West Sutherland Fisheries Trust

2016 Electro-fishing Surveys

A report to the West Sutherland Fisheries Trust, Report No. WSFT1/17

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Introduction

As part of West Sutherland Fisheries Trust's work programme, established sites in each freshwater catchment are routinely monitored every two years by undertaking 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. Where possible all sites were revisited, although some could not be accessed due to time and flow constraints. Some sites were removed from the surveys on the basis of previous results and additional sites were added in some instances. This report summarises the data for each catchment. Maps giving the location of each site and pictorially represented densities are available on request. Similarly, graphic data for each catchment is also available.

During 2016 a series of additional catchments were surveyed by WSFT under contract from SNH. Two of these catchments contained sites which are routinely monitored by WSFT within the Polly and Kirkaig catchments, therefore juvenile data from these surveys carried out in September/October has been used for comparisons.

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 all 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 (as fully quantitative multiple fishing run depletion surveys do), this is a more appropriate method when considering the purpose of the surveys; to monitor temporal changes in juvenile populations within a single catchment. A greater number of sites can be fished given available resources and the physical nature of the west Sutherland catchments. This results in a broad picture of the population status of each catchment which can then be easily 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, most commonly using small hand nets due to the narrow water channels and slow flows, 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 2 Phenoxyethanol, 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 m2 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. Garvie 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.

Site Code	Easting	Northing	Altitude	River	Situation
G2C	213250	906500	70	River Garvie	By riffle, just below deer fence
G3A	213800	906600	50	River Garvie	Downstream of ford over tributary
OB1	205200	911700	35	River Garvie	In the braids, by Keith's willow bundles in the first braid reached
OB3	205250	911650	40	River Garvie	Above large boulder in 1st main braid (OB2)
OB4	205250	911700	40	River Garvie	Centre braid, adjacent to Keith's boulders
G4D	204900	911000	25	River Garvie	By loch, to big boulders

Table 1.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
G2C	17.8	62.3	6.42	9.63	6.42	8.03
G3A	7.4	18.25	0	0	0	0
OB1	3	6.3	0	0	31.75	15.87
OB3	10.4	52.69	1.90	13.29	0	1.90
OB4	12.5	51.67	19.35	9.68	3.87	0
G4D	17.5	56.58	0	0	5.30	12.37

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*

The maximum, minimum 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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	0	19.35	4.61
Salmon parr	0	13.29	5.43
Trout fry	0	31.75	7.89
Trout parr	0	15.87	6.36

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

Trout are distributed throughout all sites other than G3A where no fish were caught or seen. Where salmon were present they dominated trout. Salmon parr densities were greater than salmon fry densities other than within OB4. Trout fry densities were higher than trout parr within OB1 and OB4. Eels were present within OB1 and OB4, with the highest number (10) seen in OB4. Minnows were present within G3A and G4D, with the highest number (18) seen in G4D. Three distinct age classes from 0+ years to 2+ years were seen within juvenile salmon populations. Four distinct age classes were seen within trout populations from 0+ years to 3+ years.

Figures 1.1 and 1.2 show temporal changes in juvenile salmonid densities per 100m^2 by catchment average, separated by salmon and trout. Figure 1.1 shows the 2016 average salmon parr density to be within the average range, while the fry density is slightly below average; however, fry densities have increased since 2012 while parr densities have increased since 2014. Figure 1.2 shows the average trout parr density of 2016 to be slightly higher than recorded in previous surveys, while the fry density remains within the average range.

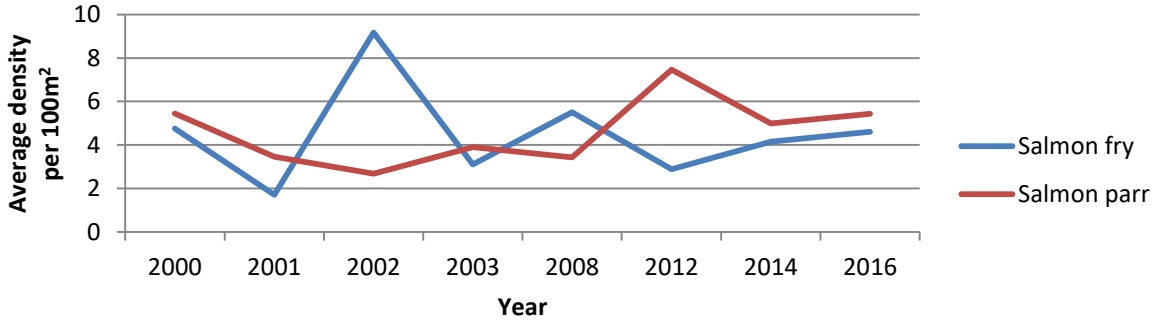

Figure 1.1: *Temporal changes in average salmon densities within the Garvie catchment*

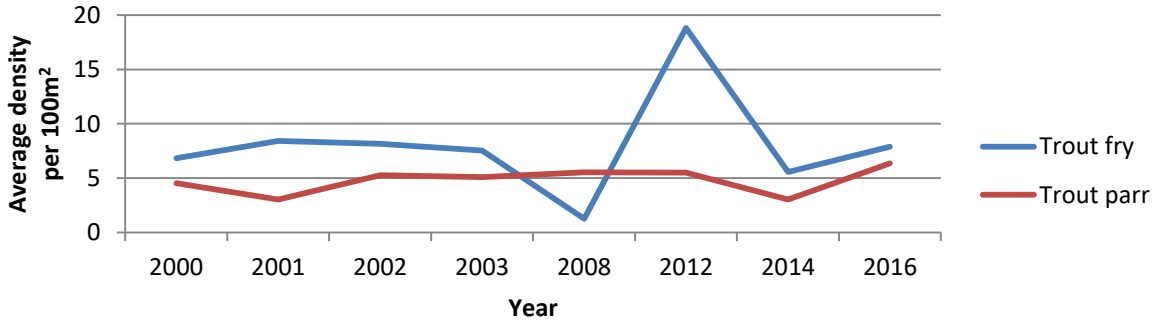

Figure 1.2: *Temporal changes in average trout densities within the Garvie catchment*

Discussion

The wet summer of 2016 forced surveys to be carried out at different periods during breaks in between the rainfall. Water levels were sufficient to undertake the surveys however they were considerably higher than ideal summer low levels meaning that minimum density estimates are likely conservative due to the densities being calculated across a larger wetted area in combination with the higher likelihood of operator error due to probable increase of escapees, particularly fry.

The absence of fish within G3A may be attributed to higher water levels combined with habitat type being more suited to adults (which may have been pushed out of the site during the survey), however trout fry and/or parr have been consistently present within this site up until 2014. There was no spawning substrate apparent within the site and it may be that presence of juveniles within this site has followed seasons of more prolific spawning, causing juveniles to disperse more widely

into predominantly parr/adult habitat. It is not possible to determine this without having surveyed on a yearly basis. However, it would be appropriate to carry out presence/absence electro-fishing surveys and invertebrate sampling during 2017 in addition to gathering more detail on habitat type in the surrounding area in order to gain further information.

G2C, OB3, and OB4 are the most consistently productive sites for salmon due to accessibility and spawning substrate, while G2C, OB1, and G4D are the most consistently productive sites for trout. Both adult and juvenile salmon generally out-compete trout for territory, however, the Oscaig woods burn (containing G4D) is a stronghold for trout populations likely due to its smaller size and habitat type; large sections of this burn contain excellent wooded habitat which provides ideal cover, increased feeding opportunities, and bankside stability. It is important for these areas of riparian woodland to be preserved, and it would be beneficial for juvenile salmonid populations to undertake strategic riparian woodland restoration throughout other areas of the catchment.

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 operator efficiency during surveys. It is however promising to note that while the catchment average trout parr density has been relatively low since surveys began, it has not fluctuated dramatically suggesting the catchment maintains a stable population of trout which is likely augmented following years of more prolific sea trout spawning. It should also be noted that within a large system of lochs connected by small burns and rivers, parr are likely to migrate into the lochs particularly in years of greater abundance as they seek superior cover through increased water depth and new feeding territories; therefore it is possible that a greater population of salmonid parr exists than those recorded in electro-fishing surveys carried out within tributaries.

2. Polly catchment

Due to SNH contract requirements, surveys were carried out for all sites in May and again in October. This report covers the October surveys in order to provide both fry and parr data; fry found in May were too small to identify to species level. 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.

Site Code	Easting	Northing	Altitude	River	Situation
polly 3	207827	912744	10	River Polly	In braids, upstream of Stac Burn
polly 5	208186	912845	35	River Polly	RB, in riffle section upstream of fence
Stac 3.1	208176	912169	30	River Polly	50 m downstream of two trees and the fence

Table 2.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
polly 3	11.7	56.16	21.37	12.46	0.00	1.78
polly 5	13.5	37.8	13.23	7.94	15.87	2.65
Stac 3.1	17.2	49.31	14.20	14.20	6.08	4.06

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*

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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	14.20	21.37	16.26
Salmon parr	7.94	14.20	11.53
Trout fry	0	15.87	7.32
Trout parr	1.78	4.06	2.83

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

Two distinct age classes from 0+ years to 1+ years were seen within juvenile salmon populations. Four distinct age classes were seen within trout populations from 0+ years to 3+ years. Trout and salmon were distributed throughout all sites, with both trout and salmon fry densities being higher than parr other than Stac 3.1 where salmon fry and parr densities were equal, and polly 3 where no trout fry were caught. Salmon densities showed an overall dominance over trout. Eels were present within all sites other than polly 5 and were most abundant at polly 3 with 5 eels seen. Minnows were not present within any of the sites.

Figures 2.1 and 2.2 show temporal changes in juvenile salmon and trout densities per 100m^2 by catchment average. Figure 2.1 shows the 2016 average salmon fry density to be the highest since surveys began, while the average parr density has fallen slightly since 2014 although is still above average. Figure 2.2 shows the average trout fry and parr densities of 2016 to be the highest on record.

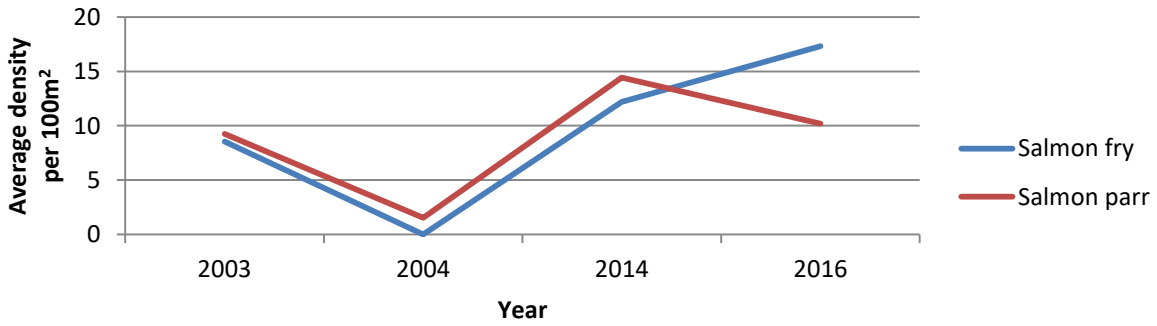

Figure 2.1: *Temporal changes in average salmon densities within the Polly catchment*

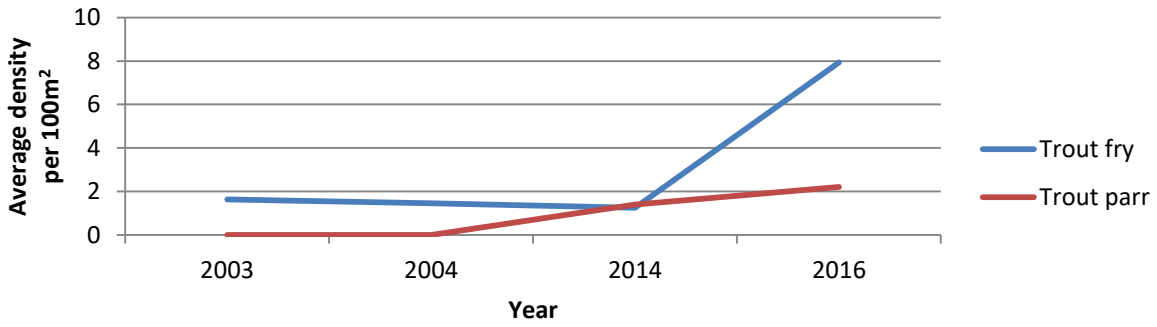

Figure 2.2: *Temporal changes in average trout densities within the Polly catchment*

Discussion

The lower Polly catchment is salmon dominated due to accessibility and habitat type. Polly 3 in particular contains a matrix-like section of boulders which provide excellent parr cover; it is likely that minimum parr densities found here were conservative due to the network of cave-like openings that would prevent fish being drawn up from underneath by the electric field. Both adult and juvenile salmon will outcompete trout for spawning areas and juvenile territories, however, the increase in trout fry and parr densities seen in 2016 may be a result in more prolific numbers of returning sea trout in recent years.

The temporal fluctuations in juvenile salmonid densities are a natural result of ecosystem dynamics and may also be attributed to varying marine pressures on migratory salmonids. However, due to time constraints it was only possible to survey a proportion of the sites originally carried out within the Polly catchment meaning that there are a smaller number of years included when considering temporal changes; as Stac 3.1 has only been surveyed once before in 2008, only Polly 3 and Polly 5 were used to calculate temporal catchment averages to provide a more accurate comparison albeit across a smaller number of years and survey sites.

3. Kirkaig catchment

Due to SNH contract requirements, surveys were carried out for all sites in May and again in October. This report covers the October surveys in order to provide both fry and parr data; fry found in May were too small to identify to species level. However, due to higher flows increasing the rate of escapees in October, graphic parr data from May has also been included as a point of reference. It must be remembered that while the minimum densities found in October are likely to be extremely conservative due to high flows, the parr densities found in May are likely to be an overestimate when considering densities usually found during surveys in the late summer; at which time only a proportion of these May parr would naturally remain within the site as a result of density dependent mortality and migration into new territories. In addition to this, the mid and upper Kirkaig sites were carried out as timed surveys at the edge of the main river stem as it is not possible to carry out a full survey of a large river using backpack equipment. This biases results towards fry due to the shallower water depth; the higher flows in October further biased results towards fry as it was not possible to move out as far into the river due to the faster current. The areas surveyed were measured allowing a conservative minimum density estimate to be calculated. This data has not been included in WSFT area average calculations and SFCC classifications due to the uncertainty of the results.

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.

Site Code	Easting	Northing	Altitude	River	Situation
K1	208350	919300	30	River Kirkaig	In braid below elder pool (height indicator). Rowan tree on RB near top of site
Mid Kirkaig	211702	917698	130	River Kirkaig	Riffle area above gorge
Upper Kirkaig	211872	917693	140	River Kirkaig	Grass below path, from cliff through bend

Table 3.1: *Electro-fishing site details*

Site Code	Length (m)	Area m^2	Minimum density ($100m^2$)			
			Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
K1	18.5	174.52	3.44	0.57	0	0
Mid Kirkaig	17.8	76.54	0	0	30.05	1.31
Upper Kirkaig	16.6	59.76	0	0	21.75	3.35

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*

Two distinct age classes from 0+ years to 1+ years were seen within both juvenile salmon and trout populations. The results show trout to be distributed throughout all sites other than K1; there is no salmon access to the Mid Kirkaig and Upper Kirkaig sites due to the naturally impassable "Falls of Kirkaig". Fry densities were greater than parr in both trout and salmon. 7 Eels were present within K1, and 1 minnow was seen in Mid Kirkaig.

Figure 3.1 displays temporal changes in juvenile salmon densities within K1. Considering the likely overestimation of the K1 parr density during May and the underestimation of the K1 fry/parr in October, it is likely that the October densities would be consistent with the previous years had the survey been carried out under normal flow conditions.

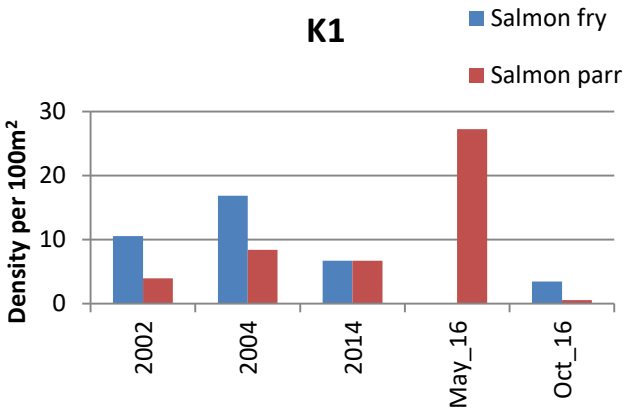

Figure 3.1: *Temporal changes in average salmon densities within K1*

Discussion

Despite the difficulties with comparisons and reliability of data due to the higher flow conditions experienced in October, it is likely that the juvenile salmon population is remaining stable, and it is promising to note an apparently healthy trout population above the falls. No trout have been recorded within K1 since surveys began. However, it would be interesting to gather juvenile trout and salmon data elsewhere in the main stem of the Kirkaig downstream of the falls in order to determine information on juvenile salmon and trout distribution; particularly due to the apparent lack of available spawning areas when considering the consistently high adult catch rates by rod and line.

4. Gleann Leireag 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 trout fry (0+ years) and parr (>1 year) per 100 m^2. Salmon are not present within the Gleann Leireag catchment upstream of the falls near the hatchery site; the survey sites are all upstream of this point. Salmon were previously stocked above the falls as a trial, however no salmon have been found since other than an extremely low number of juveniles found during the 2006 surveys.

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

Table 4.1: *Electro-fishing site details*

			Minimum density (100m^2)	
Site Code	Length (m)	Area m^2	Trout Fry	Trout Parr
GLL1	10.2	51.68	1.93	15.48
GLL2	31	53.94	20.39	9.27
GLL3	19.4	78.89	10.14	7.61

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

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.

Species/age class	Minimum	Maximum	Mean
Trout fry	1.93	20.39	10.82
Trout parr	7.61	15.48	10.78

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

Four distinct age classes from 0+ years to 3+ years were seen within the trout populations. Trout were distributed throughout all sites, with the highest density of fry found within GLL1. Parr densities were lower than fry other than within GLL1. No other species were caught or seen during the surveys.

Figure 4.1 shows temporal changes in juvenile trout densities per 100m^2 by catchment average. The 2016 average trout fry density is the lowest recorded since 2004; it is also within the lowest range recorded since surveys began. However, the average trout parr density for 2016 is the 2nd highest recorded since surveys began.

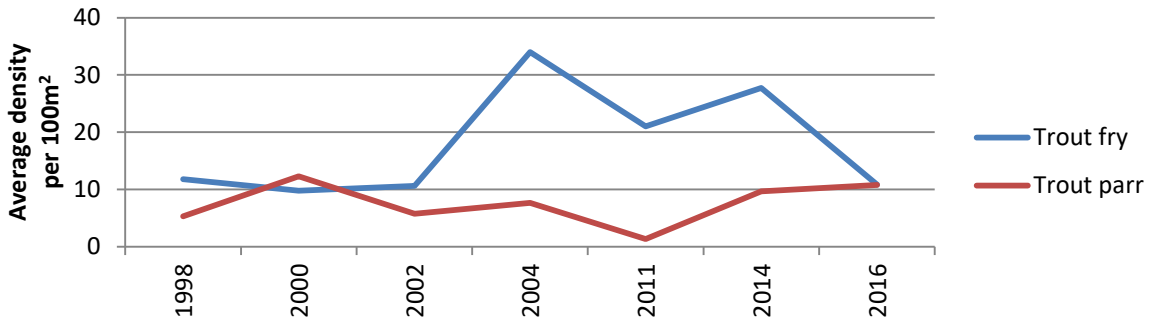

Figure 4.1: *Temporal changes in average salmon densities within the Gleann Leireag catchment*

Discussion

The habitat within GLL1 is suited to parr, GLL2 to fry, and GLL3 mixed. The results of the surveys reflect these differing habitats and show a strong and consistent population of trout within the catchment. The nursery habitat within GLL2 appears to be in good condition, which is reinforced by the consistently high densities of fry. The temporal fluctuations in the trout populations across the survey sites can be attributed to natural ecosystem dynamics, with some years yielding better spawning results and/or surviving offspring than others. This appears to be an enclosed resident population of trout due to the natural falls near the hatchery, and it is interesting to note the relatively stable population of parr (fry are more naturally prone to dramatic fluctuations) when compared with migratory systems within the west Sutherland area.

5. Loch Nam Brac 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 trout fry (0+ years) and parr (>1 year) per 100 m^2. Minimum densities of trout are also graphically displayed in figures 2 and 3. No salmon have ever been recorded in the sites surveyed within the Loch Nam Brac catchment.

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

Table 5.1: *Electro-fishing site details*

Site Code	Length (m)	Area m^2	Minimum density ($100m^2$) Trout Fry	Trout Parr
NB1	20.7	41.4	48.31	7.25
NB2	18	21.6	41.67	13.89
NBA1	16.6	32.09	158.93	0.00
NBA2	12.2	35.38	53.70	14.13
NBA3	29.2	75.92	50.05	9.22

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

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.

Species/age class	Minimum	Maximum	Mean
Trout fry	41.67	158.93	70.53
Trout parr	0	14.13	8.90

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

Three distinct age classes from 0+ years to 2+ years were seen within the trout populations. However, only one fish was found to be 2+ years suggesting trout of this age rarely remain within the burns. Trout were distributed throughout all sites, with an exceptionally high density of fry within NBA1 where no parr were present. Parr densities were lower than fry within all other sites. Eels were present within NBA1 and NBA2 with 6 and 4 eels seen respectively. Minnows were present within NBA1 and NB1 (where numbers seen were >30).

Figure 5.1 shows the 2016 average trout fry density to be the highest since surveys began. This average was undoubtedly pushed up by the exceptional numbers of fry found within NB1A; it is unclear as to why the numbers were so high within this site in comparison to previous years. Parr densities have remained stable since surveys began. Despite a slight downward trend since 2012 the 2016 surveys show average parr densities to be within the average range.

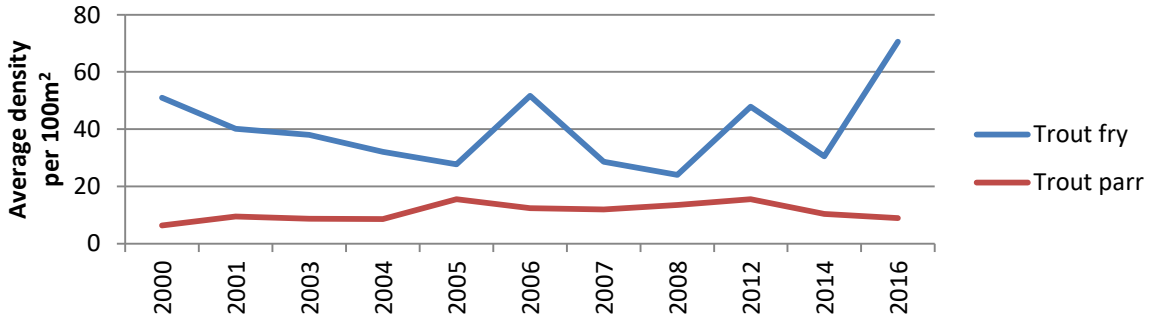

Figure 5.1: *Temporal changes in average trout densities within the Loch Nam Brac catchment*

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. The results of the surveys reflect these migratory tendencies; the lack of older trout found within the sites strongly points towards older fish moving into nearby Loch Nam Brac. The burns are small and shallow, whereas the loch provides better cover through deeper water along with increased feeding opportunities. The nursery habitat within the burns appears to be in good condition, which is reinforced by the consistently high densities of fry however, some patches of substrate are partially compacted. The temporal fluctuations in fry populations can be attributed to natural ecosystem dynamics, with some years yielding better spawning results and/or surviving offspring than others; however, similarly to Gleann Learigg it is interesting to note the very stable parr populations when comparing with other catchments. The lack of competing salmon combined with the 'enclosed system' and resident trout population of the nearby loch may provide for a more stable system than those where marine influences play a larger part.

6. Claise na Fearna 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.

Site Code	Easting	Northing	Altitude	River	Situation
Bmain3	220000	946400	50	Allt na Clais Fearna	Just above small falls, near road bridge
Bmain6	219700	946100	60	Allt na Clais Fearna	Glide near house
Bmain8	219500	945800	60	Allt na Clais Fearna	Near Loch a Bhagh Ghaimmhica
Outflow 3	220600	947700	10	Allt na Clais Fearna	In trees, close to sea, downstream of bend

Table 6.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
Bmain3	16.2	37.26	0	8.05	0	10.74
Bmain6	18.5	42.55	11.75	30.55	2.35	7.05
Bmain8	21.6	68.4	1.46	7.31	26.32	2.92
Outflow 3	8.7	26.68	0	0	3.75	3.75

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*

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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	0	11.75	3.30
Salmon parr	0	30.55	11.48
Trout fry	0	26.32	8.10
Trout parr	2.92	10.74	6.11

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

Three distinct age classes from 0+ years to 2+ years were seen within both trout and salmon populations. Trout were distributed throughout all sites surveyed. Where salmon were present, parr densities were greater than fry densities. Eels were present within Outflow 3 and Bmain6, with the highest number (4) seen in Outflow 3. 2 Minnows were seen within Bmain3.

Figures 6.1 and 6.2 show temporal changes in juvenile salmon and trout densities per $100m^2$ by catchment average. Figure 6.1 shows the 2016 average salmon parr density to be slightly below the highest recorded average, while the fry density is below average. Figure 6.2 shows 2016 to have the lowest recorded average trout fry density, with the average parr density slightly below average.

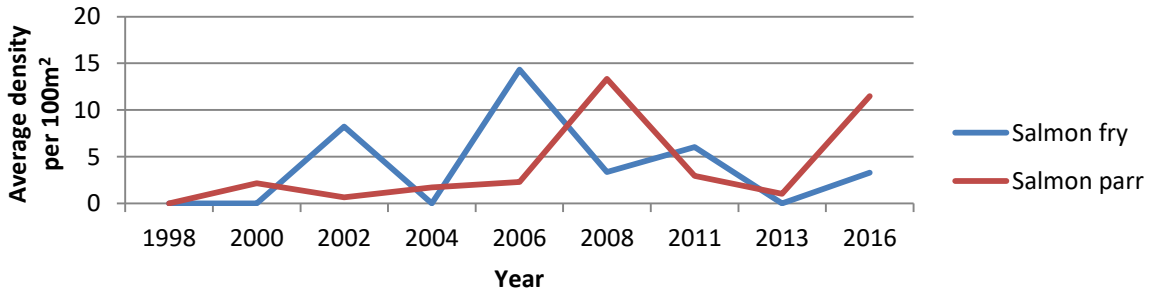

Figure 6.1: *Temporal changes in average salmon densities within the Claise na Fearna catchment*

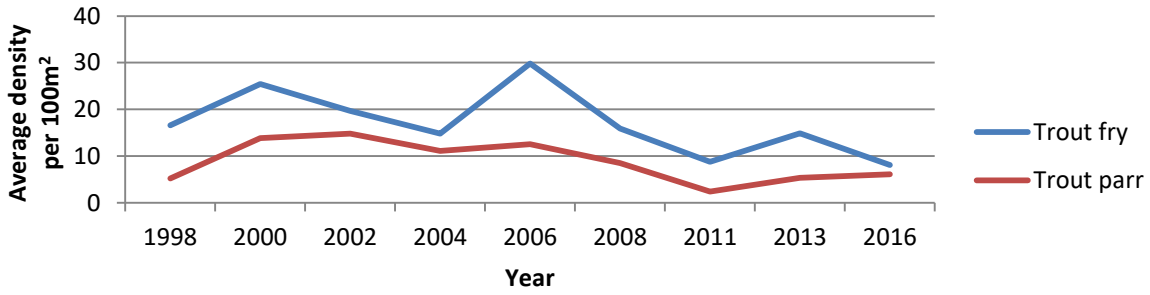

Figure 6.2: *Temporal changes in average trout densities within the Claise na Fearna catchment*

Discussion

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; however, 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.

The trout population appears to be consistent although it is currently showing a downward trend with regard to the sites surveyed and the graph displayed in figure 10. Continued monitoring will 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 slight increase in salmon densities over recent years due to adult and juvenile salmon outcompeting trout for territory. Since 2006, BMain6 has had an increase in salmon densities (despite missing fry in 2008) whilst trout densities have decreased and have been greatly outnumbered by salmon.

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; 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.

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.

Site Code	Easting	Northing	Altitude	River	Situation
BB1	222100	946500	10	Allt Bad na Baighe	30m from boundary fence
BB2	222700	946000	20	Allt Bad na Baighe	Near loch
BB4	222400	945400	50	Allt Bad na Baighe	Above falls on way to junctions of 3 tributaries
BB5	222500	945500	30	Allt Bad na Baighe	Downstream, in riffle area
BB6	222700	945600	25	Allt Bad na Baighe	Deep pool
BB7	223000	945600	15	Allt Bad na Baighe	By loch

Table 7.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
BB1	9.8	51.94	1.93	1.93	0	1.93
BB2	11.2	38.08	0.00	0.00	2.63	2.63
BB4	10.7	27.11	0.00	0.00	3.69	22.13
BB5	12.3	36.49	13.70	32.89	0	10.96
BB6	15.3	47.43	4.22	12.65	4.22	10.54
BB7	15.2	44.08	11.34	9.07	4.54	9.07

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*

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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	0	13.70	5.19
Salmon parr	0	32.89	9.42
Trout fry	0	4.54	2.51
Trout parr	1.93	22.13	9.54

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

Three distinct age classes from 0+ years to 2+ years were seen within juvenile salmon populations. 5 distinct age classes were seen within trout populations from 0+ years to 4+ years. Trout were distributed throughout all sites, with both trout and salmon densities being higher within sites above the loch, other than BB4 where there were no salmon present. Where salmon were present they showed a slight dominance over trout. Salmon parr densities were greater than salmon fry densities within BB5 and BB6, while fry densities were greater than parr within BB7, with BB1 containing equal densities of fry and parr. Trout parr densities were higher than trout fry within all sites other than BB2 where fry/parr densities were equal. Eels were present within all sites and were most abundant at BB5 with 14 eels seen. Minnows were not present within any of the sites.

Figures 7.1 and 7.2 show temporal changes in juvenile salmon and trout densities per $100m^2$ by catchment average. Figure 7.1 shows the 2016 average salmon parr density to be above average, while the fry density is below average; this may be due to poorer salmon spawning seasons between 2013 and 2015. The higher parr densities of 2016 may be explained by an increase in survival rate of 2 year old salmon; data comparisons could be made between the 2016 electro-fishing surveys and the Bad na Baighe smolt trap results of 2016 and the forthcoming 2017 trap data. Figure 7.2 shows the average trout parr density of 2016 to be the highest on record, while the fry density remains within the lower regions. The higher number of parr to fry may be due to habitat type surveyed in combination with older trout present migrating into these areas.

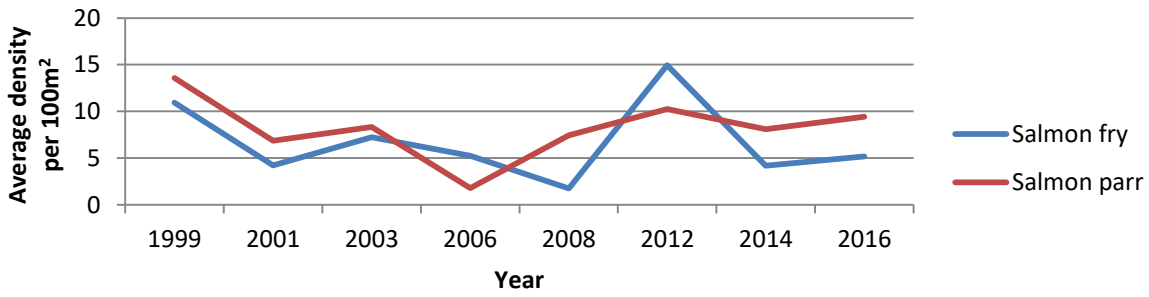

Figure 7.1: *Temporal changes in average salmon densities within the Bad na Baighe catchment*

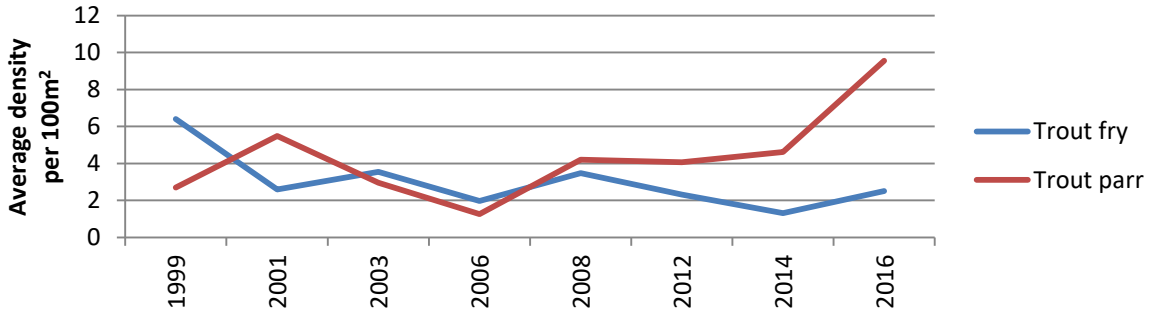

Figure 7.2: *Temporal changes in average trout densities within the Bad na Baighe catchment*

Discussion

The results of the surveys reflect the habitat of the burn below the loch appearing to be less optimal for juvenile salmonids, particularly in regard to spawning and fry habitat due to partially compacted substrates and poorer instream cover; however much of the habitat within this burn is well suited to adult trout and migrating adults due to deeper pools interspersed between the shallow areas. The temporal fluctuations in juvenile trout and salmon populations can be attributed to natural ecosystem dynamics; however it is disappointing to notice a downward trend in trout fry densities which may be a result of increasing marine pressures on sea trout. Close monitoring of juvenile populations combined with the annual smolt monitoring program and Laxford post-smolt surveys will continue to be carried out in order to determine whether or not this is part of a longer term natural cycle.

8. Loch Na Thull 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.

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

Table 8.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
NT1	17.6	65.12	84.46	6.14	33.78	3.07
NT2	14.7	70.07	4.28	0.00	18.55	1.43
NT3	21.4	40.66	130.35	63.94	9.84	2.46
NT7	7.8	16.38	30.53	36.63	6.11	24.42

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*

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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	4.28	130.35	62.40
Salmon parr	0	63.94	36.63
Trout fry	6.11	33.78	17.07
Trout parr	1.43	24.42	7.84

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

Three distinct age classes from 0+ years to 2+ years were seen both within juvenile trout and salmon populations; however only 2 salmon were found at 2+, suggesting juvenile salmon of this age class are scarce. While trout were present in all sites, there was a dominance of salmon in all sites other than NT2. Both salmon and trout fry occurred in much higher densities than parr with the exception of NT7 where salmon and trout parr densities were higher than fry. Eels were present at all sites in the catchment and were most abundant at NT2 with 22 eels seen. Minnows were not present within any of the sites.

Figures 8.1 and 8.2 show temporal changes in juvenile salmon and trout densities per 100m^2 by catchment average. Figure 8.1 shows a steady upward trend for the catchment average salmon fry and parr densities since surveys began, with the highest recorded average densities of both salmon fry and parr recorded in the 2016 surveys; the high numbers found in 2016 suggest excellent spawning seasons during 2014 and 2015 due to the vast majority of parr being 1+ in age. Figure 8.2 shows that trout fry densities have moved up and down dramatically since surveys began, with the densities found in the 2016 surveys well above average. Trout parr densities have generally been increasing since surveys began and 2016 shows the highest recorded average to date.

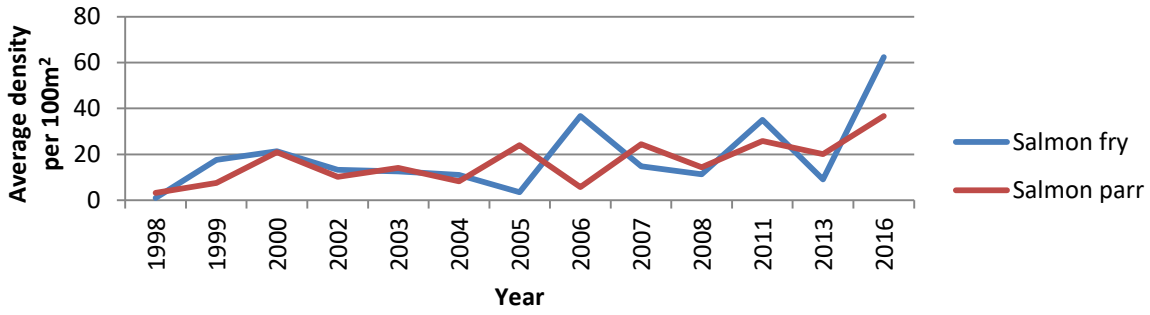

Figure 8.1: *Temporal changes in average salmon densities within the Loch Na Thull catchment*

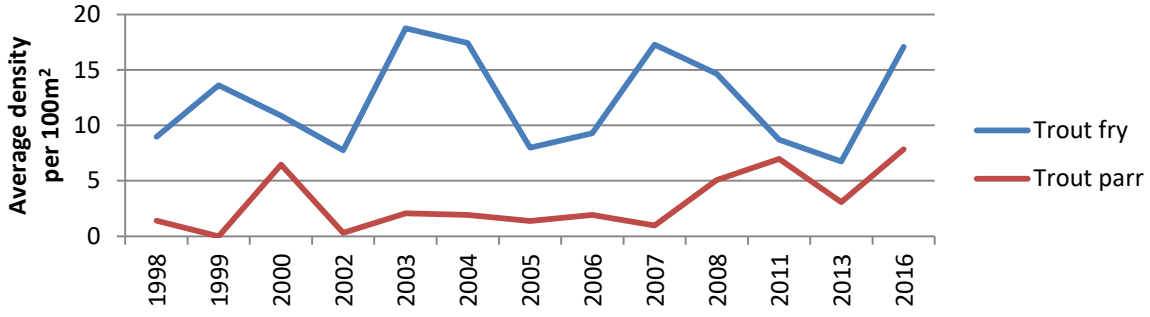

Figure 8.2: *Temporal changes in average trout densities within the Loch Na Thull catchment*

Discussion

Given the narrow access burns between the lochs it is likely that there will be years where salmon spawning prosperity varies due to access determined by rainfall. 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. The trout fry densities fluctuate dramatically. This is likely to be a result of natural ecosystem dynamics, and varying marine pressures on sea trout. It is also important to consider that both adult and juvenile salmon will out-compete trout for territories; NT2 has historically contained the lowest salmon densities, while trout fry densities remain consistently strong in this site. This is the furthest upstream site surveyed within the catchment and it would follow that it is less favoured by salmon due to the smaller size of the burn, meaning that trout have more freedom to spawn in these reaches of the catchment. 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 are likely to migrate to neighbouring lochs to seek increased cover and feeding opportunities.

9. Achriesgill 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 salmon and trout fry (0+ years) and parr (>1 year) per 100 m^2.

Site Code	Easting	Northing	Altitude	River	Situation
GL1	225700	954100	10	Achriesgill Water	In main river, just above bridge
GL2	226600	953100	70	Achriesgill Water	Down from water work, across from ruin
GL3	227100	953900	35	Achriesgill Water	Down from double passing place, by boulder pile on bend of river

Table 9.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
GL1	10.2	74.46	6.72	5.37	2.69	0
GL2	16.6	122.29	0	0	8.99	4.09
GL3	11.4	66.5	0	0	4.51	4.51

Table 9.2: *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*

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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	0	6.72	2.24
Salmon parr	0	5.37	1.79
Trout fry	2.69	8.99	5.40
Trout parr	0	4.51	2.87

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

Two distinct age classes from 0+ years to 1+ years were seen within salmon populations, and 3 distinct age classes were seen within trout populations; 0+, 1+, 3+. No 2+ trout were caught during the surveys. Trout were distributed throughout all sites surveyed, whereas salmon were only present in GL1 where they dominated trout. Trout fry densities were greater than parr other than GL3 where densities were equal. Eels were present within all sites, with the highest number (6) seen in GL2. Minnows were not present within the sites.

Figures 9.1 and 9.2 show temporal changes in juvenile salmonid densities per 100m^2 by catchment average. Figure 9.1 shows the 2016 average salmon fry density to be slightly below average due to the large peak in 2008, although 2016 shows an increase since 2012 and 2014 and where no fry were recorded. Average salmon parr densities have fluctuated since surveys began with the 2016 surveys showing an increase since 2012; however the average salmon parr density for 2016 falls within the lower regions since surveys began. Figure 9.2 shows the average trout fry density to be within the average range; it is also the highest recorded average density since 2004. The average trout parr density has fluctuated since surveys began and currently falls below the average range.

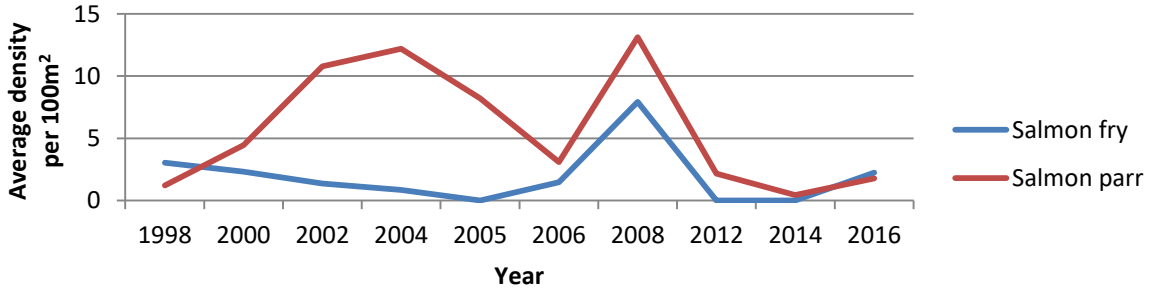

Figure 9.1: *Temporal changes in average salmon densities within the Achriesgill catchment*

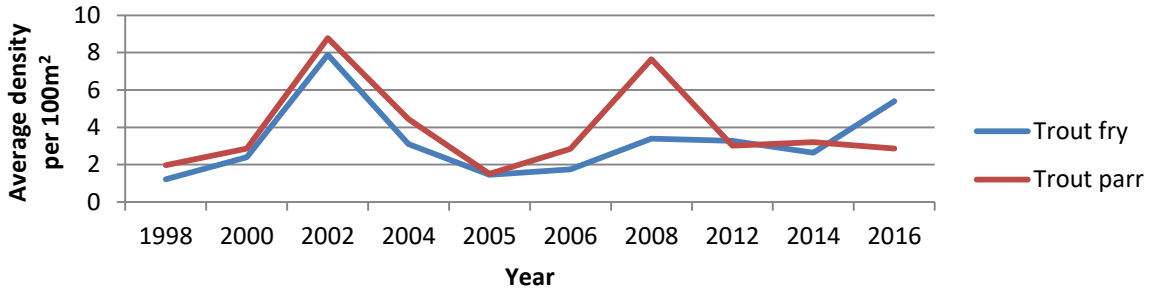

Figure 9.2: *Temporal changes in average trout densities within the Achriesgill catchment*

Discussion

With regard to juvenile salmon, the results of the surveys reflect the fact that salmon spawning prospects are likely to be heavily limited by seasonal rainfall; river levels within the steep catchment and shallow narrow tributaries with 'step pool' type sections must be sufficient to allow access to adults. GL1 is the most consistently productive of these three sites due to its close proximity to the sea, whereas the altitude of GL2 is much greater and it is situated above 'step pool' sections; this tributary also has a smaller watershed than the situation of GL3. Salmon populations tend to dominate over trout which may explain the solid consistency of juvenile trout populations within GL2 which is rarely visited by salmon. Whilst trout are consistently present throughout all sites, the fluctuations in densities (particularly where fry and parr numbers show large spikes) are likely to be attributed to varying marine pressures on sea trout with the higher densities likely to be the offspring of sea trout following seasons when numbers of returning adults have been more prolific.

10. Oldshoremore 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.

Site Code	Easting	Northing	Altitude	River	Situation
OM1	221800	958950	55	Abhainn Aisir Mhor (Oldshoremore)	Near head of Loch Aisir Mor
OM2	222100	958700	65	Abhainn Aisir Mhor (Oldshoremore)	Pool-riffle in gully, rise to the left bank
OM5	220784	958956	40	Abhainn Aisir Mhor (Oldshoremore)	Below wall, near islands. Large white rock in centre. Island and riffle in centre of site (left to right)

Table 10.1: *Electro-fishing site details*

			Minimum density (100m^2)			
Site Code	Length (m)	Area m^2	Salmon Fry	Salmon Parr	Trout Fry	Trout Parr
OM1	25	75	26.67	9.33	13.33	1.33
OM2	10.8	30.96	0	16.15	0	0
OM5	15.4	86.24	0	0	0	8.12

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*

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.

Species/age class	Minimum	Maximum	Mean
Salmon fry	0	26.67	8.89
Salmon parr	0	16.15	8.49
Trout fry	0	13.33	4.44
Trout parr	0	8.12	3.15

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

Three distinct age classes from 0+ years to 2+ years were seen within juvenile salmon populations. Four distinct age classes were seen within trout populations from 0+ years to 3+ years. Salmon were present in OM1 and OM2, with trout present in OM1 and OM5. Salmon fry densities were greater than parr within OM1, while OM2 contained only parr. Trout fry densities were greater than parr in OM1 while OM5 contained only parr. Eels were present within all sites and were most abundant at OM5 with 12 eels seen. Minnows were not present within any of the sites.

Figures 10.1 and 10.2 show temporal changes in juvenile salmonid densities per 100m^2 by catchment average. Figure 10.1 shows the 2016 average salmon fry and parr densities to be the 2nd highest recorded since surveys began subsequent to the dramatic peak in 2008. Figure 10.2 shows the average trout fry and parr densities of 2016 to be slightly below the average range.

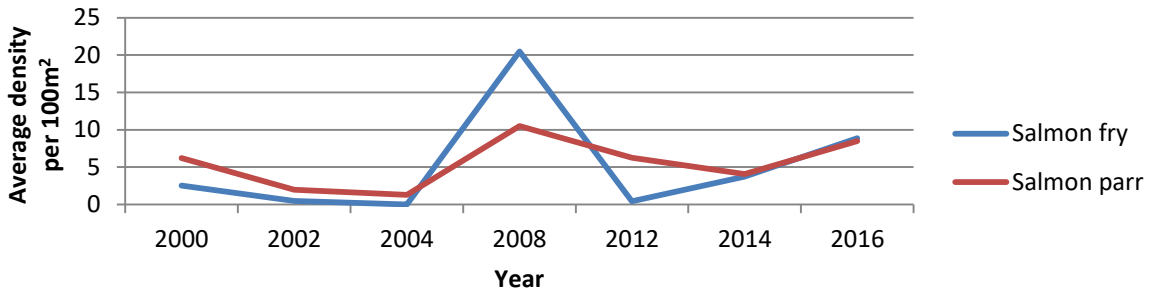

Figure 10.1: *Temporal changes in average salmon densities within the Oldshoremore catchment*

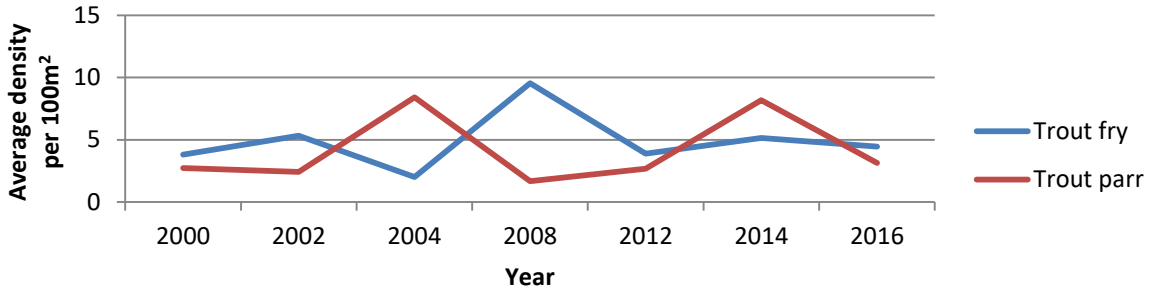

Figure 10.2: *Temporal changes in average trout densities within the Oldshoremore catchment*

Discussion

The temporal fluctuations in juvenile trout and salmon populations are likely a result of natural ecosystem dynamics and varying marine pressures on sea trout and salmon. The salmon population is likely to be heavily dependent on seasonal rainfall which will affect accessibility to spawning areas from year to year; this may explain the somewhat sporadic nature of salmon densities since surveys began. However, OM1 appears to be the most consistently productive of the sites which may be attributable to adults resting in the loch having good access to this area during spawning season. While the trout fry and parr populations generally fluctuate between extremes from year to year, it has remained within a steady and consistent range since surveys began, suggesting a healthy population.

11. Average for the West Sutherland Fisheries Trust area

The average densities of fish within each catchment are summarised (Table 8.1). 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.

Catchment	Average density (100m^2) Salmon fry	Salmon parr	Trout fry	Trout parr
Garvie	4.61	5.43	7.89	6.36
Polly	16.26	11.53	7.32	2.83
Gleann Leireag *	0	0	10.82	10.78
Nam Brac *	0	0	70.53	8.90
Claise na Fearna	3.30	11.48	8.10	6.11
Bad na Baighe	5.19	9.42	2.51	9.54
Loch Na Thull	62.40	36.63	17.07	7.84
Achriesgill	2.24	1.79	5.40	2.87
Oldshoremore	8.89	8.49	4.44	3.15
West Sutherland area average	**14.70**	**12.11**	**14.90**	**6.49**

Table 11.1: *Average densities of salmonids per catchment surveyed*
(Kirkaig not included due to uncertainty of results)
** results not included when calculating area average for salmon due to inaccessibility*

As evident from Table 11.1, figures 11.1 and 11.2, there is a good distribution of salmonid species throughout the west Sutherland area with trout present in every system surveyed. Where salmon access was possible salmon were also recorded in each catchment surveyed. The area average trout and salmon fry densities are similar, while the area average salmon parr density dominates trout parr.

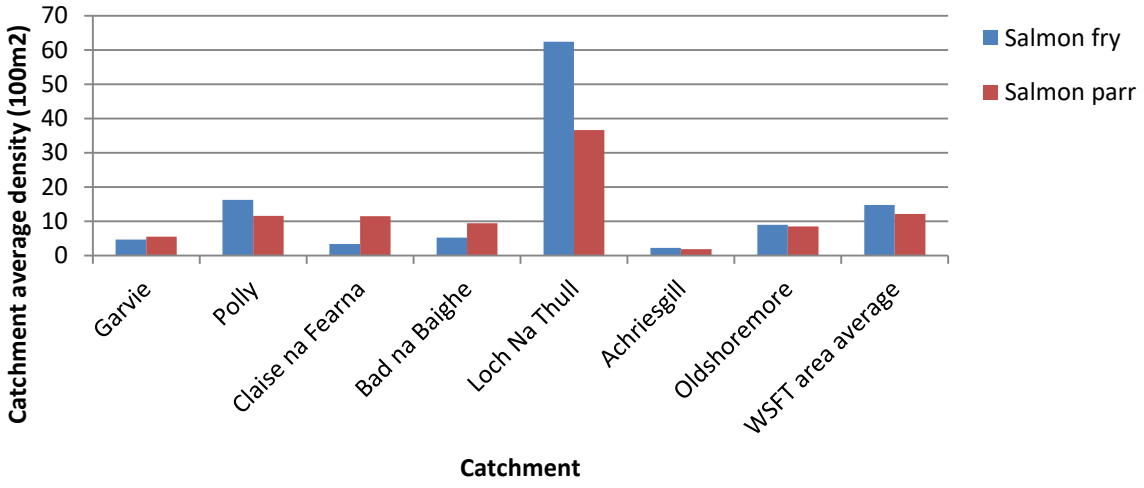

Figure 11.1: *Average salmon fry and parr densities within West Sutherland catchments shown alongside the average fry and parr densities for the West Sutherland area 2016*

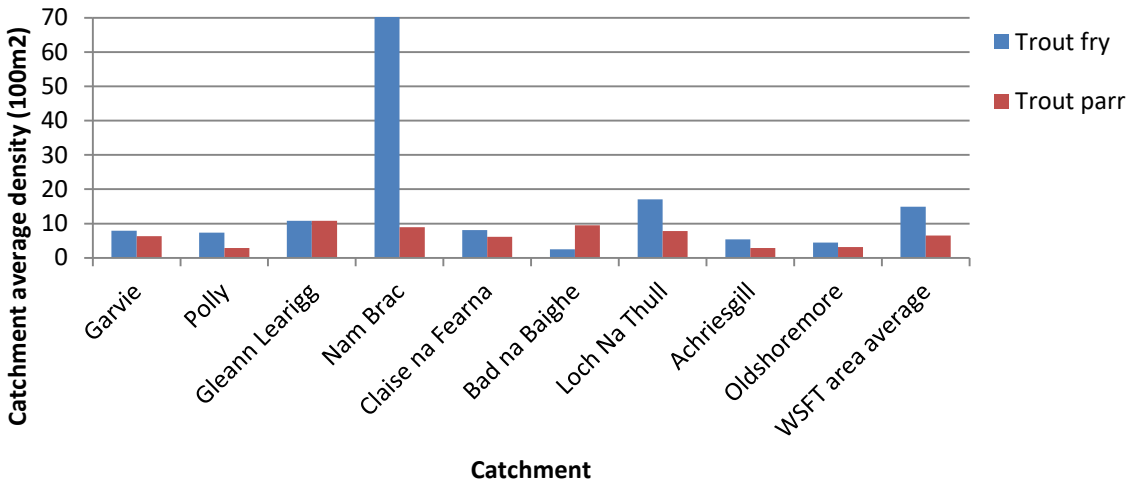

Figure 11.2: *Average trout fry and parr densities within West Sutherland catchments shown alongside the average fry and parr densities for the West Sutherland area 2016*

12. SFCC Classification

The SFCC absolute regional classification scheme, presented in Table 11.1, 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 accessibilty.

		Minimum density per 100m^2			
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	0	0	0

Table 12.1: *SFCC salmonid density classification scheme for the north west area*

The percentages of SFCC classifications across the west Sutherland area are displayed in Figure 11.1. 38% of all sites were classed as having moderate to excellent salmon fry densities (13% classed as excellent), with salmon parr densities classed as moderate to excellent within 62% of all sites (24% classed as excellent). Trout fry densities were classed as moderate to excellent in 56% of all sites, (29% classed as excellent), with 64% of sites containing moderate to excellent trout parr densities (35% classed as excellent).

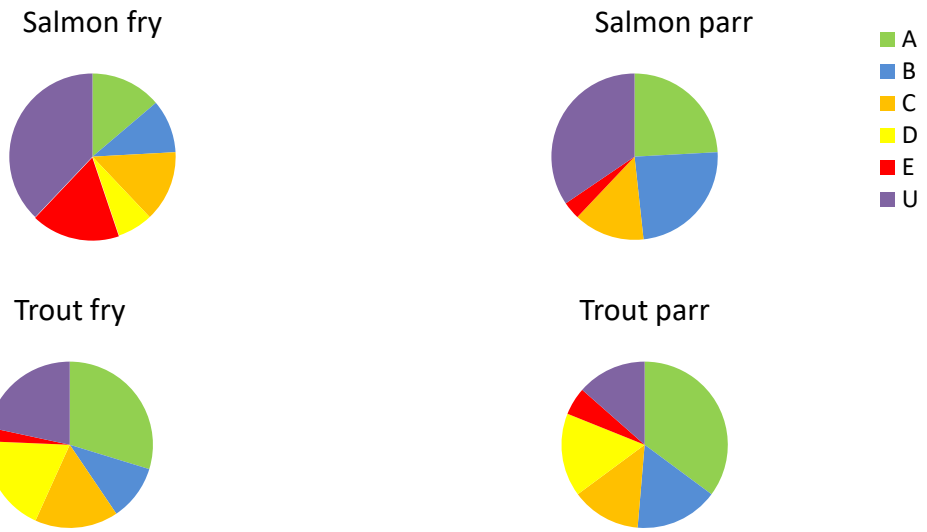

Figure 12.1: *West Sutherland area salmonid densities according to the SFCC classification scheme*

13. Discussion

The majority of the 2016 surveys covered the smaller catchments within the WSFT (most of which have flow dependent access to migratory salmonids), therefore the area average reflects systems largely only capable of supporting small salmon populations. It was however interesting to note the high juvenile densities and long term stability of trout populations within catchments or areas of catchments that are not accessible to migratory salmonids such as Loch Nam Brac and Gleann Leireag.

Due to high water flows during the summer months of 2016 it was not possible to survey Culag, Rhiconich, Sandwood, and Loch Innis; this will also have an effect on the area averages. The aim will be to survey these catchments in 2017 alongside the additional catchments due to be surveyed in accordance with the routine monitoring program. It would also be beneficial to survey K1 within the Kirkaig catchment in 2017 under normal flows.

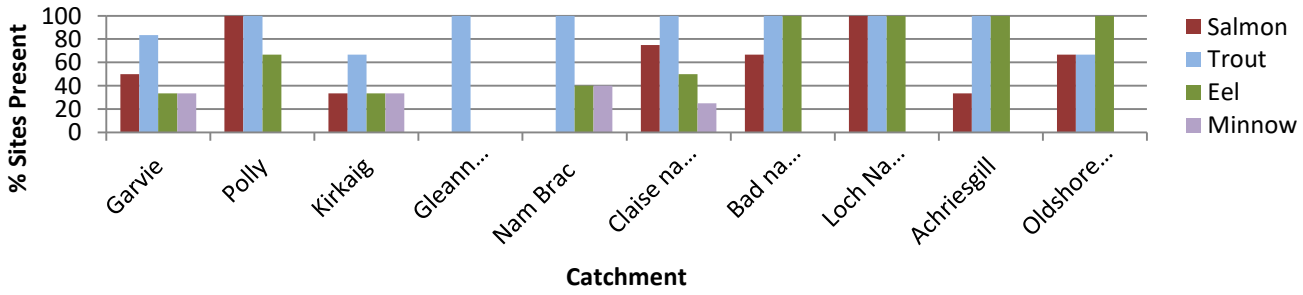

Figure 13.1: *Species composition and distribution per catchment*

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