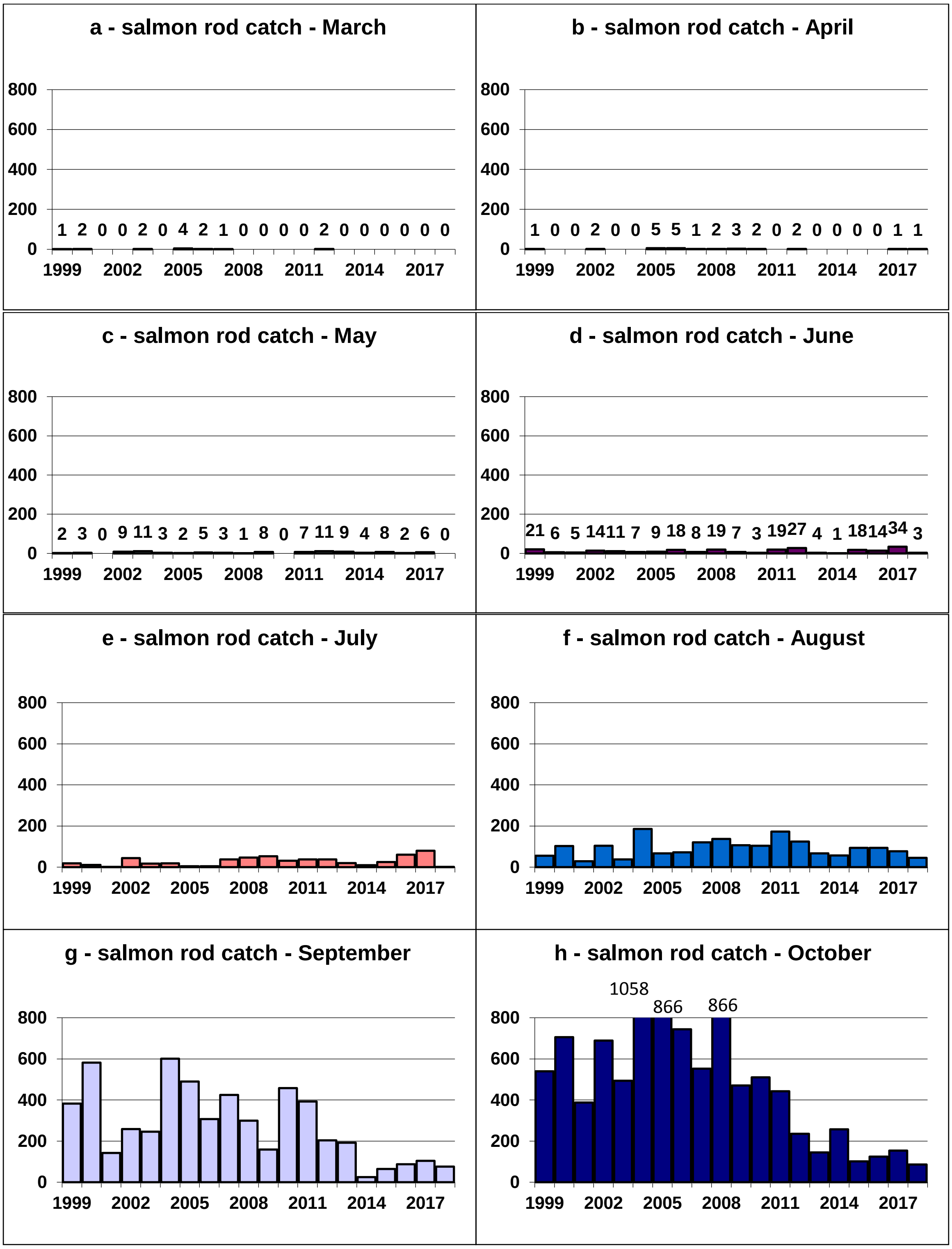


Figure 2.5 – River Lune monthly salmon rod catch, 1999 – 2018.

In summary, rod catches of salmon have declined markedly in the last 20 years, while there have been no changes to the allowable rod fishing season. Rod fishing effort has declined in this time but does not, on its own, account for the declining catches. This decline in catches reflects a genuine decline in the abundance of returning adult salmon.

The rate of catch and release angling for salmon on the Lune, as shown in figure 2.6, below, has increased since 2013 having averaged around 60% and with no apparent improvement prior to that time. Since 2014 the rate of catch and release has generally exceeded 70% with the highest rate of over 85% recorded in 2018. Recognising that mandatory 100% catch and release applies up to 16th June through National Spring Salmon Byelaws, the true voluntary catch and release rate for the 16th June to 31st October is presented separately, but shows a very similar pattern of release rates, reflecting the fact that only a very small proportion of the total annual catch is caught during the mandatory catch and release period prior to 16th June. Initially, the Lune catch and release rate was generally higher than the national average, but more recently has tended to lag behind the improving national average.

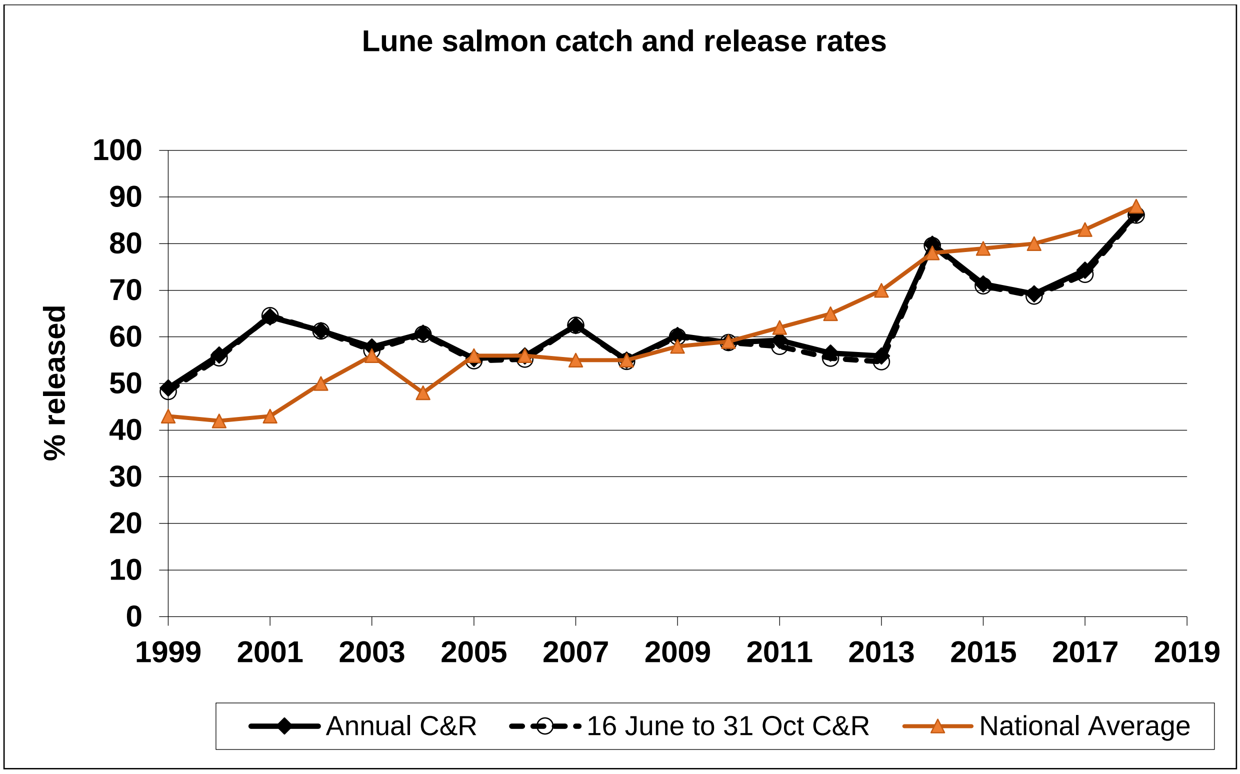


Figure 2.6 – Lune rod fishery and national average catch and release rates for salmon, 1999 – 2018.

In recent years there has been a progressive switch in the methods used by anglers to catch salmon in the River Lune, as shown in Figure 2.7, below, from lure/spinner and bait to fly.

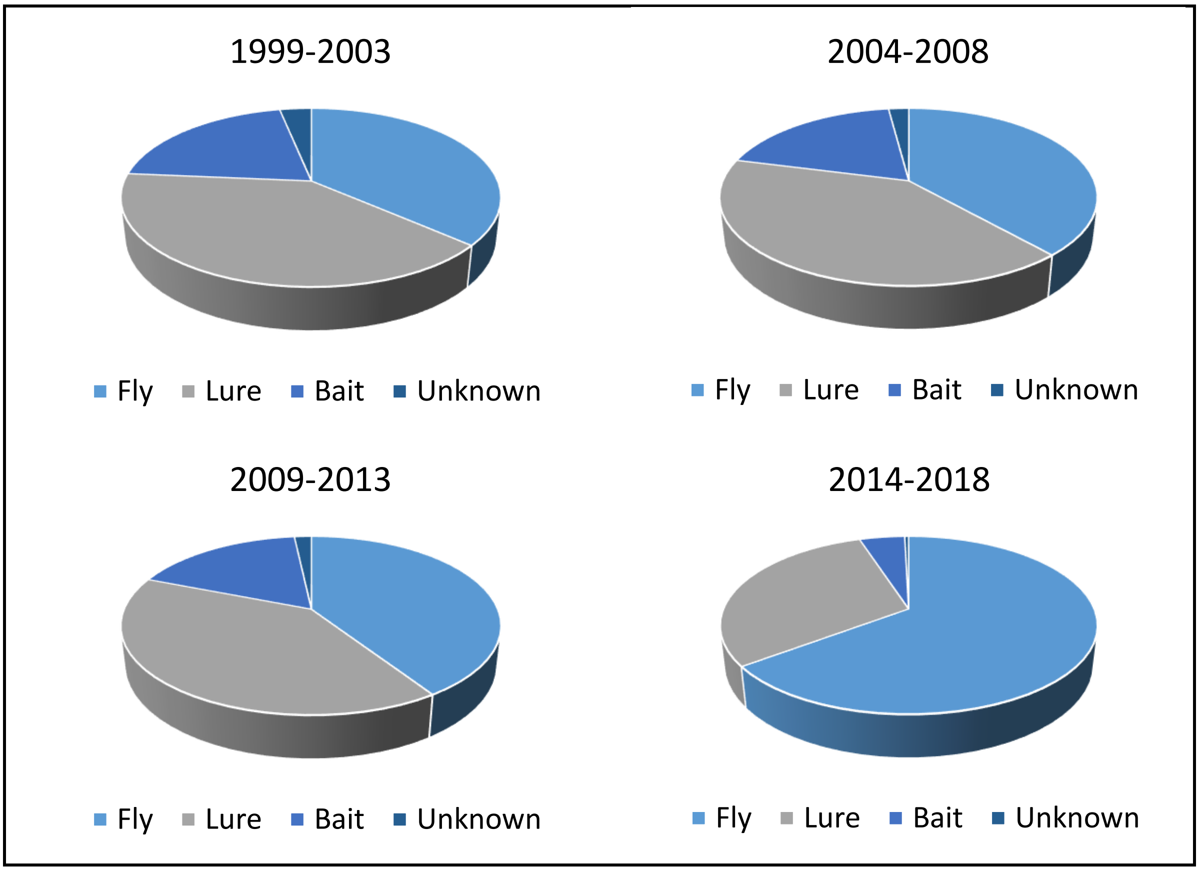


Figure 2.7 – River Lune methods of capture reported for the salmon rod fishery 1999-2003, 2004-2008, 2009-2013 and 2014-2018.

During the period 2014-2018, almost 65% of all salmon caught in the River Lune were caught on fly, with lure / spinner and bait accounting for much lower proportions of total rod catch than in previous years (30% and 5% respectively over the 2014-2018 period). Of the fish caught on fly over this same period (2014-2018), 78.7% were released, while 24.1% of lure / spinner caught fish were released and 69.4% of bait caught fish released. The current rate of release for lure/spinner caught fish is markedly lower than that for the other two methods.

The number of catch returns submitted (that include a record of fishing effort) over the period 1999 to 2018 is presented in Figure 2.8 below, along with the total number of fishing days recorded for each season and the declared catch associated with those catch returns that included a measure of fishing effort. The number of catch returns submitted by Lune anglers has been variable over this period, but has generally declined steadily. The average number of returns submitted from 1999 to 2004 (excluding 2001 when Foot and Mouth disease caused widespread access restrictions) was 1096. By comparison, the average number of returns submitted in the most recent 5-year period (2014 to 2018) was 578. Equally, the number of days fishing recorded (Note that a fishing “day” should be recognised as a fishing event rather than a specific timed duration) has declined in a similar manner, ranging from a 5-year average of 10623 for the period 1999 to 2004 (2001 excluded) to a low of 4840 days for the most recent 5-year period (2014 to 2018).

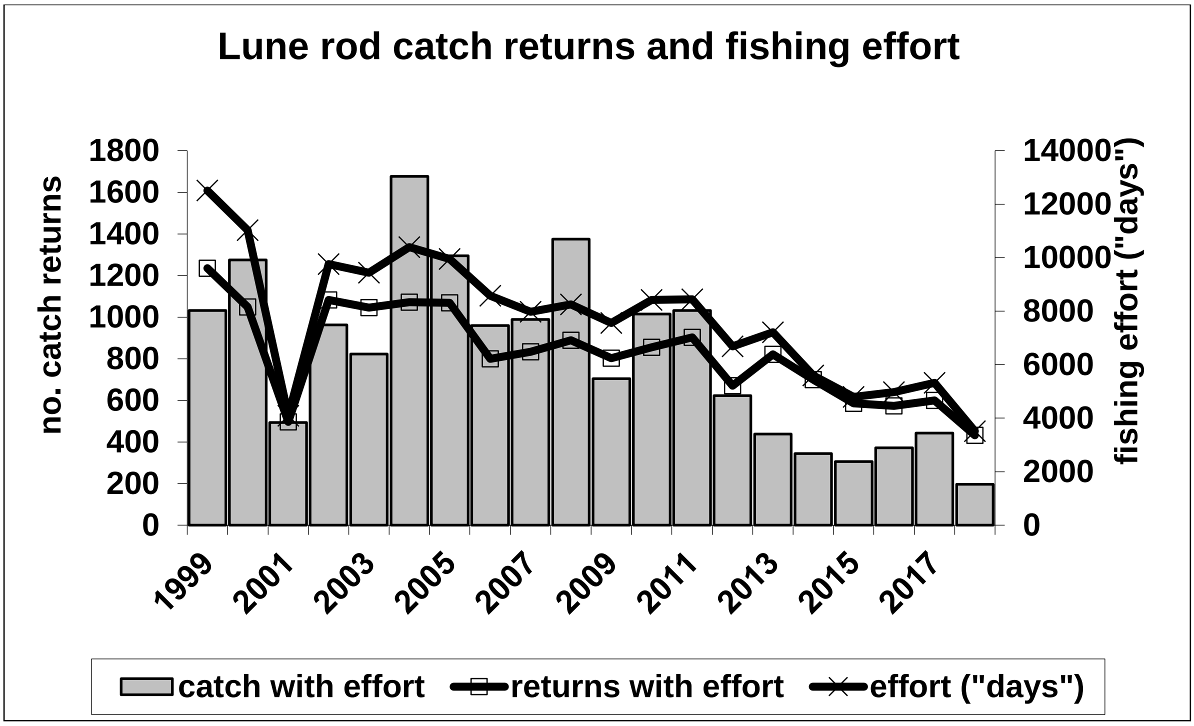


Figure 2.8 – Number of rod catch returns submitted (that include fishing effort data) and recorded fishing effort ("days") for the Lune salmon fishery, 1999 to 2018. Rod catch from these catch returns (that include fishing effort) is also presented.
Note that this catch statistic is usually lower than the published total declared catch each year due to some catch returns not including their record of fishing effort data.

The percentage of anglers declaring a catch of salmon from the Lune and the percentage of anglers declaring a kill of salmon each season is presented in Figure 2.9 below. The percentage of anglers catching salmon has generally been variable but has declined in recent years. The percentage of anglers catching salmon has remained broadly similar, around 40% from 1999 to 2012 despite the decline in the number of catch returns being submitted over the same period. Thereafter the percentage of anglers catching salmon has declined to roughly 25% in the last six years (2013 to 2018). Conversely, the percentage of anglers not catching salmon is around 75%. The percentage of anglers killing salmon has followed a very similar pattern to the percentage catching salmon, albeit at a consistently lower level. From 1999 to 2012 the percentage of anglers killing salmon has ranged from 20 to 35%. From 2013 that percentage has reduced to 5 to 15%.

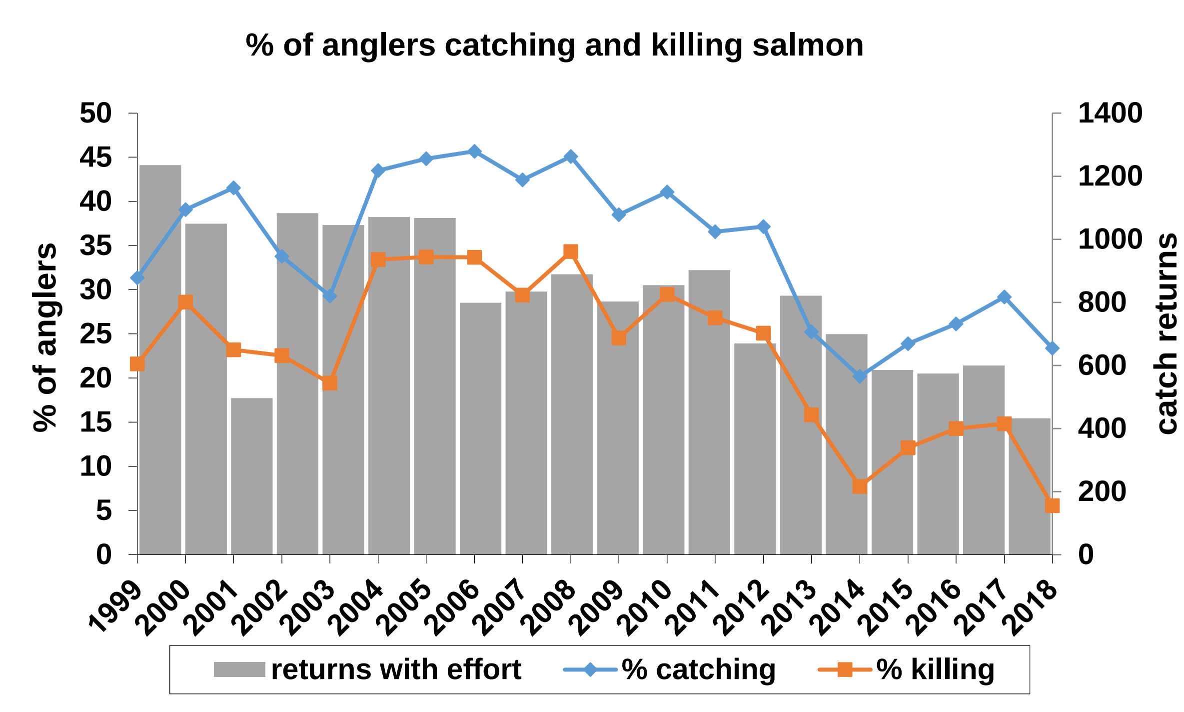


Figure 2.9 – Percentage of anglers declaring a catch of salmon and percentage of anglers declaring a kill of salmon from the Lune 1999 to 2018.

The distribution of the number of salmon killed by Lune anglers over recent years is presented in Figure 2.10 below. The percentage of Lune anglers who kill none of their catch has remained broadly consistent between 30 and 40% up until 2013. After this time that percentage has increased, most markedly reaching 75% in 2018. The percentage of the anglers who kill one salmon has also remained relatively consistent between 30 and 40% from 1999 to 2017. That percentage decreased in 2018 to 20%. The percentage of anglers killing 2 or more salmon in a season has varied between 25 to 35% up to 2013 and has declined since then. These measures essentially reflect the rate of voluntary catch and release by the rod fishery, given that relatively few anglers report catching 4 or more salmon in recent seasons (8 anglers out of 432 reported catching more than 4 salmon in 2018).

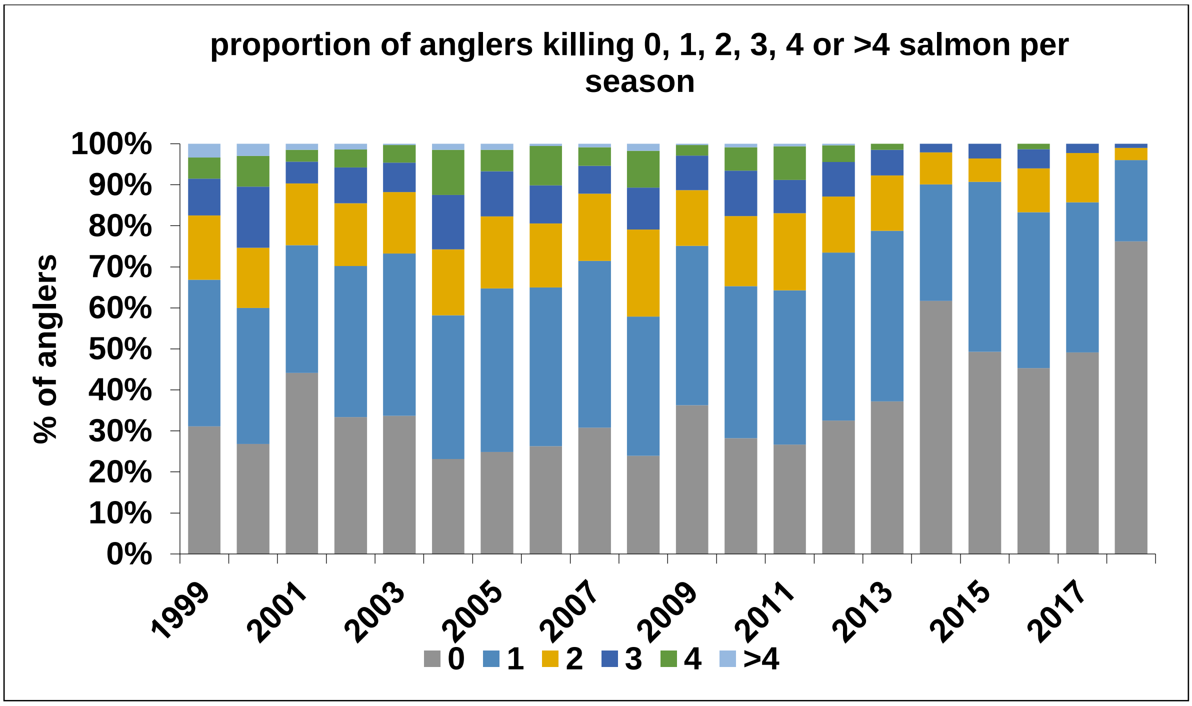


Figure 2.10 – Percentage of Lune anglers killing 0, 1, 2, 3, 4 and more than 4 salmon per season 1999 to 2018.

Note that the statistics in this graph represent the reported kill of salmon by anglers who caught fish. The zero kill statistic does not include anglers who went fishing but did not catch anything, only those who caught salmon but returned them all alive to the river.

2.3 Fishing Mortality

Apportionment of recent fishing mortality between the rod and net fisheries is summarised in Table 2 below. These estimates are based on declared catches from the fisheries and the counted upstream migration of salmon at the Forge Weir fish counter. An additional fish pass was constructed at Forge Weir during 2014 and became operational in 2015. While this pass also incorporated a resistivity fish counter, the data from it in 2015 was incomplete and poorly validated. In addition, both counters suffered flood damage in early December 2015 through the Storm Desmond flood and therefore no counts are available after this time.

Year	Pre net stock[a]	Net Mortality		Rod kill		C&R Mortality (10%)		Total rod mortality		Total rod+net mortality	
		No.	%	No. [b]	%	No. [c]	%	No.	%	No.	%
2010	9320	454	4.9	510	5.5	73	0.8	583	6.3	1037	11.1
2011	6999	278	4.0	493	7.0	72	1.0	565	8.1	843	12.0
2012	4698	157	3.3	309	6.6	40	0.9	349	7.4	506	10.8
2013	5035	233	4.6	212	4.2	27	0.5	239	4.7	472	9.2
2014	3912	222	5.7	78	2.0	31	0.8	109	2.8	331	8.5
2015	No counts available	262		98		24		122		384	
2016		322		130		29		159		481	
2017		180		130		38		168		348	
2018		250		32		20		52		302	

Table 2 – Approximate apportionment of fishing mortality by rods and nets 2010 to 2014.

[a] based on validated count at Forge weir (corrected for 94% salmon counting efficiency) + declared kill by nets.
[b] corrected rod kill = declared rod kill x 1.1

[c] C&R rod mortality assumed to be 10% of corrected rod release (declared rod release x 1.1). A mortality rate of 20% of released fish is commonly applied, as a more precautionary estimate. 10% is applied here given the high prevalence of the less damaging fly fishing method in the Lune rod fishery.

Over recent years the mortality of salmon in the rod fishery, based on the direct kill of salmon plus an estimated mortality of 10% of released salmon, has decreased as the total catch has declined and the number of fish killed has been voluntarily reduced. The mortality of salmon to the rod fishery initially exceeded that in the net fishery through 2010, 2011 and 2012. In 2013 and 2017 the mortality was similar in both fisheries. In 2014, 2015, 2016 and 2018 the mortality in the net fishery has exceeded that in the rod fishery. Overall the total net and rod kill together represent an estimated 8 to 12% of the available salmon stock over the years prior to 2015 with available counter data. Numerically, the kill of salmon by the nets has remained at similar levels in the most recent three years (2016 to 2018) to that recorded previously. National byelaws introduced in 2019 have prevented the Lune net fishery from killing salmon so salmon mortality in the net fishery will effectively be zero from 2019 onwards.

2.4 Counter Data

A resistivity fish counter is sited in the fish pass at Forge weir, near Halton, approximately 4 kilometres upstream of the tidal limit at Skerton Weir. The number of salmon counted at this site from 2000 to 2015 is presented in figure 2.11 below. An additional fish pass was constructed at Forge Weir during 2014 and became operational in 2015. While this pass also incorporated a resistivity fish counter, the data from it in 2015 was incomplete and not adequately validated. In addition, both counters suffered damage in early December 2015 through the Storm Desmond flood and therefore no complete annual counts are available after this time.

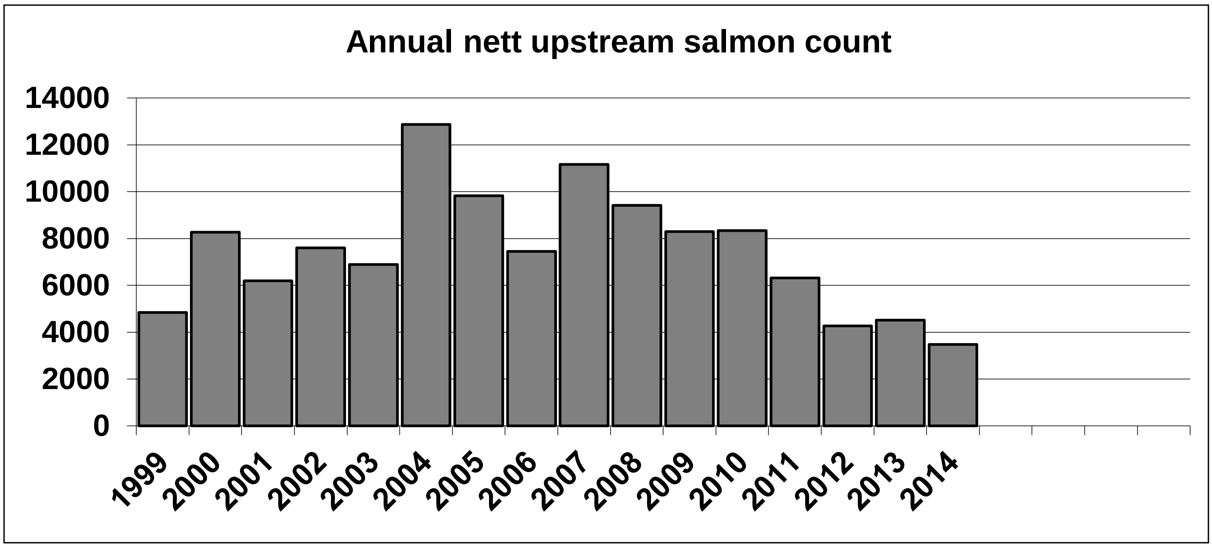


Figure 2.11 – Annual nett upstream count of salmon at Forge Weir resistivity fish counter, River Lune 1999 – 2014.

Prior to 2012, the annual count of salmon ranged from 6000 to 12000. However, there has been a clear decline since the mid-2000’s with counts since 2012 being the lowest in this time period. This very much supports the observations about salmon abundance drawn from catch data from the Lune net and rod fisheries and also from other rivers.

Monthly nett upstream counts of salmon are presented in figure 2.12 below. Counts of salmon prior to May (not shown) tend to be very low but build up through the year and tending to peak in September and October and decline thereafter. There has been a clear decline in the number of upstream migrating salmon during September, October, November and to a lesser extent also in December, since the mid 2000's.

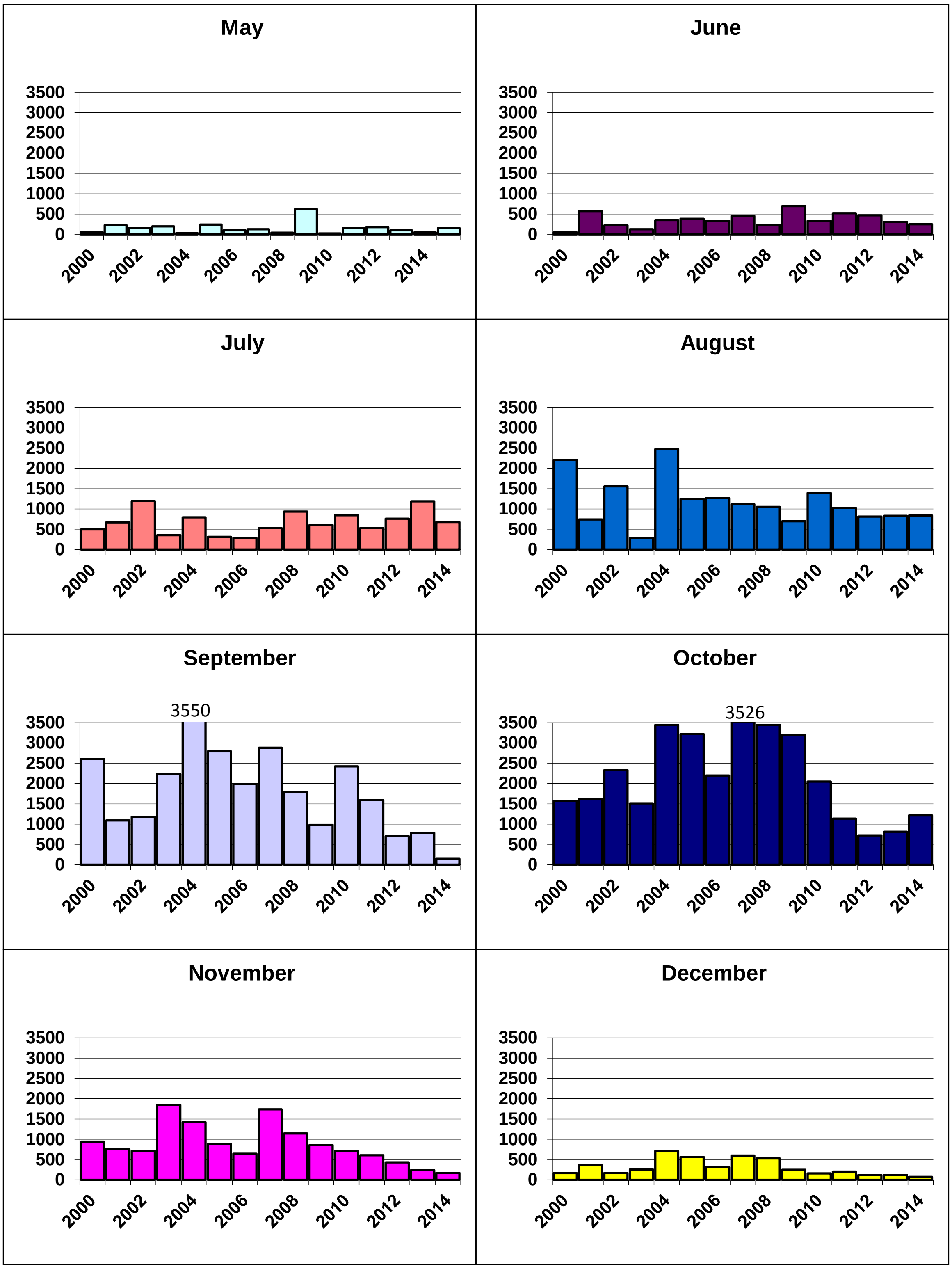


Figure 2.12 – Monthly nett upstream counts of salmon at Forge Weir resistivity fish counter, River Lune 2000 – 2014.

In summary, fish counter data shows a marked decline in runs of adult salmon to 2014, and this decline is most pronounced through September, October and November when typically 50 to 70% of the total annual run would be recorded by the counter in preceding years.

2.5 Juvenile Monitoring Data

Monitoring results from historic as well as most recent juvenile surveys (2019) are presented below. Salmon parr abundance from several long-term monitored sites, with surveys dating back to 1981, are presented in Figure 2.13 below.

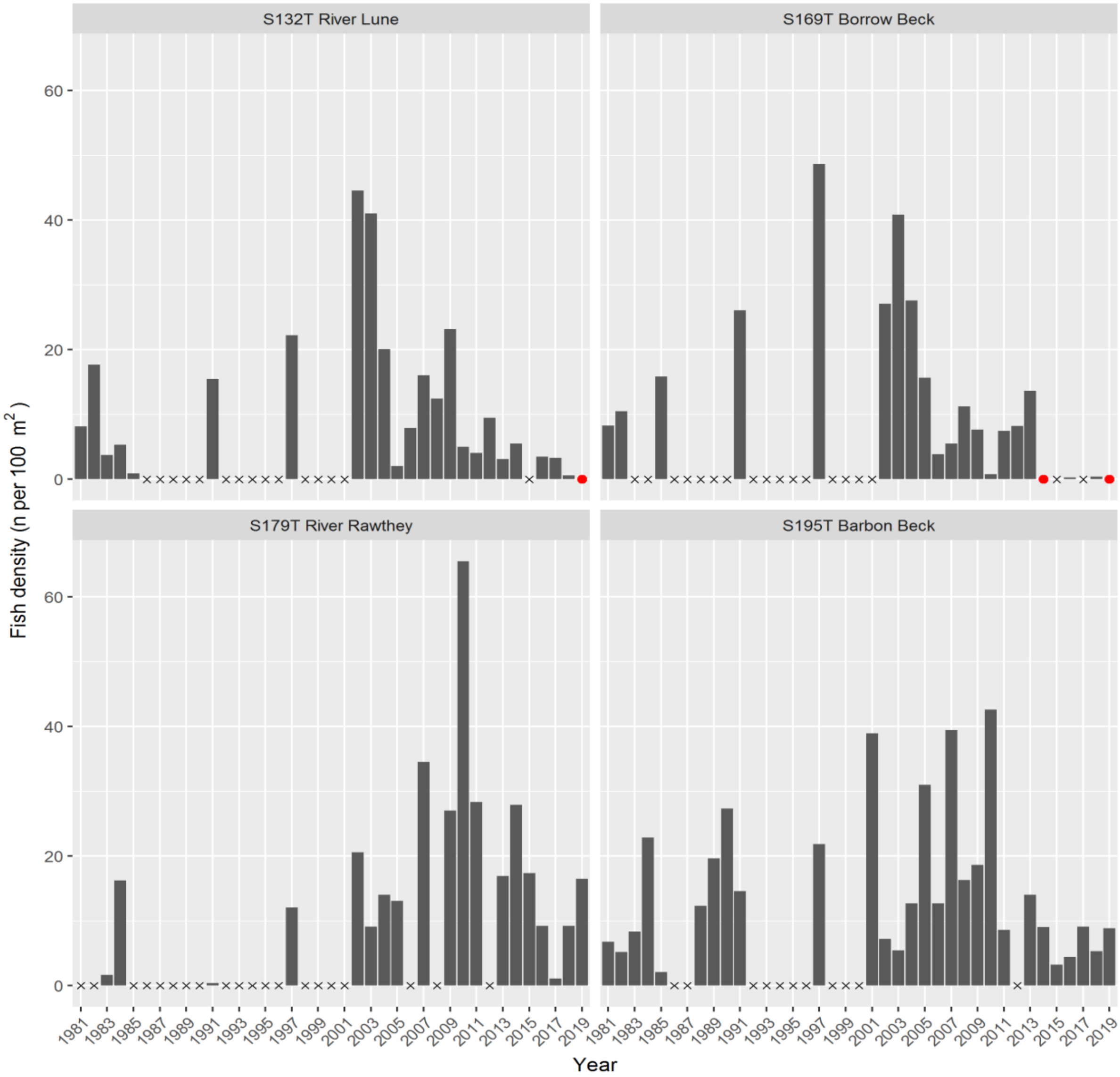
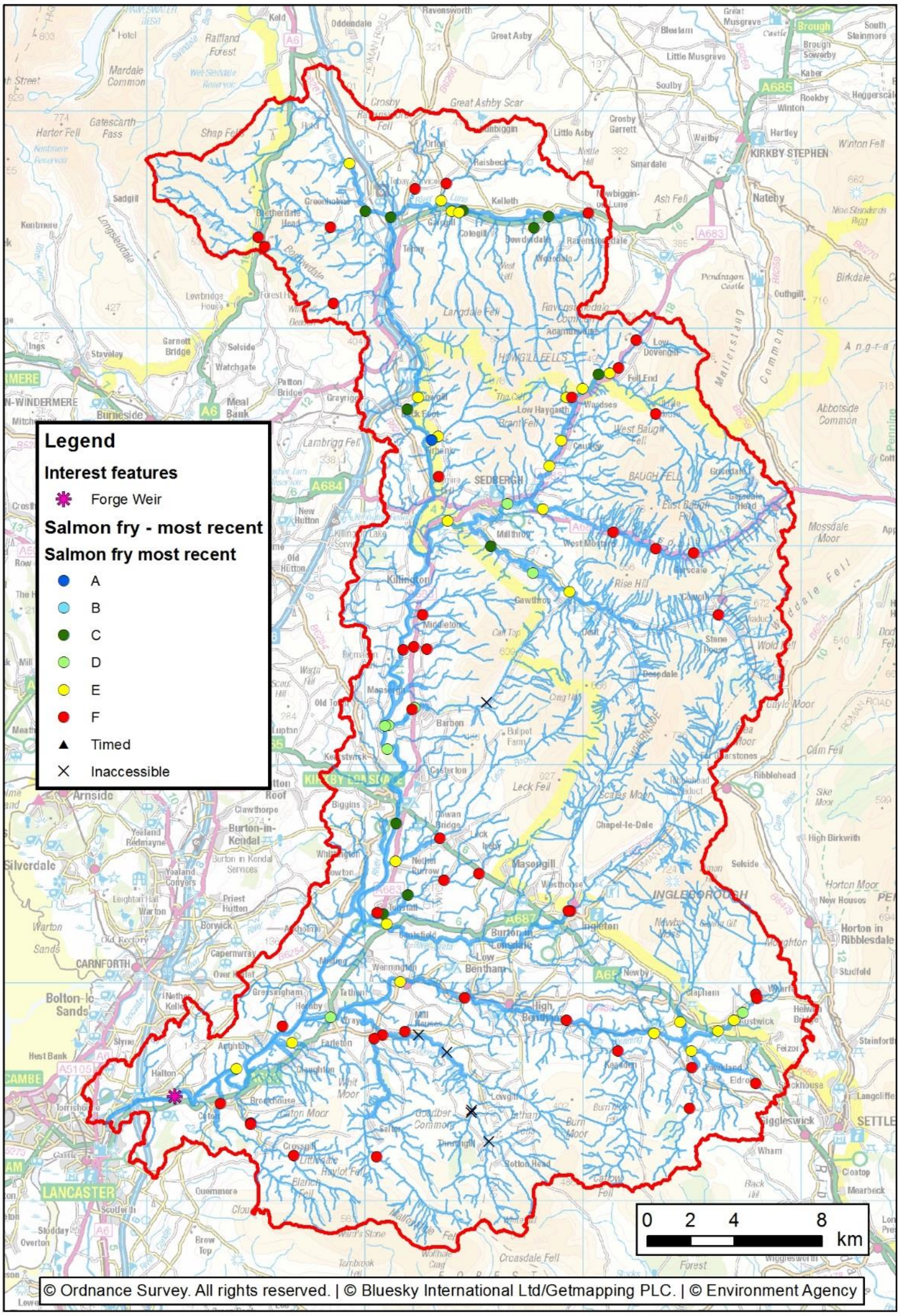


Figure 2.13 – Salmon parr abundances from long term monitored sites. Crosses denote no survey undertaken, red dots denote absence of the age class.

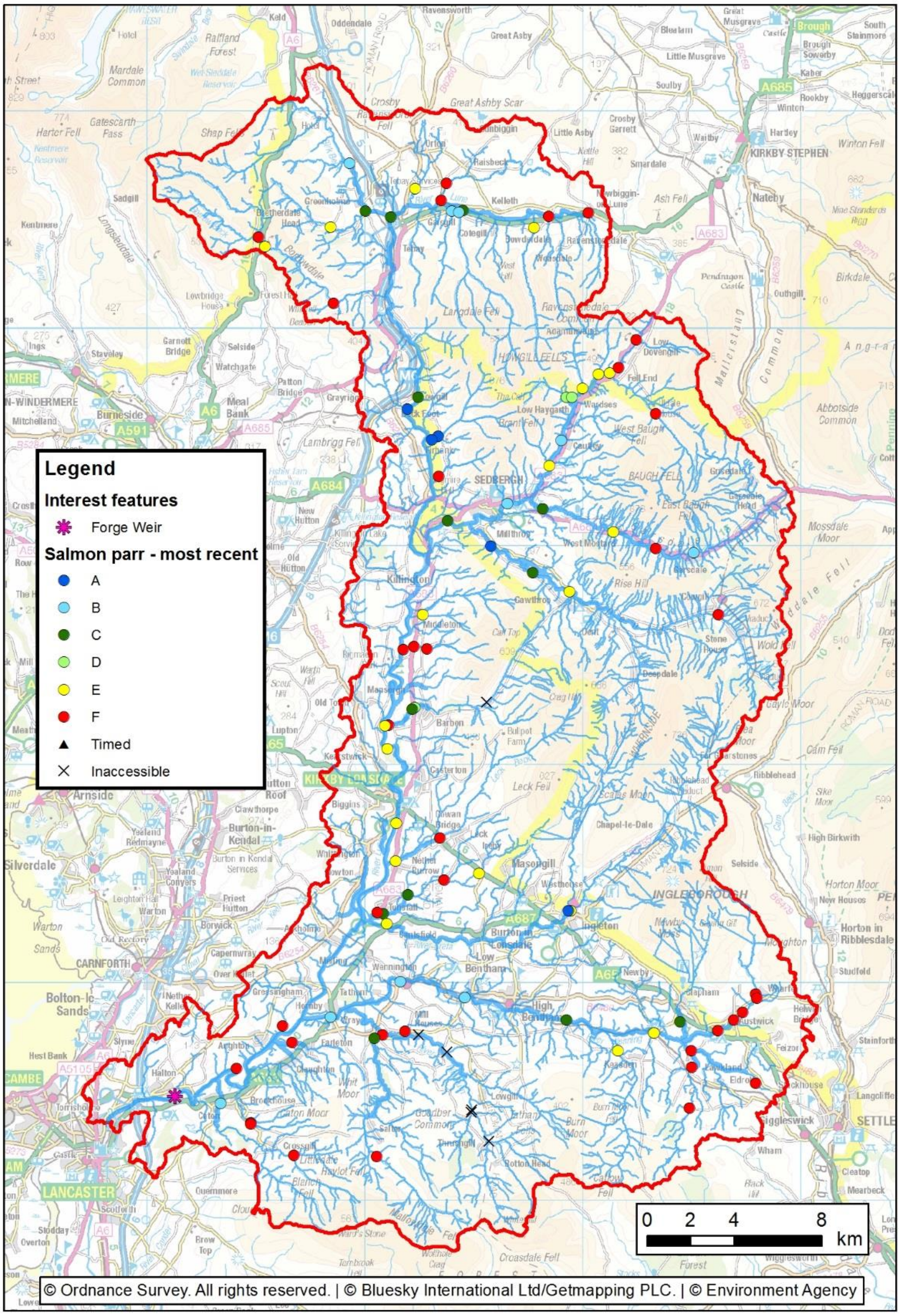
Although abundances have been quite variable over this time series, salmon parr abundances in particular have generally been at their poorest in recent years, including complete absences in some recent surveys.

The most recent comprehensive survey of the Lune catchment was undertaken in 2019 and the distribution of salmon fry and parr NFCS grades are presented in Maps 2 and 3 below.



Map 2 – geographical distribution of salmon fry abundance grades, 2019. (includes best densities of some sites back to 2010)(includes Artle beck site upstream of impassable weir)

The 2019 survey illustrated the widespread absence or low abundance of salmon fry with best densities generally being recorded in the upper catchment.



Map 3 – geographical distribution of salmon parr abundance grades. (includes best densities of some sites back to 2010)(includes Artle beck site upstream of impassable weir)

Similar to the results for salmon fry, the salmon parr were broadly absent or present at generally low densities through many of the surveyed sites. Best densities were recorded in lower Wenning, Rawthey, Clough, Dee and upper river.

For the wider catchment surveys undertaken every 3 to 6 years, the distribution of National Fisheries Classification System (NFCS) grades for survey sites is presented in the graphs below (figure 2.14) separately for salmon fry and salmon parr. (Grade A represents the highest abundance, and E the lowest, with F indicating that age class being absent).

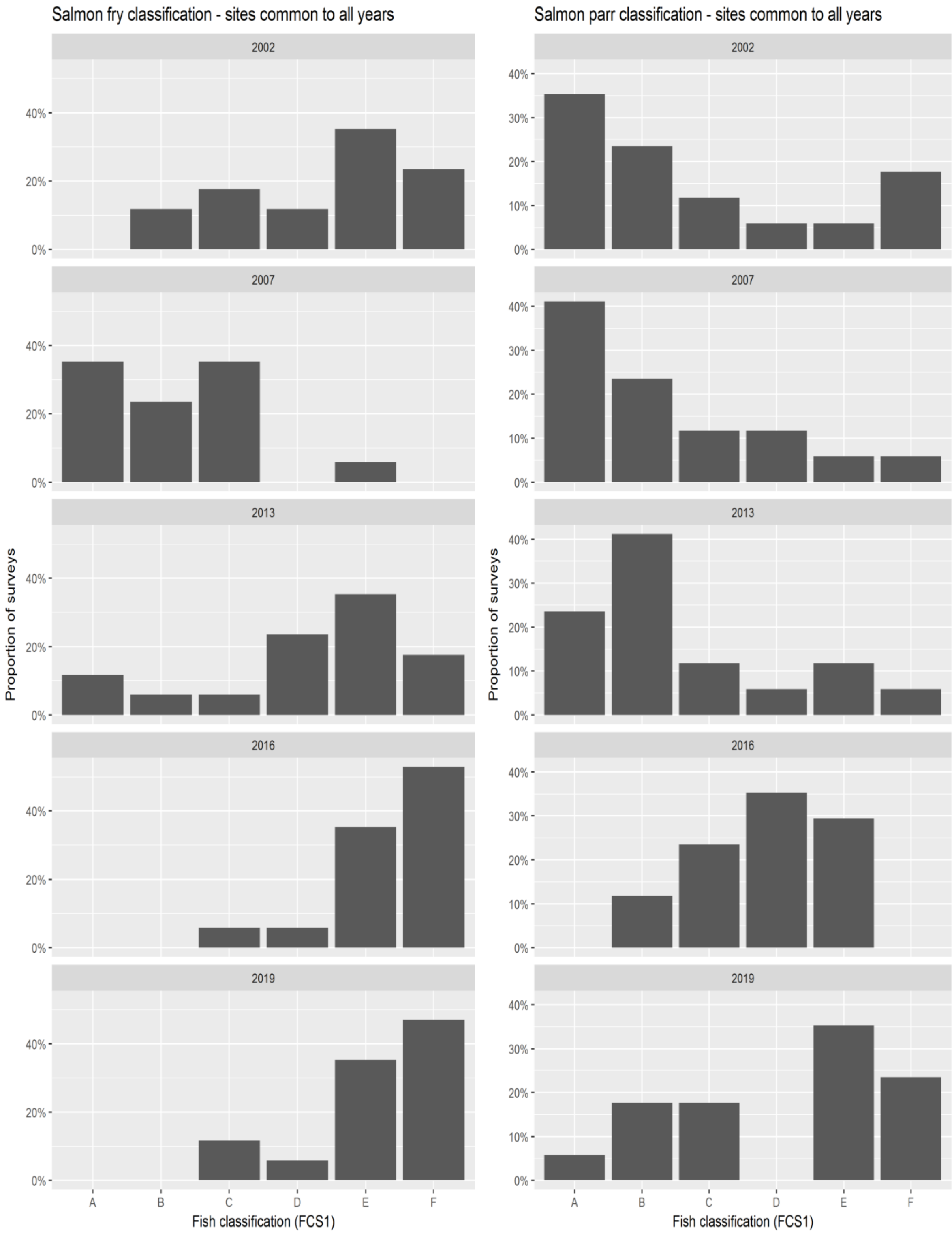


Figure 2.14 – The proportion of River Lune sites surveyed, achieving respective NFCS grades for salmon fry (left) and salmon parr (right) in 2002, 2007, 2013, 2016 and 2019 surveys.

The distribution and abundance of salmon fry was relatively poor at these sites in 2002, with mostly mid-range and low abundances (grades C to E) or absences (grade F) recorded. The

2007 survey was markedly better for salmon fry with high and mid-range abundances recorded. In 2013, the mid to low ranges dominated again while the 2016 and 2019 surveys have demonstrated the worst results for these sites with low abundances and absences dominating.

In contrast, the abundance of salmon parr at these sites has been relatively good through the 2002, 2007 and 2013 surveys, with high abundances dominating in these three surveys. However, there was a marked reduction in abundance of parr in the 2016 survey with mid-range and low densities dominating the survey, and the same pattern being evident in 2019.

The poor results seen in the 2016 survey particularly, are likely to have been a consequence of the devastating December 2015 floods associated with the named storms Desmond, Eva and Frank which were particularly damaging and coincided with the peak of salmon spawning through December 2015. Similar results were observed on other rivers including the Usk and Wye. Of particular concern is the fact that the abundances of both salmon fry and especially parr on the Lune have remained at relatively poor levels in the latest 2019 survey. This is particularly evident when comparing these survey results with the trout fry and parr survey results for these same sites, presented in figure 3.11 (page 41). The results for trout show a very similar effect of the December 2015 floods in the 2016 surveys for both fry and parr. However, the 2019 survey results show a clear improvement in juvenile trout abundances. So, these results for salmon juveniles cannot be readily attributed to any likely environmental effects such as poor water quality, and are most likely due to low abundance of spawning adults.

In summary, the distribution and abundance of juvenile salmon appears to have declined in the most recent surveys. While the poor results in 2016 may have been attributed to extensive damaging flooding during the 2015 spawning period, the 2019 results appear to be just as poor, but cannot be attributed to any such damaging recent flooding. The poor 2019 survey results are most likely caused by a decline in the number of spawning adult salmon in the previous winters (2017 and 2018).

2.6 Salmon Stock Assessment

Lune salmon stock assessments have largely been based on data recorded by the EA fish counter at Forge Weir, as a reliable measure of the salmon run that is independent of the rod catch. A variety of technical and flood related problems since 2015 mean that the counter data has not been a sufficiently complete or reliable record of the salmon run since that time. Stock assessments since 2015 have therefore been based on rod catch data.

In order to understand the relative accuracy of the stock assessments derived from the two different measures of the salmon run (fish counter and rod catch), the results from applying both methods are compared for the period when both sets of data are available – 1996 to 2014. The annual assessments from the two methods are presented in Figure 2.15 below.

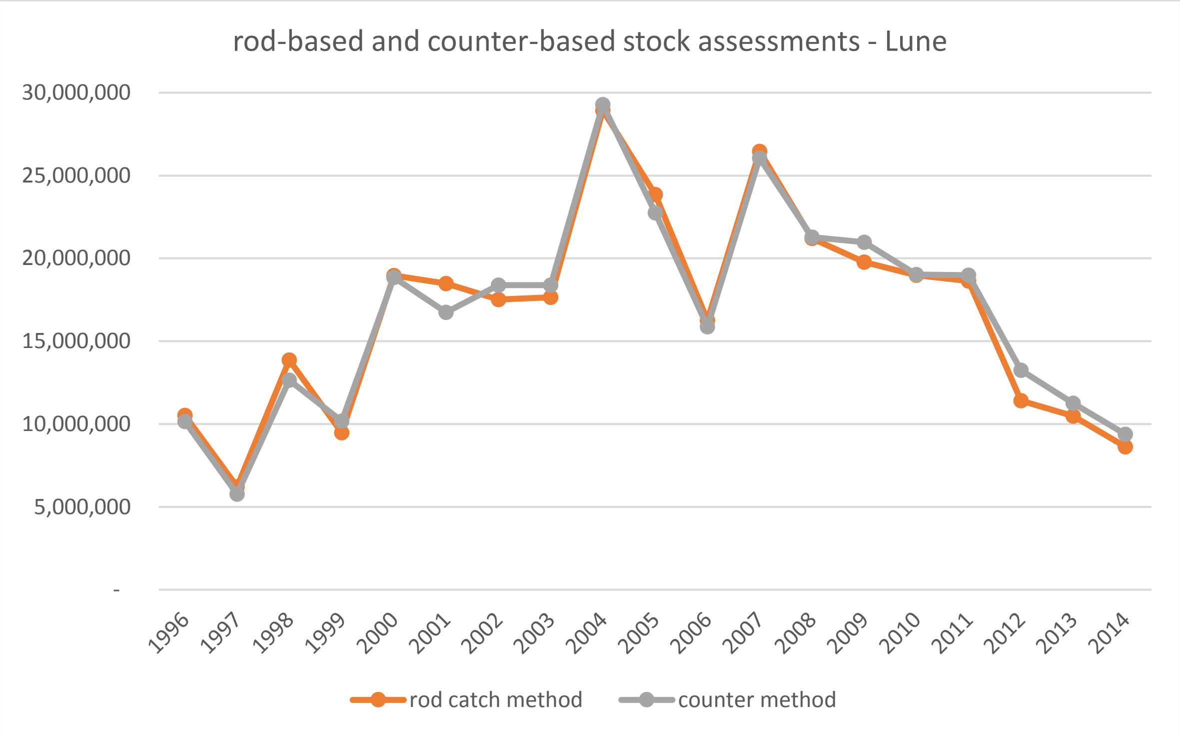


Figure 2.15 – Salmon stock assessments, expressed as egg deposition, based on rod catch and fish counter methods.

Importantly, the two methods consistently produce near identical assessments. The reliance solely on the rod-catch assessment method since 2015 can therefore be considered a sufficiently robust description of the stock, in the absence of the counter data.

During previous stock assessment reviews, errors were identified in some recent Lune rod-catch assessment calculations. It was therefore necessary to correct the catch-based annual stock assessments (egg deposition) since 2015 as follows:

- An incorrect proportion of females in both the one sea-winter and the multi-sea-winter parts of the salmon stock was applied to previous stock assessments (51.5% instead of 44.7% for 1SW and 51.5% instead of 68.7% for MSW), resulting in a slight under-estimation of the annual egg deposition. These have been corrected here for the current (2018) stock assessment and preceding assessments.
- An incorrect calculation meant that the number of one sea-winter salmon in the estimated undeclared catch was unrealistically high. This has resulted in a slight over-estimation of egg deposition in catch-based stock assessments since 2015.

That calculation is corrected here for the 2018 assessment and relevant preceding assessments.

An error in the assessment of each years Lune salmon stock since 2003 against the Conservation Limit was also identified and corrected.

- The original Lune Conservation Limit of 11.8 million eggs, was re-calculated in 2003 using a lower, more realistic estimate of marine survival that was prevailing at that time, in line with national guidance, and as undertaken on all other salmon rivers at that time. This calculated a revised CL of 10.0 million eggs for the Lune. However, the annual Lune stock assessments continued to be compared and reported against the pre-2003 higher Conservation Limit. All relevant stock assessments calculated since 2017 (including in the 10 preceding years) and presented here, are compared against the correct prevailing lower CL of 10.0 million eggs.

Salmon Conservation Limit (CL) compliance for the River Lune stock, according to the corrections identified above, is presented in Figure 2.16. The Lune salmon stock has consistently exceeded it's conservation limit prior to 2014 although with a clear declining trend since 2004 and the five lowest stock assessments in this period occurring in the last six years.

The management target defines a buffer or safety level of stock where more than one CL failure in a five year period is unlikely to happen. The management target for the Lune since 2003 is 13.9 million eggs. That target has not been achieved since 2012. The CL of 10 million eggs has not been achieved in 2 of the last 5 years, 2014 and 2018.

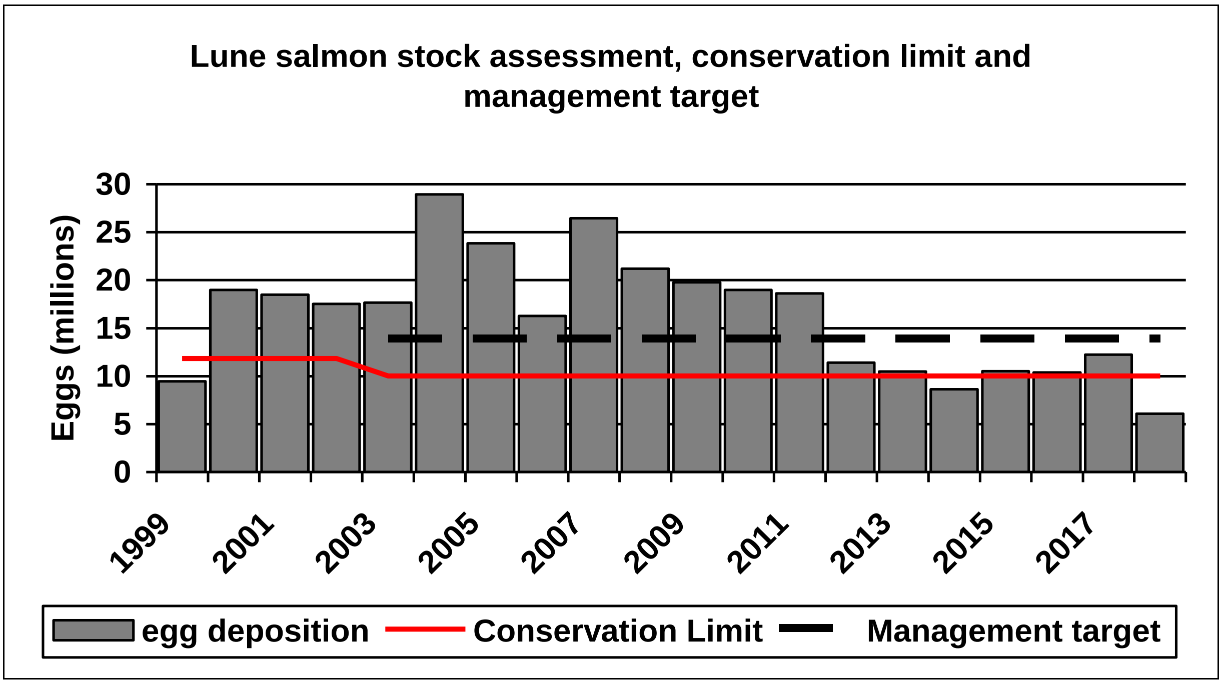


Figure 2.16 – River Lune annual salmon stock assessment (expressed as egg deposition), Conservation Limit and Management Target.

Note that stock assessments prior to 2015 were based on fish counter data and since 2015 have been based on rod catch data.

It is evident that the salmon stock on the River Lune has declined markedly from the notable high of 2004. The formal stock assessment method defines the Lune salmon stock as being "At Risk" of failing its management target in 2018, and is also predicted to remain in this same category in 2023 (Fig 2.17) with a clear declining trend in abundance being apparent.

Lune stock assessments have largely been based on counter data from the Environment Agency's Forge Weir fish counter prior to 2015. A new fish pass was constructed at the downstream end of Forge weir during 2014 by a community hydropower developer, and became operational in 2015. While this new pass also incorporated a resistivity fish counter and monitoring trap facility, the validation of this new counter in 2015 was inadequate, therefore not allowing us to calculate a likely total run for that year. Subsequent validation in 2016 has shown this counter to have a high accuracy (>95%) in counting salmon. The floods of December 2015 caused damage to both fish counters and repeated technical issues, particularly to the EA counter, mean that no complete run estimates can be calculated from 2015 to 2019. In the absence of counter data we rely on rod catch data as a measure of the stock size. Importantly, the stock assessments based on rod catch data alone give very similar results to the assessments based on counter data, for the years when both datasets are available. We can therefore have confidence that the incorporation of rod catch-based assessments for 2015 to 2018 still provide a sufficiently reliable and consistent assessment of the Lune salmon stock.

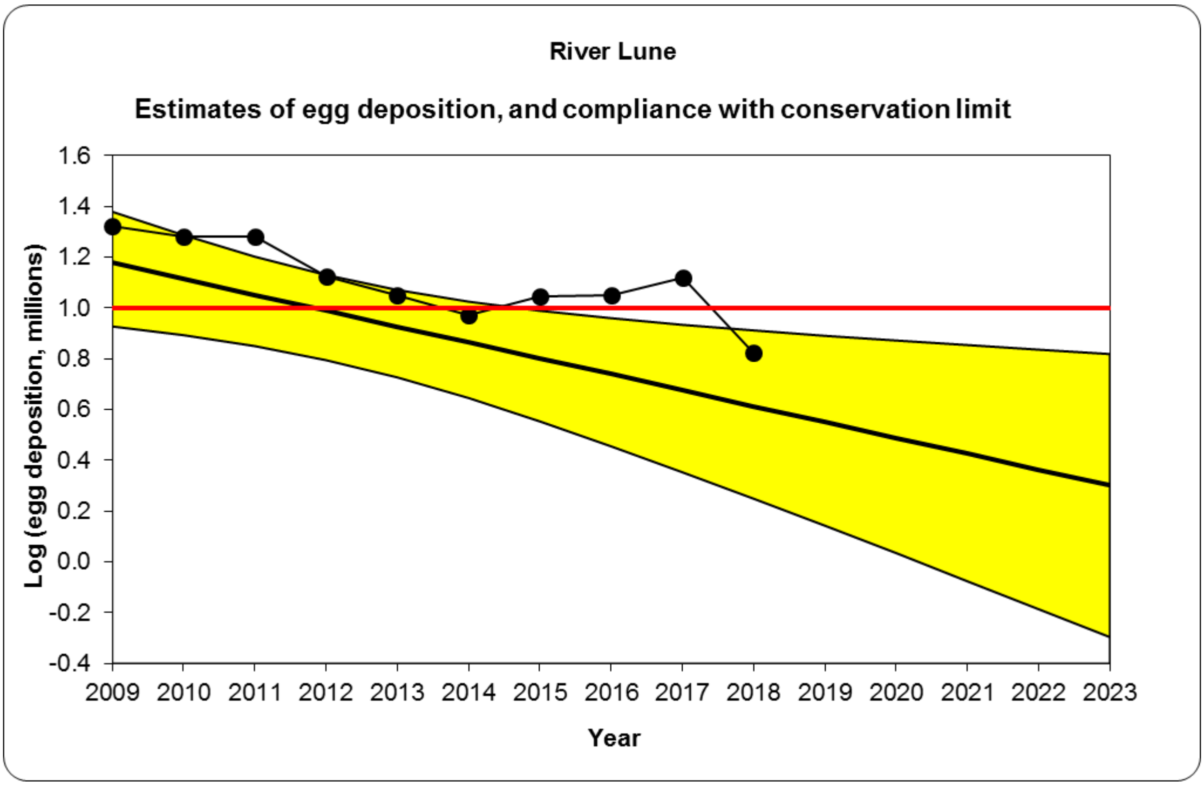


Figure 2.17 – River Lune salmon conservation limit compliance 2009 – 2018 and projected compliance to 2023.

The Lune salmon stock is currently classified as being "At Risk" of failing to achieve its conservation limit in at least 4 years out of 5, and is declining.

3. River Lune Sea trout stock

3.1 Net Catches

The number of sea trout recorded caught by the net fishery in the estuary is presented in Figure 3.1 below.

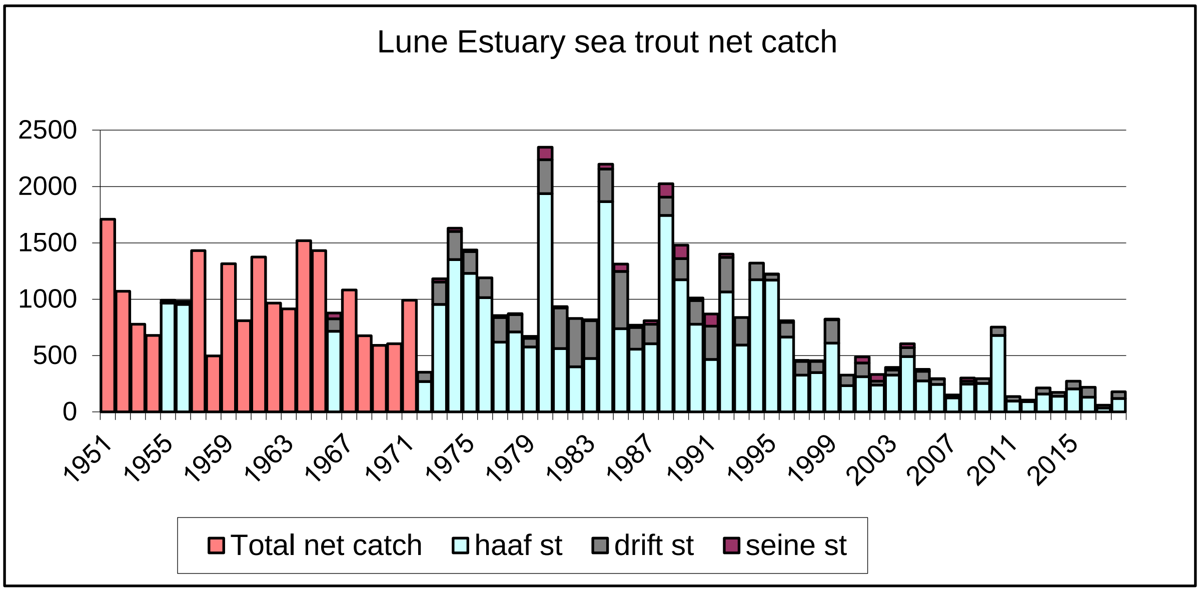


Figure 3.1 – Lune Estuary annual net catch of sea trout 1951 to 2018.

Over the period, the sea trout catch by the nets has been quite variable, but notably at it's consistent lowest over the last 10 years. Prior to 1999 the average annual net catch of sea trout was 1070, ranging from a low of 351 in 1972 to a high of 2349 in 1980. Since 1999, that average has been 325 sea trout per season. Even in the last 20-year period a decline is apparent with the 5-year average catch from 1999 to 2003 being 473 and the most recent 5-year average catch being 180 (2014 to 2018). Notably this latter 20-year period has seen no change to the number of licenced nets or to the available fishing season. The haaf net fishery accounts for roughly 80% of the total net catch of sea trout.

The pattern of monthly sea trout catches in the haaf and drift net fisheries is presented in figure 3.2 below.

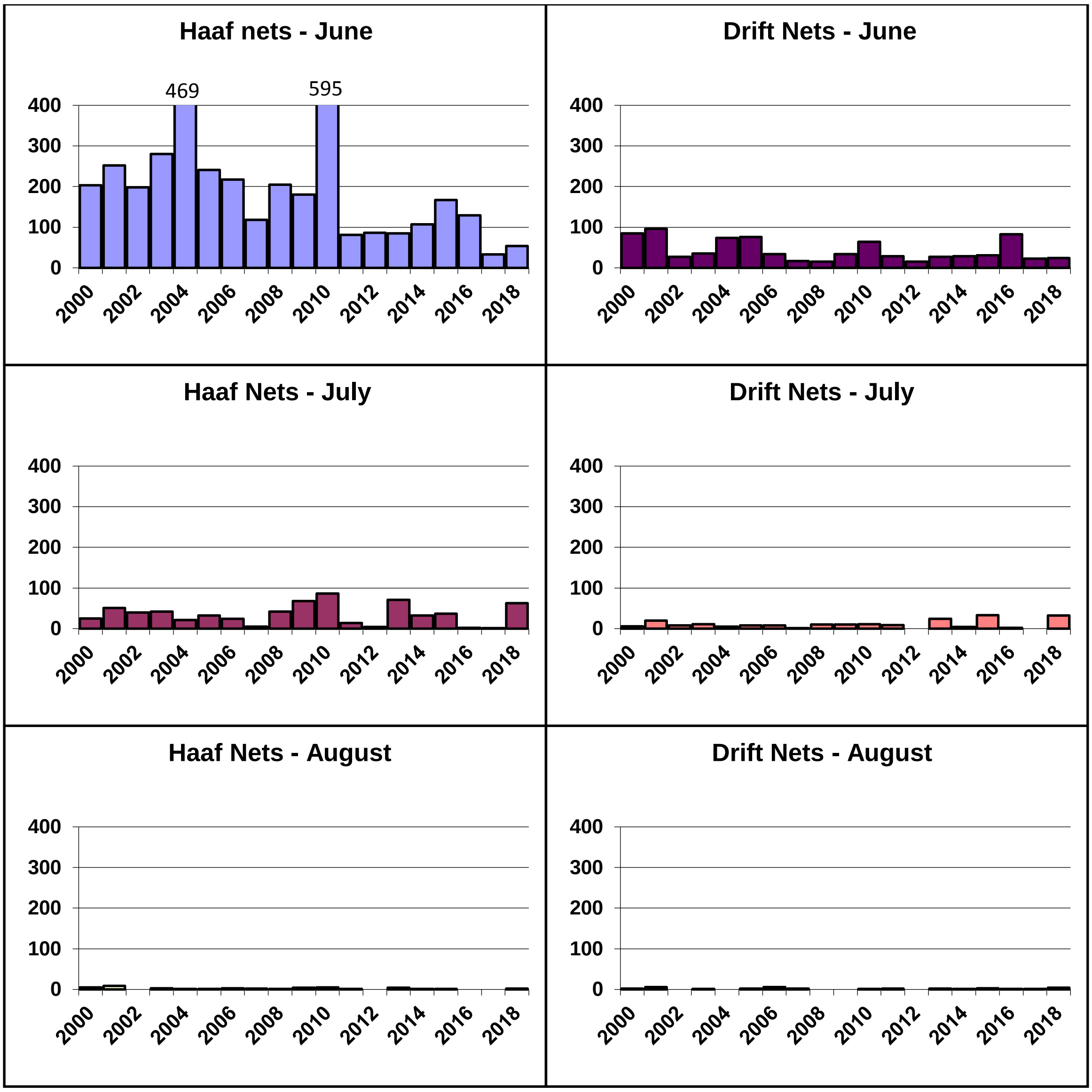


Figure 3.2 – Monthly net catches of sea trout in the Lune Estuary net fishery, 2000 to 2018.

The majority of sea trout caught by the nets are taken in the haaf net fishery in June with progressively lower catches taken in July and August. The haaf net fishery dominates the monthly sea trout catches. The haaf net sea trout catches during June have decreased in recent years.

The pattern of tides fished by the haaf and drift nets, and the sea trout catch per tide fished is presented in figure 3.3 below.

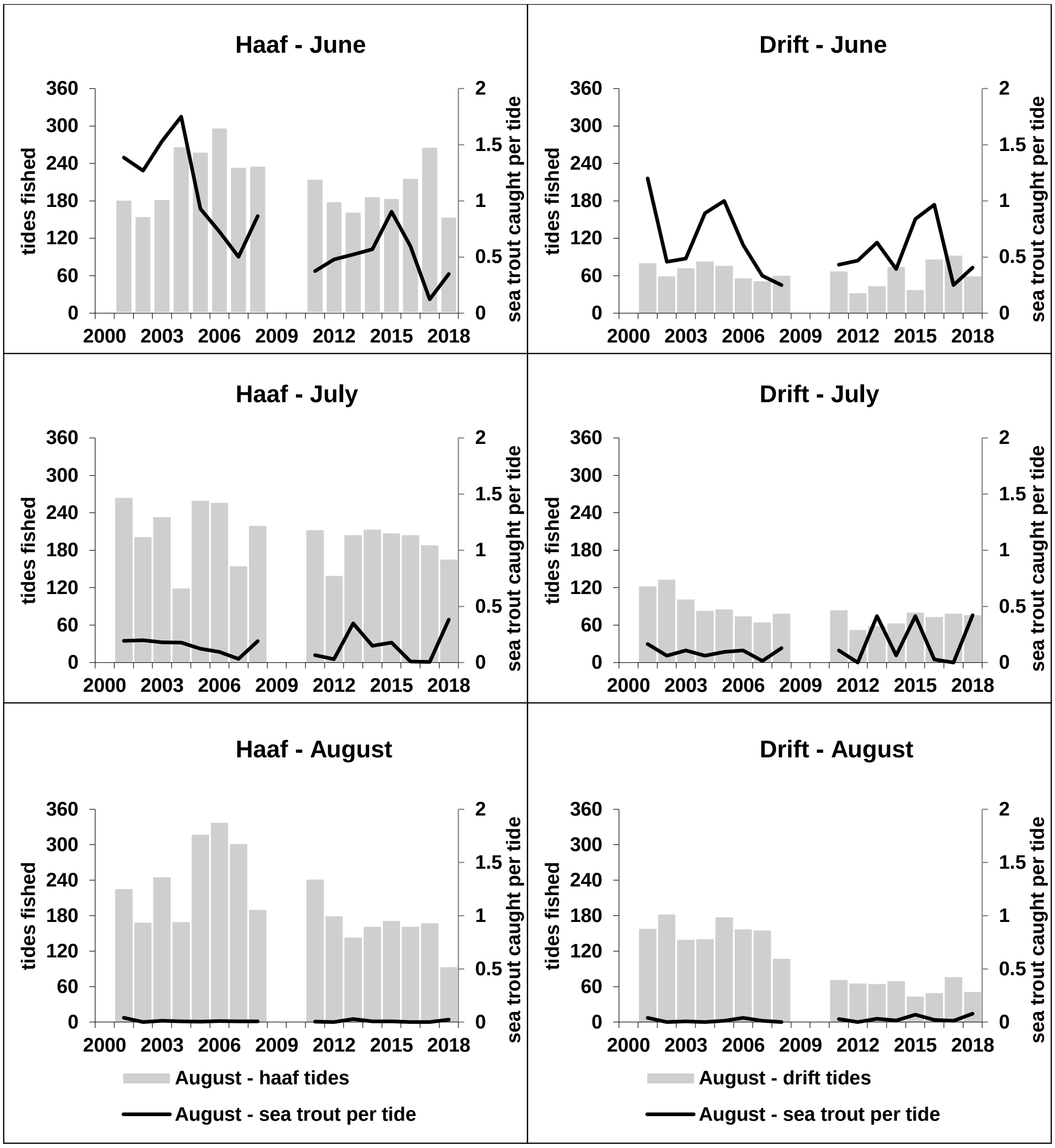


Figure 3.3 – Lune estuary haaf and drift net fisheries, monthly tides fished and sea trout catch per tide 2000 to 2018.

The catch of sea trout per tide fished is highest in June for both fisheries, with the haaf nets recording a higher catch per tide than the drift nets, reflecting the abundance of sea trout in the estuary at this time.

3.2 Rod Catches

The pattern of annual sea trout catches in the rod fishery is presented in Figure 3.4 below.

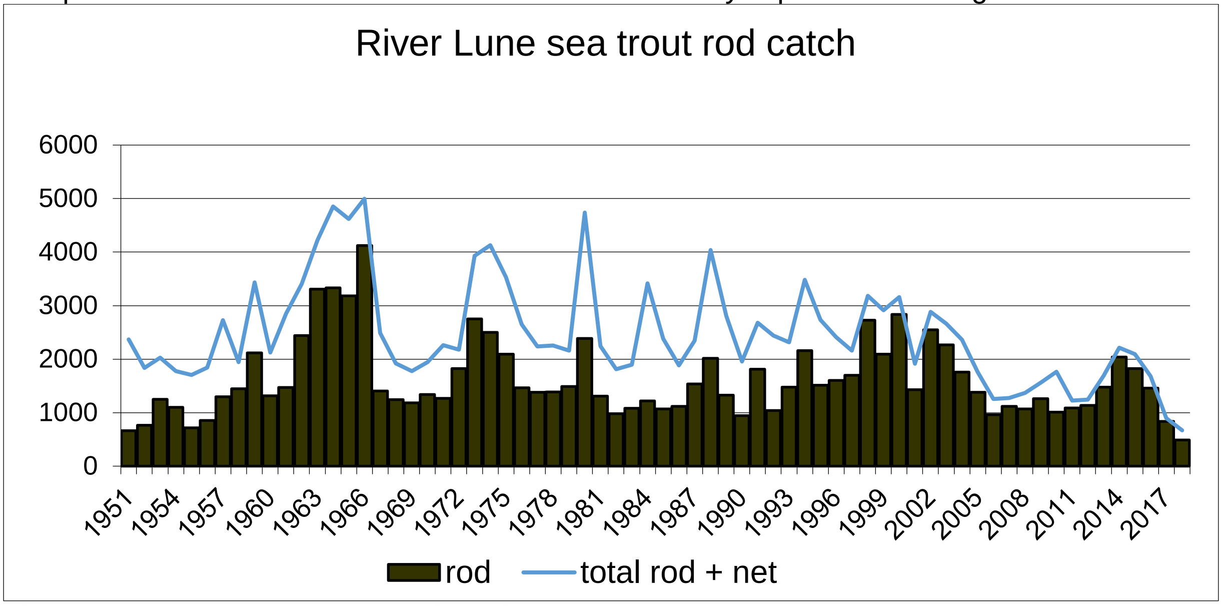


Figure 3.4 – River Lune annual rod catch of sea trout 1951 to 2018

While rod catches have been variable over this time, with particularly high catches through the mid 1960's, there is no strong underlying improvement or decline in catches. Having said that, the 2017 and 2018 rod catches have been the lowest in recent record, although it should be recognised that 2018 was an exceptionally dry and warm early summer that may have impacted the run of sea trout into the river, and also reduced fishing effort through that time, reflected in the lowest rod catch on record. Total rod plus net catches have generally been quite variable but prior to 2005 have rarely fallen below 2000 sea trout per year. Since 2005 total catches have rarely exceeded 2000 sea trout per year and in 2017 and 2018 have been below 1000 sea trout per year. Despite this apparent reduction in catches in 2017 and 2018, anecdotal observations suggest that the abundance of spawning sea trout in spawning tributaries in those years have been as good as have been observed previously.

The pattern of monthly rod catches of sea trout is presented in figure 3.5 below. Catches during May are relatively low but increase through June and are at their highest during July and August, and declining to low levels through September and October. There is a suggestion of a decline in monthly catches for June through to October because of relatively higher catches in the early 2000's

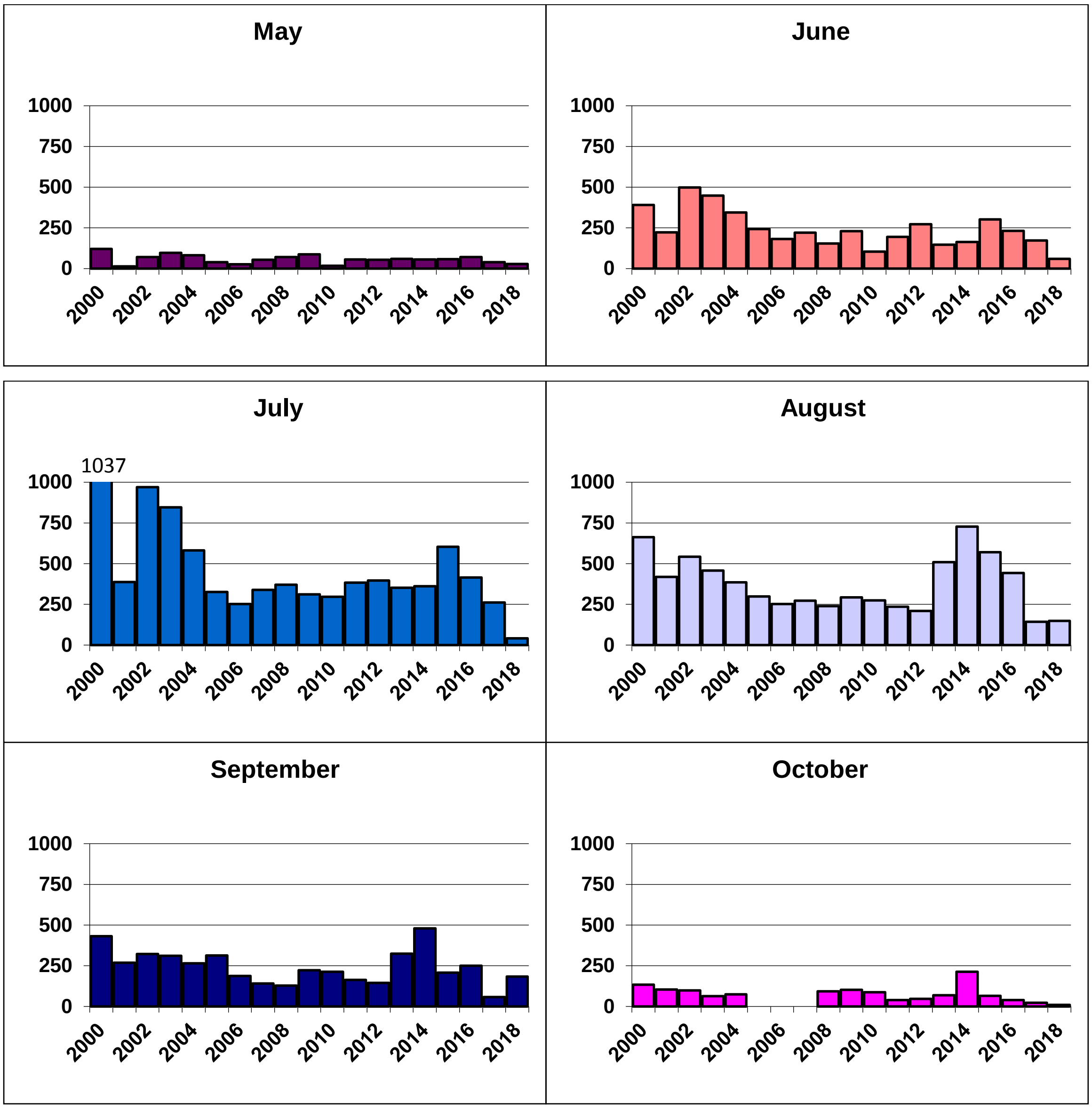


Figure 3.5 – River Lune monthly rod catch of sea trout 1951 to 2018

The rates of catch and release for sea trout from the rod fishery are presented in figure 3.6 below.

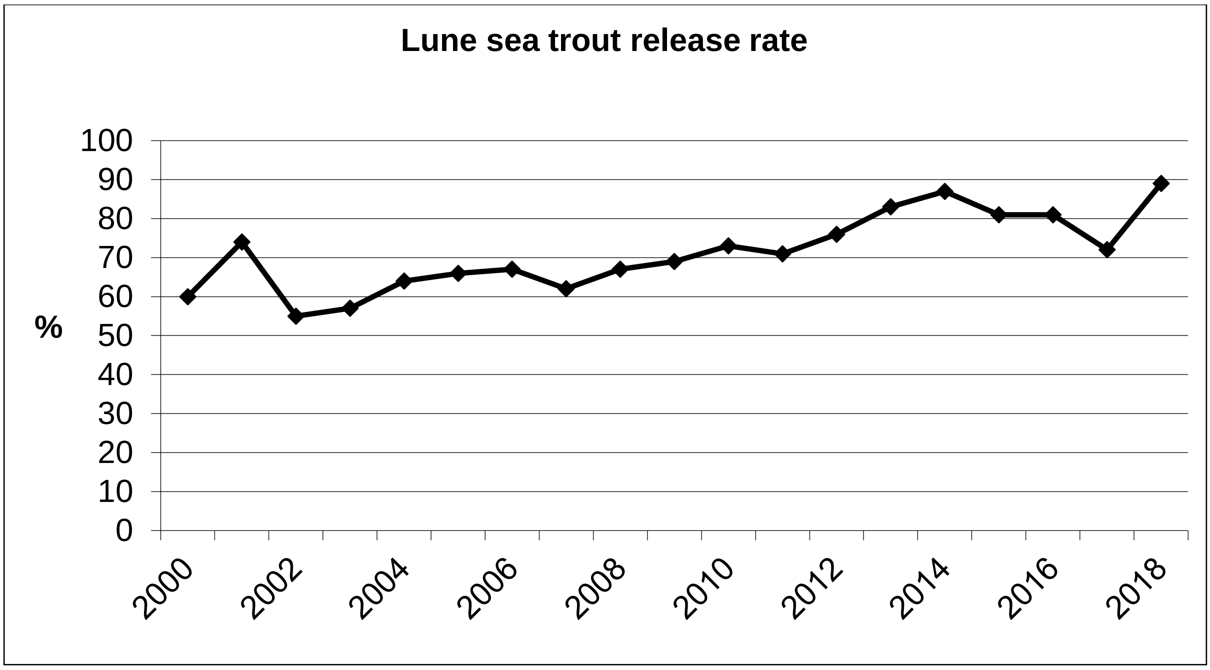


Figure 3.6 – River Lune annual catch and release rate for sea trout 2000 to 2018.

The proportion of the sea trout rod catch that is released alive has increased from around 60% twenty years ago to in excess of 80% in recent years.

The distribution of the sea trout catch amongst rod anglers is presented in figure 3.7 below.

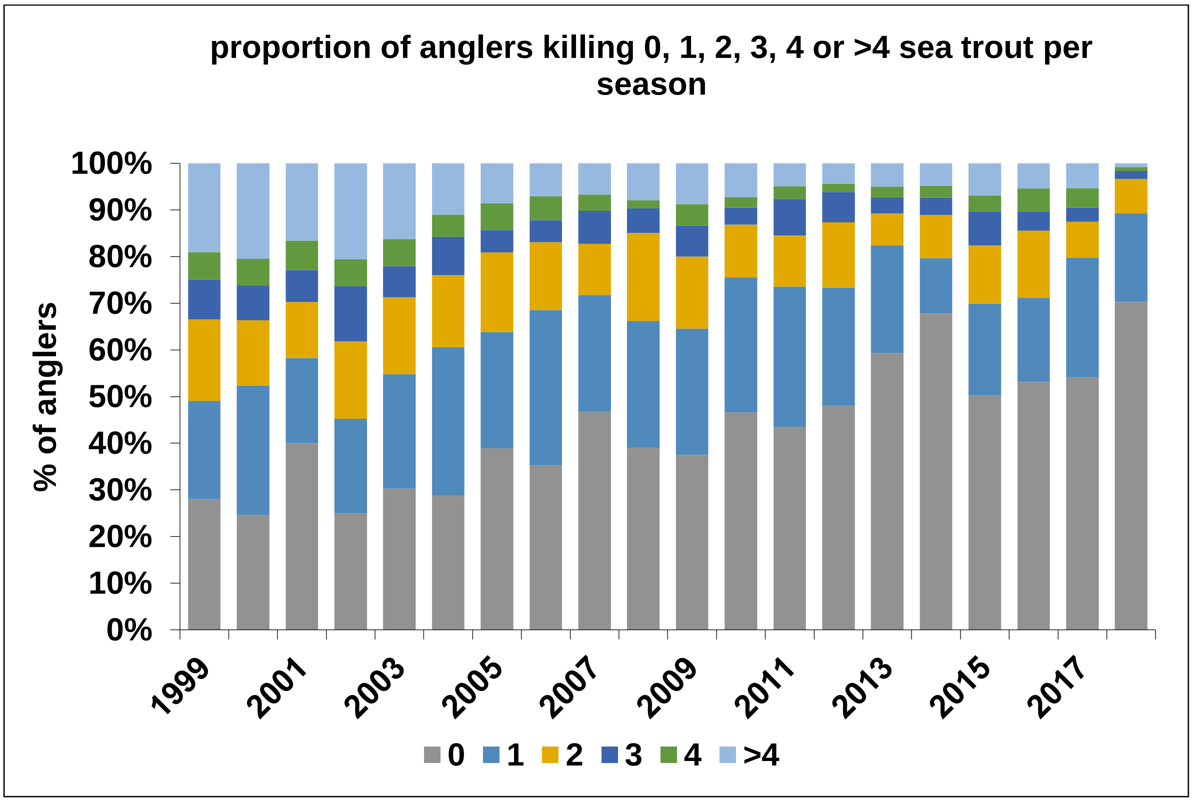


Figure 3.7 – Percentage of Lune anglers killing 0, 1, 2, 3, 4 and more than 4 sea trout per season 1999 to 2018.

Over the period, the percentage of anglers who kill no sea trout has increased from 20 to 30% initially, to in excess of 50% now. The percentage of anglers killing one or two sea trout per season has stayed broadly the same over the period at around 30 to 40%, but declining to slightly under 30% most recently (2018). The percentage of anglers killing more than 2 sea trout per season has declined most markedly from an initial 30%+ to 10% or less in 2017 and 2018. These changes illustrate the increasing voluntary uptake of catch and release principles through this period as no specific regulations have been introduced for the protection of sea trout through this time.

3.3 Fishing Mortality

Apportionment of recent sea trout fishing mortality is summarised in Table 3 below.

Year	Pre net stock[a]	Net Mortality		Rod kill		C&R Mortality (10%)		Total rod mortality		Total rod+net mortality	
		No.	%	No. [b]	%	No. [c]	%	No.	%	No.	%
2010	12101	753	6.2	304	2.5	80	0.7	384	3.2	1137	9.4
2011	6303	136	2.2	345	5.5	85	1.4	430	6.8	566	9.0
2012	7821	105	1.3	297	3.8	95	1.2	392	5.0	497	6.4
2013	8607	213	2.5	268	3.1	135	1.6	403	4.7	616	7.2
2014	13610	174	1.3	289	2.1	195	1.4	484	3.6	658	4.8
2015	No counts available	272		377		163		540		812	
2016		217		310		130		440		657	
2017		58		226		58		284		342	
2018		179		62		48		110		289	

Table 3 – Approximate apportionment of sea trout fishing mortality by rods and nets 2010 to 2014.

[a] based on validated count at Forge weir (corrected for 85% sea trout counting efficiency) + declared kill by nets.
[b] corrected rod kill = declared rod kill x 1.1
[c] C&R rod mortality assumed to be 10% of corrected rod release (declared rod release x 1.1). A mortality rate of 20% of released fish is commonly applied, as a more precautionary estimate. 10% is applied here given the high prevalence of less destructive fly fishing in the Lune rod fishery.

The rod fishery tends to account for a higher kill of sea trout than the net fishery. Over recent years the mortality of sea trout in the rod fishery, based on the direct kill of sea trout plus an estimated mortality of 10% of released sea trout, has ranged between 3 and 7% of the total sea trout run. Overall the total net and rod kill together represent an estimated 5 to 10% of the available stock over recent years when counter data has been available to provide the independent run size estimate. Since 2015, when counter data has not been available, total mortality (in 2015 and 2016) has continued at similar levels to previous, but has markedly declined in 2017 and 2018, suggesting likely lower total mortality if runs have remained similar to previous.

3.4 Counter Data

The number of sea trout counted at the EA Forge Weir fish counter from 2000 to 2014 is presented in figure 3.8 below. Up to 2010, the count ranged between 8,000 and 12,000 sea trout per year. Lower counts from 5,000 to 7,000 were recorded during 2011 to 2013, but numbers improved to in excess of 10,000 in 2014.

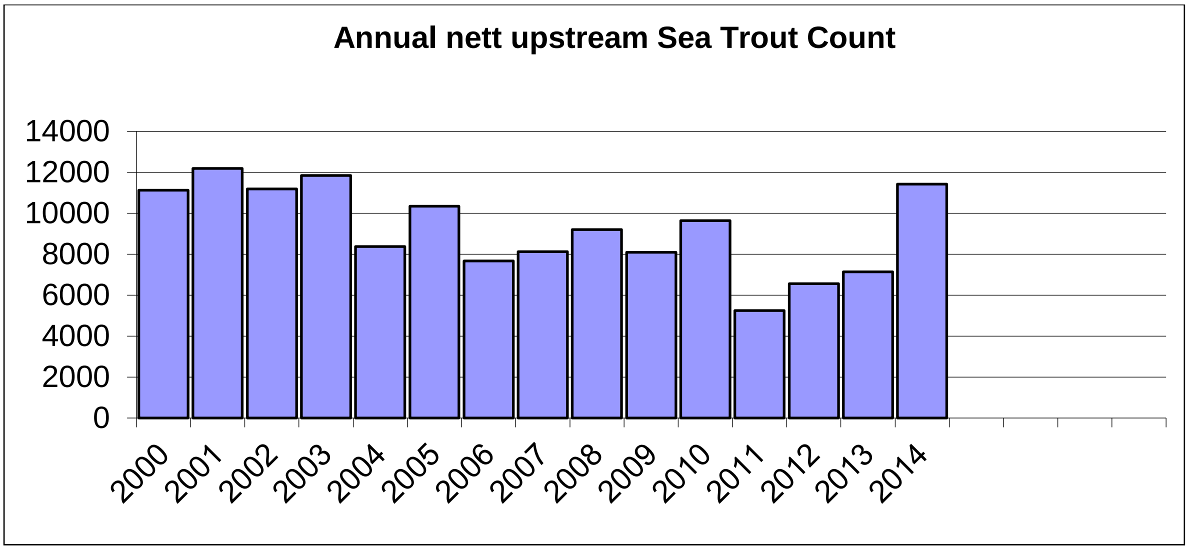
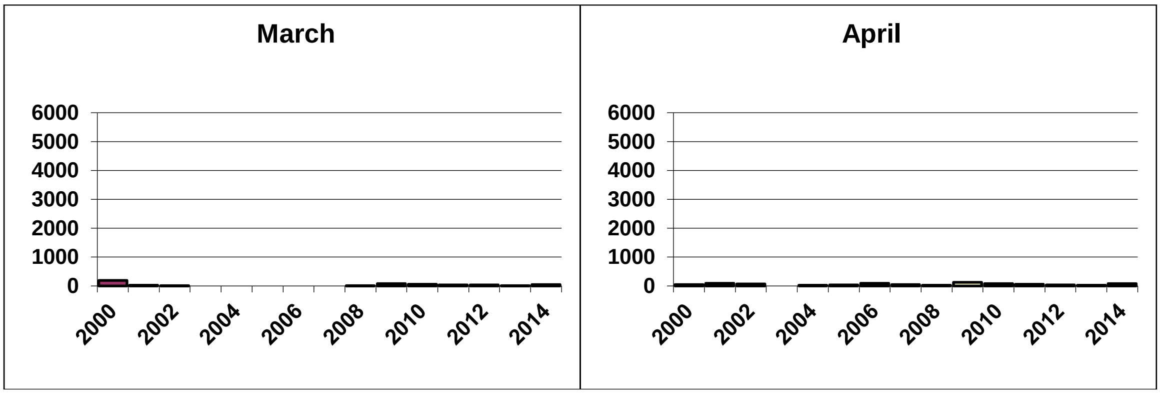


Figure 3.8 – Nett upstream migration of sea trout recorded at Forge Weir fish counter 2000 to 2014.

Monthly nett upstream counts of sea trout at the EA Forge Weir counter are presented in figure 3.9 below. Counts prior to May are very low each year, but quickly improve through May and peak during June and July. Numbers then decline quickly through August and are generally quite low through September and October, and very low during November and December. There is an indication that the May, June and July counts have all declined to a small extent since the early 2000's, although the July counts have perhaps become more variable, recording some of the lowest and highest counts for that month in the later years.



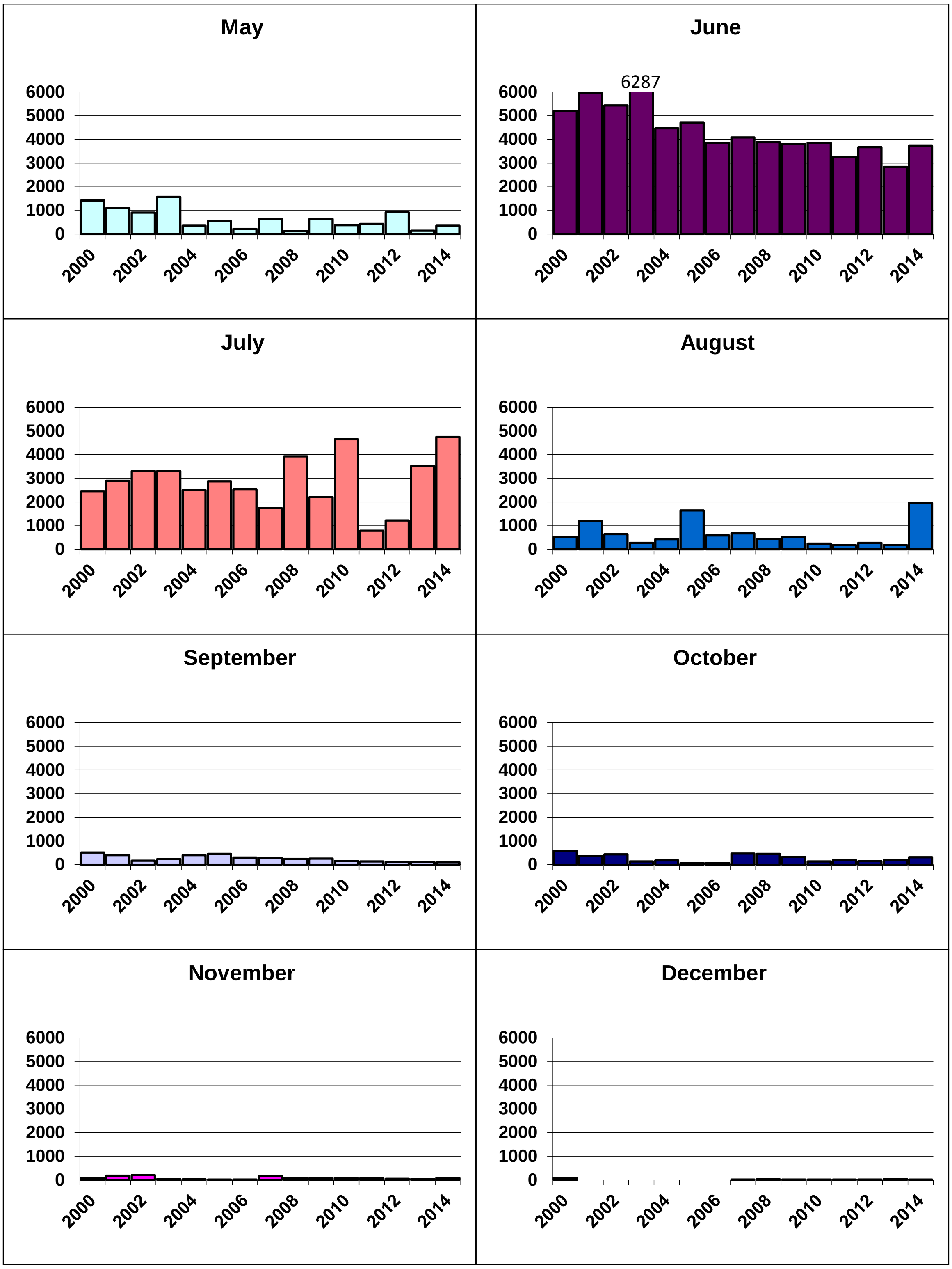


Figure 3.9 – Monthly nett upstream migration of sea trout recorded at Forge Weir fish counter 2000 to 2014.

3.5 Juvenile Monitoring Data

Juvenile trout abundance from several long-term monitored sites, with surveys dating back to 1981 are presented in Figure 3.10 below.

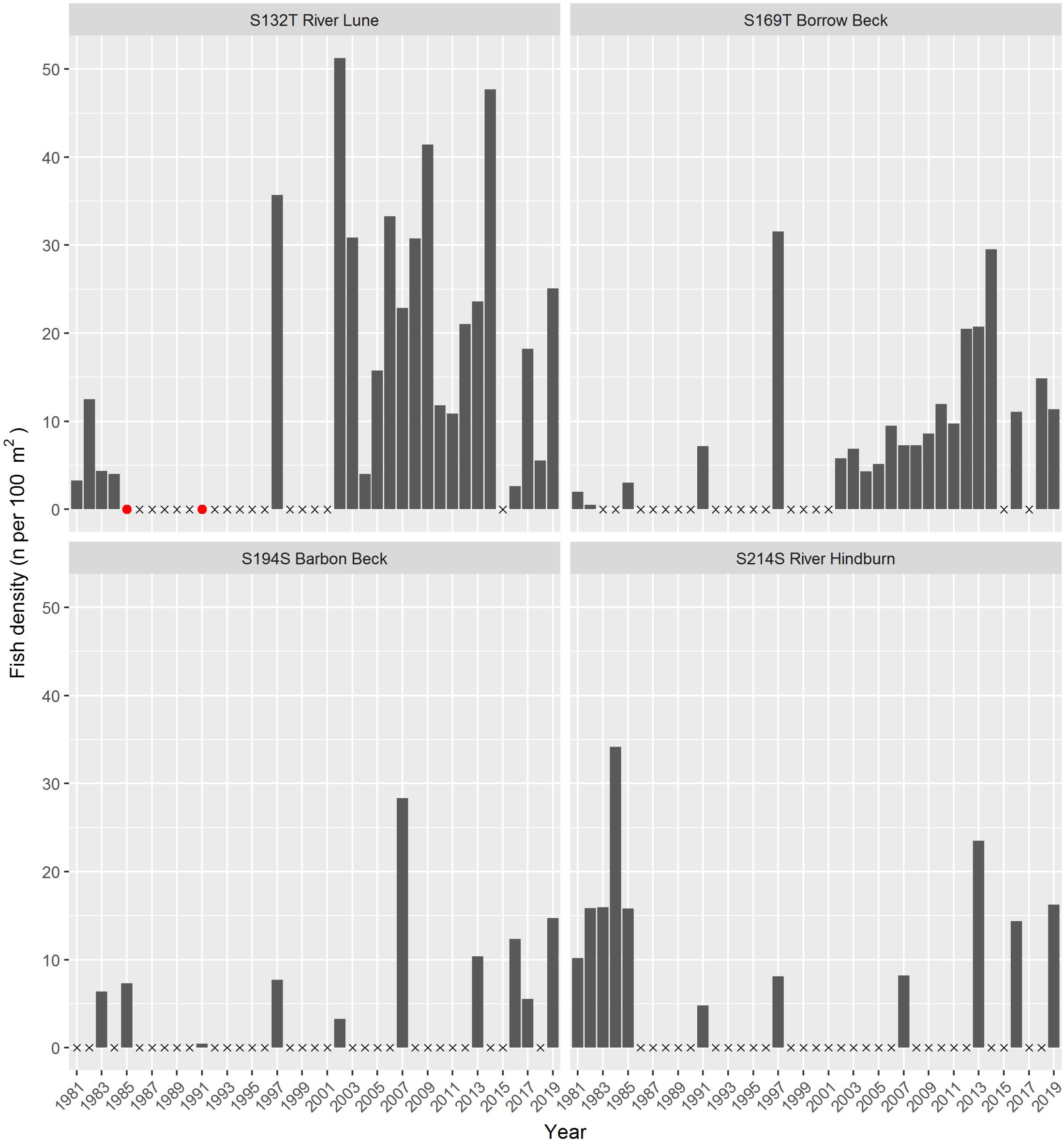


Figure 3.10 – The abundance of trout parr at long-term monitored sites across the Lune catchment. Crosses denote no survey undertaken, red dots denote absence of the age class.

In contrast to salmon parr abundance at these same sites (Figure 2.13, page 23), trout parr abundance has generally been good, and appears to have been improving to some extent, at least at the Borrow Beck and Barbon Beck sites. This reinforces the evidence that declining juvenile salmon abundance is most likely caused by lack of spawning adults rather than any immediate environmental quality issues.

Sites monitored in less frequent spatial surveys, provide a more general picture of changes in juvenile trout abundance, as depicted in the graphs below (figure 3.11).

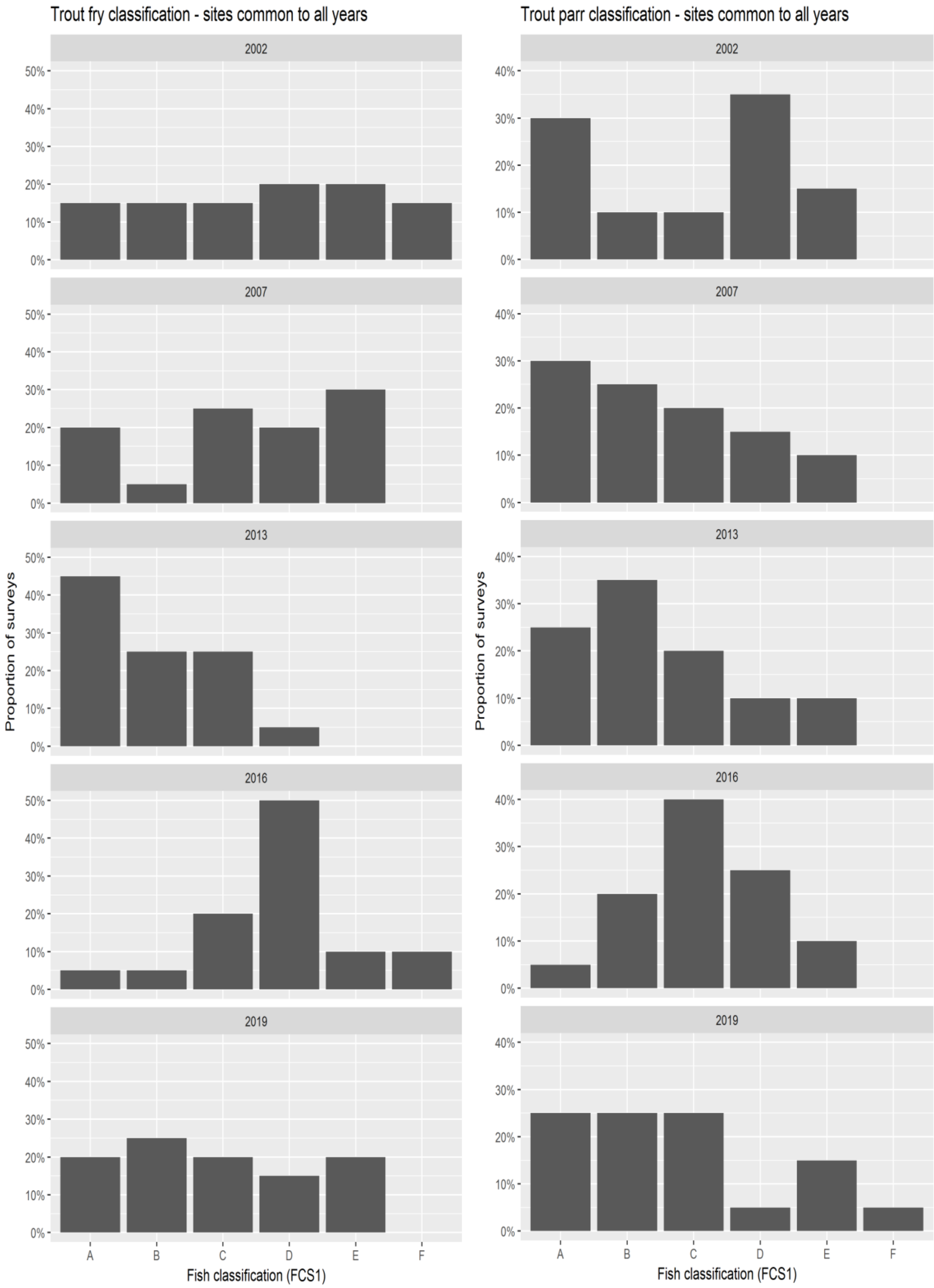


Figure 3.11 - The proportion of River Lune sites surveyed, achieving respective NFCS grades for trout fry (left) and trout parr (right) in 2002, 2007, 2013, 2016 and 2019 surveys.

The distribution of trout fry grades has been variable, but clearly improved towards more of the higher grades from 2002 to 2013. The 2016 survey was dominated by mid to low C and D grades, possibly reflecting, as was the case with salmon grades (Fig 2.14, page 26), an impact of the extensive flooding associated with named storms Desmond, Eva and Frank in December 2015. The 2019 survey showed an improvement in trout fry grades with more, higher grades again recorded. The distribution of trout parr grades has been a little more consistent than trout fry grades, with the higher A, B and C grades tending to dominate. The possible December 2015 flooding effect seems to have reduced the spread of trout parr grades, with the mid-range grade C dominating and grade A’s at their lowest recorded level in the 2016 survey. And most recently, the 2019 survey has seen an improvement in the number of higher A and B grades for trout, in contrast to the sustained poor performance of salmon parr (Fig 2.14, page 26).

4. Fisheries Management Options

4.1 Salmon

As identified in Section 3.5 above, the Lune salmon stock is classified as “At risk” of failing the management objective of exceeding the conservation limit in at least four years out of five, based on the 2018 stock assessment, and is also predicted to remain in that category in five years-time. As such, our Decision Structure guides us to **“Identify a range of options to urgently achieve zero exploitation by both rods and nets (including 100% catch and release), looking to maintain socio-economic benefits where possible”**. The combined kill of salmon by both the rod and net fisheries should therefore be reduced from present levels in order to help to improve the status of the stock in the short term. National byelaws implemented for the 2019 season have already prevented any kill of salmon from net fisheries including the Lune for the next ten years. Future options to reduce the current level of kill by the rod fishery are considered below.

Salmon Option 1 – No change – maintain current fishing restrictions for rod fisheries
Given:

- the current and predicted “At risk” status of the Lune salmon population,
- <u>and</u> the prevailing strong downward trend in abundance,
- <u>and</u> the apparent recent reduction in juvenile salmon numbers;

then, simply maintaining the current rod fishing restrictions for another ten year period does not meet our own Decision Structure guidance and is therefore not considered any further as a viable option. Nets are already currently prevented from killing salmon through national time limited byelaw that expires in 2028.

Salmon Option 2 – Reduce killing of salmon by rod fishery
The rod fishery has been restricted by a 4 salmon per angler per season, time-limited byelaw that expired after the end of the 2019 fishing season. This is additional to the national spring salmon byelaws that prevent the killing of any salmon prior to 16th June, and the North West Regional annual close time byelaw that prevents angling from 1st November to 31st January following.

Four main options to reduce rod exploitation are considered here:

- <u>Extending the annual mandatory catch and release period for rods.</u>
  The potential reduction in numbers of salmon killed by extending the current mandatory catch and release period, are very modest. For example in the 2018 season when fishing was voluntarily curtailed due to the early summer drought conditions, and the total salmon run appeared to be low, the number of salmon declared killed by month were; 1, 0, 12, 7, and 9 for June to October respectively.
- <u>Reduce the season bag limit for rods.</u>
  Over the last five years, a total of 2891 catch returns were received from anglers fishing the Lune and only two of those catch returns recorded as many as 4 salmon (each) in a season, both recording these catches in 2016. The previous 4 salmon per angler per season byelaw was therefore largely irrelevant in recent years, because so few anglers are actually catching that number of salmon in recent seasons. (Figure 2.10, page 19).
  A potential reduced bag limit of 1 salmon per angler per season would deliver only very modest savings. For example, such a bag limit would have saved just 5 salmon

in 2018, when 4 anglers killed more than 1 salmon each (3 anglers killed 2 salmon, and 1 angler killed 3 salmon).

- Fishing method restrictions for rods.
  Possible method restrictions for rod and line fishing would be aimed at improving the survival of released salmon, more-so for the more damaging fishing methods of spinning and bait fishing. Given the current prevalence of different fishing methods currently used on the Lune, such restrictions would again deliver only modest improvements in catch and release survival, with 65% of the salmon catch taken by fly fishing – the least damaging method, with high survival rates, 30% taken by spinner, and 5% taken on bait. (Figure 2.7, page 16). Given a prevailing estimated catch and release mortality in 2018 of 20 salmon, possible restrictions on bait and/or spinning would potentially have resulted in perhaps 3 to 5 more salmon surviving the rod fishery to spawn.
- Voluntary reduction in number of salmon killed by rods.
  Voluntary restrictions are typically more acceptable to anglers than mandatory restrictions. Currently, voluntary restraint is already more effective than the 4 salmon per angler per season byelaw that had been in place until recently (although the reducing stock of salmon means anglers now rarely catch at this level), and approximately 75% of anglers killed nothing in 2018 (Figure 2.10, page 19). Of the salmon currently killed (in 2018) by the rod fishery, almost 70% are accounted for by individual anglers who only kill one salmon each – 20 anglers killed 1 salmon each, 3 anglers killed 2 each, and 1 angler killed 3. Local and national angling representative organisations have strongly promoted increasing voluntary rates of catch and release, particularly since national byelaws were proposed in 2016. Further voluntary restrictions may not be sufficiently protective for this failing salmon stock.

There is no obvious single management option identified here to markedly reduce the kill of salmon by the rod fishery, to help towards recovering the Lune salmon stock. Even a combination of two or more of the above measures would still deliver only a partial, small improvement in the number of adult salmon escaping the fishery to spawn.

Salmon Option 3 – Prevent killing of salmon by rod fishery

Importantly, with the salmon stock level so low, it is likely that the continued lawful killing of salmon in the rod fishery, even at the current relatively low rate, would not readily accommodate any marked improvement in the number of spawning adults and subsequent juvenile stock. Given the particularly poor juvenile survey results in 2019, for both fry and parr age classes, it is clear that every spawning adult is important in producing as good a future juvenile population as possible, therefore maximising the production of smolts. Applying a byelaw for the mandatory release of all salmon caught by the rod fishery would therefore provide the greatest level of protection for the Lune salmon stock at the current time, thereby maximising the number of adult salmon surviving the fisheries to spawn and boost the subsequent juvenile stock. (Table 2, page 19) Current levels of reported kill range from roughly 30 to 130 salmon in recent seasons, while levels of catch and release mortality range from 20 to 40 salmon per season, assuming that the high prevalence of less-damaging fly fishing continues and relatively good catch and release practice is widely adopted for all fishing methods.

Salmon Preferred Option

New mandatory catch and release byelaw for all salmon caught by the rod fishery and no change to the national byelaws (Dec 2018) that currently stop the killing of salmon in the net fishery.

4.2 Sea Trout

The Lune sea trout fishery is classified as “Probably Not At Risk” at present (2018 assessment), based on a simplistic assessment of the performance of the rod fishery. While measures are necessary to protect salmon stocks, it is important that the exploitation of sea trout by rods and nets does not increase to a level that might begin to impact that stock and potentially cause it to decline into a Probably At Risk or At Risk category.

Sea Trout Option 1 – No change – maintain current fishing restrictions for rod and net fisheries.

A high level of voluntary catch and release prevails in the rod fishery (Fig 3.6, page 36) and should be maintained, as should the low catch in the net fishery (Fig 3.2, page 32). The haaf net fishery can now only kill sea trout, and is prevented from fishing prior to 1st June. Prior to the season restrictions that commenced in 1999, 26 licenced haaf nets caught 25, 24 and 12 sea trout prior to 1st June in the 1998, 1997 and 1996 seasons respectively, accounting for up to 7% of the total haaf net sea trout catch. Although only small numbers of sea trout were caught prior to 1st June, the earlier running sea trout tend to be the larger repeat spawning specimens that can contribute a disproportionate amount of trout egg production. As such we would not be prepared to consider advancing the opening of the haaf net fishing season for sea trout to allow any increased exploitation of these earlier running larger fish. A catch limit of 6 sea trout per angler per season has been suggested by rod fisheries representatives, to be implemented as a byelaw, but very few anglers currently catch this number of sea trout in a season (Fig 3.7, page 36).

Sea Trout Option 2 – Cap or Reduce exploitation by rods and nets

The status of the sea trout fishery does not immediately warrant a mandatory reduction in exploitation. However, maintaining the existing high level of voluntary catch and release angling and the current low level of net exploitation are both essential.

Sea Trout Option 3 – Zero kill of sea trout – close net fishery and apply mandatory catch and release to the rod fishery.

Closure of the net fishery to protect sea trout is not warranted at the present time. Equally, the application of mandatory catch and release to the rod fishery for sea trout is not warranted at present.

Sea Trout Preferred Option

There is no pressing need for any exploitation restrictions for sea trout at the present time. The preferred option for sea trout at present is maintaining the status quo, with no specific mandatory restrictions necessary, but a continuation of the current voluntary restraint in killing sea trout is expected.

5. Benefits and Impacts

Our primary objective for the management of salmon fisheries is **to ensure the conservation or restoration of the salmon stock**. When new fisheries management measures are considered, socio-economic factors may be taken into account to influence the nature and balance of regulations affecting different stakeholder groups and the rate of stock recovery that is planned.
Consideration is also given to:

- *whether a proposed measure will have an unreasonable effect on someone's livelihood (e.g. net fishing) or the value of their property (e.g. fishing rights); this may mean that it is necessary to reduce the benefit of a conservation measure, for example by planning the recovery of the stock over a longer period;*
- *whether one group of stakeholders will be unreasonably affected relative to another; where reductions in exploitation are required, the effects on netsmen and anglers should be equitable;*
- *the effect of controls on the viability of commercial and recreational fisheries; for example, catch and release controls will generally have a greater economic effect on commercial than recreational fisheries;*
- *the heritage value of the fishery; where fishing methods are unique to a very small number of locations, consideration is given to retaining a residual fishery and/or permitting a low level of catch.*

5.1 Benefit of proposed mandatory catch and release byelaw

The Lune salmon stock is currently classed as At Risk of failing it's conservation limit more than once in a five year period (2018 assessment). The total salmon fishing mortality by both rods and nets ranged from 8 to 12% of the estimated stock from 2010 to 2014. Fishing mortality in the net fishery has been zero since the 2019 season and mortality in the rod fishery was 3% in 2014 and has probably not exceeded that level substantially since 2014.

The 2018 stock assessment of 6.6 million eggs, against the Conservation Limit of 10 million eggs, represents a deficit of 3.4 million eggs (Fig 2.16, page 29). At an average fecundity of 5600 eggs per female this equates to a deficit of roughly 600 adult female salmon in 2018.

The 2018 National byelaws that prevent the killing of salmon by the net fisheries will have saved roughly 250 salmon in 2019, based on the preceding 5-year (2014-2018) average catch by the Lune nets.
In the last 5 years (2014-2018) the corrected declared kill of salmon by the rod fishery has ranged from 32 to 130 salmon per year, averaging over 90 salmon per year. Mandatory catch and release would save approximately ninety percent of these catches, given an estimated level of 10% mortality associated with catch and release.

The fisheries themselves are not likely to be the cause of the current poor performance of stocks, and the prevention of killing of salmon will not, on its own, be sufficient to make up the current deficit in the number of spawning adults. However, allowing salmon to continue to be lawfully killed by the operating fisheries will at best, delay, or at worst, prevent the recovery of the stock.

5.2 Minimum Nett Economic Value of the Lune salmon fisheries

The following calculation attempts to calculate **Nett Economic Value** of a salmon fishery to the country and is defined by summing the following components:

- Value to fishery owners (calculated by estimating the market value of fishing rights).
- Value to salmon anglers (calculated by estimating the consumers' [anglers'] surplus).
- Value to net licencees (calculated by estimating nett profits from catch sales)

5.2.1 Market value of the fishing rights

The market value of fishing rights is defined as the present value of the capitalised future nett benefits to the owners of the fishery. The market value of a salmon fishery is a function of both the average annual rod catch and the value of each salmon caught within the fishery. In order to eliminate as much yearly variation as possible from the rod catch data, it would be appropriate to use a five-year average of recent rod catches. To compensate for the 30 to 40% of anglers that still fail to make a catch return, the average annual declared catch has been multiplied by a correction factor of 1.1 (Small, 1998) to obtain an estimate of the total catch. This correction factor reflects the fact that 60% of anglers report 90% of the catch. Radford *et al* (1991) performed a national survey in 1988 to establish the mean value of a salmon in various regions on England and Wales. These were revised by Radford *et al* (2001), taking into account inflation within the intervening period, this study valued rod caught salmon in the North West in 2001 to be worth £8,000 per fish caught. Those 2001 values have been scaled up to a current day (2019) value of £13,300 (based on Bank of England inflation calculator).

5.2.2 Anglers' Consumers Surplus.

This term describes a means by which an economic valuation can be put upon the value of the fishery to anglers. It can be defined as the difference between what anglers would be willing to pay for their fishing and what they actually pay. The final total for a given river represents the sum of the surpluses for all of the individual anglers who fish the river. There has only been one study to calculate the capitalised anglers' consumers' surplus of salmon anglers (Radford, 1984). The techniques utilised in the assessment are complex. To simplify this, Radford (1984) attempted to make a comparison between the market value of the fishing rights and the capitalised anglers' surplus for four salmon rivers throughout England and Wales. The resulting ratios obtained from this study varied widely. To ensure consistency on a national basis, the lowest ratio obtained (1:1) has been used as the basis for a conservative estimate of the capitalised anglers' consumers' surplus. In conclusion, for the purposes of this report, the capitalised anglers' consumers' surplus is taken to be equivalent to the estimated market value of the fishing rights **(Table 5.1)**.

Mean declared Annual rod catch 2014-2018	Mean total Annual rod catch	Mean Regional value per salmon (2019)	Market (capital) value to rod fishery	Angler's consumers Surplus
343	378	£13,300	£5.03million	£5.03million

Table 5.1 – Capital value of rod fishery and Angler's Consumers Surplus (2019)

5.2.3 Netsmens Nett Profit

Importantly, the national byelaws introduced in December 2018 prevent all taking and killing of salmon by the net fishery in the Lune estuary from 2019 onwards, therefore the nett profit as of 2019, based on salmon catches in the net fishery is now zero. Based on previous levels of catch up to 2018 season, the capitalised nett profit of salmon fishing to the nets was in the region of mid-tens of thousands of pounds.

The current minimum nett economic value for the River Lune salmon fisheries can be calculated by summing the three components described above. The summary of the calculation is provided in Table 5.2 below.

Fishery component	**Value (£K)**
Fishery owners	5,030
Salmon anglers	5,030
Netsmen	0
Minimum Nett Economic Value (2019)	**10,060**

Table 5.2 – Minimum nett economic value of River Lune salmon fisheries (2019)

5.3 Angler and Netsmen Behaviour

The National byelaws introduced in December 2018 prevented the killing of salmon in the Lune estuary net fisheries. The impact of those byelaws on the haaf and drift net fisheries was considered at that time and compensation will be paid accordingly for the loss of income associated with those salmon fishing restrictions. **No further catch restrictions for the remaining haaf net fishery are proposed here, so there will be no further specific economic impact.**

The National byelaws introduced in December 2018 did not specifically restrict the Lune rod fisheries, because the Lune salmon stock was classified as Probably At Risk at that time (based on 2017 classification). However, the possible impact of a number of restrictive catch options were specifically examined through angler survey and reported in the accompanying socio-economic assessment for those byelaws and these were relevant to the Lune stock as it was classified then in 2017, and are also likely to still be broadly relevant to the current classification (At Risk in 2018) and regulations proposed herein.

For the 2017 nationally proposed option of applying mandatory catch and release to rivers in the At Risk category (Option 3), combined with seeking improved rates of voluntary catch and release for Probably at Risk and Probably Not at Risk rivers, a reduction in fishing effort of 22% was estimated for the North West based on consultation responses.

Angling effort expressed as the number of days fished by migratory salmonid rod licence holders on the Lune has already fallen by over 70% over the past 20 years from ~12,500 days in 1999 to ~3,500 days in 2018. A similar trend is broadly observed in other salmon and sea trout areas in England and Wales. Notwithstanding this background decline in fishing effort, a potential 22% reduction in the 2018 level of fishing effort on the Lune could reduce the number of recorded fishing days to around 2,800. The potential reduction in effort does not necessarily equate to a similar reduction in catch, as a high proportion of the catch is usually accounted for by a small proportion of the anglers. On the Lune for the last 5 years, between 71 and 80% of the anglers have recorded no catch (average 75%, 2014-2018) and it is likely that the less successful anglers may be the first to leave the fishery. Nonetheless, a possible reduction in catch, in the order of 20 to 40 salmon (representing 10 to 20% of 2018 catches) would reduce the nett economic value of the salmon fishery by £500,000 to £1,000,000. To put such a reduction in catch into context, the total Lune rod catch of salmon has declined from almost 1000 salmon per year (5-yr average 1999-2003) to 343 salmon per year (5yr average 2014-2018).

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Appendix 1 Salmon management procedures/developments in England and Wales

Conservation Limits (CLs) and Management Targets (MTs)

Setting conservation limits

The use of CLs in England and Wales has developed in line with the requirement of ICES and NASCO to set criteria against which to give advice on stock status and the need to manage and conserve individual river stocks. CLs indicate the minimum desirable spawning stock levels below which stocks should not be allowed to fall. The CL is set at a stock size below which further reductions in spawner numbers are likely to result in significant reductions in the number of juvenile fish produced in the next generation.

Two relationships are required to derive the CLs:

(i) a **stock-recruitment curve** – defining, for the freshwater phase of the life cycle, the relationship between the number of eggs produced by spawning adults (stock) and the number of smolts resulting from those eggs (recruits).

(ii) a **replacement line –** converting the smolts emigrating from freshwater to surviving adults (or their egg equivalents) as they enter marine homewaters. This relationship requires an estimate of the survival rate at sea.

The model used to derive a stock-recruitment curve for each river assumes that juvenile production is at a 'pristine' level for that river type (i.e. is not affected by adverse water quality, degraded physical habitat, etc.).

Similarly, in deriving the replacement line, marine survival rates for most river stocks were assumed to be equivalent to the rates estimated on UK monitored rivers (such as the North Esk) in the 1960s and 1970s. Default survival values recommended for this purpose were 25% for 1SW salmon and 15% for MSW fish (Environment Agency, 1998). However, that period is thought to be one of high sea survival, and new default values of 11% for 1SW salmon and 5% for MSW fish, which are more representative of sea survival over the last 20-30 years, were introduced by the Environment Agency in April 2003 (Environment Agency, 2003b).

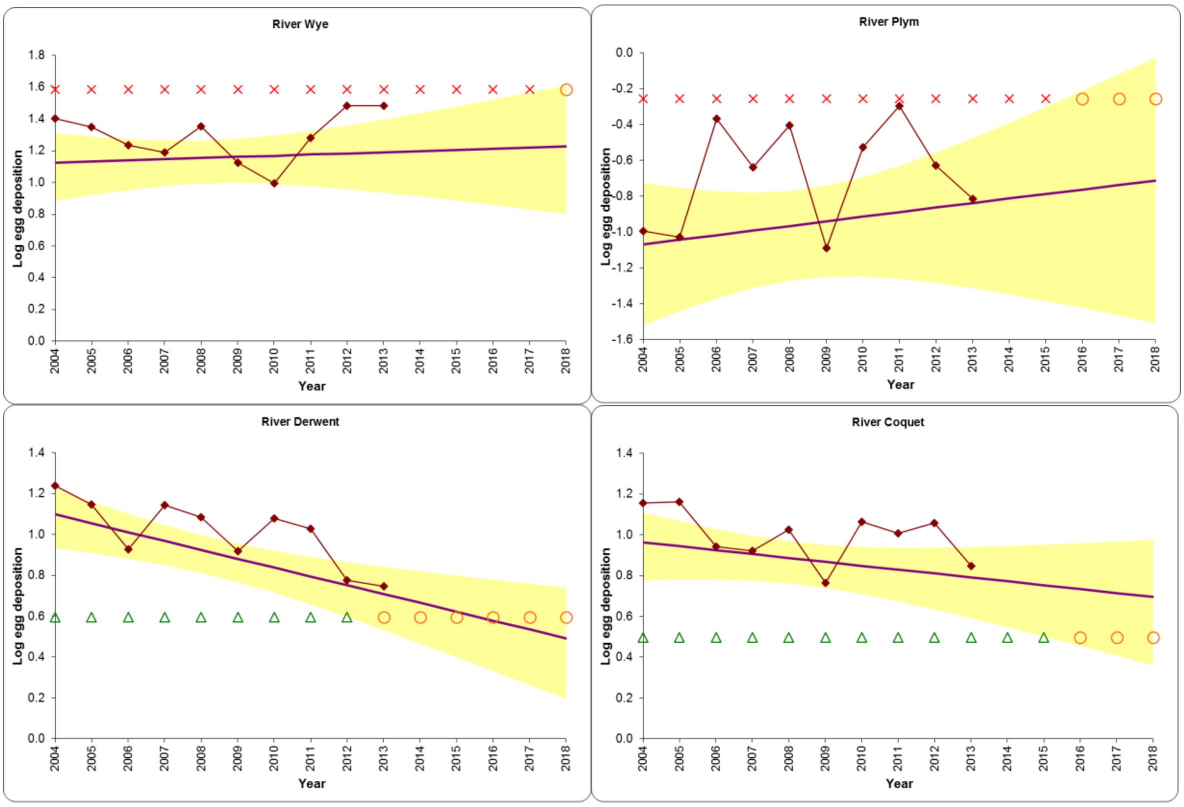
These rates have now been applied in calculating CLs for all the 64 principal salmon rivers. Since 2003, the CLs for all principal salmon rivers for which egg deposition estimates are assessed annually have incorporated the new lower marine survival estimates. The net effect of these changes was to reduce the CLs: the scale varied from river to river, but resulted in a 26% reduction, on average, in England and Wales from values used prior to 2003.

Introducing marine survival rates which are intended to be closer to those currently experienced by UK salmon stocks will reduce the effect of high mortality at sea as a cause of failing CLs. This will help managers focus on other issues over which they have more control (e.g. poor environmental quality in-river, over-exploitation by net and rod fisheries, etc.) when compliance failure occurs. The reduction in CLs means, however, that lower levels of spawning escapement are accepted before the stock is considered to be threatened. The Environment Agency also uses the 'management objective' for each river (e.g. in reviewing management actions and regulations) that the stock should be meeting or exceeding its CL in at least four years out of five (i.e. at least 80% of the time). This management objective is built into statistical procedures for assessing compliance with CLs (below).

Compliance assessment

The performance of salmon stocks in England and Wales is assessed using a compliance scheme designed to give an early warning that a river has fallen below its CL. An approach introduced in 2004 provides a way of summarising the performance of a river's salmon stock over the last 10 years (including the current year), in relation to its CL. Bayesian regression analyses are applied to egg deposition estimates from the last 10 years, on the assumption that there might be an underlying linear trend over the period. The method fits a 20-percentile regression line to the data and calculates the probability that this regression line is above the CL, and thus that the CL will be exceeded four years out of five (the management objective). If there is a low probability (<5%) that the 20-percentile regression line is above the CL, the river fails to comply (i.e. is regarded 'at risk'). If the probability is high (>95%), the river complies in that year (i.e. is 'not at risk'), whereas between these probability values we cannot be certain of the stock status (the river is assessed as either 'probably at risk' (5%< p <50%) or 'probably not at risk' (50%≤ p <95%). The results are in broad agreement with the compliance scheme used prior to 2004. The current scheme also allows the 20-percentile regression line to be extrapolated beyond the current year in order to project the likely future performance of the stock relative to its CL, and so assess the likely effect of recent management intervention and the need for additional measures.

The compliance plots for the Rivers Wye, Plym, Derwent and Coquet for the years 2004-2013 are shown below as examples. These include individual egg deposition estimates (black dots on the graphs) for these years, the 20 percentile regression lines and (shaded) 90% Bayesian Credible Intervals (BCIs), and the CL lines (represented by up to three symbols: X, O and Δ).



When the upper bound (95 percentile) of the regression line BCI is below the CL line, the river is judged to be failing its CL (i.e. there is a ≥95% probability of failure or the river is 'at risk'). For example, this is the case on the Wye from 2004 to 2017 and on the Plym from 2004 to 2015 and is indicated by the X symbol on the CL line. When the lower bound (5 percentile) of the regression line BCI is above the CL line the river is judged to be passing its CL (i.e. there is a ≤5% probability of failure and the river is 'not at risk'). This is the case on the Derwent from 2004 to 2011 and the Coquet from 2004 to 2014 and is indicated by the Δ symbol on the CL line. For all other years on these rivers, the shaded BCI of the regression line overlaps the CL line and so the status of the river is judged as 'uncertain' (i.e. the probability of failure is >5% but <95%, and the river is either 'probably at risk' or 'probably not at risk'). This is the case on the Derwent from 2012, the Coquet from 2015, the Wye from 2018 and on the Plym from 2016 and is indicated by the O symbol on the CL line.

Egg deposition estimates for a river may be consistently above the CL but status may still be uncertain. This is the case on the Coquet from 2015 and the Derwent from 2012 (O symbol on the CL line). In part, this reflects the marked year-to-year variation in egg deposition estimates on these rivers, which produces broad BCIs around the regression lines, but also arises because of the slope of the trend line and the increasing uncertainty associated with all regressions once extrapolated beyond the data set.

As well as providing an assessment of the status of a river in relation to its CL, the direction of the trend in the 10-year time-series of egg deposition estimates and its statistical significance may also serve as an important indicator of the need to take management action and of the degree of intervention required. Thus, a clear negative trend would give additional cause for concern.

The MT for each river is a spawning stock level for managers to aim at, to ensure that the objective of exceeding the CL is met four years out of five in the long run (i.e. 80% of the time). The value of the MT has been estimated using the standard deviation (SD) of egg deposition estimates for the last 10 years, where: MT = CL + 0.842*SD. The constant 0.842 is taken from probability tables for the standard normal distribution, such that the CL forms the 20-percentile of a distribution, the average (or 50-percentile) of which equates to the MT.

CLs and MTs form only one part of the assessment of the status of a stock, and management decisions are never based simply on a compliance result alone. Because stocks are naturally variable, the fact that a stock is currently exceeding its CL does not mean that there will be no need for any management action. Similarly, the fact that a stock may fall below its CL for a small proportion of the time may not mean there is a long-lasting problem. Thus, a range of other factors are taken into account, particularly the structure of the stock and any evidence concerning the status of particular stock components, such as tributary populations or age groups, based for example on patterns of run timing and the production of juveniles in the river sub-catchments. These data are provided by a programme of river catchment monitoring.

The assessment approach described above is incorporated into the national decision structure (see below) for guiding decisions on fishery regulations.

The Decision Structure for developing fishing controls in England and Wales

The compliance assessment approach described above for determining the performance of each salmon river is also incorporated into a national decision structure for guiding decisions on the need for fishery regulations. The 'Decision Structure' is applied annually to each salmon river in April following the annual stock assessments. Fishery managers for each river are then advised of these assessments and the outcome of applying the 'Decision

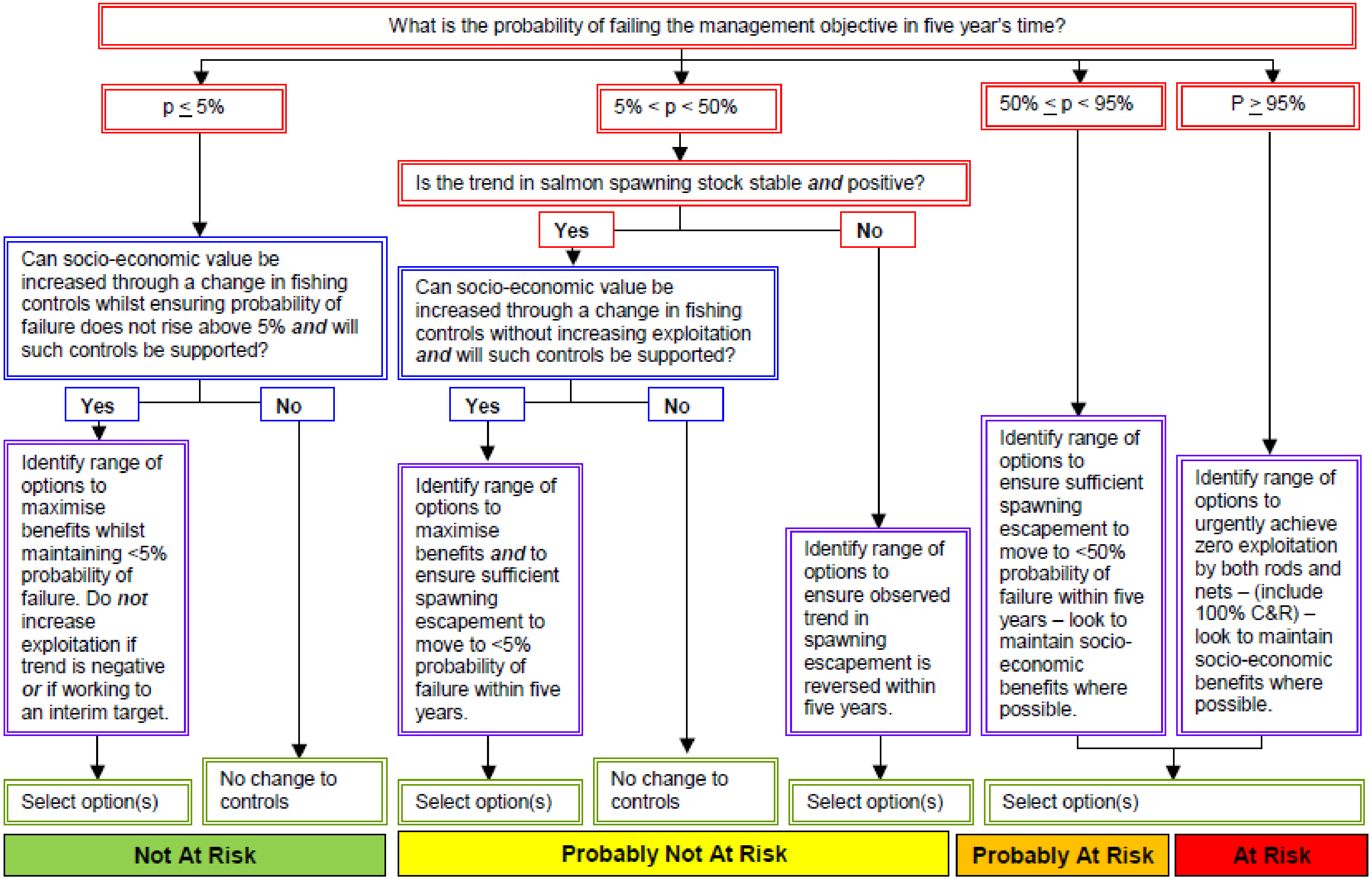
Structure'. They then decide what, if any, changes in regulation are appropriate as guided by the Decision Structure outputs. Recovering rivers that do not yet have CLs set are deemed to be 'at risk' and, under new measures approved in 2018, all such rivers in England will be subject to mandatory C&R from 2019. Similar provisions will apply in Wales if measures are approved.

In 1998, NASCO and its Parties agreed to apply a Precautionary Approach to the conservation, management and exploitation of salmon in order to protect the resource and preserve the environments in which it lives. In keeping with this, the assessment and management of salmon in England and Wales seeks to avoid the possibility of stocks reaching unfavourable levels. The Precautionary Approach requires that more caution is exercised when scientific information is uncertain. Where there are threats of serious or irreversible damage to stocks, uncertainty in scientific information should not be used as a reason for postponing or failing to take management and conservation measures.

The methodology for assessing salmon stocks, and the associated compliance scheme and decision structure, are currently under review to consider the need for possible improvements. The aim is to undertake this within the next three years with the likelihood that improvements will be introduced in stages as developments allow.

The 'Decision Structure' is shown in the schematic flow chart below, together with explanatory notes for its use.

The Decision Structure - Developing fishing controls for salmon fisheries in England and Wales



Notes to accompany Decision Structure

1. Initial stage – stock assessment (red boxes)

This is the assessment of the probability that the salmon river will be meeting its CL four years out of five (the management objective) in five years' time. The information to answer these questions comes from the annual assessment process outlined in Section 8, with the latest results available in the most recent annual assessment report.

2. Second stage – initial screening for potential options (blue boxes)

This stage screens options appropriate to those rivers that have a **<50% probability of failing the management objective** taking into consideration socio-economic concerns and stakeholder support. Management options that would not be supported by stakeholders can be ruled out. One of the possible options is to 'do nothing'.

For rivers where there is **>50% probability of failing the management objective**, all options must be carried through to the next (evaluation) stage.

3. Third stage – option evaluation (purple boxes)

The purpose of this stage is to set out and evaluate options to realise the required changes in exploitation.

For rivers where 50% ≤ p <95% (where p = probability of failing the management objective) **and the trend is down** and with an annual catch of >20 salmon and C&R rate <90%, then voluntary catch and release (C&R) will be promoted for 1 year. If this fails to significantly improve C&R rates, mandatory C&R or closure of the fishery will be considered. Protected rivers such as SACs (Special Areas of Conservation) are given particular emphasis.

For rivers where the above criteria apply, except that the annual mean salmon catch is <20 salmon, voluntary measures will be promoted.

For rivers where p>95% (i.e. the management objective is clearly being failed) and with an annual catch of >20 salmon and a C&R rate <90%, then voluntary C&R will be promoted for 1 year. If this fails to significantly improve C&R, mandatory C&R or closure of the fishery will be considered.

For rivers where p ≤ 95% for 5 consecutive years (i.e. the management objective is clearly being met), the possibility of relaxing controls including on nets will be considered if stakeholders agree.

Rivers that are recovering from historical degradation that do not yet have CLs set are deemed to have a >95% probability that they are failing unless there is better information available. Fishers on such rivers are encouraged to practice 100% C&R at the same time as regulators and partner organisations work on the necessary environmental improvements. If the potential for these rivers is greater than an average rod catch of 20 salmon, then mandatory C&R is considered throughout the season as an interim measure. However, controlled development of fisheries may be permitted on these rivers in parallel with the recovery of stocks.

4. Final stage – selection and implementation (green boxes)

The final stage of the Decision Structure is the selection and implementation of the appropriate regulatory action.