2020 Electro-fishing Surveys

A report to the West Sutherland Fisheries Trust, Report No. WSFT1/21

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Introduction

As part of West Sutherland Fisheries Trust's work programme, established sites in different freshwater catchments are routinely monitored through electro-fishing surveys, which are carried out in accordance with Scottish Fisheries Coordination Centre (SFCC) protocol. This provides valuable information on temporal changes within juvenile salmonid densities. This report summarises the data for each catchment surveyed and draws them together into an area-side summary. Individual reports for each catchment, giving maps and detailing the data graphically, are available on request.

Methodology

Electro-fishing equipment operates by creating an electrical field in the water which affects the muscles of the fish, causing them to swim towards the positive electrode (anode) and subsequently immobilises them for a brief period. At this point they can be captured for processing before being released unharmed into the river sections from which they were caught. As the electrical field is restricted in size and the conductivity of the water generally extremely low in most WSFT catchments, the best operating conditions are within shallow water in narrow tributaries. While it is possible to sample large main river stems, the escape rate is higher than that found in the narrower tributaries. Similarly, a high escape rate is found in exceptionally shallow, stony or weedy areas, where fish can move into the substrate and are thus inaccessible to the nets.

Semi quantitative surveys are conducted in compliance with SFCC protocol. This involves one fishing run of a site in order to calculate a minimum estimate of juvenile salmonid densities. Although semi-quantitative surveys do not calculate absolute densities, they are quicker, enabling more sites to be covered, and give an indication of changes over time. This results in a broad picture of the population status of each catchment which can then be compared from year to year.

Fish densities were assessed using an electracatch backpack supplying smooth direct current (DC). Fish drawn to the hand-held anode were netted into a bucket and were retained until the end of the run for processing. The sites were fished systematically in an upstream direction, applying the same fishing pressure throughout to ensure that all fish had the same probability of capture as far as possible, thus increasing the reliability and accuracy of the minimum estimates of density.

All fish were anaesthetised using MS222, identified to species and measured (± 1 mm). Small scale samples were taken from a proportion of each length range for age determination. The fish were then placed in a bucket before being returned to the survey site upon complete recovery. Densities of fish were calculated as minimum estimates, such that a minimum number of fish present per 100 m^2 could be determined. Water level was not used in the density estimates, although it must be realised that stream conditions will have an impact on the density determined and efficiency of the fishing technique.

Bankside and instream characteristics, including substrate type, water flow, and riparian cover, were recorded at each site in accordance with the SFCC habitat survey associated with electrofishing surveys.

Results

1. Hope catchment

Table 1.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 1.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 1.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
H1A	247700	957800	30	Allt a Mhuillin, upstream of road, round bend by large rocks
H2A	247400	956900	10	Braesgill burn, below road
H2B	247500	956900	15	Braesgill burn, above road and below sheep dip.
H4A	246300	947700	25	Tributary at shed by Ben Hope path.
H9A	242000	941500	120	Abhainn Strath Coir an Easaidh, above 2nd bridge
H9B	243600	941800	60	Abhainn Strath Coir an Easaidh, behind Lodge
H10A	243200	941500	100	Allt a Choire Ghrainde, below H9A, at 1st bridge
H12A	245200	942600	30	By passing place on road to Gober, above bridge

Table 1.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
H1A	7.6	35.21	0.00	2.84	5.68	8.52
H2A	8.7	38.28	18.29	10.45	15.67	7.84
H2B	9.3	40.30	54.59	9.93	7.44	2.48
H4A	14.1	55.46	12.62	7.21	18.03	5.41
H9A	8.0	74.93	0.00	0.00	8.01	4.00
H9B	9.9	82.17	21.91	7.30	3.65	2.43
H10A	11.0	71.50	0.00	0.00	6.99	2.80
H12A	4.8	52.96	1.89	5.66	9.44	0.00

Salmon and trout were present throughout the system, except for H9A and H10A, where salmon were absent. Salmon fry densities were greater than parr at all sites except H1A and H12A. Trout fry were greater than parr at all sites except H1A.

The minimum, maximum and mean densities are given for all sites (Table 1.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 1.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	54.59	13.66
Salmon parr	0.00	10.45	5.42
Trout fry	3.65	18.03	9.37
Trout parr	0.00	8.52	4.19

Figures 1.1 and 1.2 show temporal changes in juvenile salmonid densities per 100 m^2 by catchment average, separated by stage. Figure 1.1 shows a decrease in salmon fry since 2008, although the fry densities have recovered since the 2015 surveys. Salmon parr densities have dropped since 2015. Figure 1.2 shows that trout fry and parr densities have generally increased since surveys began, with the highest recorded trout fry densities during the 2017 surveys.

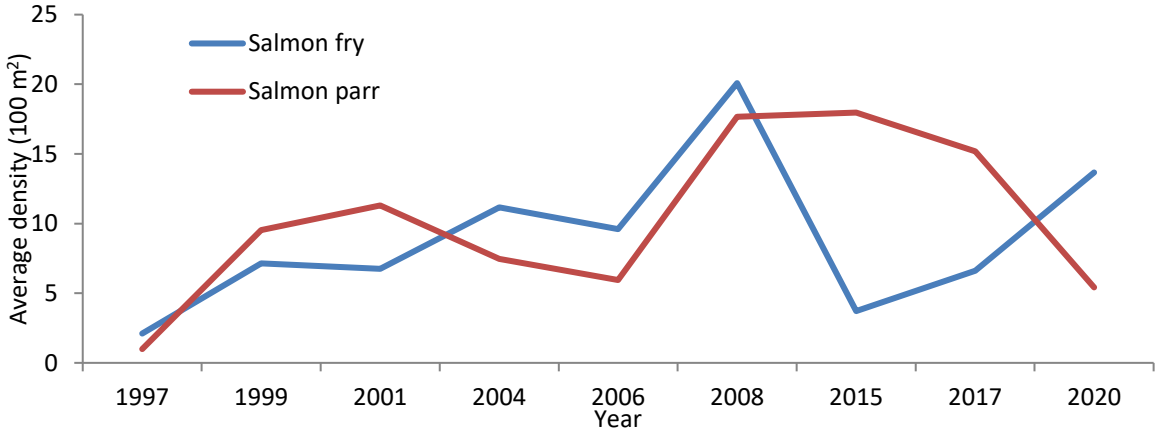

Figure 1.1: Temporal changes in average salmon densities within the Hope catchment

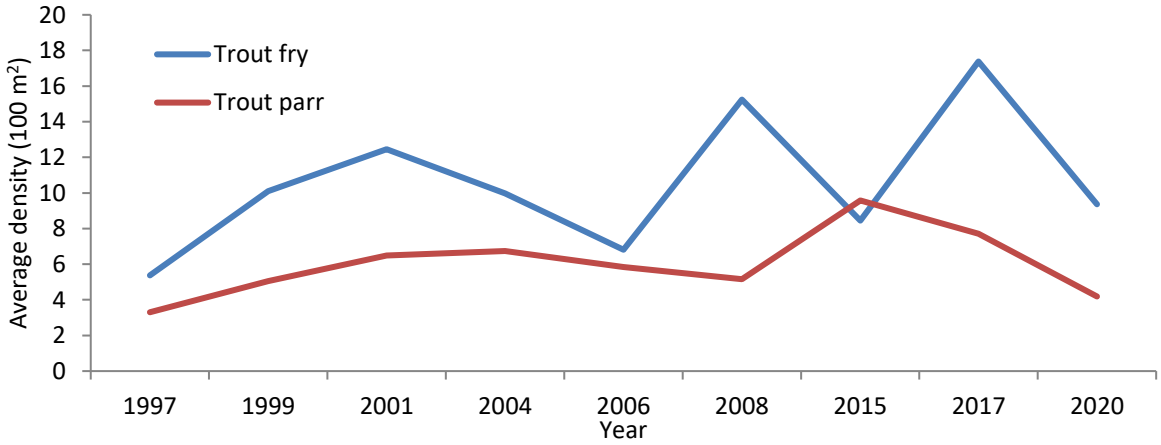

Figure 1.2: Temporal changes in average trout densities within the Hope catchment

Discussion

Salmon historically form a small component of the population at H9A and were absent in 1997 and 2003. However, there were no salmon seen in either 2017 or 2020, which would suggest that there may have been a change in the catchment, such that access is now fully blocked. An examination of this tributary to assess accessibility would therefore be advisable.

In 2014 Hurricane Bertha caused considerable changes to some of the tributaries along the east shore of Loch Hope. With respect to this survey, H2 and H4A were severely altered in terms of both sediment and riparian areas. In H2, while both sites have been impacted physically, H2A shows little impact in terms of fish densities in comparison to H2B, where salmon now appear to be more numerous. Within this burn, a greater physical change was observed in H2B, where the burn widened significantly, and the sediment became less stable. Continued monitoring of this burn is recommended, particularly while it remains unstable.

The relatively low salmonid densities in the upper catchment, when compared to the regional classification, are of some concern. This is likely to reflect habitat within and upstream of the Strathmore River. Strategic planting of mixed broadleaf trees within riparian zones would undoubtedly improve fish cover, food availability, and bankside stability and would prove beneficial to the fish populations. This has started in parts of the catchment, particularly around H9B, with slight increases in density apparent although it will take some time for the impacts to be fully felt.

2. Achriesgill catchment

Table 2.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 2.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 2.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
GL1	225700	954100	10	In main river, just above bridge
GL2	226600	953100	70	Down from water work, across from ruin
GL3	227100	953900	35	Down from double passing place, by boulder pile on bend of river
GL5	227700	954400	75	Upstream of burn and rowan tree

Table 2.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
GL1	7.8	61.88	8.08	0.00	4.85	3.23
GL2	11.9	80.92	0.00	0.00	3.71	19.77
GL3	9.8	46.71	0.00	0.00	14.99	6.42
GL5	7.7	44.66	0.00	0.00	2.24	4.48

Salmon were only present at GL1, with no parr found within the survey. Trout were present throughout the catchment, with parr being present in greater numbers than fry.

The maximum, minimum and mean densities are given for all sites (Table 2.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 2.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	8.08	2.02
Salmon parr	0.00	0.00	0.00
Trout fry	2.24	14.99	6.48
Trout parr	3.23	19.77	8.48

Temporal changes in juvenile salmonid densities per 100 m^2 by catchment average were calculated for both salmon and trout. This demonstrates that the salmon population showed a notable improvement in 2004, 2007 and 2008 before returning to levels seen between 1998 and 2002 (Fig. 2.1). From this, it would also appear to be relatively common to find no fry during the surveys. Trout,

in contrast, have shown fluctuating densities over time but are currently high compared to previous years (Fig. 2.2). Parr routinely dominate the survey, reflecting the habitat surveyed.

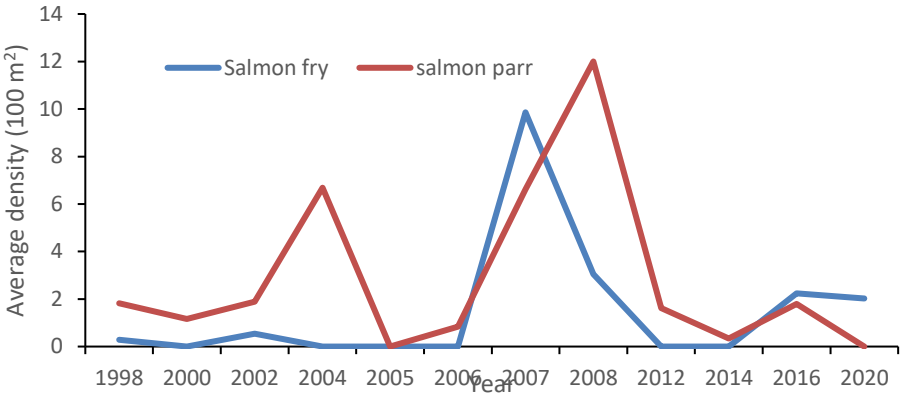

Figure 2.1: Temporal changes in average salmon densities

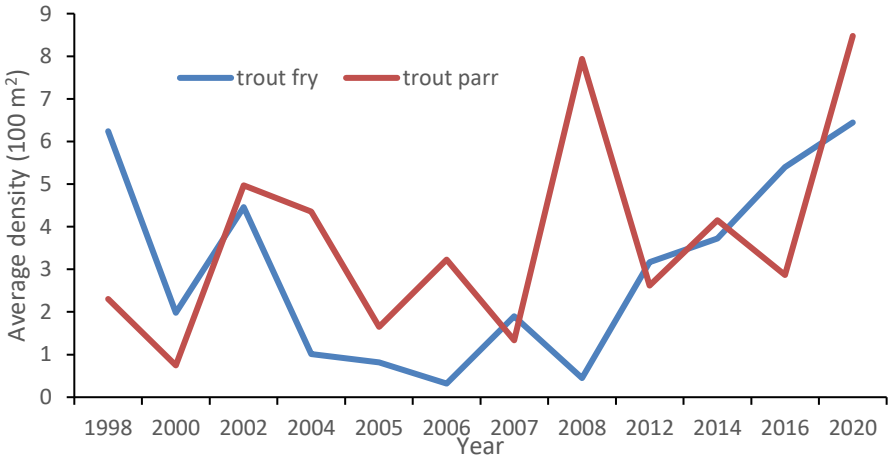

Figure 2.2: Temporal changes in average trout densities

Discussion

Salmon within the catchment would appear to be intermittent, with access to the upper reaches (GL2 – GL5) likely to be influenced by water flow. This is supported by the consistent population found at GL1. Habitat, both instream and riparian, at GL1 is poor, reflecting the low densities observed. The predominance of trout parr throughout the survey reflects the available habitat. Fry habitat is patchy within a catchment which is dominated by steep tributaries and 'step pool' sections. While GL3 has less boulders, and more suitable fry habitat, it is deeper than optimal.

The removal of the retaining dam for Generals Loch in 2004, after the survey, would not appear to have had a long-term impact on the salmon populations within the catchment. This is primarily a trout system, again reflecting access and habitat availability. The trout populations appear to be stable, with variations potentially reflecting changes in the river conditions and efficiency of the survey technique between years.

3. Oldshoremore catchment

Table 3.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 3.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 3.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
OM1	221800	958950	55	Near head of Loch Aisir Mor
OM2	222100	958700	65	Pool-riffle in gully, rise to the left bank
OM3	222800	958300	80	Before glide, at widest part of the channel
OM5	220784	958956	40	Below wall, near islands. Large white rock in centre. Island and riffle in centre of site (left to right)
WS_4502	221093	959261	50	Upstream of road bridge, below loch

Table 3.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
OM1	13.5	43.65	9.16	6.87	16.04	4.58
OM2	14.6	37.96	7.90	2.63	15.81	2.63
OM3	9.4	21.62	13.88	4.63	0.00	0.00
OM5	14.8	105.08	0.00	2.85	0.95	6.66
WS_4502	7.4	77.11	1.30	1.30	0.00	3.89

Salmon and trout were present throughout the system, except for OM3, where trout were absent. Parr densities were greater than fry at OM5 and WestSutherland_4502.

The maximum, minimum and mean densities are given for all sites (Table 3.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 3.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	13.88	6.45
Salmon parr	4.30	6.87	3.66
Trout fry	0.00	16.04	6.56
Trout parr	0.00	6.66	3.55

A look at the annual variations in salmon densities (Fig. 3.1) indicates that the 2020 densities are within the range previously observed. Trout densities are also average for the catchment (Fig. 3.2).

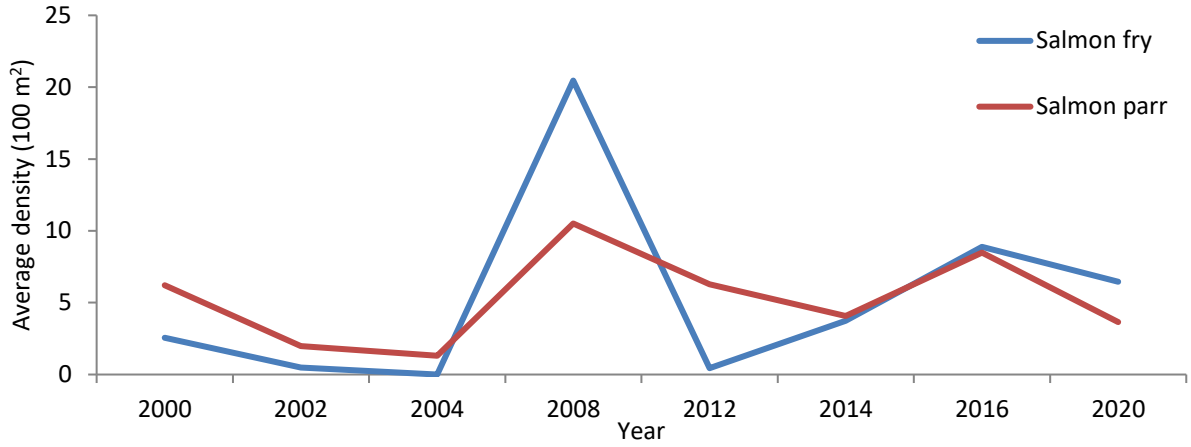

Figure 3.1: Temporal changes in average salmon densities within the catchment

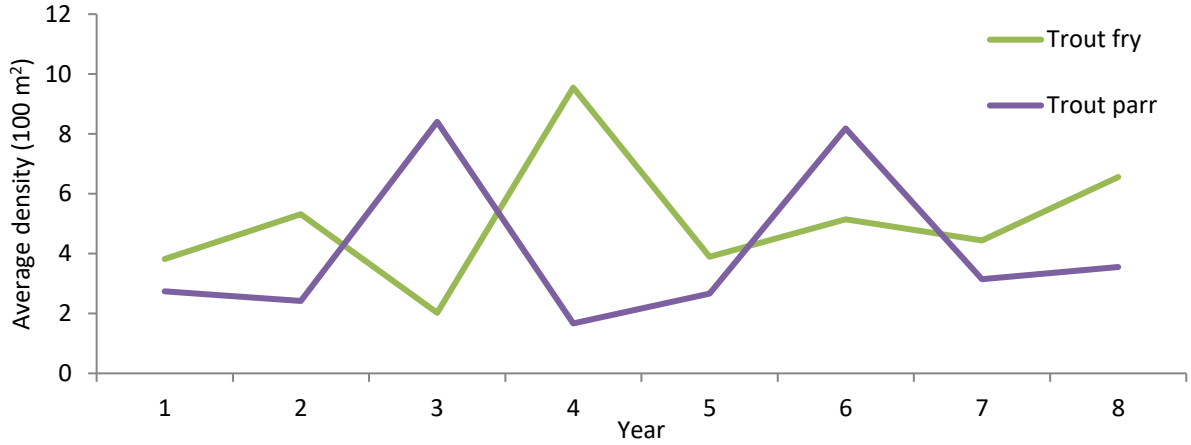

Figure 3.2: Temporal changes in average trout densities within the catchment

Discussion

Salmon are present throughout the catchment, at similar densities to trout. With the exception of OM5, which has habitat more suitable to parr, fry densities were greater than parr at all sites. This reflects the natural dynamics resulting from the high density dependent mortality found in salmonid populations and the movements of fish as they grow and spread to additional areas. As a result of this, you would also expect to see more extreme temporal fluctuations in fry densities, as can be witnessed in the salmon densities.

Despite the fluctuations observed, the 2020 population appears to lie within the range historically observed within the catchment and would suggest a relatively stable population. This would suggest that available habitat is the limiting factor to salmonid populations and habitat improvements would be required to improve salmonid densities.

4. Loch Innis na Ba Buidhe catchment

Table 4.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 4.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 4.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
LI1	222200	957500	20	From 2nd meander through gate
LI2A	223000	956900	50	Above bedrock falls, just before bend in river
LI2C	222620	956900	15	Downstream point 20m from loch, upstream point is top of bend by the top of original channel.
LI3	222600	957000	15	By track, just above loch

Table 4.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
LI1	14.3	19.07	0.00	0.00	36.71	31.46
LI2A	9.5	30.72	0.00	0.00	3.26	13.02
LI2C	15.5	58.9	0.00	0.00	11.88	23.77
LI3	14.4	17.76	0.00	0.00	39.41	16.89

There were no salmon present within the catchment during 2020. Trout parr densities were greater than fry in the LI2 tributary.

The maximum, minimum and mean densities are given for all sites (Table 4.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 4.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	0.00	0.00
Salmon parr	0.00	0.00	0.00
Trout fry	3.26	39.41	22.82
Trout parr	13.02	31.46	21.29

Salmon have been historically present within the catchment, although variably and at low densities, with 2014 and 2020 the only years where they have been absent (Fig. 4.1). Trout, in contrast, have remained relatively stable over this period, with parr densities showing a slight increase, while fry increased then returned to original levels (Fig. 4.2).

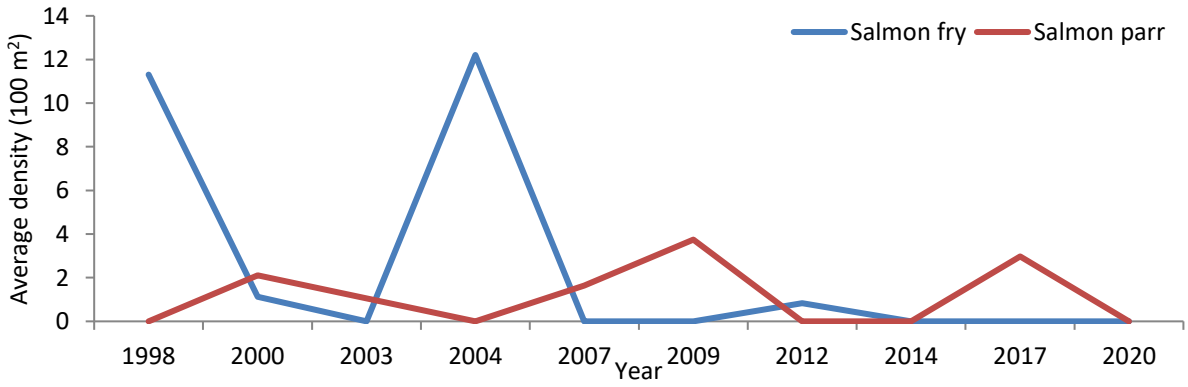

Figure 4.1: Temporal changes in average salmon densities within the catchment

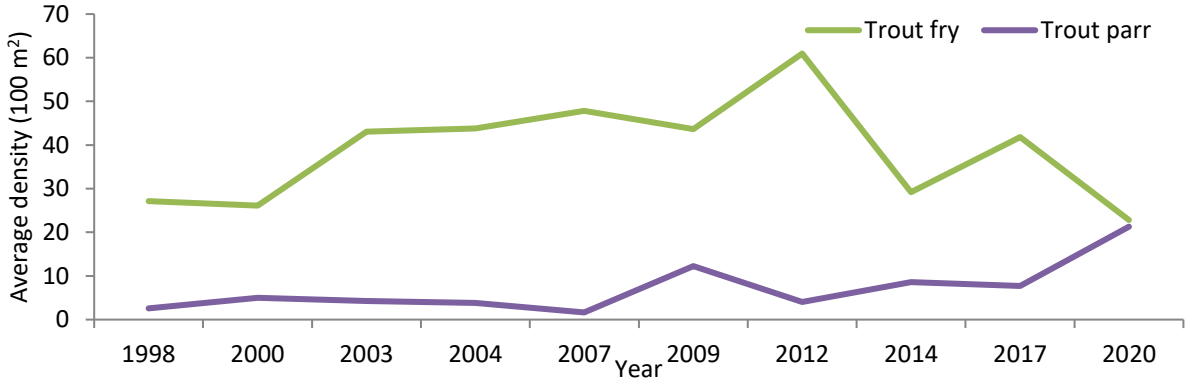

Figure 4.2: Temporal changes in average trout densities within the catchment

Discussion

Evidence from these surveys indicates that Loch Innis na Ba Buidhe is a trout system with some salmon access possible. The trout population remains healthy and stable with consistently good densities throughout. The tributaries examined all flow into Loch Innis and have a mix of instream conditions, but this does not appear to have affected the distribution of fish in this area. Riparian habitat throughout the survey area is poor and riparian fencing and bank stabilisation would be recommended.

There was a significant washout event in the LI2 tributary in 2006, which caused a major change in the course of the burn, its sediment and the bank structure. Following this no salmon were found in LI2B, although they still occur in LI1. This would suggest that the habitat changes have had a profound impact on the existing salmon habitat and population within the catchment. However, the salmon population has always been transitory, indicating that access to the system is likely to be flow dependent.

5. Loch na Thull catchment

Table 5.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 5.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 5.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
NT1	224700	951300	35	Above the road bridge, by trap location
NT2	224800	951100	45	Below Loch Na-Cailich, by large boulder
NT3	224500	951600	35	By telegraph poles, between two bends and next to small stream on right
NT7	224600	951400	30	Below road bridge

Table 5.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
NT1	10.0	33.7	100.98	0.00	32.67	2.97
NT2	8.7	41.8	2.39	0.00	21.55	0.00
NT3	18.1	37.4	21.38	16.04	34.75	0.00
NT7	8.0	18.7	37.49	16.07	101.77	5.36

Salmon and trout were present throughout the system. Fry densities are higher than parr for both species at each site.

The maximum, minimum and mean densities are given for all sites (Table 5.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 5.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	2.39	100.98	40.56
Salmon parr	0.00	16.07	8.03
Trout fry	21.55	101.77	47.69
Trout parr	0.00	5.36	2.08

A look at the annual variations in salmon densities (Fig. 5.1) indicates that the 2020 densities are within the upper end of the range previously observed for both fry and parr, with a general increase in population with time observed. Trout densities, by contrast, were relatively constant, increasing to the highest recorded average densities of trout fry and parr in 2020 (Fig. 5.2).

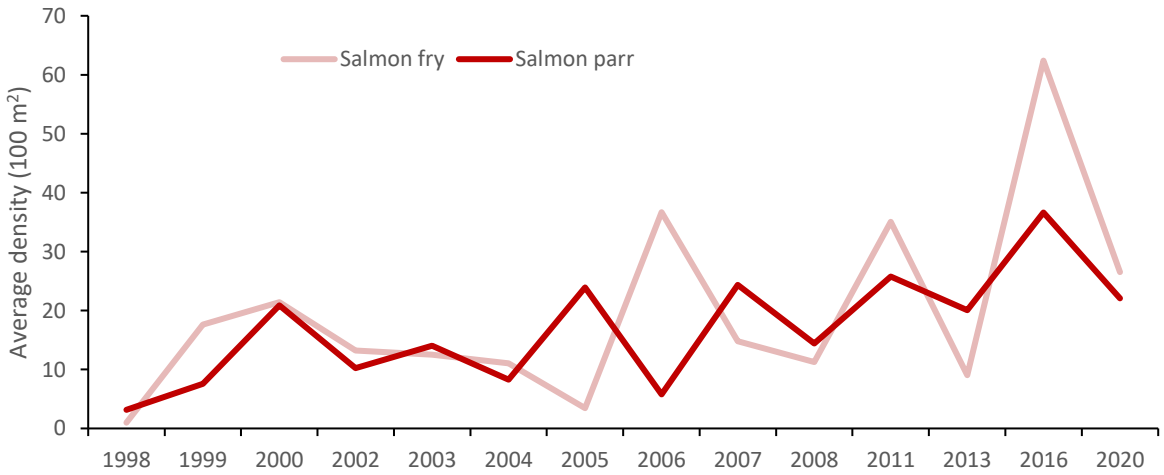

Figure 5.1: Temporal changes in average salmon densities within the catchment

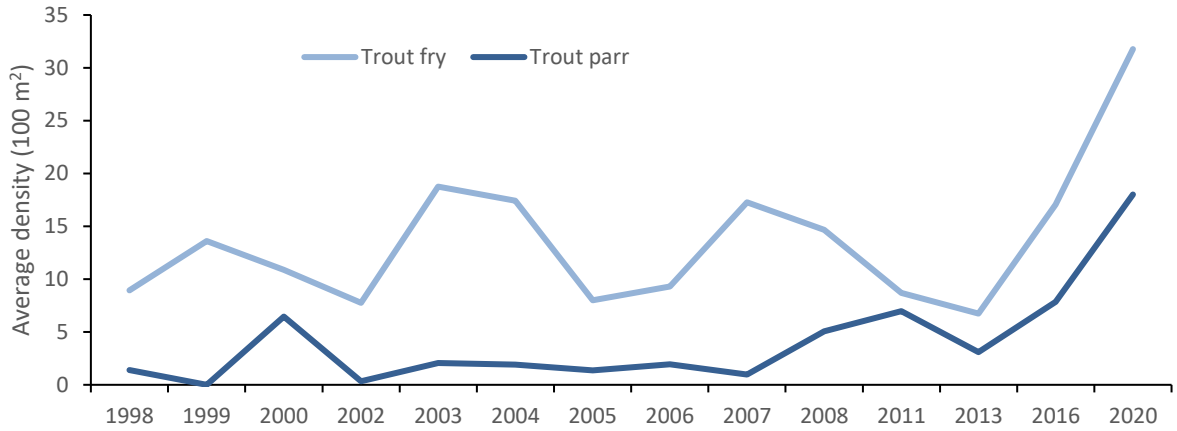

Figure 5.2: Temporal changes in average trout densities within the catchment

Discussion

Trout fry and parr densities have fluctuated around the same density since surveys began, however there has been an upward trend since 2013 leading to a record high in the 2020 survey. The more extreme fluctuations seen in the trout fry densities are likely to be a result of natural ecosystem dynamics. It is also important to consider that both adult and juvenile salmon will out-compete trout for territories, with NT2 historically containing the lowest salmon densities, while trout fry densities remain consistently strong in this site. Despite the fluctuations in the trout fry populations the average density of parr has been on an upward trend. As the trout parr grow they will migrate through the system to deeper areas.

Both salmon fry and parr have declined from their 2016 levels but are still above the average densities for this area and have an increasing trend. Salmonid fry densities are naturally higher than parr in all freshwater catchments as a result of density dependent mortality combined with migration as the parr grow and move into new feeding territories. Whilst this is largely reflected in the surveys within the Loch na Thull catchment, there are certain years where salmonid fry numbers drop below that of parr. The peaks and troughs are likely to reflect the longer-term natural population dynamics.

The increase in densities over recent years suggests that there is no major cause for concern in regard to instream freshwater habitat, although strategical planting of mixed broadleaf trees in riparian zones would be extremely beneficial, and would provide better fish cover, additional food sources, and bankside stability.

6. Laxford catchment

Table 6.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 6.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

The dominance of salmon within the catchment is apparent, with trout being more abundant where salmon are low or absent. While this is partly the result of site selection, it is also a reflection of the species composition within the catchment, with trout being more abundant in the smaller burns around Lochs Stack and More. With few exceptions (L18D and L26A for salmon, UNBL, UNBM and UNBU for trout), fry was the dominant stage present within the surveys.

Table 6.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
L14	230500	942700	50	Beside Loch Stack
L18A	230900	942200	40	Downstream of bridge at Lone
L18B	231100	942300	50	Downstream of trees in gorge
L18C	231200	942400	45	Middle of S bend
L18D	231300	942600	55	Within conifer corridor (Scots Pine/Rowan)
L19	230700	941700	40	Near quarry on way to Lone, below track
L20	230700	941600	50	50 m u/s of trees from riffle to drop off - deep scour
L26A	229500	939700	50	Below Ian's house in the gorse bushes
L36	230900	938200	50	Maternity Burn, below road
L53	234700	935900	40	Below rough track into Allt a Reinidh
L59B	234800	934300	60	50m above bridge
Laxford_4634	234786	934939	45	Kinloch burn, below houses
TS1	223719	946819	30	Up from Bridge, from corner
TS2	224311	946938	30	Below wall at Dudleys Pool
TS4	225032	946605	30	Tail of Rock Pool, on LB
TS10	225949	944688	35	Corner Pool, LB. Bottom about 10 m downstream of bench
UNBL	229759	943791	50	From large rock to riffle
UNBM	229545	944038	60	From rocks to riffle
UNBU	228815	944038	70	Below culvert, from corner

Table 6.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
L14	34.5	89.7	5.57	1.11	14.49	3.34
L18A	11.4	135.7	32.43	15.48	2.95	0.00
L18B	7.0	68.8	17.43	10.18	5.81	0.00
L18C	14.0	48.5	51.51	18.55	16.48	2.06
L18D	8.5	33.2	24.13	24.13	12.07	0.00
L19	17.0	26.6	30.04	0.00	153.96	30.04
L20	19.3	64.3	35.75	6.22	3.11	0.00
L26A	12.0	65.6	25.91	33.54	21.34	0.00
L36	27.0	41.4	0.00	0.00	176.33	4.83
L53	28.7	39.2	2.55	0.00	160.63	0.00
L59B	17.0	38.5	0.00	0.00	7.79	0.00
Laxford_4634	10.2	42.8	25.68	4.67	28.01	0.00
TS1	9.8	35.9	27.83	16.70	0.00	0.00
TS2	13.4	66.1	25.71	4.54	0.00	1.51
TS4	11.0	39.6	32.83	15.15	0.00	0.00
TS10	9.0	30.3	29.70	16.50	0.00	0.00
UNBL	16.0	44.8	24.55	8.93	0.00	8.93
UNBM	12.0	39.6	17.68	15.15	7.58	0.00
UNBU	19.1	37.6	2.66	2.66	0.00	2.66

The maximum, minimum and mean densities are given for all sites (Table 6.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 6.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	35.75	21.69
Salmon parr	0.00	33.54	10.18
Trout fry	0.00	176.33	32.13
Trout parr	0.00	30.04	2.81

Temporal changes have been worked out for the 7 sites that have been consistently surveyed since 1997. These sites are: L18A, L18D, L19, L26A, L36, L59A and L59B (L59A has been substituted with Laxford_4634, which is within 100 m).

The highest recorded average salmon fry and parr densities were seen in 2017 (Fig. 6.1). Despite the decrease observed in 2020, the values are still above the general trend line and demonstrate an increasing population. Trout fry and parr densities also remain within the average densities seen since surveys began (Fig. 6.2), suggesting a relatively stable population. The pronounced changes in average fry densities with time are likely to reflect the timing of the survey and river conditions, with a high fry mortality naturally occurring with time in all salmonid populations.

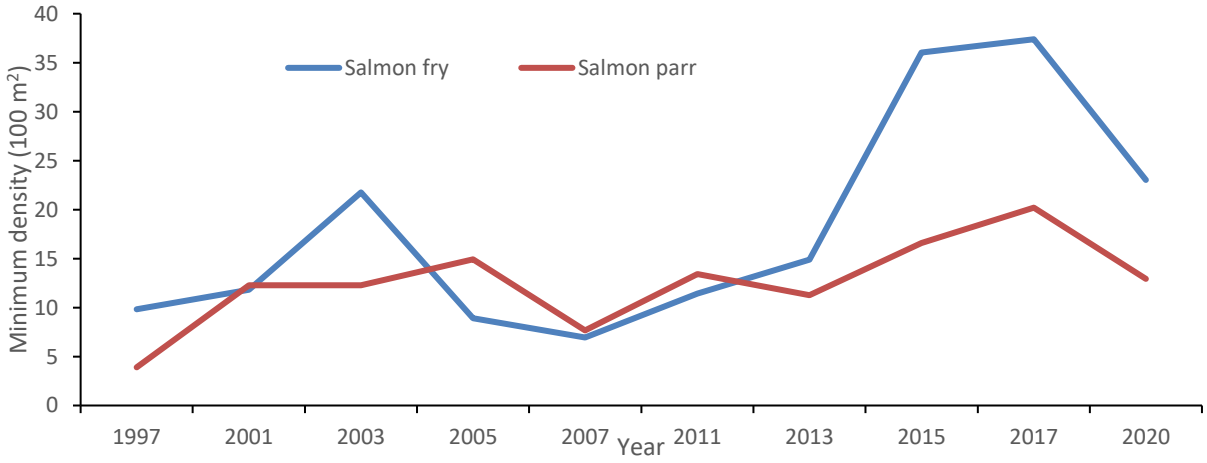

Figure 6.1: Temporal changes in average salmon densities within the Laxford catchment

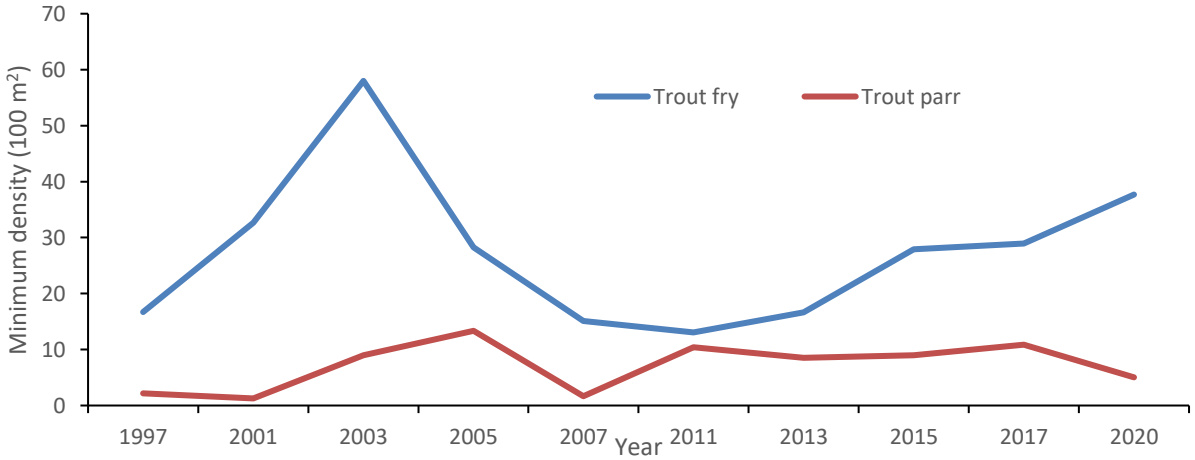

Figure 6.2: Temporal changes in average trout densities within the Laxford catchment

Discussion

Salmonid fry densities are naturally higher than parr in all freshwater catchments as a result of density dependent mortality combined with migration as the parr grow and move into new feeding territories. In addition, the short length of some of the burns and the presence of lochs within the catchment will cause parr to migrate to the loch margins where conditions are potentially more stable. The greater annual fluctuations in fry compared to parr densities is a result of the density dependent mortality prevalent in this age class which will be affected by the timing of the survey and environmental conditions. This is reflected within the surveys.

Within the annual fluctuations observed, there is a general trend of increasing salmon densities across the catchment. This indicates that the catchment is not deteriorating in terms of habitat, but that in order to see a significant increase in salmon numbers it will require additional catchment management and habitat improvement. To this end, the river management plan was produced in 2019 and it is recommended that these actions be undertaken. In particular, the planting of riparian woodland could have a long-term benefit to the fish populations

In contrast, the trout populations have remained relatively stable since 1997. This likely reflects the trout burns monitored, their size and the stability of those areas. As with salmon, there will be a downward migration of parr into the lochs, particularly from the small burns. Within mixed species burns, it should also be noted that salmon will out-complete trout for the optimal habitat, so an expanding salmon population has the potential to impact on trout densities.

7. Bad na Baighe catchment

Table 7.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 7.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 7.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
BB1	222100	946500	10	30m from boundary fence
BB2	222700	946000	20	Near loch
BB4	222400	945400	50	Above falls on way to junctions of 3 tributaries
BB5	222500	945500	30	Downstream, in riffle area
BB6	222700	945600	25	Deep pool
BB7	223000	945600	20	By loch

Table 7.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
BB1	9.3	48.7	0.00	0.00	4.11	2.05
BB2	6.6	24.4	0.00	0.00	0.00	4.10
BB4	9.4	32.3	0.00	0.00	9.30	6.20
BB5	7.2	24.2	41.25	20.63	0.00	12.38
BB6	13.5	37.4	10.71	13.39	2.68	13.39
BB7	10.4	35.0	8.57	5.71	19.99	8.57

Trout are present at all sites, with densities being higher within sites above the loch. Salmon were present solely at sites above the loch, other than BB4. Salmon parr densities were greater than salmon fry densities within BB6.

The maximum, minimum and mean densities are given for all sites (Table 7.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 7.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	41.25	10.09
Salmon parr	0.00	20.63	6.62
Trout fry	0.00	19.99	6.01
Trout parr	2.05	13.39	7.78

Salmon parr densities are relatively consistent with historical levels after 2008 (Fig. 7.1), although there was a decline to 2020. In contrast, fry densities are more variable with time, although at the higher level during this survey. Trout, in contrast have remained relatively constant with time while parr densities have shown a sharp increase to 2016 before declining to 2020 (Fig. 7.2).

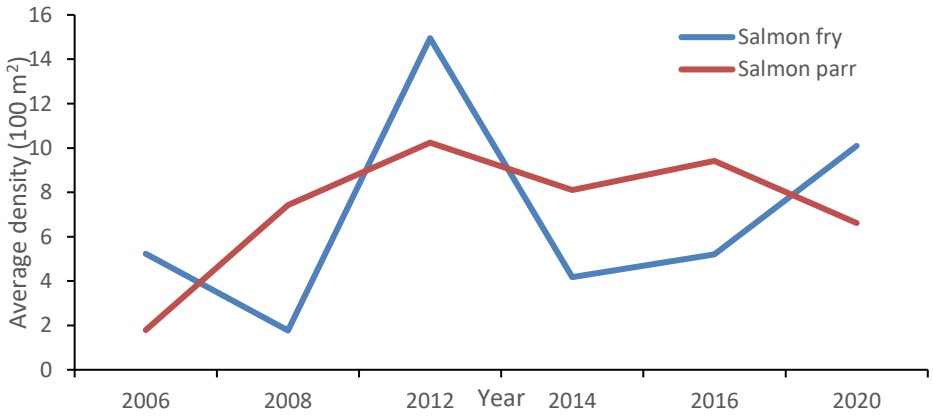

Figure 7.1: Temporal changes in average salmon densities

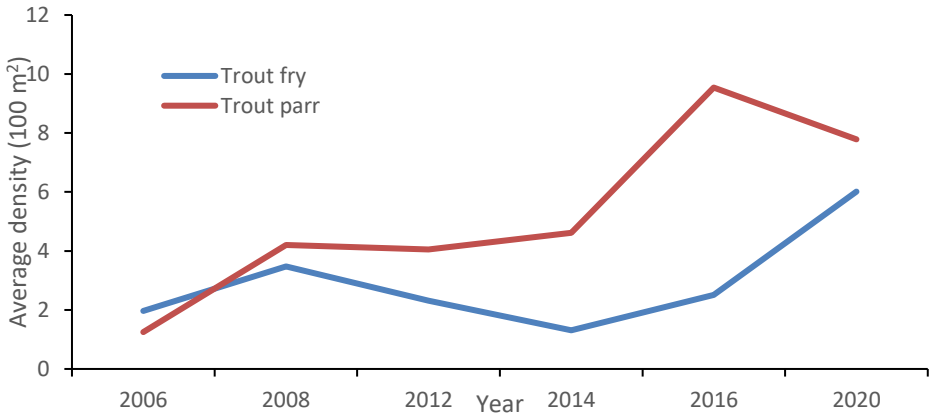

Figure 7.2: Temporal changes in average trout densities

Discussion

Natural fluctuations in juvenile densities with time are to be expected, particularly in fry. These are most obvious within the salmon populations and reflect environmental conditions and survey timing acting on the high natural mortality of this stage. This is less apparent in the trout population but still present. Despite this, juvenile salmonid densities have remained relatively stable or increased over the period of this study.

That, combined with the classification of most of the sites as having good to excellent densities for this area, would suggest that the populations remain healthy. The exception to this is the outflow, which, as well as showing poor densities, also has a loss of salmon populations and reduction in trout in 2020. This would suggest a change in habitat quality with time in this area. The proposed tree planting should help to improve this area over time.

Salmonid fry densities would be expected to be naturally higher than parr as a result of density dependent mortality combined with migration as the parr grow and move into new feeding territories. However, trout parr dominate the survey each year, while salmon parr have historically dominated, although 2020 has proved an exception. This, coupled with good densities, would suggest that it reflects the habitat at the survey sites rather than a spawning issue *per se*.

8. Claise na Fearna catchment

Table 8.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 8.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 8.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
Bmain3	220000	946400	50	Just above small falls, near road bridge
Bmain5	219759	946191	55	Downstream of bend in river, opposite Council Depot
Bmain6	219700	946100	60	Glide near house
Bmain8	219500	945800	60	Near Loch a Bhagh Ghaimmhica
Outflow 3	220600	947700	10	In trees, close to sea, downstream of bend
Outflow 4	220600	947500	30	Upstream of trees, downstream of bend in river

Table 8.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
Bmain3	14.6	42.3	0.00	0.00	0.00	18.89
Bmain5	6.2	13.9	0.00	14.44	7.22	14.44
Bmain6	10.0	21.0	14.29	23.81	23.81	4.76
Bmain8	18.3	45.8	0.00	2.19	78.69	34.97
Outflow 3	8.4	30.8	0.00	0.00	3.25	6.49
Outflow 4	10.9	21.8	0.00	0.00	0.00	18.35

Trout are present at all sites. Where salmon were present, parr densities were greater than fry densities. No salmon were found in the outflow to Loch na Claise Fearna, and fry were only present at Bmain6.

The maximum, minimum and mean densities are given for all sites (Table 8.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 8.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	14.29	2.38
Salmon parr	0.00	23.81	6.74
Trout fry	0.00	78.69	18.83
Trout parr	4.76	34.97	16.32

The 2020 average salmon parr density has declined from 2016 but is still higher than most previous years (Fig. 8.1). Salmon fry density, in contrast, is below average, with little change from 2016. The 2020 trout fry and parr densities have increased from 2016 (Fig. 8.2), with trout parr densities this year being their highest since records began.

Figure 8.1: Temporal changes in average salmon densities within the catchment

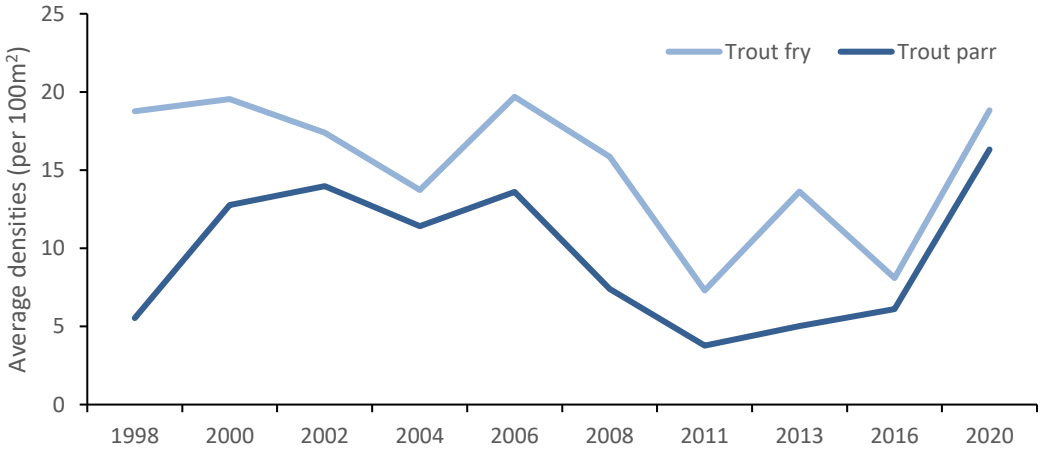

Figure 8.2: Temporal changes in average trout densities within the catchment

Discussion

The Claise na Fearna catchment is dominated by trout, with high fry densities commonly being recorded, especially in site Bmain8. The trout population appears to have boomed in the last few years since the last survey in 2016. The past decade had shown a steady downward trend in trout populations up until the 2020 survey where they appear to have bounced back throughout all sites. Continued monitoring should be carried out in order to determine whether or not this is part of a more long-term natural cycle. However, it may be partially attributed to a significant decrease or absence in salmon populations within the sites.

The 2020 salmon parr population within the catchment overall have shown a decline from 2016, although are still relatively high in comparison to the majority of years from 1998-2013. The salmon fry population has remained consistently low for the last decade. At site Bmain6, salmon parr densities have been high for the past decade and even with the declining trend over recent years they appear to still be outcompeting trout for territory. In contrast, all other sites have been dominated by trout since records began.

Outflow 3 is within a section that is over shaded which may explain lower densities of salmonids due to lack of light penetration to support prey items, however it is a fairly steep gradient and there may not be sufficient spawning habitat in close proximity. This site does show consistent low to moderate trout densities and only one occurrence of salmon fry, perhaps due to a lack of resting pools for adults. There are other areas within the catchment where over shading may be having an adverse effect on salmonid populations and it would be interesting to carry out some pruning of these over shaded areas in combination with continuing juvenile surveys in order to monitor the effects of this.

The temporal fluctuations in juvenile trout and salmon populations can be attributed to natural ecosystem dynamics along with varying and fluctuating marine pressures on salmon and sea trout as a small catchment consisting of loch systems connected by narrow burns requires sufficient water levels to allow migratory fish to access spawning habitat. This may further explain the more sporadic appearance of juvenile salmon and also missing year classes (largely fry) following seasons when adults have not been able to access the site areas.

9. Loch nam Brac catchment

Table 9.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 9.2, together with minimum estimates of density for trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 9.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
NB1	218300	947200	70	By lochside
NB2	218400	947150	70	Upstream of road culvert
NBA1	217886	948641	70	Between two riffles just below loch
NBA2	218030	948780	70	Downstream of small waterfall
NBA3	218400	949300	50	Below road culvert

Table 9.2: A summary of the density of trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

Site Code	Length (m)	Area (m^2)	Minimum density (100 m^2)	
			Trout Fry	Trout Parr
NB1	20.0	40.3	24.83	4.97
NB2	13.0	16.6	12.08	6.04
NBA1	16.1	49.4	48.61	24.31
NBA2	9.2	62.6	11.19	0.00
NBA3	30.0	96.0	15.63	10.42

Salmon were not present within the system however trout were present at all sites. Fry densities were greater than parr at all sites except NBA2, where no parr were found. This is as expected given the natural population dynamics of fish.

The maximum, minimum and mean densities are given for all sites (Table 9.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 9.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Trout fry	11.19	48.61	22.47
Trout parr	0.00	24.31	9.15

A look at the annual variations in densities (Fig. 9.1) indicates that fry densities show considerable variation, with the 2020 densities at the lowest observed. However, parr densities have remained relatively constant throughout the survey period.

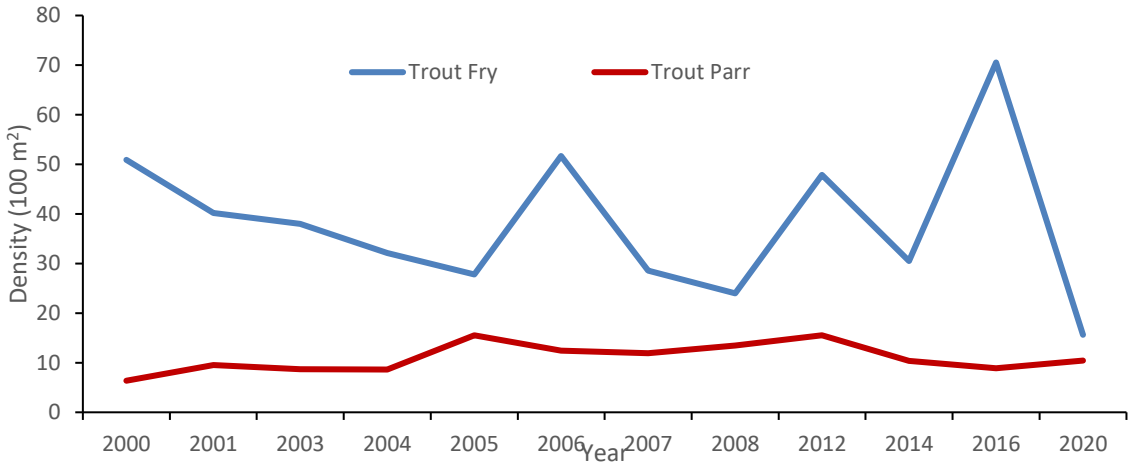

Figure 9.1: Temporal changes in average trout densities within the catchment

Discussion

Trout parr densities have fluctuated but remained fairly consistent over the majority of sites apart form NBA1 where an unusually high number of parr were recorded. In previous years, site NBA1 has had high densities but these are usually of fry. The 2020 survey was the first to show a higher density of parr than fry within this site.

Salmonid fry densities are naturally higher than parr in all freshwater catchments as a result of density dependent mortality combined with migration as the parr grow and move into new feeding territories. The results of the surveys reflect these migratory tendencies, with the lack of older trout found within the sites indicating the movement of older fish into deeper areas, such as the loch.

Despite the fluctuations observed in the fry densities, the trout population within the catchment would appear to be stable and healthy. The lack of competing salmon combined with the 'enclosed system' and resident trout population may provide for a more stable system than those where marine influences play a larger part.

10. Bhadaidh Daraich catchment

Table 10.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 10.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 10.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
BD2	216000	944700	20	Below loch
BD4	216300	944200	35	Between small rocks and higher barrier
BD5	216300	944100	45	Just below loch

Table 10.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
BD2	8.5	30.3	0.00	0.00	3.30	16.49
BD4	11.4	25.5	0.00	0.00	7.86	19.64
BD5	21	67.2	0.00	0.00	11.90	1.49

The maximum, minimum and mean densities are given for all sites (Table 10.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 10.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	0.00	0.00
Salmon parr	0.00	0.00	0.00
Trout fry	3.30	11.90	7.69
Trout parr	1.49	19.64	12.54

Figure 10.1 show temporal changes in juvenile trout densities per 100 m^2 by catchment average. Fry density was in the lower range of densities noted previously. The average trout parr density has levelled since 2012 and is within the average range.

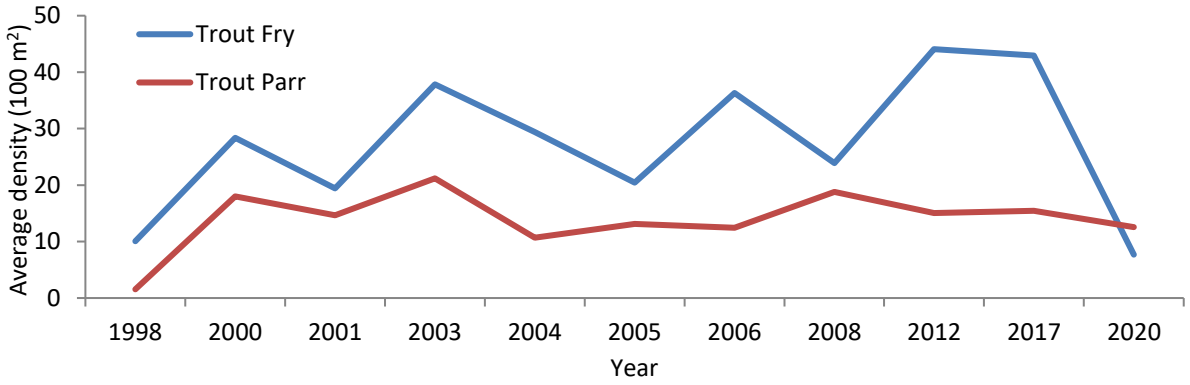

Figure 10.1: Temporal changes in average trout densities

Discussion

Within the natural fluctuations observed within fish populations, parr have remained stable since 1998. Given the high level of density dependent mortality operating on fry populations, they are, by nature, more prone to large fluctuations and this is observed within the catchment. The sharp decline in 2020 is likely linked to large drop in density observed at BD2. There has been some reconstruction of the burn downstream of this site, with the creation of a pool system which will have altered the dynamics in this area and thus the observed densities. It is unknown when this construction took place.

Salmonid fry densities are naturally higher than parr in all freshwater catchments as a result of density dependent mortality combined with migration as the parr grow and move into new feeding territories. However, parr numbers are particularly low within BD2 and BD5. This is reflected historically, particularly in the case of BD5.

There appears to be a strong population of trout within the Bhadaidh Daraich catchment, supported by good spawning grounds and fry habitat. This suggests there is no major cause for concern regarding the natural habitat in terms of instream characteristics. However improved fish passage, particularly through the lochan at the mouth of the catchment and the culvert under the A894, would enhance the population dynamics of the system.

11. Geisgeil catchment

Table 11.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 11.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 11.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
G1	217352	941790	20	Just above fence line to step/falls
G2	217401	941859	20	Just below second fence (reed bed). Island braids
G3	217401	941613	20	By loch, below fence

Table 11.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density ($100m^2$)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
G1	6.2	59.11	3.38	1.69	6.77	6.77
G2	8.8	56.91	19.33	1.76	14.06	3.51
G3	9.3	46.19	0.00	0.00	2.16	6.49

Trout were present throughout the system, with salmon absent from G3. Salmon fry densities were greater than parr throughout, but this only held for trout at G2.

The maximum, minimum and mean densities are given for all sites (Table 11.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 11.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	19.33	7.57
Salmon parr	0.00	1.76	1.15
Trout fry	2.16	14.06	7.66
Trout parr	3.51	6.77	5.59

A look at the annual variations in both salmon (Fig. 11.1) and trout (Fig. 11.2) densities indicate that there has been a switch from parr to fry over the years, but that the overall number of salmon has remained similar. Trout have shown a slight increase overall.

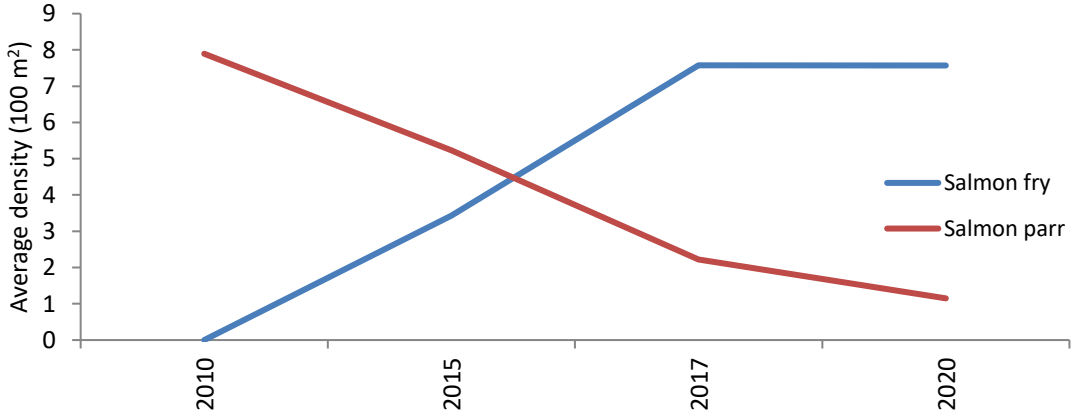

Figure 11.1: Temporal changes in average salmon densities within the catchment

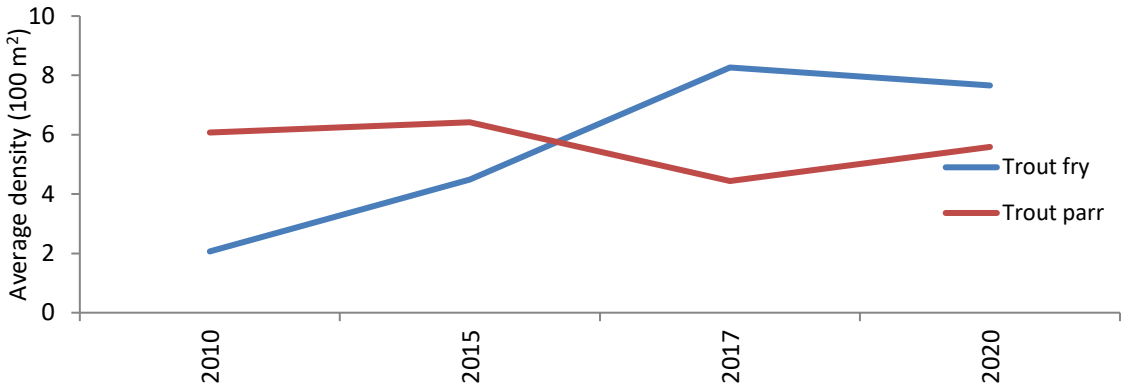

Figure 11.2: Temporal changes in average trout densities within the catchment

Discussion

There would appear to be a relatively consistent, if small, population of salmon within Loch Bad nam Mult. At present the access to the loch is flow dependent and it is possible that improved access would benefit this population and allow it to increase. Currently, the densities are lower than would be expected on a regional scale. The apparent preference of salmon for the smaller burn to the north is unexpected and may reflect spawning availability. However, it should also be noted that this burn lies within a woodland regeneration area and the benefits that this riparian habitat brings to salmonid populations.

These surveys indicate that Geisgeil is primarily a trout system. Trout parr remain consistent within the catchment, while fry densities have increased. This, together with the consistent salmon population, would indicate that the habitat is currently towards carrying capacity. However, densities are lower than would be expected based on the SFCC classification and it is recommended that habitat improvements are considered, including improvements to the access. The population shift from parr to fry suggests changes in the habitat structure at the sites surveyed, with parr potentially moving down into the loch.

12. Duart catchment

Table 12.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 12.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 12.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
D2	220100	937400	40	Above hatchery, just before bend into waterfall pool. From the first trees to the riffle
D3	218300	937200	50	In riffle, just before bend down to falls
D4	219000	937400	25	Right braid of river between the two lochs
D5	221400	936400	60	Near mouth of river, just after boulder bar before sharp bend
D6	221400	936200	60	Approx. 100m from loch, just before small fall at bend. Near stock fence on right.
D8	221000	936200	60	Left braid of riffle below Loch Allt nan Ramh
D9	220600	936400	50	In riffle area above Loch Yucal, by corner of deer fence

Table 12.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
D2	13.2	36.5	5.48	16.43	49.29	16.43
D3	9.4	60.5	6.61	3.31	31.42	6.61
D4	9.2	57.4	0.00	0.00	0.00	3.49
D5	7.8	13.3	37.71	45.25	7.54	15.08
D6	9.0	23.1	12.99	4.33	12.99	38.96
D8	6.3	35.1	11.41	2.85	5.70	2.85
D9	7.8	58.0	1.73	1.73	5.17	5.17

Salmon were present at all sites other than D4. Trout densities were greater than salmon at all sites other than D5 and D8. Salmon fry occurred in higher densities than parr within D3, D6 and D8, while they were of equal density at D9. Trout fry densities were higher than trout parr densities at D2, D3 and D8. They were of equal density at D9.

The maximum, minimum and mean densities are given for all sites (Table 12.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 12.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	37.71	10.85
Salmon parr	0.00	45.25	10.56
Trout fry	0.00	49.29	16.02
Trout parr	2.85	38.96	12.66

Salmon parr densities are increasing with time, although slightly lower than in 2015 (Fig. 12.1). Fry densities have also declined since 2015 but are high compared to historic levels. Trout parr are also increasing with time (Fig. 12.2), with 2020 having the greatest density recorded in these surveys. Fry are more variable but also show an increasing trend, with recorded densities in 2020 being above average.

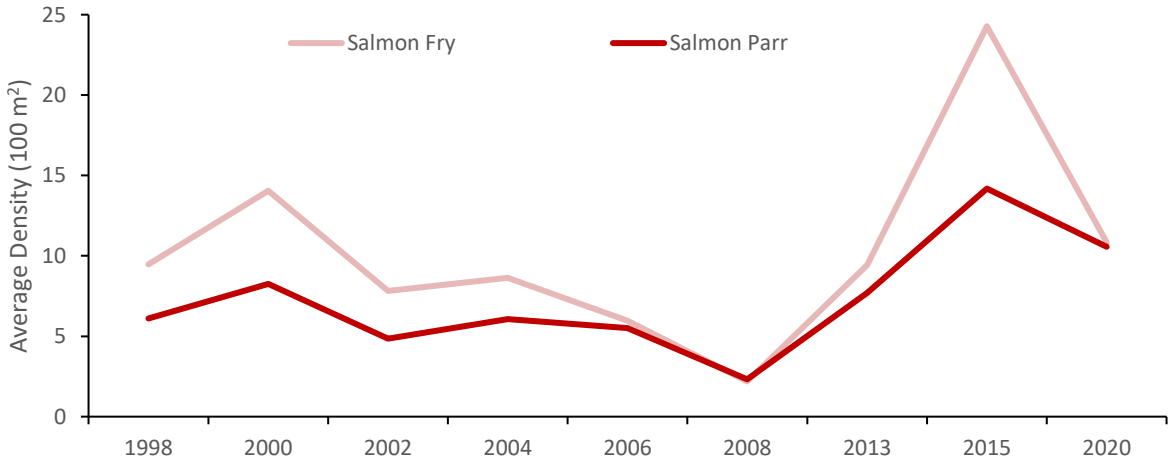

Figure 12.1: Temporal changes in average salmon densities

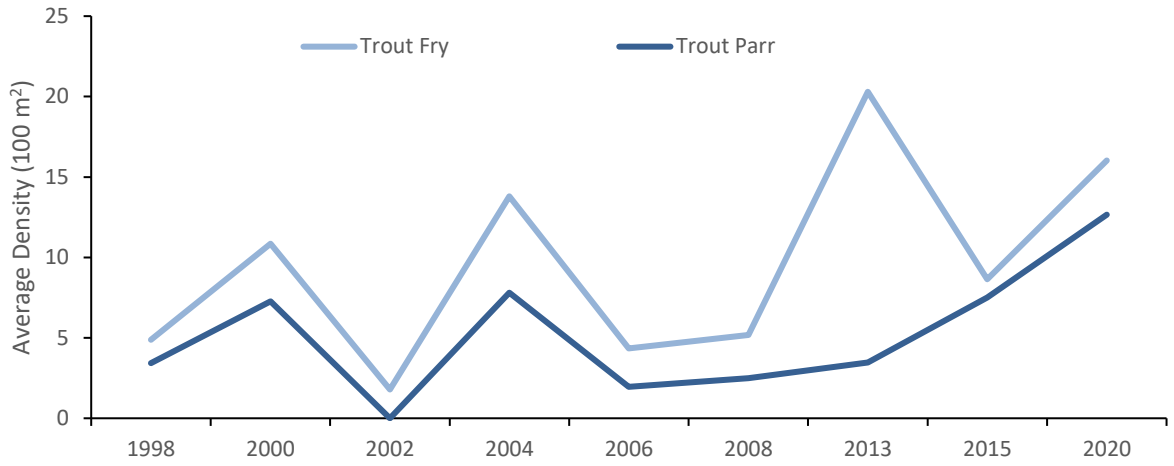

Figure 12.2: Temporal changes in average trout densities

Discussion

Since the decline in recorded average salmon density from 2000 (reaching the lowest figures in 2008), the average densities have seen a dramatic increase, with what appears to have been exceptional salmon spawning in 2014, followed by a few less productive years. This pattern is likely to have been part of a longer term natural cycle, with marine pressures potentially playing a large part.

The peaks and troughs within trout populations are also likely to be a result of natural ecosystem dynamics. There certainly seems to be a steady base population of resident trout, which appears to be augmented with prolific fry numbers cyclically, suggesting spawning sea trout. Together with the increased pressures possible in the marine environment, it is also possible that the population is naturally shifting to a resident state. The costs and benefits of a migratory lifestyle are constantly operating on trout populations, and changes in environmental factors and mortality between the 2 environments will have an impact on the 'choices' made.

Considering the above, in the case of both salmon and trout there appears to be no major cause for concern over freshwater habitat in regard to instream characteristics. Trout are clearly using the habitat productively. However, strategic planting of mixed broadleaf trees within riparian zones would dramatically improve fish cover, food availability, and structural bankside reinforcement.

13. John Muir Trust catchments at Quinaig

Table 13.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 13.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 13.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
I23	220700	925800	80	Between bridges on new road and old road
I30A	223500	924400	60	At road junction
I30C	223413	924616	80	Below pool at base of waterfall
JMT_TP1	223389	929993	155	Flat rock up to riffle
JMT_TP2	223550	929862	160	On straight, start at boulders
JMT_TP3	223572	929795	160	Just before bend, just below riffle to riffle

Table 13.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
I23	12.7	25.4	0.00	7.87	59.06	15.75
I30A	12.5	46.67	60.00	15.00	10.71	0.00
I30C	6.6	27.5	61.82	29.09	3.64	7.27
JMT_TP1	14.2	68.63	0.00	0.00	17.49	1.46
JMT_TP2	10.5	53.2	0.00	0.00	5.64	0.00
JMT_TP3	8.8	42.83	0.00	0.00	7.00	23.35

No salmon were found in the Unapool Burn (JMT-TP) but were present in the tributaries of the Inver catchment (I). With the exception of I30 and JMT-TP3, trout fry densities were greater than parr. No salmon fry were found at I23. There were no other species recorded during the survey.

The maximum, minimum and mean densities are given for all sites (Table 13.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 13.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	61.82	20.30
Salmon parr	0.00	29.09	8.66
Trout fry	3.64	59.06	17.26
Trout parr	0.00	23.35	7.97

Discussion

As repeat sites from previous surveys, it is possible to look at temporal changes in I23 and I30A since 1997. All other sites are new. I23 has shown a shift in structure from salmon to trout over time, with 2006 being the cross over point. Since then trout densities, particularly fry, have continued to increase. I30A, in contrast, has retained a similar population structure although salmon densities, particularly parr, have declined.

This survey would appear to indicate that populations in some areas are sub-optimal. Habitat management would therefore be recommended, with riparian planting likely to have the biggest effect. It is therefore recommended that the project be considered as a management policy within the Quinag area, with the potential to provide management practices with the JMT Estates.

14. Gleann Leireag catchment

Table 14.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 14.2, together with minimum estimates of density for trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 14.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
GLL1	215900	930700	80	Just up from braid - tree on the left in middle of site
GLL2	217100	930600	125	Just below path
GLL3	217800	929700	125	Below falls, after bend

Table 14.2: A summary of the density of trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)	
Site Code	Length (m)	Area (m^2)	Trout Fry	Trout Parr
GLL1	9.8	47.4	10.56	16.89
GLL2	8.2	25.0	24.00	4.00
GLL3	14.7	33.8	41.41	5.92

Trout are present at all sites, with the highest density of parr found within GLL1. Parr densities were lower than fry other than within GLL1.

The maximum, minimum and mean densities are given for all sites (Table 14.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 14.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Trout fry	10.56	41.44	25.32
Trout parr	4.00	16.89	8.94

The 2020 average trout fry density is one of the highest recorded since the start of the survey (Fig. 14.1). The average trout parr density is also higher than average in historic terms but have not changed significantly since 2014.

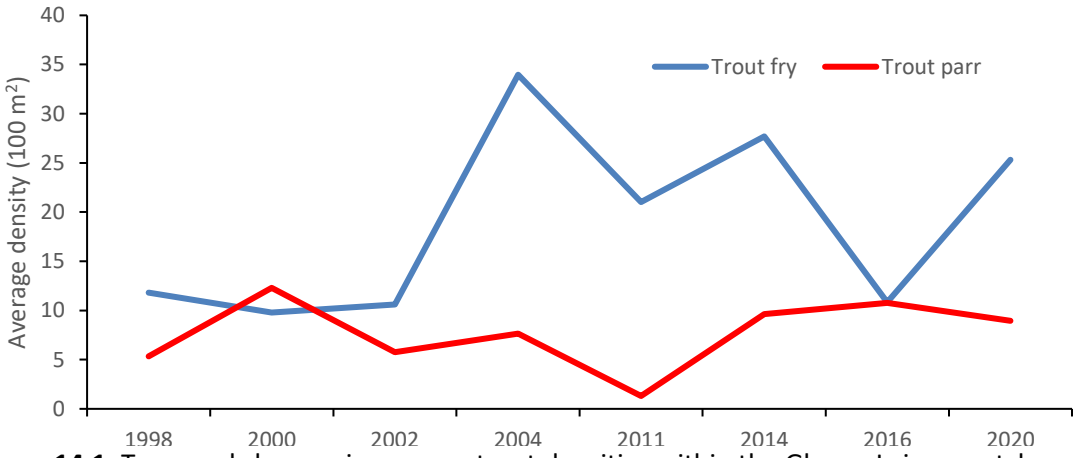

Figure 14.1: Temporal changes in average trout densities within the Gleann Leireag catchment

Discussion

Parr populations have remained relatively constant over the period of these surveys, with a reduction in 2011. This reduction was observed at all sites, with no parr recorded at either GLL2 or GLL3 and may

reflect environmental conditions in that year and the movement of fish within the catchment. Fry populations are more variable, but this can be attributed to natural ecosystem dynamics, with density dependent mortality acting on this age class, coupled with changes in the timing of the survey and the environmental conditions at that time.

These surveys indicate that the trout population is healthy, although there are some opportunities for habitat improvements within the catchment. In particular, habitat improvements within the tributaries and riparian planting around the catchment.

15. Oldany catchment

Table 15.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 15.2, together with minimum estimates of density for trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 15.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
LP1	210200	932900	15	Bottom line on hydro pole
LP2	210100	932800	15	Just below middle bridge
LP5	210100	932150	20	Below fish holding pool at the bottom of the gorge

Table 15.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
LP1	10.4	89.79	1.11	3.34	6.68	1.11
LP2	9.3	39.68	0.00	2.52	10.08	0.00
LP5	12.3	86.10	0.00	0.00	9.29	0.00

Salmon and trout were both present below the hydro-electric station outflow, while only trout were present above the tailrace.

The maximum, minimum and mean densities are given for all sites (Table 15.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 15.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	1.11	0.37
Salmon parr	0.00	3.34	1.95
Trout fry	6.68	10.08	8.68
Trout Parr	0.00	1.11	0.37

Discussion

It has been 16 years since the last electrofishing survey in the Oldany catchment. Over this period it is possible that there has been a number of changes within the catchment. Despite this, the salmon population appears to be similar to that seen in 2004, while the trout have similar densities but there

has been a switch from predominantly parr to fry. While the latter may be the result of natural dynamics, it is also possible that there has been a shift in habitat. However, further monitoring will be required to determine this.

16. Clashnessie catchment

Table 16.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 16.2, together with minimum estimates of density for trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 16.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
TS1A	205611	930862	15	Below road, near bottom field, along fence
TS1B	205564	930654	25	Below fence, from bend to fence
TS2	205538	930563	25	Over fence opposite croft above TS1B

Table 16.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	Length (m)	Area (m^2)	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
TS1A	13.1	27.5	0.00	3.64	7.27	21.81
TS1B	15	39.8	0.00	0.00	0.00	5.03
TS2	9.4	25.1	0.00	0.00	0.00	23.93

Salmon were only present at TS1A. Trout parr densities were greater than fry within all sites, in contrast to the expected pattern within salmonid populations.

The maximum, minimum and mean densities are given for all sites (Table 16.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 16.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	0.00	0.00
Salmon parr	0.00	3.64	1.21
Trout fry	0.00	7.27	2.42
Trout Parr	5.03	23.93	16.92

Trout are present throughout the time sampled, although in decreasing numbers (Fig. 16.1). The survey sites are parr dominated, with 2020 being more similar to 2009 than 2016. Only one salmon has been seen over the period of these surveys, demonstrating that this is a trout catchment. This agrees with anecdotal angling information.

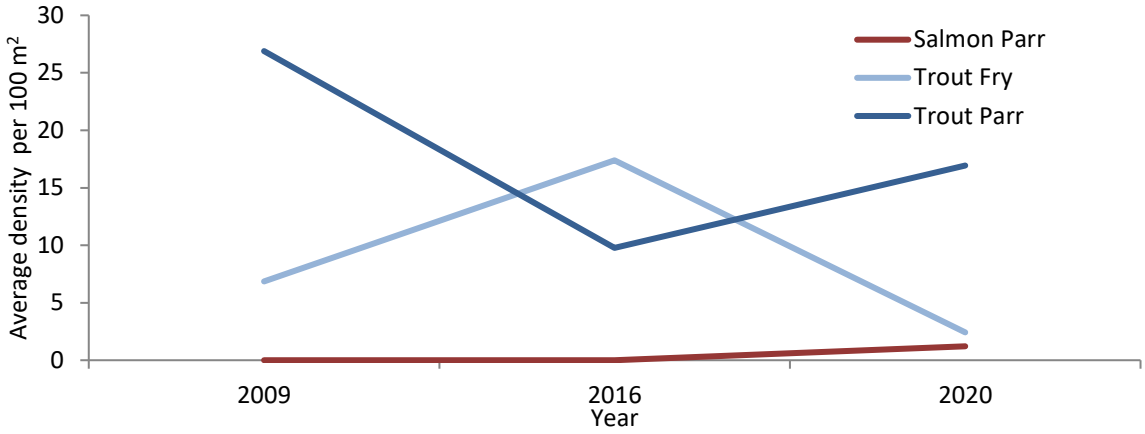

Figure 16.1: Temporal changes in average salmonid densities

Discussion

Trout is the dominant species within this catchment, with densities varying over time. While there are insufficient data points with time to draw conclusions on the reasons. The move to an annual survey will provide additional information on this. Anecdotal evidence suggests that Clashnessie is a non-migratory catchment, although the presence of salmon parr within this survey would refute this. It is, however, likely that the migratory population is transient and based on a specific set of conditions allowing the fish into the mouth of the catchment.

The fry densities of 2020 are lower than those in 2016 across all sites apart from TS1B where they have remained constant. In contrast, parr densities of 2020 are higher than those in 2016 across sites TS1A and TS2. This may be the result of reduced spawning but could also reflect environmental conditions, with 2020 being exceptionally dry during the spring period.

As a result of fry densities being lower in 2020 compared to 2016, two of the sites previously classed as “excellent” under the SFCC absolute regional classification scheme are now in the “moderate” and “unclassified” bracket. The densities of 2020 are likely to be a result of natural ecosystem dynamics, however it is not possible to gauge any picture of major temporal fluctuations or trends in the juvenile population densities when comparing only 3 separate survey years. Nevertheless, it is promising to see such high densities of juvenile trout in the past surveys over the space of 11 years as this suggests a very healthy system.

17. Culag catchment

Table 17.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 17.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 17.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
CG2	210000	921700	25	Riffle adjacent to side braid on left bank approx. 70m upstream of School Loch
CG3	210000	921800	25	Just above loch below bend in muddy area

Table 17.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
CG2	16.8	236.9	7.18	0.84	0.00	0.00
CG3	20.5	84.7	0.00	0.00	2.36	0.00

While only salmon were present at CG2, only trout fry were found at CG3. Fry densities were greater than parr at both sites.

The maximum, minimum and mean densities are given for all sites (Table 17.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 17.3: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	0.00	7.18	3.59
Salmon parr	0.00	0.84	0.42
Trout fry	0.00	2.36	1.18
Trout parr	0.00	0.00	0.00

Salmon fry and parr densities follow a similar pattern with time, with fry dominating (Fig. 17.1). 2020 densities of both are low compared to historic data from the catchment. Trout fry densities during 2020, in contrast, are above average for the sites (Fig. 17.2). Trout parr are not generally seen within these sites. Within the 2 sites surveyed, salmon are routinely more abundant than trout.

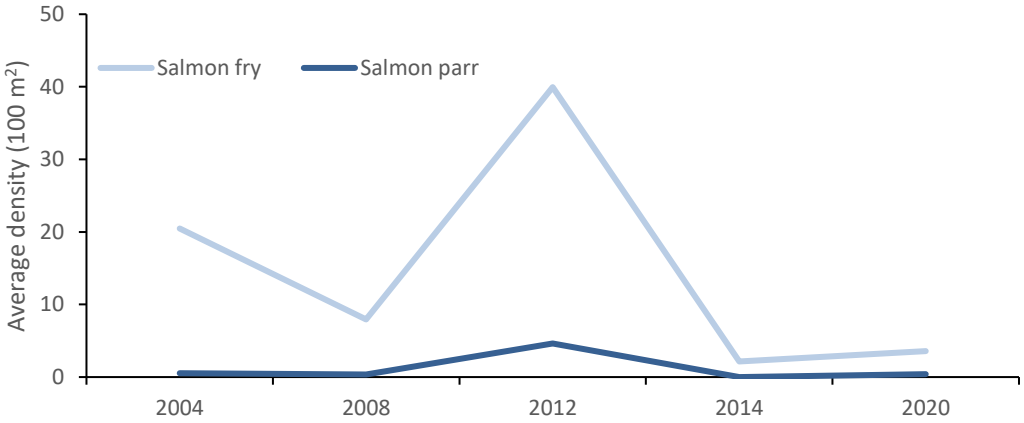

Figure 17.1: Temporal changes in average salmon density

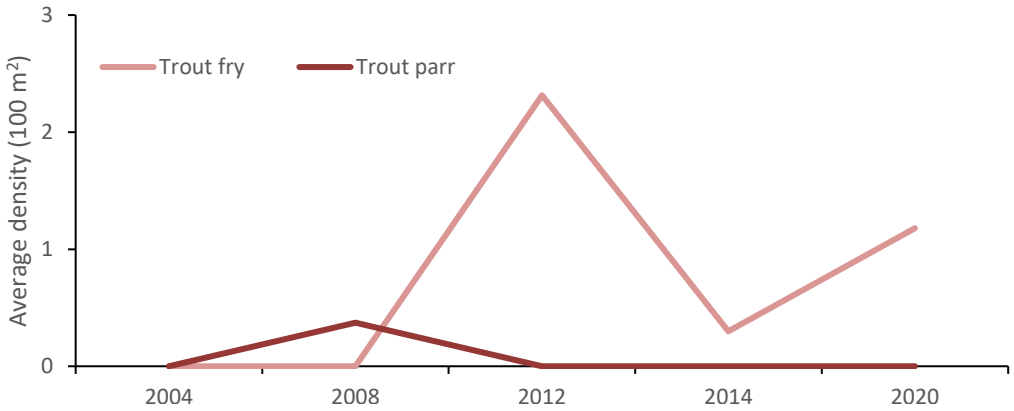

Figure 17.2: Temporal changes in average trout density

Discussion

Salmon densities in 2020, both fry and parr, are low although similar to those found in 2014. The lack of salmon in CG3 is unusual and would have contributed to the overall reduction but does not explain the low levels noted. Trout densities are also low in comparison with previous years, although fry are higher than 2014. Generally, fry are more abundant than parr throughout these sites although this is expected and is typical of the catchment.

With only 2 sites sampled within this catchment it is difficult to draw any conclusions as to potential issues within the catchment. There were originally 3 sites within the survey, but one was lost due to excess aquatic weed growth. Given that the 2 sites recorded here have not significantly altered since 2000 however, it is possible that there is a problem with access. It would therefore be worth carrying out a further survey of the outflow assess any potential blockages.

18. Garvie catchment

Table 18.1 gives the grid reference, altitude, and location of each site fished. The length and area fished are presented in Table 18.2, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Table 18.1: Electro-fishing site details

Site Code	Easting	Northing	Altitude	Situation
G2C	213250	906500	70	By riffle, just below deer fence
G3A	213800	906600	50	Downstream of ford over tributary
G4C	204900	910700	40	From riffle just below join of rivers to tree opposite red boulder
G4D	204900	911000	25	By loch, to big boulders
OB3	205250	911650	40	Above large boulder in 1st main braid (OB2)
OB4	205250	911700	40	Centre braid, adjacent to Keith's boulders
OB5	205200	911600	35	Braid off main river, last braid from the road

Table 18.2: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

			Minimum density (100 m^2)			
Site Code	**Length (m)**	**Area (m^2)**	**Salmon Fry**	**Salmon Parr**	**Trout Fry**	**Trout Parr**
G2C	28.2	94.9	1.05	8.43	11.59	2.11
G3A	8.2	23.5	0.00	0.00	0.00	0.00
G4C	9.1	32.2	0.00	0.00	6.21	21.74
G4D	9.2	13.2	15.15	7.58	68.18	22.73
OB3	9.4	49.8	0.00	4.02	0.00	4.02
OB4	7.0	33.8	0.00	5.92	5.92	11.83
OB5	8.8	50.5	3.96	5.94	3.96	5.94

Salmon and trout were present throughout the system, except for G3A, where no fish were caught or seen, and G4C, where no salmon were found. Salmon parr densities were greater than fry at all sites except G4D. Trout fry were not found in OB3, and were present at greater densities than parr at G2C and G4D only.

The maximum, minimum and mean densities are given for all sites (Table 18.3). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 18.3: A summary of the densities determined for all sites surveyed

Species/age class	**Minimum**	**Maximum**	**Mean**
Salmon fry	0.00	15.15	2.88
Salmon parr	0.00	8.43	4.55
Trout fry	0.00	68.18	13.69
Trout parr	0.00	22.73	9.77

A look at the annual variations in salmon densities (Fig. 18.1) indicates that the 2020 densities are within the lower end of the range previously observed for both fry and parr. Trout densities, by contrast, are average for the catchment (Fig. 18.2). Trout would appear to dominate the catchment except for 2016.

Figure 18.1: Temporal changes in average salmon densities within the catchment

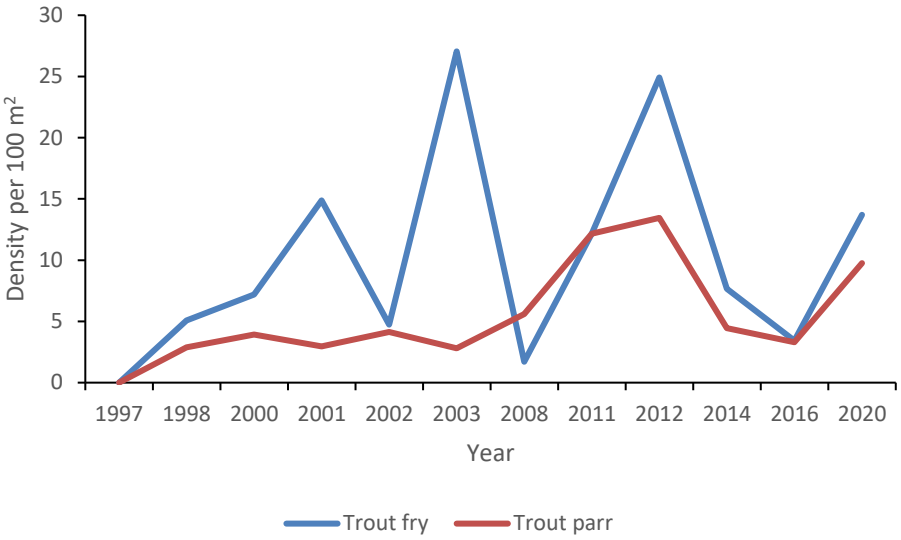

Figure 18.2: Temporal changes in average trout densities within the catchment

Discussion

The absence of fish within G3A reflects the situation observed since 2014 and is likely to be a function of the available habitat. The consistent presence of trout juveniles prior to 2014 would, however, suggest that there has been a change in this tributary. This could be in flow, accessibility or substrate. Alternatively, it could reflect a reduction in spawning or spawning success more widely, with a subsequent reduction in the movement of juvenile to sub-optimal habitats. This is not reflected in the pattern observed at other sites however, and an assessment of access would be beneficial.

In a mixed salmon and trout population, salmon will frequently outcompete trout. However, during the 2020 survey trout routinely outcompete salmon within this catchment. This reflects the available habitat and supports the view that the Garvie catchment is primarily a trout system, as seen in the catch returns. The Oscaig Woods is of greatest singular importance to the trout. This is likely to be intensified by the riparian woodlands surrounding the burn, which produce shading, cover, bank stability and increased food supply. The preservation of this habitat, and its extension to other parts of the catchment, is highly recommended.

The temporal fluctuations in juvenile trout and salmon populations can be attributed to natural ecosystem dynamics, fluctuating marine pressures on migratory salmonids, and river conditions affecting the efficiency of the surveys. However, despite this, the surveys would suggest a relatively stable salmon population and a fluctuating but health trout population.

19. Remaining NEPS sites

Table 19.1 gives the grid reference and catchment of each site, together with minimum estimates of density for salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

As expected, given the reason and method of site selection, salmon dominate the sites, with fry being the dominant life stage at all sites except Inver_4665. The latter reflects the habitat surveyed. The sampling sites within the Dionard have poor instream cover and are sub-optimal for electrofishing. The low densities are therefore likely to reflect the habitat surveyed rather than the situation within the river.

Table 19.1: A summary of the density of salmon and trout fry (0+ years) and parr (greater than 1 year) at each site per 100 m^2

Site Code	Easting	Northing	Catchment	Minimum Density (100 m^2) Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
4507	233697	958499	Dionard	15.40	1.81	1.81	0.00
4523	233918	958868	Dionard	8.20	0.51	0.51	0.51
4530	232975	957216	Dionard	4.11	0.82	0.82	0.00
4529	224757	920384	Inver	35.03	17.51	4.17	0.00
4649	224963	918378	Inver	26.46	21.17	1.76	0.00
4665	224655	919597	Inver	5.05	17.69	0.84	0.84
4509	208668	913656	Polly	9.64	7.23	0.80	0.00
4633	207390	913373	Polly	22.96	2.65	1.77	0.88

The maximum, minimum and mean densities are given for all sites (Table 19.2). This summarises the data and allows comparisons within the system and with other systems within the west Sutherland area.

Table 19.2: A summary of the densities determined for all sites surveyed

Species/age class	Minimum	Maximum	Mean
Salmon fry	4.11	35.03	15.86
Salmon parr	0.51	21.17	8.68
Trout fry	0.51	4.17	1.56
Trout parr	0.00	0.88	0.28

Discussion

As NEPS has been developed as an addition to the Salmon Conservation Regulations, attempting to bring juvenile densities into the classifications, the sites are selected on the basis of their accessibility to salmon. As such, the dominance of salmon at each site is to be expected. Trout were present at all sites surveyed, although at low densities.

The densities observed at each site are a reflection of the habitat present as well as the status of the fish population p*er se*. Salmon and trout, as well as fry and parr, tend to use different habitats and this is reflected in the results obtained. Despite the selection of the sites for salmon presence, the random nature of the site selection ensured that there was no bias in habitat selection and that the results reflect a broad assessment of the west Sutherland population as opposed to that of individual catchments.

20. Average for the West Sutherland Fisheries Trust area

The average densities of fish within each catchment are summarised (Table 20.1). This allows comparison between the catchments, although it should be noted that temporal changes in density throughout the summer months and habitat differences between catchments are not considered in this table. The timing of sampling is important, with fish moving within the tributaries as a result of water height and temperature, food availability and size. Thus, sampling after a spate may give a low density as a result of washout, whilst drought may decrease density as fish move into deeper water to avoid predation or desiccation or may increase density as a result of concentration in severe cases. Similarly, densities will be greater shortly after hatching, reducing with time as the fish grow and require a larger territory for survival.

Table 20.1: Average densities of salmonids per catchment surveyed

Catchment	Average density (100 m²)			
	Salmon fry	Salmon parr	Trout fry	Trout parr
Hope	13.66	5.42	9.37	4.19
Achriesgill	2.02	0.00	6.48	8.48
Oldshoremore	6.45	3.66	6.56	3.55
Loch Innis na Ba Buidhe	0.00	0.00	22.82	21.29
Loch na Thull	40.56	8.03	47.69	2.08
Laxford	21.69	10.18	32.13	2.81
Bad na Baighe	10.09	6.62	6.01	7.78
Claise na Fearna	2.38	6.74	18.83	16.32
Loch nam Brac	0.00	0.00	22.47	9.15
Bhadaidh Daraich	0.00	0.00	7.69	12.54
Geisgeil	7.57	1.15	7.66	5.59
Duart	10.85	10.56	16.02	12.66
Quinag	20.30	8.66	17.26	7.97
Gleann Leireag	0.00	0.00	25.32	8.94
Oldany	0.37	1.95	8.68	0.37
Clashnessie	0.00	1.21	2.42	16.92
Culag	3.59	0.42	1.18	0.00
Garvie	2.88	4.55	13.69	9.77
NEPS additional sites	15.86	8.68	1.56	0.28
West Sutherland area average	**8.33**	**4.10**	**14.41**	**7.93**

As evident from Table 20.1 and Figures 20.1 and 20.2, there is a good distribution of salmonid species throughout the West Sutherland area with trout present in every system surveyed. Salmon were present in most catchments and would not be expected in Loch nam Brac or Gleann Leireag as a result of natural barriers downstream of the survey area. The area average trout densities are greater than salmon densities.

Figure 20.1: Average salmon fry and parr densities within West Sutherland catchments shown alongside the average fry and parr densities for the West Sutherland area 2020

Figure 20.2: Average trout fry and parr densities within West Sutherland catchments shown alongside the average fry and parr densities for the West Sutherland area 2020

21. SFCC Classification

The SFCC absolute regional classification scheme, presented in Table 21.1, was developed so that fish populations could be compared across Scotland, allowing electrofishing results in Sutherland to be presented in a Scottish context. Unlike the relative regional classification scheme, this does not take into account river width which is known to affect salmonid densities with generally more fish present in narrower tributaries. When compared to the SFCC regional classification scheme for the North West area, salmonid densities range from absent (unclassified) to excellent and there is a lot of within-catchment variation, in part due to the location, habitat type, and accessibility.

Table 21.1: SFCC salmonid density classification scheme for the North West area

		Minimum density (100 m²)			
SFCC Class	**Descriptor**	**Salmon fry**	**Salmon parr**	**Trout fry**	**Trout parr**
A	Excellent	26.05	13.09	15.80	8.58
B	Good	14.15	8.04	8.25	4.31
C	Moderate	8.00	4.67	4.26	2.72
D	Poor	4.42	2.58	1.99	1.52
E	Very poor	0.78	0.66	0.44	0.22
U	Unclassified	0.00	0.00	0.00	0.00

**The percentages of SFCC classifications across the west Sutherland area for 2020 are displayed in Figure 21.1. 39% of all sites were classed as having moderate to excellent salmon fry densities (15% classed as excellent), with salmon parr densities classed as moderate to excellent within 38% of all sites (20% classed as excellent). Trout fry densities were classed as moderate to excellent in 61% of all sites, (25% classed as excellent), with 59% of sites containing moderate to excellent trout parr densities (25% classed as excellent).

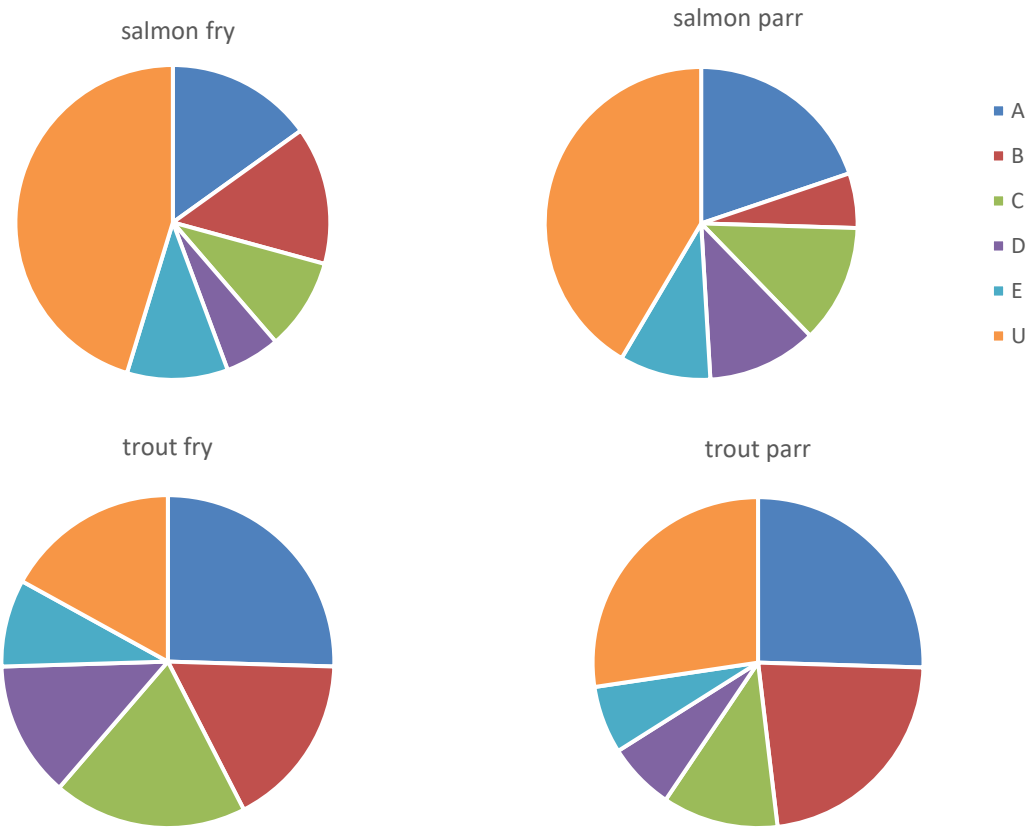

Figure 21.1: West Sutherland area salmonid densities according to the SFCC classification scheme

22. Other species

While undertaking these surveys we also encounter other species within the sites. Trout can be seen to be present at the majority of sites surveyed, with only 5 catchments having sites that did not contain the species (Fig. 22.1). Salmon, in contrast, were only present at all sites in 3 catchments. Eels were present in all catchments, apart from Quinag, but only at all sites within 6 catchments, indicating some variability in distribution. Minnows were also widespread throughout the area, although absent from 8 catchments, and with only the Culag returning minnows at each site. This is likely to reflect the location of the sites and the fact that the minnow is an introduced species and therefore more likely to be patchily distributed. Stickleback were only recorded during the assessment of additional NEPS sites, specifically within the Dionard.

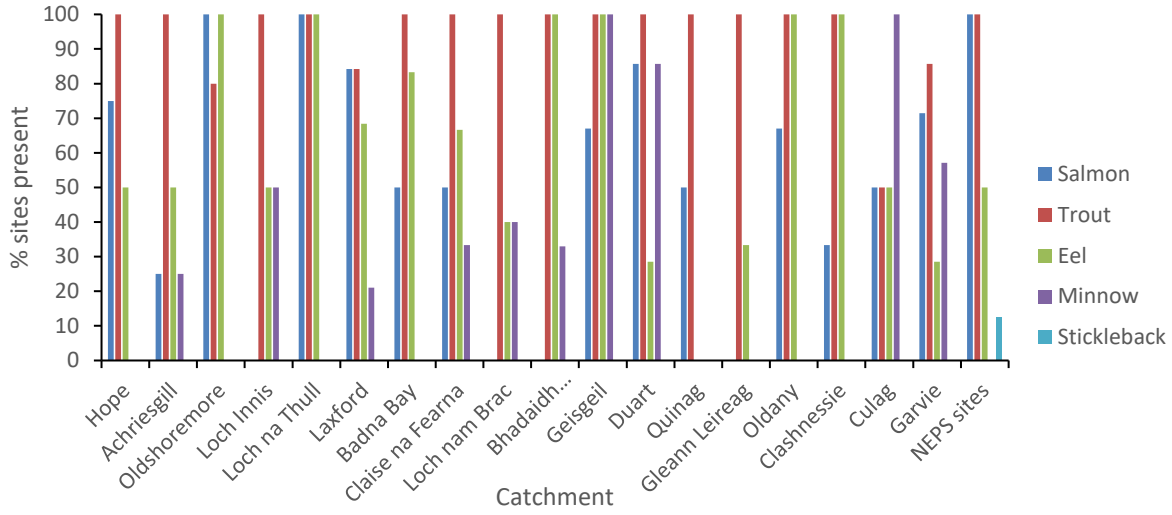

Figure 22.1: Species composition and distribution per catchment

23. Discussion

Suspension of the 2020 NEPS programme as a result of Covid-19 enabled a more wide-ranging assessment of catchments within the area. The decision was made, however, to include some of the previous NEPS sites and these have been included within this report. While reported within the summary as NEPS, and treated as a single catchment, it included information on 3 separate catchments – Dionard, Inver and Polly.

Catchments surveyed during 2020 included 4 trout dominated systems, of which 2 are inaccessible to migratory fish. This is balanced with the inclusion of 2 larger salmon dominated catchments which would suggest that the area average is a good reflection of the situation within West Sutherland and not dominated by catchment selection. This indicates that trout are the more dominant species within the area, with both fry and parr densities being greater than salmon. This is as expected given the nature and scale of the rivers and burns within the area, with a large number of small, coastal burns and a few larger salmon dominated systems.

The spread of minnows within the area is of some concern and reflects angler practice to a large extent. Introduced historically as live bait, their spread partly reflects the accessibility of the sites, i.e. proximity to roads, and their relatively high reproductive rate. Where present they can out-compete salmonids, thus impacting on their population. This should therefore be monitored to ensure that there is no spread to virgin sites.

Whilst instream habitat characteristics within the West Sutherland area are generally favourable for salmonids, strategic planting of mixed broadleaf trees within riparian zones would undoubtedly improve fish cover, food availability, and bankside stability.