Fish Population Survey of

The Donich Water, River Goil, Argyll

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Background

In August 2013, Argyll Fisheries Trust undertook surveys of fish populations of the Donich Water, a major tributary of the River Goil catchment, Lochgoilhead, Argyll, on behalf of Hydroplan UK to inform the development of a run-of-the-river hydroelectric generating scheme.

Main findings

- Atlantic salmon (*Salmo* salar) fry (young of the year) were found at low density at one site and salmon parr (older than one year) were found at low-to-moderate density at all three sites.
- Brown trout (*Salmo trutta*) fry were found at low density and trout parr at high density at all three sites surveyed. A young sea trout was also found at the lower-most site.
- European Eels (*Anguilla anguilla*) were also found at all three sites.

The following conclusions were reached:

- These data and others collected in 2002 and 2013 suggest that recruitment of salmon and trout may vary year-to-year in the Donich Water. The variation may be due to limitations on suitable spawning habitat and adult sea returns of mature adult salmon and sea trout.
- The habitat appear to be more suited to older juveniles (parr and sub-adults) some of which may migrate upstream into the Donich Water from the main River Goil.
- The development of a hydro generation scheme will need to provide sufficient water flow to allow adult fish to migrate and spawn in autumn and to allow incubation of eggs and support older free-swimming juveniles throughout the year. The transport of river bed sediments must also be retained to provide spawning grade substrates and maintain the condition of the habitat for salmonid fish.

Acknowledgements

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1. INTRODUCTION

In August 2013, Argyll Fisheries Trust undertook surveys of fish populations of the Donich Water, a major tributary of the River Goil, Lochgoilhead, Argyll, on behalf of Hydroplan UK to inform the development of a run-of-the-river hydroelectric generating scheme. The aims of the surveys were to identify the distribution of fish within the catchment, provide an indication of their relative abundance.

Migratory salmonids; Atlantic salmon (*Salmon* salar) and sea trout (*Salmon* trutta) and other native fish populations commonly use freshwater habitats for breeding and development of early life-stages. Typically, juvenile salmon and trout spend between 1 and 3 years in freshwater before migrating to sea as smolts. Salmon may spend between one and three years in the North Atlantic Ocean before returning to mature and spawn within their natal river, at or close to their original hatching site. Trout differ from salmon in that they are part of a resident brown trout population and migratory forms may migrate varying distances from the natal stream as sea trout or Lacustrine (lake dwelling) brown trout but may spend a similar time feeding prior to maturation and return to spawn. The use of both marine and freshwater habitats during their life-cycle makes migratory salmonids vulnerable to deterioration or loss of accessibility in one or more of a wide range of habitats. Isolated resident brown trout populations are also present upstream of waterfall barriers to migration from the sea.

Other native fish such as European eel (*Anguilla anguilla*), Lamprey (*Lampetra spp.*) and stickleback (*Gasterosteus aculeatus*) also utilise freshwater habitats in the Argyll region but understanding of the status of these populations is less well defined. Non-native introduced species such as minnow (*Phoxinus phoxinus*) and stone loach (*Noemacheilus barbatula*) are present in various catchments and may utilise tributary streams for recruitment.

The electrofishing survey technique used in this fish survey are designed to investigate relatively shallow areas of flowing water (< 1m depth) in which juvenile salmonid and other fish frequently inhabit. Juvenile life stages of salmonid fish are targeted by such surveys as unlike adult fish they are generally present throughout the year and provide a history of which species have spawned in the vicinity of the survey site in recent years. The technique is also effective for non-salmonid species, but the shallow water habitats sampled may not reflect their habitat preferences, which may change on a seasonal basis.

2. METHODS

To assess the fish populations in the Donich Water catchment sampling of fish was undertaken in August 2013 using an electrofishing survey technique. The electrofishing technique is used to temporarily stun fish in the close vicinity of the operator, allowing fish to be retained and processed prior to release. Fish surveys were conducted during low-to-medium flow conditions with backpack electric fishing equipment, using smooth direct current between 300 and 400 volts. The voltage was varied depending on the conductivity, depth and flow of the water at each site. All surveys (see below) were undertaken in accordance with version 2.3 of the Scottish Fisheries Co-ordination Centre (SFCC) protocols (SFCC, 2007). An assessment of the in-stream and riparian habitat characteristics were undertaken at each site. All fish were returned to the site on completion of the survey. Digital photographs were taken of each site to aid identification during future surveys (Appendix I).

Fully-quantitative sampling (i.e. fished three times over a known area) were utilised to estimate the density of fish present within the site at the time of the survey (Zippen, C. 1956) where sufficient numbers of fish were found (site one). Data at other sites were collected by single-run (semi-quantitative) sampling providing estimates of minimum density of salmonid fish. To enable comparison between sites, minimum estimates of fish density are used throughout the text.

Captured fish were anaesthetised prior to being identified to species level and measured for length. Scale samples were removed from a small number of salmonid fish at each site to provide age information to allow estimates of fry (< 1 year old) and parr (> 1 year old) abundance to be calculated. Other non-salmonid species were recorded for length only.

In order to provide a guide to the relative abundance of salmonid fish sampled during the survey, minimum density estimates were classified according to a classification scheme (Godfrey, 2005) for the west coast of Scotland district according to stream width at the survey site (Appendix II).

A total of three sites were surveyed in 2013 (Table 2.1 and Figure 2.1) in relation to the proposed location of the infrastructure and the distribution and variety of nursery habitat available to fish.

Table 2.1 Electrofishing survey sites

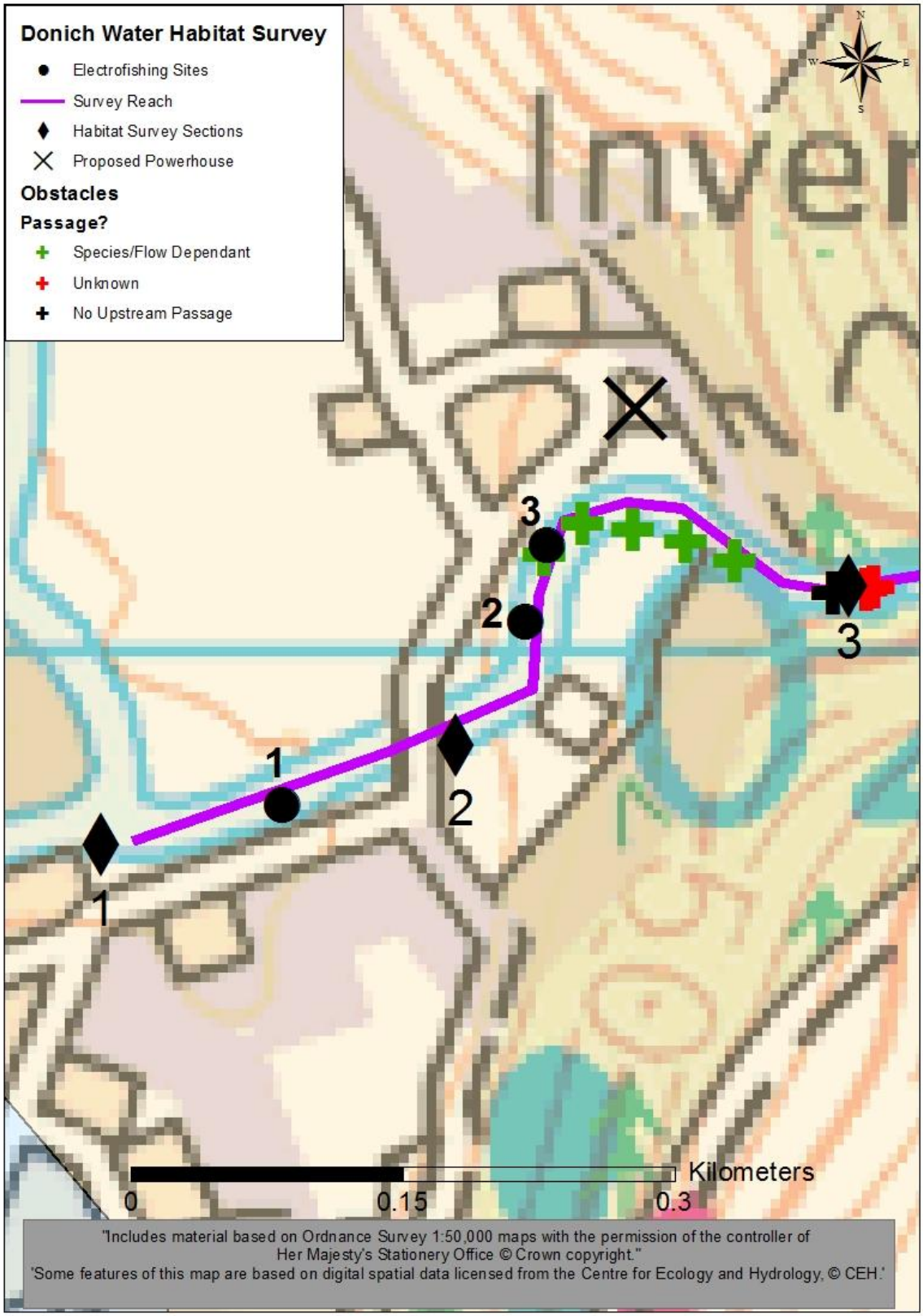
Site No.	Site	Easting	Northing	Altitude (m)	Length (m)	Width (m)	Area (m^2)
1	40m D/S of track bridge	220199	701904	10	20	8.3	166
2	50m U/S of track bridge	220329	702014	18	12.2	13.8	168.4
3	Opposite house on right bank	220341	702056	27	14.3	9.0	128.7

At the time of survey water flow conditions were at a low, clear summer level (Table 2.2). Water conductivity ranged from 28 to 30 microsiemens and water temperature was 12.2 degrees centigrade (°C).

Table 2.2 Conditions at survey sites

Site	Temp (°C)	Conductivity ($\mu S/cm^{-1}$)	Water flow	Water clarity
1	12.2	28	Low	Clear
2	12.2	30	Low	Clear
3	12.2	30	Low	Clear

Figure 2.1 Electrofishing survey site locations



3. RESULTS

The distribution and relative abundance of salmonid and non-salmonid fish are given separately below;

3.1 Salmonid fish

Juvenile salmon and trout were found at all sites surveyed downstream of the lower-most waterfall obstacle to fish migration. Estimates of abundance for juvenile salmon (Table 3.1 and Figures 3.1 and 3.2) and juvenile trout (Table 3.2 and Figure 3.3 and 3.4) are given as the minimum number of fish per 100m² of wetted stream bed. Zippen estimates of fish density and confidence limits (95 %) where a sufficient number of trout were caught at site 1.

Table 3.1 Electrofishing survey results for salmon (no. of fish per 100m²)

	Salmon Fry				Salmon Parr			
Site	**No.**	**Min. Est.**	**Zippen Est.**	**95% CL (+/-)**	**No.**	**Min. Est.**	**Zippen Est.**	**95% CL (+/-)**
1	1	0.6	-	-	1	0.6	-	-
2	0	-	-	-	4	2.4	-	-
3	0	-	-	-	2	1.6	-	-

Table 3.2 Electrofishing survey results for trout (no. of fish per 100m²)

	Trout Fry				Trout Parr			
Site	**No.**	**Min. Est.**	**Zippen Est.**	**95% CL (+/-)**	**No.**	**Min. Est.**	**Zippen Est.**	**95% CL (+/-)**
1	4	1.2	3.5	6.6	16	9.0	9.6	0.1
2	1	0.6	-	-	10	5.9	-	-
3	1	0.8	-	-	9	7.0	-	-

The classification of minimum density estimates of juvenile salmon and trout (Table 3.4) ranged from class F where no fish were found to class A where a relatively high density of fish was found.

Table 3.3 Comparison of Juvenile fish abundance classification for Clyde coast region

Avg. width (m)	Site	Salmon		Trout	
		Fry	Parr	Fry	Parr
8.3	1	E	E	D	A
13.8	2	F	C	E	A
9.0	3	F	D	E	A

Minimum estimates of salmon fry (young of the year) density were found to be 0.6 fry per 100 m² at site 1 (class E). Minimum estimates of salmon parr (more than one year of age) ranged between 0.6 parr per 100 m² at site 1 (class E), 2.4 at site 2 (class C) and 1.6 at site 3 (class D).

Minimum estimates of trout fry (young of the year) ranged from 1.2 fry per 100 m² at site 1 (class D) to 0.6 fry at site 2 (class E) and 0.8 fry per 100 m² at site 3 (class E). Minimum estimates of trout parr (more than one year of age) was 9.0 at site 1, 5.9 at site 2 and 7.0 parr per 100 m² at site 3 (all class A). A young sea trout (22 cm) was also caught at site 1.

3.2 Non-salmonid fish

European eel were found at all three sites (Table 3.4).

Table 3.4 Comparison of the number of non-salmonid fish found

Site	European Eel	Length range (mm)
1	4	100 - 180
2	3	120 - 140
3	1	170

Figure 3.1 Distribution and relative abundance (class) of salmon fry

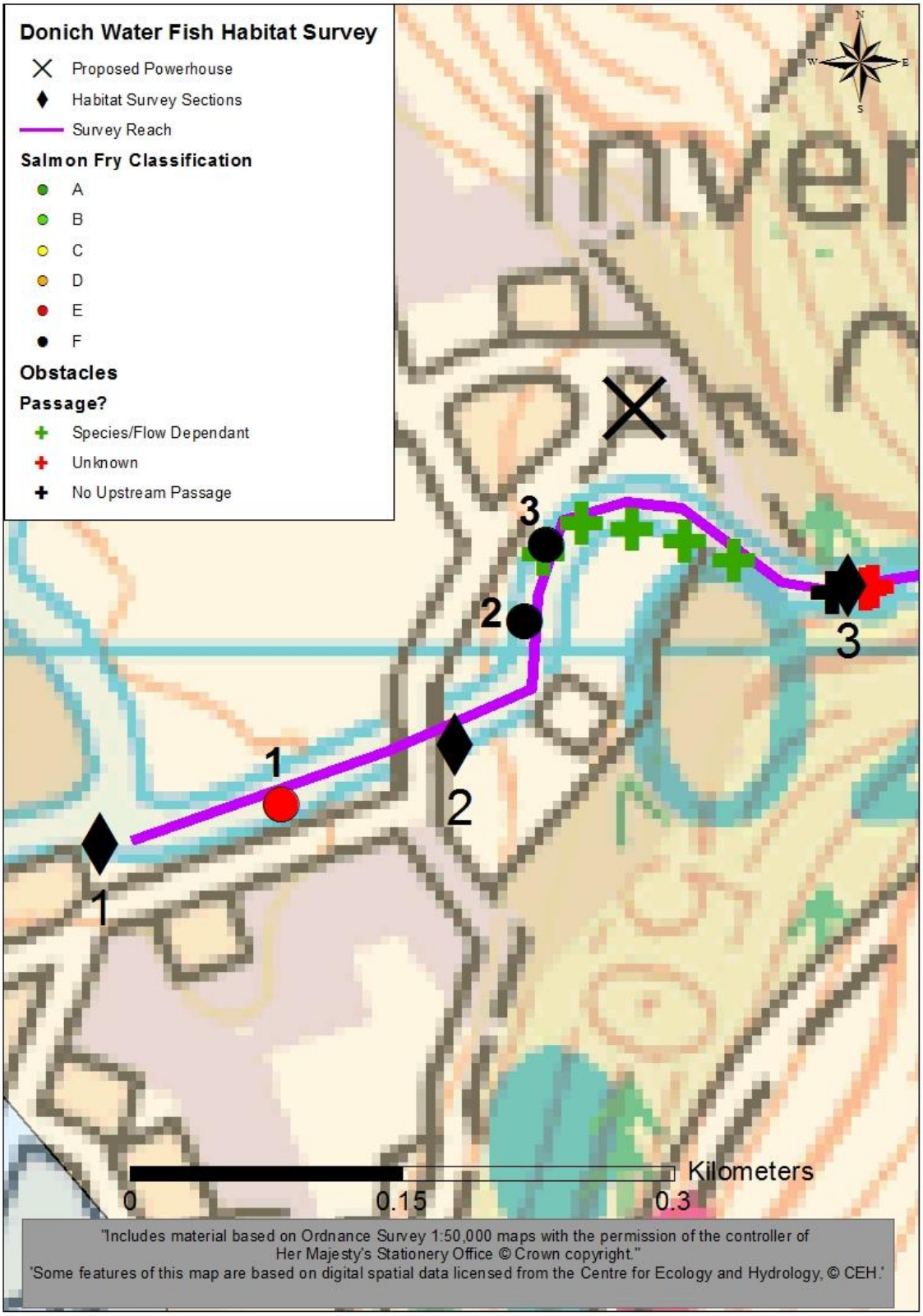


Figure 3.2 Distribution and relative abundance (class) of salmon parr

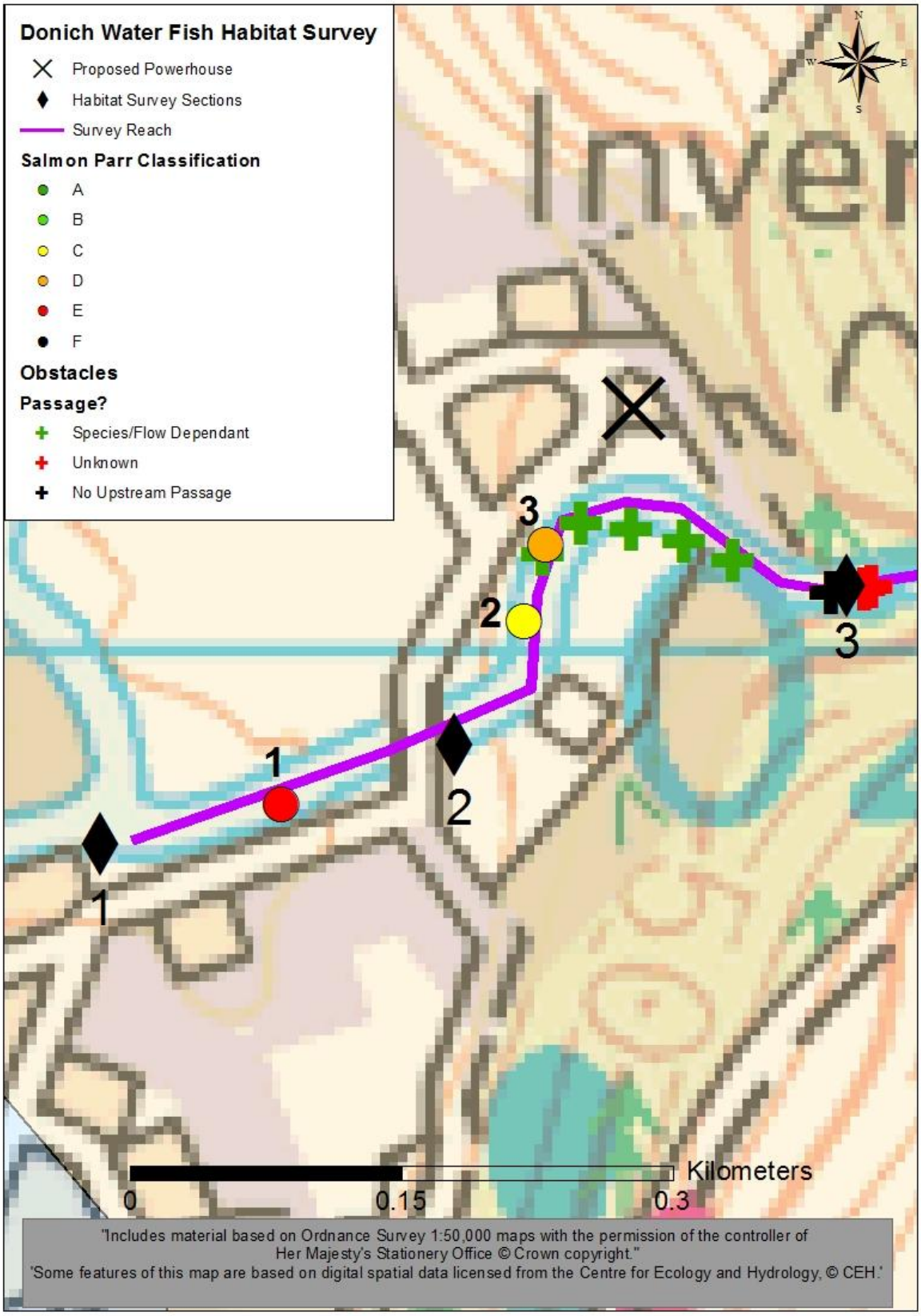


Figure 3.3 Distribution and relative abundance (class) of trout fry

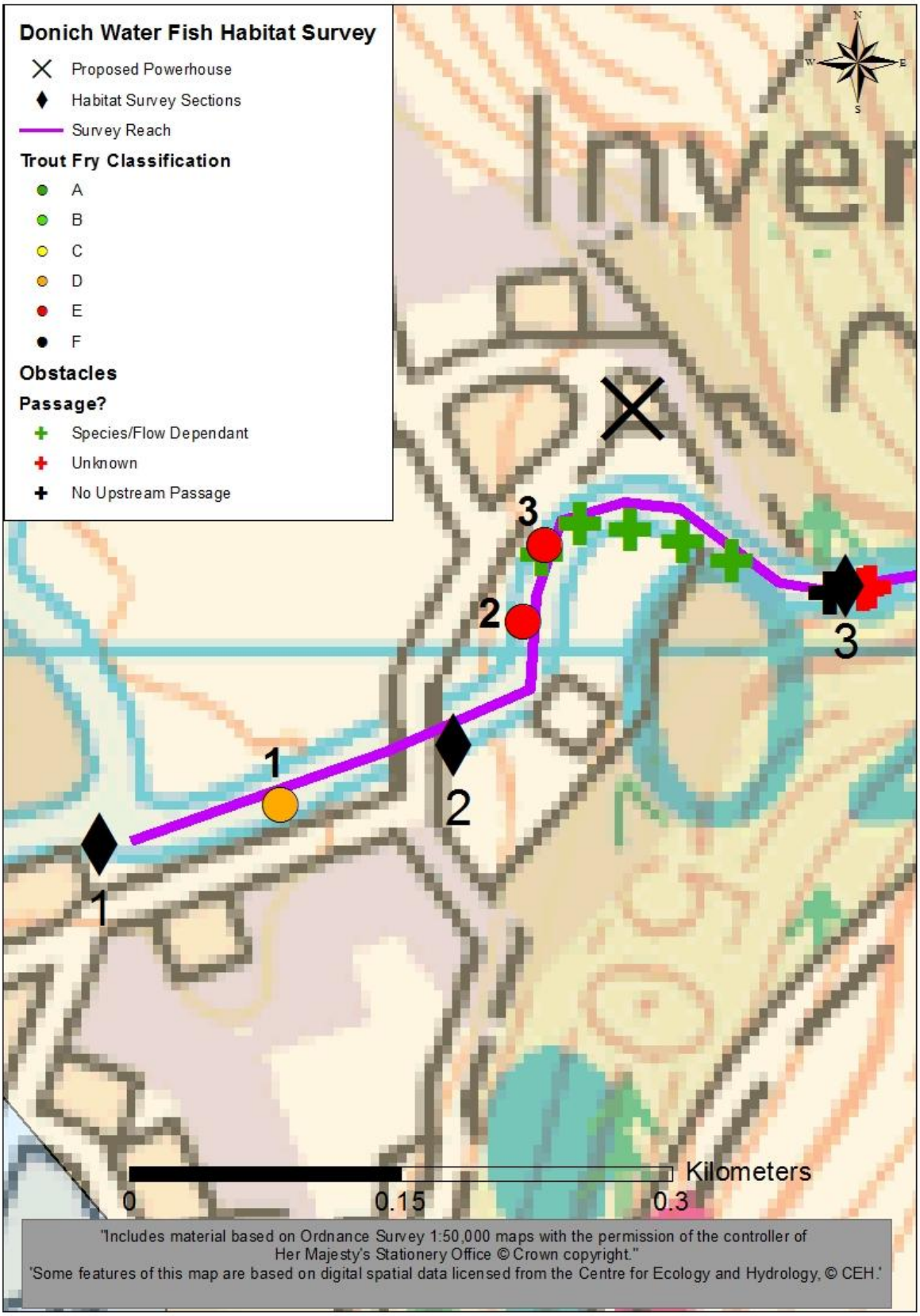
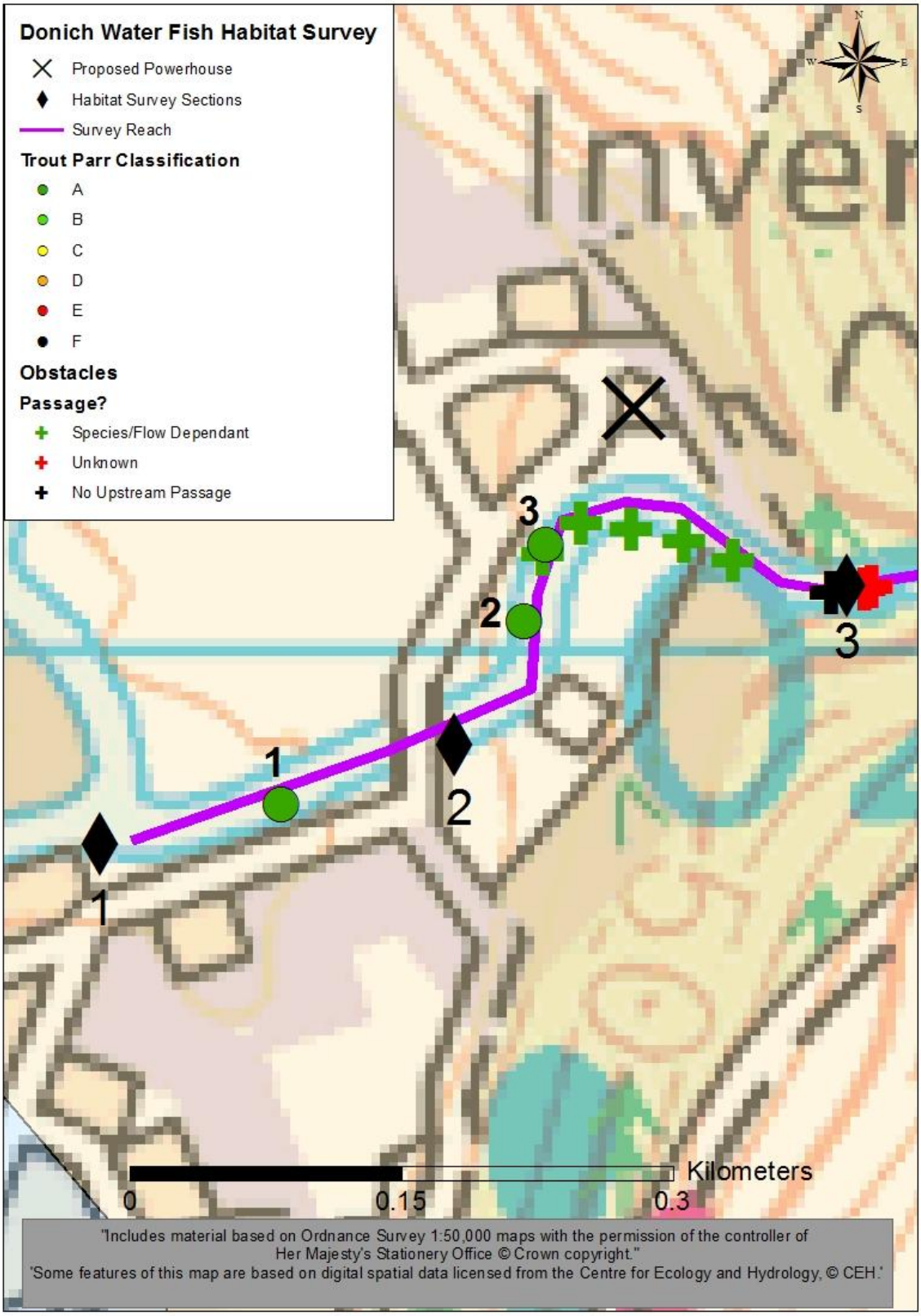


Figure 3.4 Distribution and relative abundance (class) of trout parr



4. DISCUSSION

The native fish species sampled in the survey; Atlantic salmon, brown trout and European eel are amongst those expected in relation to their natural range and the habitat types surveyed.

4.1 Atlantic salmon

The Atlantic salmon fry found only at survey site 1, and parr that were found at all three sites surveyed downstream of the impassable waterfalls indicate that habitat is utilised for recruitment of salmon that form part of a larger population of the River Goil. The very low density of salmon fry found at site 1 suggest that there was little salmon spawning activity in the Donich Water in the autumn of 2012. Salmon Parr distribution was wider than that of fry which may suggest that there was more spawning activity in the autumn of 2011. However, previous surveys of the Donich Water (at site 1) in 2002 and 2009 found a similar result as the 2013 survey; low-to-moderate densities of salmon parr (compared to other sites in the Clyde coast region), but no salmon fry. It is therefore possible that salmon parr may migrate upstream into the Donich Water from the main river, which has been suggested, may occur in early summer (Armstrong et. al., 1997), possibly to establish feeding territories due to competition for or lack of habitat in the main river.

The fish habitat survey (AFT, 2013) found three potential spawning sites in the accessible habitat with a total area of 13 m², which suggest there is some habitat available for spawning within the reach, but may not be utilised by salmon at this time.

4.2 Brown trout

Unlike salmon, trout fry were found at all three sites surveyed, but fry density was relatively low compared to trout parr which was relatively high at all sites. Previous surveys at site 1 found a high density of trout fry in 2002, but found none in 2009, suggesting that there has been significant variation in spawning activity by trout at this site. The variation in trout fry may be as a result of changing numbers of adult spawning trout, which are likely to be sea-run. Unlike fry, trout parr abundance was also found to be relatively high in 2013 and the two previous surveys. The more stable abundance of older trout, suggest that the habitat in the Donich Water may be more suited to larger juveniles and pre-adults than to spawning and fry life stage.

4.3 Other fish

European Eels found at all three sites surveyed downstream of the waterfall obstacle suggest that the habitat within the accessible reach of the Donich Water is suitable for relatively small eels to inhabit. The distribution of eels may also include habitat upstream of the waterfalls which they are able to migrate around during periods of wet weather.

5. CONCLUSIONS

The information on fish distribution and abundance found in 2013 and previous surveys conducted in 2002 and 2009 provides some indication of the implications for management of the fish populations of the Donich Water in relation to use of water resources for hydroelectric generation.

The habitat downstream of the lower-most waterfall in the Donich Water is potentially utilised for the recruitment of Atlantic salmon and brown trout (possibly sea run). European eel are also found to be widespread. The patchy distribution and low density of salmon fry found in 2013 and lack of fry found in 2002 and 2009 suggest there may not have been significant recruitment of salmon in this reach of habitat each year. The low density of trout fry found in 2013 and differences found in previous surveys suggest that recruitment of trout has also been variable year-to-year.

The fish and habitat surveys suggest that spawning habitat is limited to a few small patches which may influence recruitment along with the variation in numbers of adult sea returns of salmon and sea trout. The surveys also indicate that the habitat may be better suited to older juveniles (parr) which may be colonised from the main river where competition between juveniles may be higher or habitat conditions less suitable.

The development of a hydroelectric scheme will need to maintain sufficient water flow and habitat condition to allow migratory salmonid fish to migrate, spawn and raise juvenile life-stages. The erosion, transport and deposition of substrates are natural processes, upon which salmonid fish populations rely to replenish spawning grade and larger materials. The construction of the dam at the water intakes and pool creation upstream has potential to arrest

the natural supply of substrates and potentially reduce their availability downstream. Any affect as a result of substrate supply and subsequent availability of spawning substrates may take a number of years to become evident.

6. APPRASIAL OF METHODOLOGY

The electrofishing methodology utilised in the survey is appraised in relation to a number of factors affecting the efficiency and interpretation of electrofishing survey data;

6.1 Location and timing of surveys

The location and seasonal timing of sampling is likely to be reflected in the abundance of fish sampled at survey sites. Sampling of fish close to spawning sites are likely to record higher densities of juvenile fish than sites further away. Additionally, sampling relatively early in the summer may yield a higher density of juveniles compared to samples taken later in the summer as juveniles grow and disperse and effects of dependant mortality reduce density over time. Therefore, the sampling undertaken in August is likely to reflect juvenile population abundance at a time where initial high rates of early density dependant mortality or dispersal have taken place but the likely carrying capacity of the site may not have been reached. It would be expected that further mortality or emigration would arise depending on the suitability of the habitat for over-wintering juveniles.

6.2 Sampling error

The minimum density estimates of juvenile abundance are also likely to vary between sites depending on the relative complexity of the habitat being sampled. Those habitats with relatively poor potential to provide cover for fish are likely to yield a higher percentage of the fish present in the first run as there are lower numbers of fish present and fewer features for them to become lodged or trapped and visibility of fish to the survey workers to become impaired. Conversely, it is expected that fewer of the total number of fish present will be sampled in complex habitat in the first sampling run and therefore confidence limits generated at these sites are likely to be significantly larger than for sites with less diverse fish cover.

The survey was also primarily aimed at the primary shallow water habitats of juvenile salmonids during the summer period, therefore non-salmonid species may be less abundant in the shallow faster flowing habitats surveyed may be underrepresented in this study.

6.3 Interpretation of data

The results of the electrofishing survey indicate that the methodology used provided adequate data to identify the salmonid fish present at sampling sites and an indication of their relative abundance at the time of survey. However, the frequency, distribution and degree of accuracy of the fish sampling programme may not be sufficient to fully describe the distribution of all fish species. The current interpretation of the classification of juvenile fish abundance used in this study may misrepresent some fish data as the assessment is based on a limited number of previously surveyed sites from all over the Clyde coast of Scotland region and therefore may not reflect accurately the status of this fish population.

7. REFERANCES

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Appendix I – Electrofishing survey site photographs

Fig. 1 Survey site 1

Fig. 2 Juvenile trout and salmon caught at site 1

Fig. 3 Survey site 2

Fig. 4 Survey site 3

Appendix II – Quintile ranges for juvenile salmonid density for sites for different classes of river width for Clyde Region (Godfrey, 2005).

Min. Percentile	Width Class				
Salmon fry (0+)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	0.7	0.7	1.5	0.3	E
20th	5.5	8.5	4.5	7.4	D
40th	11.2	15.6	5.5	9.7	C
60th	19.1	25.4	17.7	16.5	B
80th	53.5	50.4	41.5	30.0	A
100th	115.6	210.6	89.1	62.8	
(%) zero density	35.2%	34.3%	23.1%	10.5%	
Salmon parr (1++)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	0.7	0.7	0.4	0.3	E
20th	1.6	1.6	1.6	1.1	D
40th	3.0	3.9	3.1	2.2	C
60th	4.6	5.6	6.0	4.4	B
80th	6.9	9.2	12.6	6.9	A
100th	19.3	24.0	20.5	37.0	
(%) zero density	32.4%	31.4%	30.8%	5.3%	
Trout fry (1++)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	0.9	0.6	0.5	0.4	E
20th	5.0	2.8	1.8	1.4	D
40th	9.2	4.4	2.7	2.1	C
60th	15.8	6.8	4.2	2.7	B
80th	28.8	16.7	5.3	4.6	A
100th	87.4	145.5	40.0	8.6	
(%) zero density	8.5%	5.7%	7.7%	10.5%	
Trout parr (1++)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	0.9	0.6	0.6	0.2	E
20th	2.5	1.4	1.5	0.8	D
40th	4.8	3.8	2.1	1.2	C
60th	6.1	5.9	3.4	2.1	B
80th	8.5	9.9	5.3	2.7	A
100th	29.7	42.9	8.6	4.1	
(%) zero density	14.1%	17.1%	15.4%	36.8%	