Fisheries research report 2016

R Lauridsen, WRC Beaumont, S Gregory,
L Scott, J Marsh, J Picken and D Roberts

Interreg
France (Channel Manche) England
SAMARCH
SAlmonid MAnagement Round the CHannel
European Regional Development Fund

Game & Wildlife Conservation Trust

www.gwct.org.uk/fisheriesreport

Contents

Authors: R Lauridsen, WRC Beaumont, S Gregory, L Scott, J Marsh, J Picken and D Roberts

For more information please contact the:
GWCT's Salmon & Trout Research Centre,
East Stoke, Wareham, Dorset, BH20 6BB.
Tel: 01929 401894 Email: fisheries@gwct.org.uk

Front cover: River Frome spring salmon. © GWCT;
Above: Netting rotary screw trap catch © GWCT

Sarah Chare, head of fisheries from the Environment Agency, visited East Stoke to find out about our fisheries research and the important work that the GWCT undertakes to halt salmon declines.

Foreword

Welcome to the 2016 GWCT fisheries report. It has been another busy year building on the knowledge gained over past years. We now hold 44 years of adult salmon records and 12 years of robust smolt estimates. Valuable lessons can be learned for the better survival of salmon in freshwater as we log fish on their outward journey and when they return to the river to spawn.

This year we estimated that 9,539 salmon smolts migrated past East Stoke on the lower Frome, on their way to sea in the spring. This is slightly higher than the five-year average (9,033) but below the 10-year average (10,595). The adult salmon estimate was 748 fish which is down slightly on 2015 but higher than most recent years. This information has been reported to the UK Government and the International Council for the Exploration of the Seas (ICES) who advise Governments on the management of salmon.

The team submitted their report to the Environment Agency on the effects of the small-scale Archimedes screw hydro-turbine scheme at Bindon Mill on salmon smolts. This study is important given the rapidly increasing number of these schemes appearing around the country, which is partly facilitated by Government incentives. Thankfully, despite large numbers of smolts passing through the Archimedes turbine, the Bindon Mill turbine had no effect on the survival of smolts between the turbine tag readers and our tag readers at East Stoke (3.5km downstream).

Of particular concern this year, were the very low numbers of salmon parr (young of year) caught during our annual parr tagging programme in September. Despite concerted efforts by the team, the numbers of parr were around half of what we would normally expect. This decline is not confined to the Frome. Poor recruitment of juvenile salmon has been recorded around the country and there is concern of the knock-on effects to future year classes of returning adults.

Given that 98% of Frome salmon migrate to sea at one year old, the impacted year class will be leaving the river in spring 2017. Here we will be able to gauge the true impact of the low numbers of parr in 2016. Smolt output and not fry or parr numbers is the true measure of a river productivity and this serves to illustrate the importance of our unique smolt monitoring facility at East Stoke.

David Mayhew
Chairman of the GWCT Fisheries Research Steering Committee

David Mayhew, Chairman of the Fisheries Research Steering Committee.

1. River Frome salmon population

Our new PIT tag readers are extremely efficient with an adult detection efficiency of more than 95%.

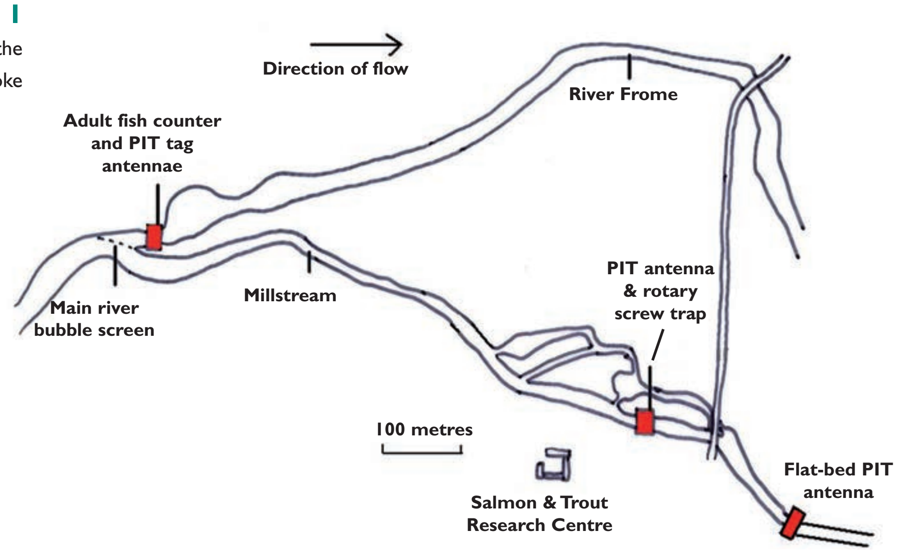
The GWCT fisheries research group is based at East Stoke on the banks of the river Frome in Dorset and the Atlantic salmon population in the river is at the core of our work. For the past 44 years, we have quantified the number of adult salmon returning to the Frome so that over the years of studying this population, we have built up an unparallelled monitoring infrastructure at East Stoke and elsewhere in the catchment (see Figure 1).

Like most rivers feeding the North Atlantic, the number of returning adult salmon to the Frome showed a marked decline in the early 1990s (see Figure 2). Because this collapse was observed in nearly every river across the salmon's distribution the consensus opinion is that the decline is caused by problems in the marine environment; such as warmer sea temperatures. However, this highlighted the importance of being able to separately analyse the changes affecting survival that occur in freshwater and those that occur at sea. Only by monitoring both smolt output (freshwater production) and returning adults (marine survival) are we able to separately analyse the two components of the salmon lifecycle.

Estimating the density of juveniles and the number of emigrating smolts on a catchment scale is very difficult. However, it is possible to estimate population size by marking a proportion of the population and then sampling the population later-on and seeing what proportion of the re-captures are marked. At the beginning of the millennium the fisheries group decided to take advantage of developments in PIT tag technology and use these tags (microchips) to obtain population estimates at different juvenile stages.

Figure 1

Site plan of the counting equipment at the Salmon & Trout Research Centre at East Stoke



Whereas conditions at sea are impacted by global activities, managing the freshwater environment is much more tangible and optimising the output of smolts from freshwater will help to offset a lower marine survival and hopefully then boost the population.

Each PIT tag contains a unique code. Our PIT tag systems not only provide us with population level data but also life history data of individuals. Utilising PIT tags we are therefore able to quantify and compare parameters such as growth and survival in different parts of the catchment, as well as changes to these parameters between years. Hence we are able to identify environmental drivers of changes within the population. It is exactly such knowledge that can inform us how best to manage the river catchment to optimise the output of smolts.

Adult salmon estimate

We estimate the number of returning adults using a resistivity counter that detects the change in electrical resistance of the water caused by a salmon swimming over the counter. As well as providing population data, the adult counter provides data on migration timing and the environmental factors that influence this. For individuals captured by the video attached to the counter, it also provides estimates of adult fish length, enabling us to look at changes in marine growth over time. In addition, an estimate of the adult return can be made from the PIT tag data obtained from adult fish as they migrate back into the river. The relationship between the freshwater production of smolts and returning adults enables us to quantify the marine survival of separate smolt cohorts. The combination of adult counter and PIT tag data offer a unique opportunity to answer questions about salmon life history that would be difficult to repeat on other rivers.

The resistivity counter provides an estimate of population size and the associated video images enable us to look at changes in marine growth.

The run of adult salmon is presented for the period 1 February to 31 January inclusive. Past data and personal observations indicate that most of the upstream movement in January is caused by the continued migration of fish from the previous calendar year migrating to spawn, not fish migrating to spawn in 11 months' time.

A large part of the effort in running the East Stoke adult counter is focused on verifying and matching the 'counts' from the monitoring equipment. Counts generated by the resistivity counter are identified and verified by a combination of trace waveform analysis, video frame-grab and videotape analysis. Once again in 2016, debris coming down the river resulted in broken wires and consequently

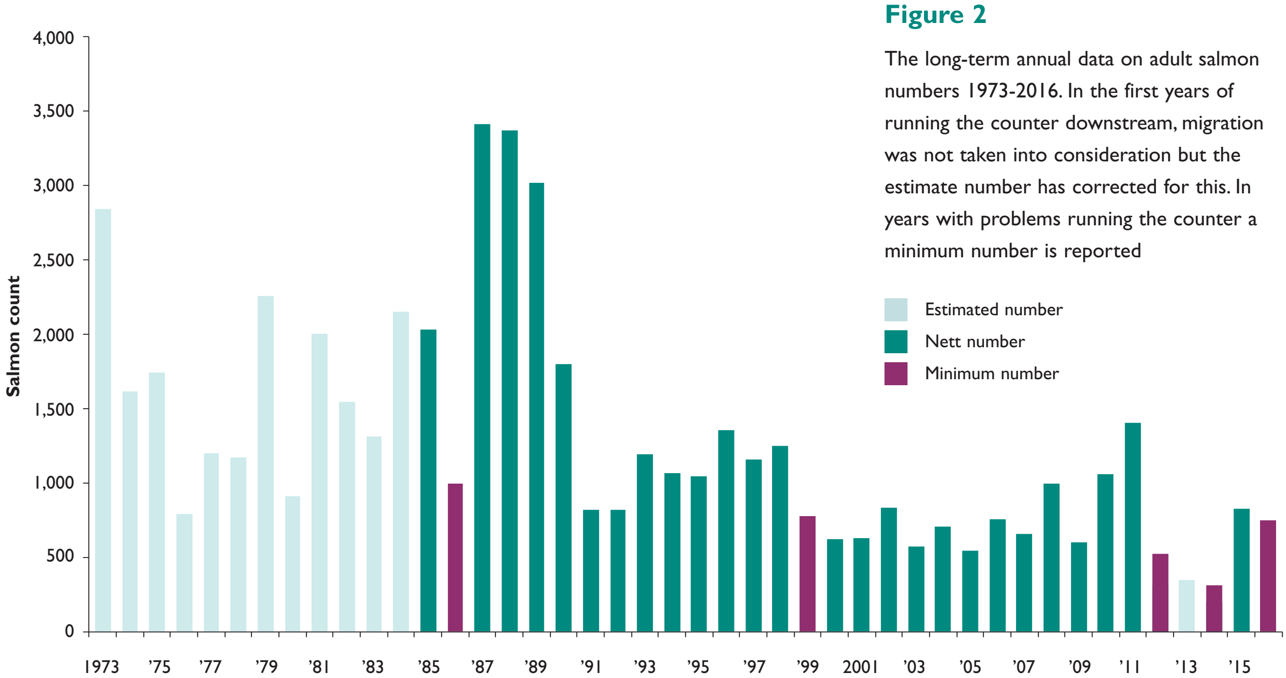


Figure 2

The long-term annual data on adult salmon numbers 1973-2016. In the first years of running the counter downstream, migration was not taken into consideration but the estimate number has corrected for this. In years with problems running the counter a minimum number is reported

Floods and debris in 2016 caused damage to the fish counter so it was not fully operational for some periods.

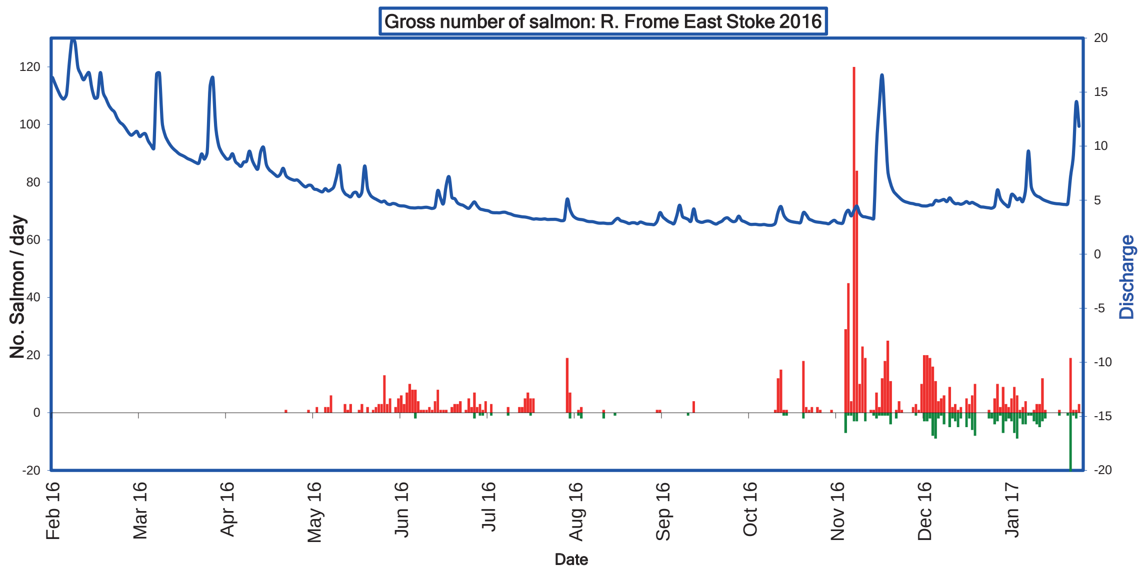
the counter was not fully operational for some periods. Fortunately, this was early in the year when we know from past experience that few fish move into the river. Nevertheless, we must treat the 2016 data as a minimum estimate as some fish may have been missed.

The spring run of multi-sea-winter salmon on the Frome was strong in 2016, whereas the run of grilse was late and most grilse migrated past East Stoke in late autumn (see Figure 3). These late grilse will most likely have been in the lower river since the summer – this is a well-known pattern on the Frome but is particularly pronounced in years with dry summers/autumn, like 2016. The final nett upstream estimate was 748 which, for the second-year running, meets the conservation limit for the river (see Figure 2).

Figure 3

The monthly run data for 2016 and a graph showing daily gross upstream numbers and river flow

	MONTH												
Month	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Total
Gross U/S	0	0	1	56	101	41	30	6	56	418	159	103	971
Gross D/S	0	0	0	0	4	5	8	1	4	31	75	95	223
Nett U/S	0	0	1	56	97	36	22	5	52	387	84	8	748



Smolt estimate

Eighty percent of salmon smolts are diverted by the bubble curtain down the Mill Stream where a proportion are trapped in the rotary screw trap. Scanning each fish showed that only 8% of the 2016 smolts were tagged.

We have estimated the number of smolts emigrating from the river since 1995 but the installation of our first PIT antennae in 2002 marked a milestone in the accuracy of these estimates. This methodology has enabled us to provide very accurate estimates and to calculate potential variation around these estimates (95% confidence intervals).

During the smolt run we use a device called a Bio-Acoustic Fish Fence (BAFF) to divert the fish into the Mill Stream at East Stoke (see Figure 1). The BAFF is a curtain of bubbles that has sound entrained within the bubbles, thereby creating an audio-visual impression of a barrier diverting the fish. The diversion efficiency of the BAFF is very good, deflecting approximately 80% of the smolts down the Mill Stream, where a proportion are trapped using a rotary screw trap.

Nearly 2,900 salmon smolts were caught in the trap and the total salmon smolt run in 2016 was estimated at 9,534 (see Figure 4), which is slightly up on the five-year average (9,033) but a little down on the 10-year average (10,597). In an average year, 10% of the fish caught in the trap are tagged but in 2016 only 8% of the salmon smolt were tagged, which reflects the difficult river conditions during the 2015 tagging campaign where we fell 1,500 salmon parr short of deploying the targeted 10,000 tags.

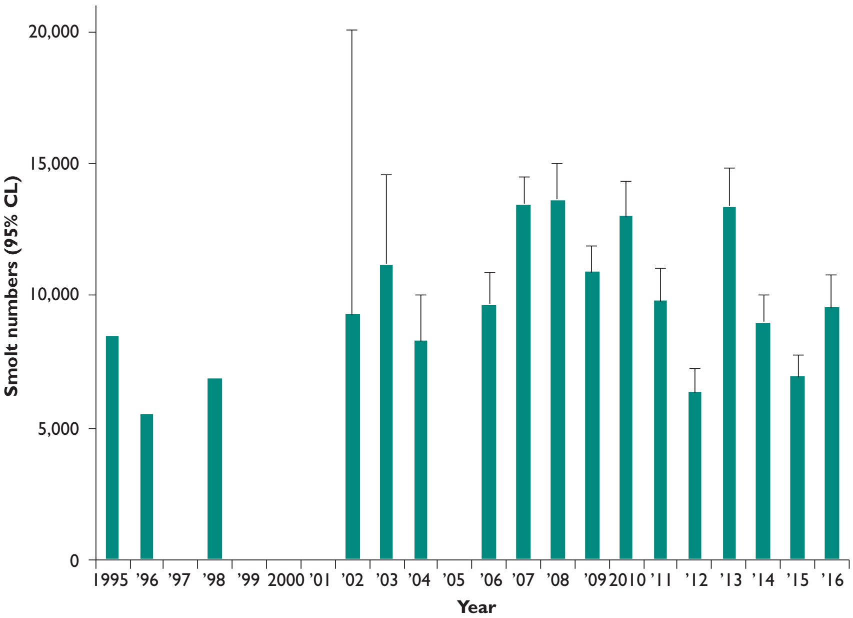


Figure 4

Estimated spring smolt population 1995-2016

Juvenile estimates

For each of the past 12 years, in September, we have electro-fished and tagged approximately 10,000 juvenile salmon (8-15% of the juvenile salmon population in the catchment) with PIT tags. These small tags (just 12mm long x 2mm wide – see picture) are inserted into parr and enable us to individually identify the fish when they swim past our detector antennae. We also remove the adipose fin (the small fin behind the dorsal fin) so that we and other fishery surveys can identify tagged fish when they are recaptured. The PIT tag stays with the fish for life and passage of tagged fish out to sea and any fish returning from the sea are recorded by the tag detecting equipment installed throughout the catchment. In 2016 we captured low numbers of salmon parr from most sites that we visited despite good conditions for electro-fishing with predominantly dry weather and a low river. Thus, we tagged only half the targeted 10,000 salmon parr. Poor recruitment of salmon from the 2015/16 spawning season has been observed in many rivers across England and Wales so it appears to be a national, rather than a local, phenomenon. One thing that stood out during the 2015/16 spawning season was the warm weather during the early part of the winter. The high air temperature was reflected in very high water temperatures in the Frome where the

A salmon parr about to be tagged. (Above) PIT tag (circled) and its individual ID (shown on the label).

average water temperature for December 2015 was 10.8°C. This was the highest December temperature recorded in the last decade (2001-2012), 3.4°C warmer than the average December temperature in this period and 1.8°C warmer than the second warmest December recorded in 2006. The high water temperatures during spawning and early egg incubation may well have had a negative impact on egg survival and, therefore, parr recruitment.

The true measure of freshwater productivity is the smolt output and as salmon in the Frome only spend one year in freshwater before smolting, the parr from the 2015/16 spawning season will smoltify in the spring of 2017. The proportion of tagged smolts in the 2017 smolt run will tell us whether the density of parr in the catchment was low or whether our catch efficiency was poor. If the density of parr was indeed low in 2016, then it is possible that there will be compensation in the form of higher overwinter survival due to less competition. With the PIT systems on the Frome we can determine this by the redetection probability (survival) of the tagged individuals during the smolt run and we are therefore in a unique position to answer such questions.

A post-spawning male salmon (kelt). Nearly all the male salmon die after spawning.

2. Salmon redd distribution update

A study undertaken by GWCT/Cardiff MSc student Elinor Parry has been published as *The effects of flow on Atlantic salmon (Salmo salar) redd distribution in a UK chalk stream between 1980 and 2015* in the international peer-reviewed journal, *Ecology of Freshwater Fish.*

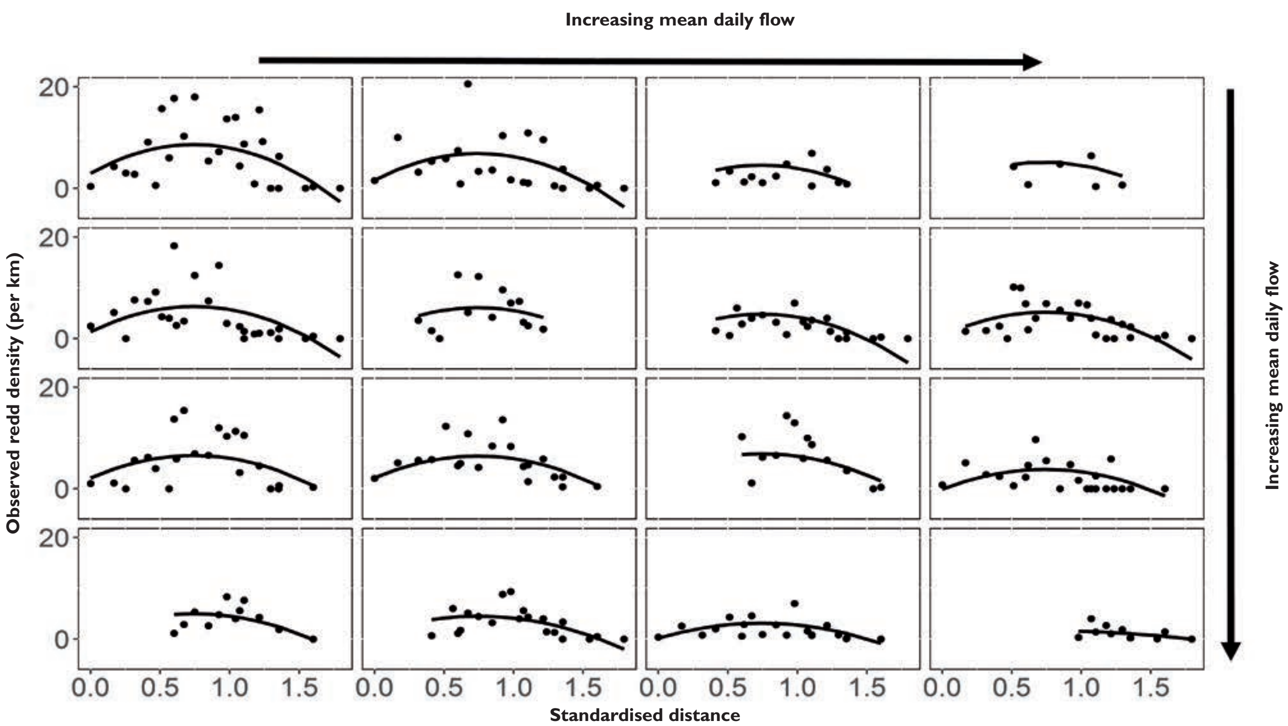
We analysed 16 years of redd distribution and flow data between 1980 and 2015 using statistical models and found that highest redd densities occurred within the middle reaches of the main river. Mean flow during the critical spawning migration period (October to December) did not affect the density of redds directly but affected the relationship between redd density and distance from the tidal limit: redd densities were spread more uniformly throughout the river under high flow conditions, whereas redds were more aggregated in the middle river reaches under low flow conditions (see Figure 5).

Our findings suggest that access to upstream spawning grounds was limited under low flow conditions, which could have negative repercussions on juvenile survival as it results in high parr densities in the middle river.

Following on from Elinor's work, we will collate more data on river Frome redd distributions, together with the Environment Agency and other partners, and archive it in a single coherent database. This will provide an important resource to learn more about Frome salmon spawning behaviours and for their future management.

Figure 5

Plots showing redd densities against standardised distance from the tidal limit. Each panel represents a different year characterised by a measure of mean daily flow from 1 October to 31 December, and panels are ordered from low (top left) to high (bottom right) flow. Lines are the 'top-ranked' model fits. As flow and distance were standardised, no units are specified for these variables



3. Salmon parr lengths in the UK and France

These two Frome juvenile salmon illustrate the size contrast between young-of-the-year (YoY) and one year-old parr. We show that YoY salmon parr are shrinking in the Frome and two French rivers (Oir and Scorff). One implication of our finding is that salmon parr might emigrate to sea older, ie. they might stay in the river an extra year or more to grow before emigrating to sea.

In 1998, N. LeRoy Poff and Alexander Huryn published a scientific paper suggesting that some environmental variables, such as water temperature, affect wild Atlantic salmon at a regional geographical scale (eg. continent-wide), perhaps because they affect all individuals in a population. Conversely, other environmental variables, such as river flow, affect them at a local geographical scale (eg. catchment-wide), perhaps because they affect individuals in different populations differently depending on local conditions, such as available habitat. Understanding the geographical scale at which different environmental variables affect wild salmon will allow us to plan management actions at an appropriate geographical scale.

Almost 20 years since the publication of their scientific paper, no study has attempted to test Poff & Huryn's predictions, in part because it requires a statistical

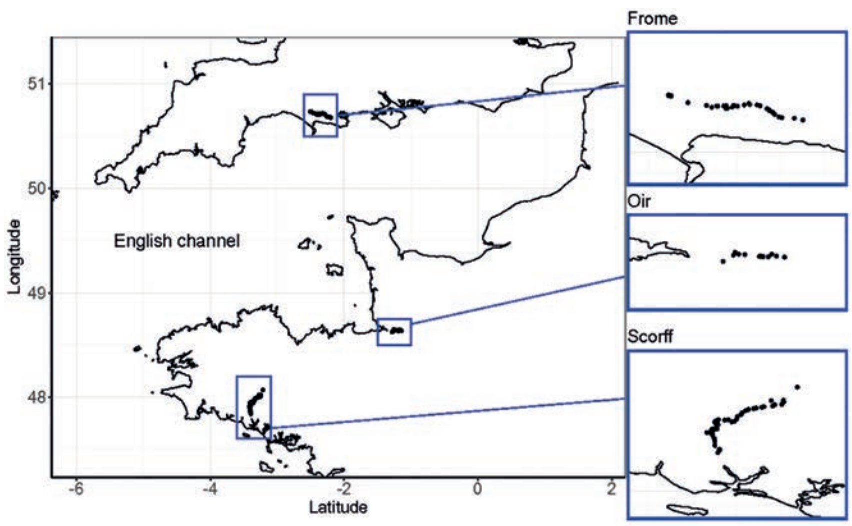


Figure 6

A map showing the locations of the three rivers included in this study: rivers Frome (Dorset, UK), Oir (Normandy, France) and Scorff (Brittany, France)

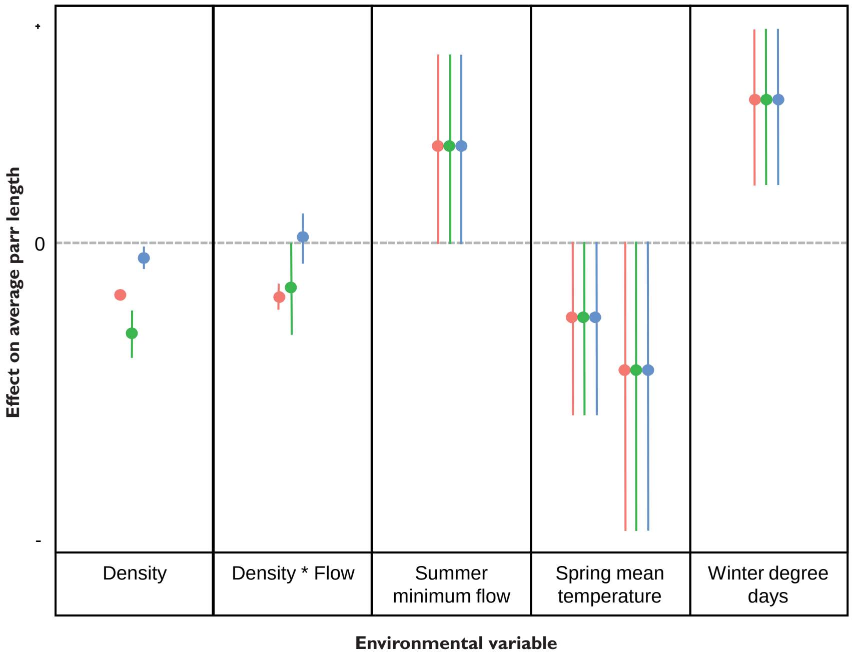


Figure 7

A plot showing the effect of five environmental variables on average juvenile salmon lengths (+ side of 0: makes them longer); 'regional' effects are identical across rivers and 'local' effects affect each river differently. The asterisk between density * flow indicates that the effect of density was dependent on flow conditions. There are two effects for spring mean temperature because it was a non-linear effect

- Frome
- Oir
- Scorff

analysis of effects acting at different geographical scales that is difficult to design and difficult to implement because of insufficient high-quality data.

With help from our colleagues at INRA in Rennes (France) and Cefas (UK), we have collated a large and long-term sample of juvenile salmon (approximately 100,000 individuals collected over 10-25 years) from three rivers in the UK and France (see Figure 6) to describe the effects of environmental variables on their body length. We predicted that water temperature would have a similar effect on juvenile salmon lengths on all three rivers, while river flow would have an effect that differed between the three rivers.

Our findings supported our predictions. Juvenile salmon were longer in years of higher overwinter water temperature (measured as degree days) and this effect was best explained as a single 'regional' effect applicable to all three rivers (see Figure 7). Similarly, spring mean temperature was best explained with a single 'regional' effect. Thus, these temperature-related variables were having a similar effect on juvenile salmon in all three rivers.

In contrast, juvenile salmon were shorter in years when there was a higher juvenile salmon density, or more individuals competing for food or space, and its interaction with total discharge (see Figure 7), and these effects were best explained by 'local' river-specific effect, which suggested that their effects were different between rivers and influenced by local conditions.

Summer minimum flow had a positive effect on juvenile salmon length (ie. less severe drought was better for juvenile salmon) but was best explained as a single 'regional' effect, contrary to our expectations, suggesting that it influenced salmon similarly in all three rivers, perhaps because it's effect is strong and is related to temperature; river water tends to be closer to air temperature during drought because there is less water to buffer changes in air temperature.

In this project, we have shown that environmental variables affect biological processes at different but predictable geographical scales. Temperature-related variables affect body sizes of cold-blooded animals, such as fish, at a regional scale. In contrast, non-temperature variables, such as the density of potential competitors and water abstraction, exert their influence at a local scale.

Our findings highlight the importance of integrating local and regional management plans to mitigate the impacts of climate change, such as rising river water temperature and diminishing summer river flows, on the body size, and ultimately the conservation, of cold-blooded species. Accordingly, we continue to work closely with our French colleagues and other salmonid population managers around the UK and Europe, to improve the effectiveness of tools used in salmonid population management.

4. Understanding autumn migration

Wading downstream with the inflatable PIT tag antenna (green device) which links to a GPS enabling us to determine the distance travelled by individual fish during the autumn shift.

Salmon from the River Frome display a classic spring smolt migration peaking at the end of April. However, with the installation of full river coverage of our PIT tag detectors at East Stoke in 2002, it became clear that a second migration period of juveniles takes place in late autumn (see Figure 8). This autumn migration of parr usually happens during the first few high flow events after mid-October and has been observed on a number of rivers in the UK, France and America. It has been proposed that this autumn movement is an early sea migration, but it has also been suggested that these are weak individuals that quickly die.

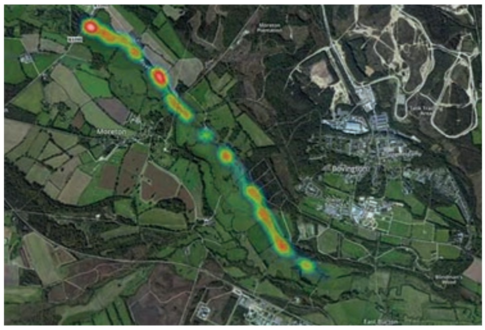
We have conducted tests and found that these autumn migrants are unable to tolerate saltwater, but we have also detected some of these autumn migrants as returning adults. As some fish obviously survive but are not adapted for saltwater in the autumn, this migration must be a downstream shift within freshwater rather than an early migration to sea.

Observations from stationary PIT tag detectors provide us with information on tagged individuals passing fixed points on the river so we know when and where the individual was tagged and when it passed our detectors. However, it does not tell us where the detected individual stops its migration and gives no information on migrating individuals that haven't passed a fixed antenna.

With the increased detection range of our new PIT tag equipment it has been possible to develop an inflatable floating antenna that can be used for mobile scanning of the river for PIT tags. In the autumn of 2016 we used one of these mobile antennas to scan the main river channel from Dorchester to Wool (20 kilometres) before and after the main autumn shift (see left).

During these mobile tracking surveys, we detected more than 1,500 individual tags and because the mobile antenna is linked to a GPS (see below), we can determine the distance travelled by these individuals between tagging and before the autumn shift. For individuals detected both before and after the autumn shift period, we will be able to determine the distance travelled.

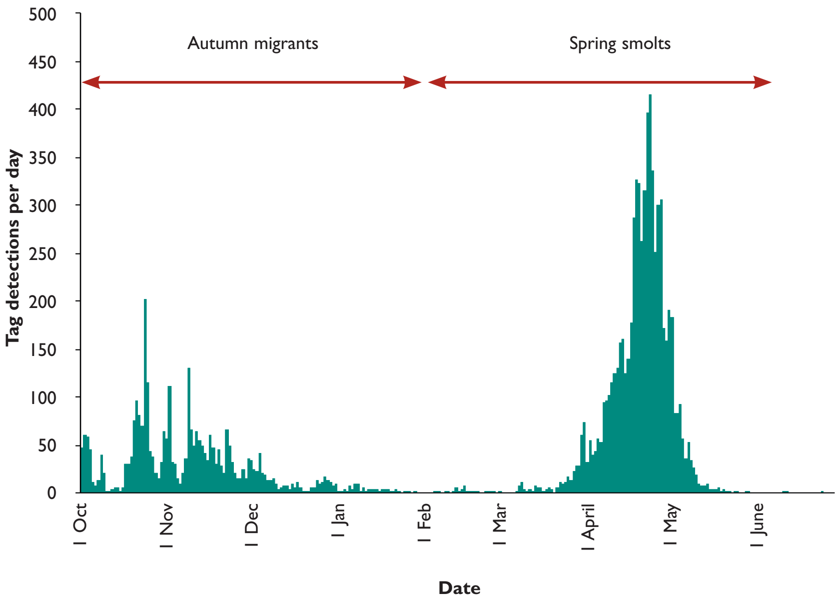
The mobile tracking data will enable us to better describe and understand the autumn movement for the population as a whole and not just the individuals that migrate past the stationary antennae. This will ultimately bring us closer to understanding who moves and why.



(Right) Heat map of the density of detected tags. We have found an early juvenile migration during the autumn before smolting which is a downstream shift within freshwater rather than an early migration to sea.

Figure 8

Five years of PIT tag detections at East Stoke illustrating the autumn migrant run and the 'normal' spring smolt run



Game & Wildlife
CONSERVATION TRUST

Cefas

5. Flow reduction, salmonids and growth rates

River flow regimes are widely recognised to be the most important variable controlling key aquatic processes such as water quality, levels of dissolved oxygen, sedimentation, and habitat quality and distribution, which in turn influence the distribution and abundance of salmonids within our rivers. Flow regimes are also likely to affect the growth of salmonids, which in turn dictates the likelyhood of survival for that fish. Increasing demands on water resources, due to a growing human population, threatens the ecosystems that hold salmonids due to abstraction (reducing the amount of water within the river) and habitat fragmentation. Climate change adds another layer of uncertainty. Modelled climate projections for southern UK suggest that summers are likely to become drier and warmer over the next 50 years, potentially reducing river flow and negatively impacting the populations of salmonids within them.

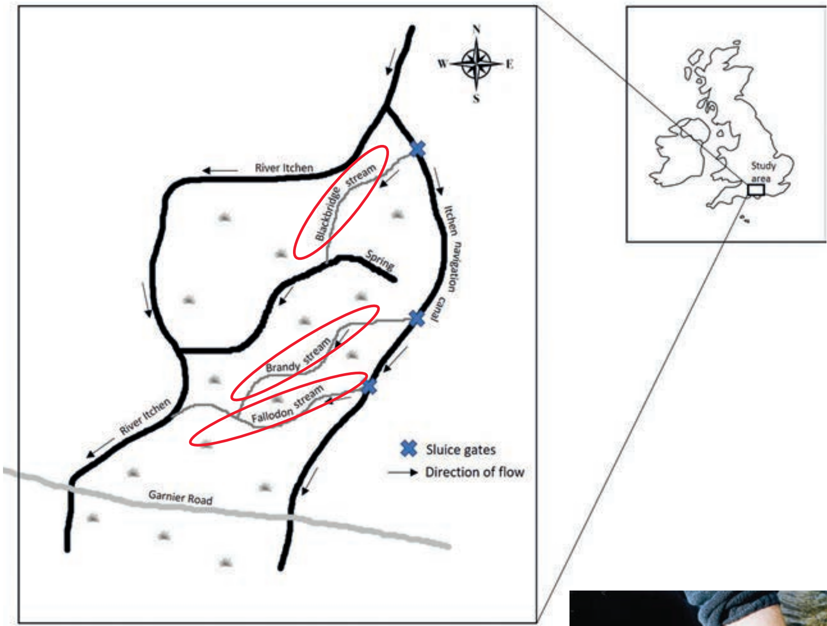
In 2015 a preliminary study was undertaken investigating the effect of different levels of flow reduction (control (no reduction), 45% reduction and 90% reduction) on the growth rate of young of the year brown trout. The study was carried out on three streams in Winchester, connecting the Itchen navigation canal to the River Itchen (see Figure 9). Each stream experienced one treatment for 28 days, after which flows were reinstated to pre-manipulation conditions. Electro-fishing was carried out before, during and after the flow reduction.

Preliminary results suggest an impact of flow reduction on trout growth, with reduced growth in the 90% reduction treatment towards the end of the flow manipulation period (see Figure 10). Flow reduction increases fine sediment deposition, causing lower prey availability due to a shift from stream-bed dwelling to burrowing macroinvertebrates. Such changes in the macroinvertebrate community reduces food availability for the trout resulting in reduced growth.

The brown trout is a native species of high conservation and recreational value, which contribute towards the UK fisheries industry which is worth over £1 billion annually to the UK economy. Knowledge-based management of natural resources, such as water that are impacted by anthropogenic activity, will be increasingly important into the future.

Figure 9

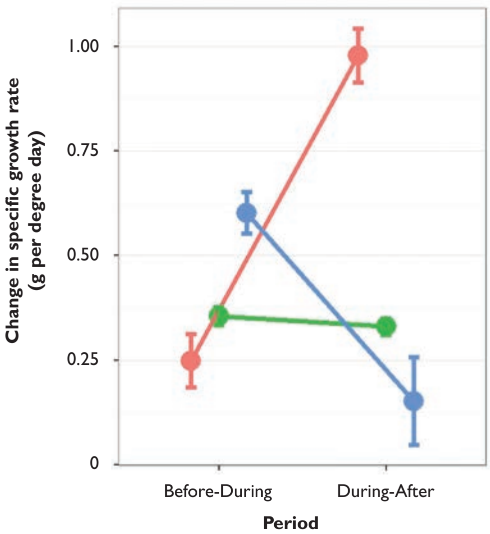
Schematic representation of the study site. Inset shows approximate location of the three study streams flowing from the Itchen navigation canal to the main River Itchen



Preliminary results show a reduction in trout growth with a reduction in flow, due to less food availability.

Figure 10

Growth rate of young of the year brown trout



Control
45% reduction
90% reduction

6. Salmon habitat use

Figure 11

Eighteen study sites (red circles) on the river Frome, Dorset

Queen Mary University of London

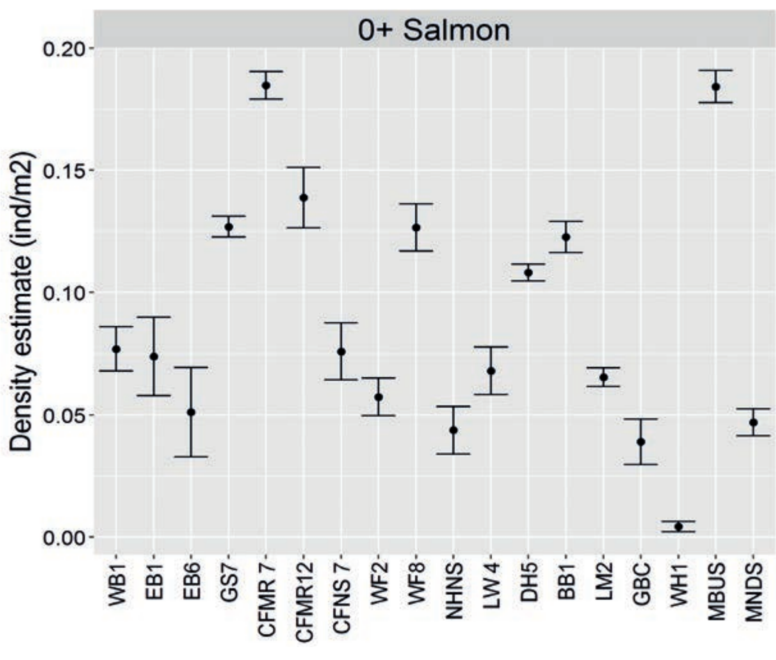
Game & Wildlife CONSERVATION TRUST

The freshwater stage of the salmon life cycle is crucial in determining salmon productivity. The phase during emergence of fry and the establishment of summer feeding territories of Atlantic salmon parr has been classed as a critical period for survival. For this reason, efforts have focused on how to maximise juvenile salmon production to conserve healthy populations. Survivorship and growth in salmon parr is highly dependent on the availability of adequate food resources and physical habitat. Habitat components such as water depth, flow, in-stream plant cover and stream substrate are crucial for parr survival.

The absence of any significant coarse substrate (cobbles, boulders) in lowland streams for physical shelter makes submerged macrophytes (aquatic plants) a fundamental requirement for juvenile salmon. Water crowfoot *(Ranunculus spp.)* is a group of submerged fine leaved plants considered to be the key macrophyte in chalk stream ecosystems for their roles in providing refugia for invertebrates and fish and their ability to alter flow dynamics and sediment deposition.

Figure 12

Density estimates of young of the year (0+) salmon Error bars denote the lower and upper 95 % confidence intervals. Sites are ordered in ascending distance from the tidal limit of the river Frome



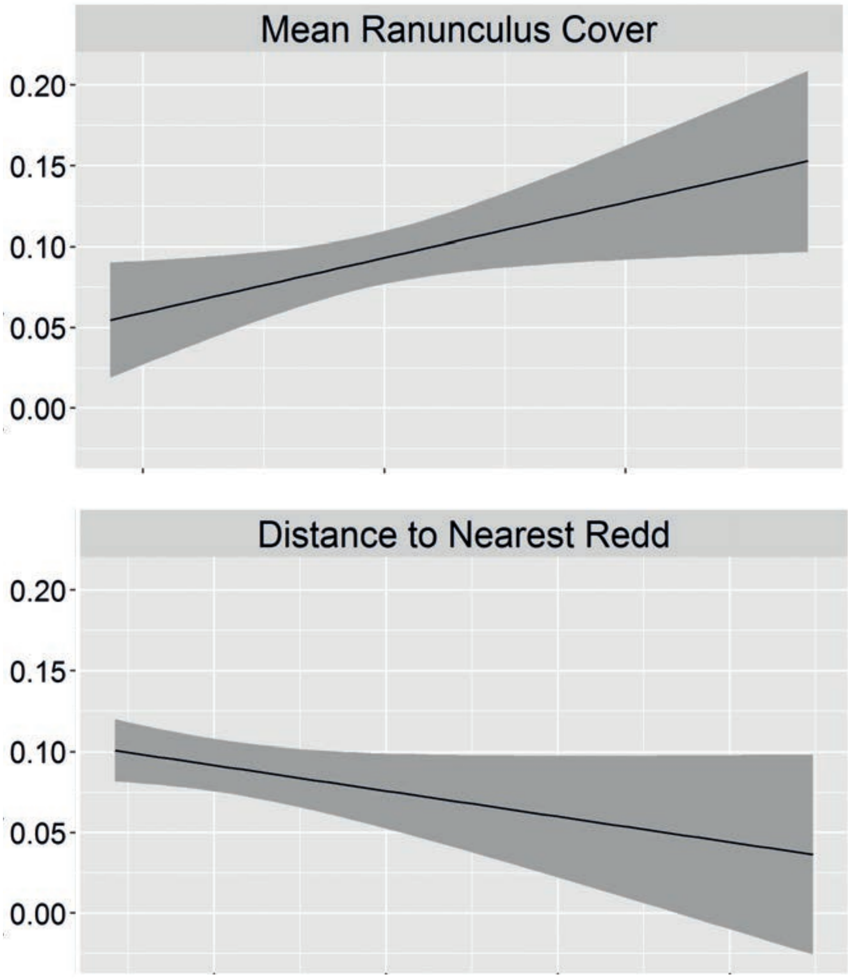


Figure 13

Two key variables, Ranunculus cover and distance to nearest redd, associated with juvenile salmon abundance. Solid black line indicates the trend line of the effect of the habitat variable on density and shaded area denotes the standard error

Sampling aquatic invertebrates using a surber sample.

An understanding of habitat use by juvenile salmon at this critical life stage is essential for the effective conservation and management of salmon. The aim of this study is to explore relationships between key ecological variables – water depth, flow, substrate, in-stream (particularly macrophytes) cover and food source (invertebrates) – and juvenile salmon densities.

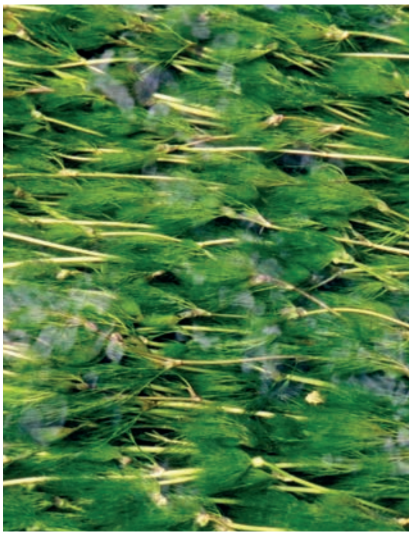
A three-year study is currently on-going, sampling 18 sites on the river Frome, Dorset (see Figure 11) each summer. Sites are being electro-fished quantitatively for juvenile salmon to estimate their abundance, sampled for aquatic invertebrates to determine abundance and diversity of prey, and surveyed for physical habitat characteristics.

Analysis of the first year's data show some interesting initial findings. Overall abundance of juvenile salmon caught during electrofishing was 1,478 individuals, and there was considerable variation in juvenile salmon abundance between sites (see Figure 12). Water crowfoot was the dominant macrophyte at most sites.

Statistical analyses were performed to assess the relative importance of habitat variables, prey abundance and diversity in explaining the juvenile salmon abundance across all study sites. Among other factors, two key variables were identified: water crowfoot and the presence of a salmon redd close to the study site. Figure 13 illustrates the relationships found: greater abundance of juvenile salmon was associated with increasing cover of water crowfoot and lower abundances of juvenile salmon were associated with an increasing distance between study site and the nearest salmon redd.

This study will complement the primary PhD project studying how water crowfoot influences the physical habitat and plant and invertebrate communities in chalk streams. Combining the knowledge of what type of habitat promotes the highest juvenile salmon densities with an increased understanding of how water crowfoot can create these 'ideal' conditions opens the possibility of utilising water crowfoot as a management tool to maximise salmon production.

Water crowfoot Ranunculus spp. bed. (Iwan Jones)



7. How do beaver dams influence salmonids?

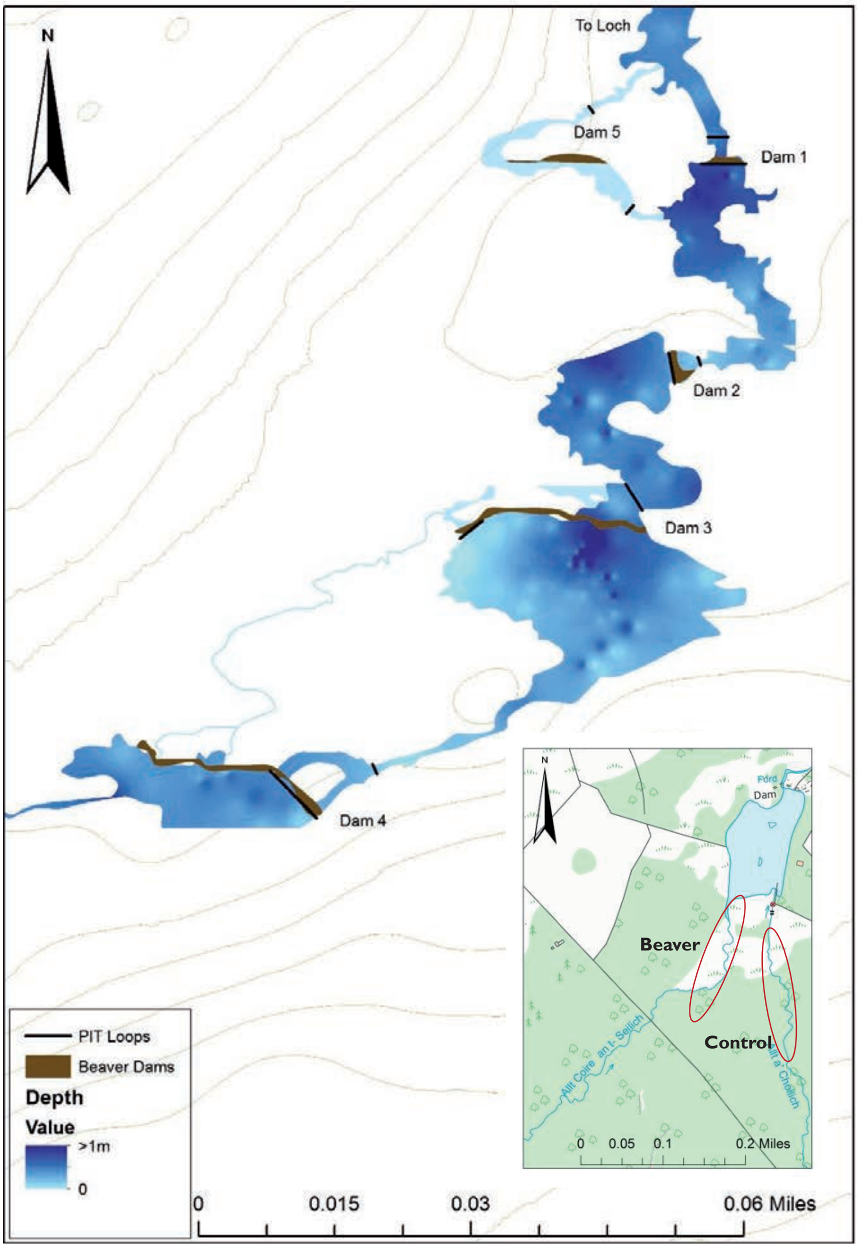
Populations of re-introduced and escaped Eurasian beaver *(Castor fiber)* currently exist in England and as of November 2016, beavers have been given native species status in Scotland. Fishery bodies are anxious that the return of beavers to Scotland may effect salmonid populations that are already under pressure. Concerns have been raised that beavers, and more specifically the dams that they construct, may negatively impact populations of migratory fish, particularly salmon and trout, by impeding their movements and fragmenting important habitats. Beaver activity can, however, be beneficial to other species and they are often referred to as 'ecosystem engineers'. Beavers can modify their habitat and in doing so, they significantly increase species richness and diversity.

PhD researcher Robert Needham has spent three autumn spawning seasons in the north of Scotland using PIT telemetry to assess the ability of brown trout to pass a series of beaver dams in both up- and downstream directions.

The study site consists of a Loch with two feeder tributaries, where beavers have been present since 2007. The beavers have altered one of the feeder tributaries, constructing five dams resulting in three new bypass channels, (see Figure 14) while the other tributary has had no beaver activity.

Figure 14

Map of the study site. Inset OS map show the Allt Coire an t- Seilich ('beaver') on the left and Allt a' Choilich ('control') on the right before beaver release and the core map shows the Allt Coire an t- Seilich post beaver modification. Illustrates location of beaver dams, PIT antennae, water loggers and water depth



Robert Needham has been assessing the ability of brown trout to pass a series of beaver dams.

Data analysis is still in the early stages, but to date:

- 924 trout have been PIT tagged.
- Upstream & downstream passage passing all dams has been observed by the installed PIT antennae.
- The beaver dams are proving to be partial barriers, with flow conditions influencing the success rate of upstream passage (see Figure 15).
- Larger trout appear to pass dams more successfully (see Figure 16).
- New channels have formed bypassing three of the five beaver dams and fish have been recorded using these to negotiate the dams.
- Spawning continues to be observed above the dam 4 (most upstream) in the beaver modified tributary.

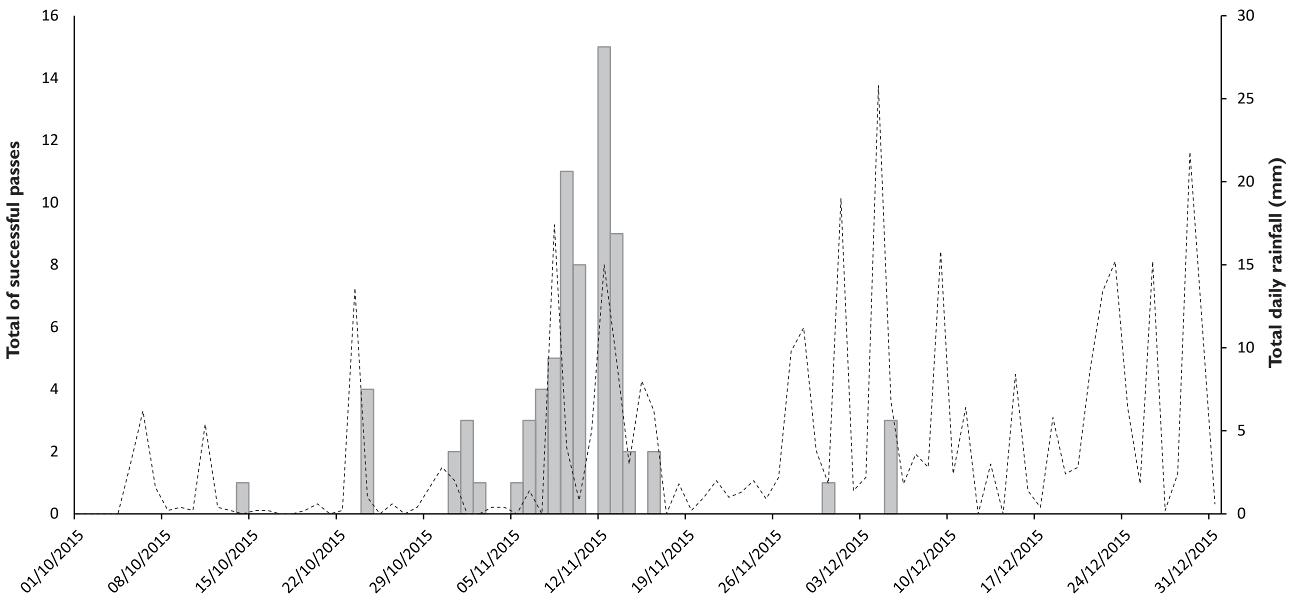
Much has been said in the media about beaver effects – negative and positive – and we look forward to following this project to its conclusion as it provides vital evidence about this new conservation issue.

UNIVERSITY OF Southampton

Game & Wildlife CONSERVATION TRUST

Figure 15

The columns illustrate the number of successful upstream passages of the beaver dams in relation to daily rainfall (dotted line). The total number of successful passages recorded was 121



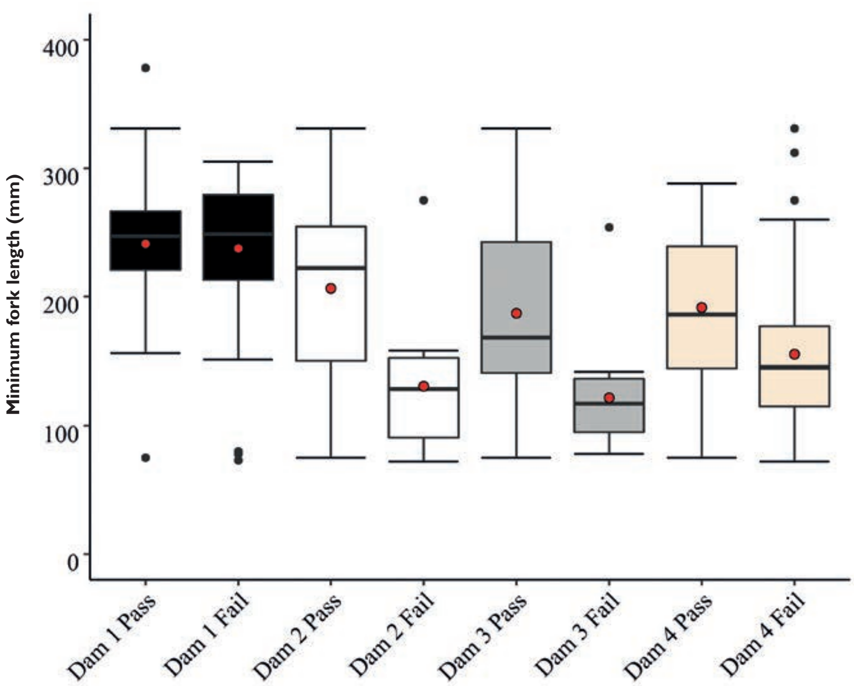


Figure 16

Comparing fork length (mm) of individual brown trout with successful and failed upstream passage attempts at the beaver dams (total number of individuals 139)

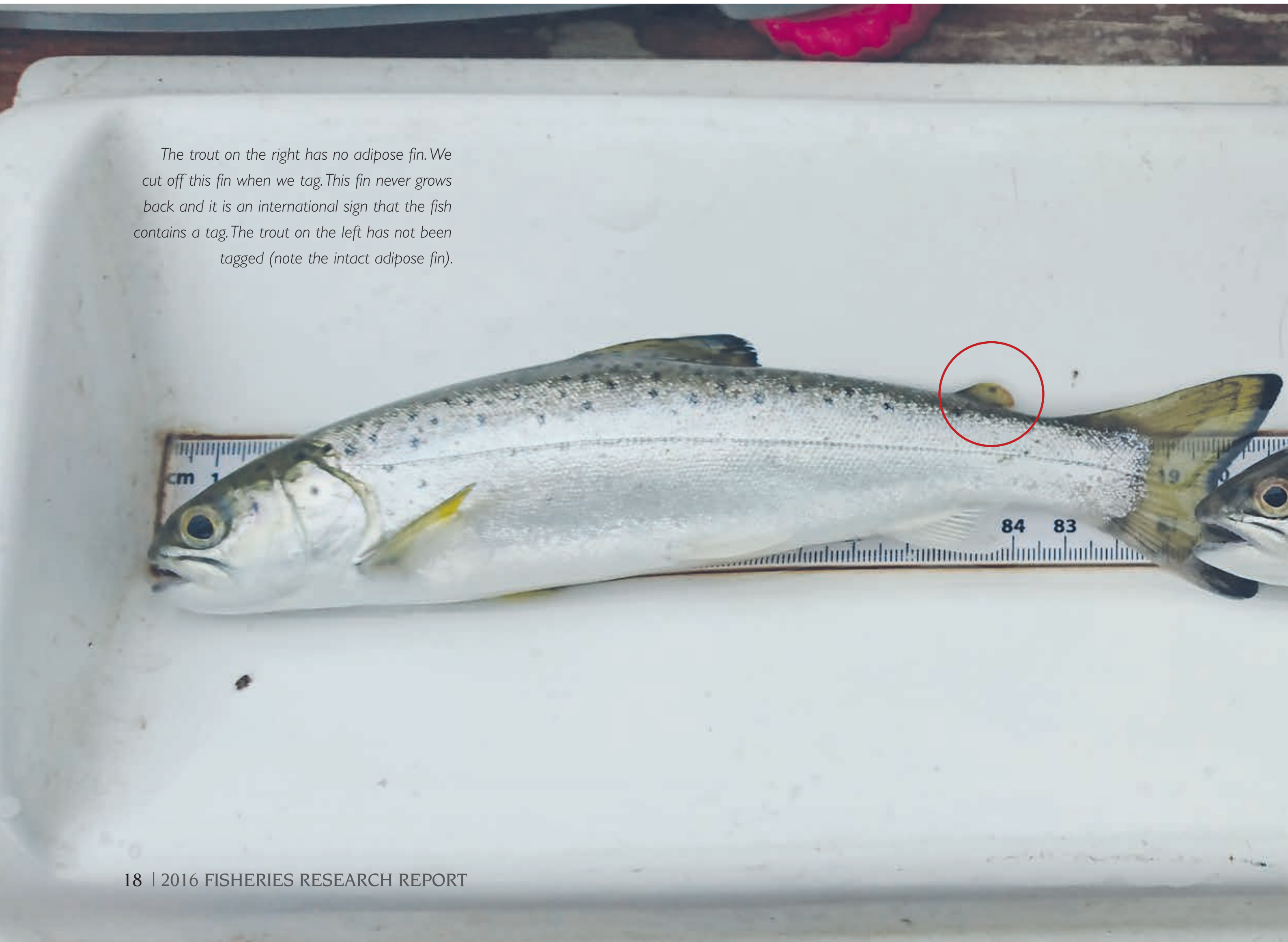
8. Finding out about trout

Sedated salmon and sea trout smolts waiting to be weighed, measured and checked for tags. We detected 77 one-year old trout smolts at East Stoke on our automated in-stream antennae during the 2016 smolt run.

The River Frome has a considerable population of migratory trout and with PIT tag detectors already installed in the catchment, tagging trout has long been something we would wish to do. Resources have been the limiting factor but with help from a new Cefas project to study the importance of small streams for salmonids, we amassed enough resources to kick start a trout tagging programme. In both 2015 and 2016, we PIT tagged nearly 3,000 young of the year trout during our salmon tagging program. Trout tags were deployed throughout the catchment from East Stoke to Sandhills, 60km upstream of East Stoke. Trout were tagged in the main river, carriers and tributaries. Some of these parr will remain all their life in their native stream as residents, while others will smoltify and migrate to sea. Migratory trout encounter richer feeding grounds at sea and attain greater final body size than their freshwater resident counterparts. Because fecundity is intrinsically linked to body size, particularly for females, migratory individuals enjoy greater lifetime fecundity. Migration, however, is energetically costly and leads to increased exposure to predation. Tagging trout parr throughout the catchment will enable us to look at which individuals migrate.

One of the primary questions that we will be able to answer with this project is: which part of the catchment produces the trout smolts, is it the lower river or does the propensity to migrate depend on the productivity of the parr habitat?

We detected 77 one-year-old trout smolts at East Stoke during the 2016 smolt run and we are expecting to record even more of the 2015 year-group during the 2017 smolt run, as the majority of trout smolts in the Frome are two years old. The combination of the PIT tag detectors and the smolt trap at East Stoke will also provide us with an estimate of the number of emigrating trout smolts at a



The trout on the right has no adipose fin. We cut off this fin when we tag. This fin never grows back and it is an international sign that the fish contains a tag. The trout on the left has not been tagged (note the intact adipose fin).

This work will enable us to estimate the number of emigrating trout smolts at a catchment level and eventually provide an estimate of returning adults and marine survival.

catchment level and eventually provide a measure of number of returning adults and marine survival. We will continue to tag trout parr in the years to come and will gain more knowledge of this enigmatic species from recordings of tagged individuals emigrating from and returning to the river.

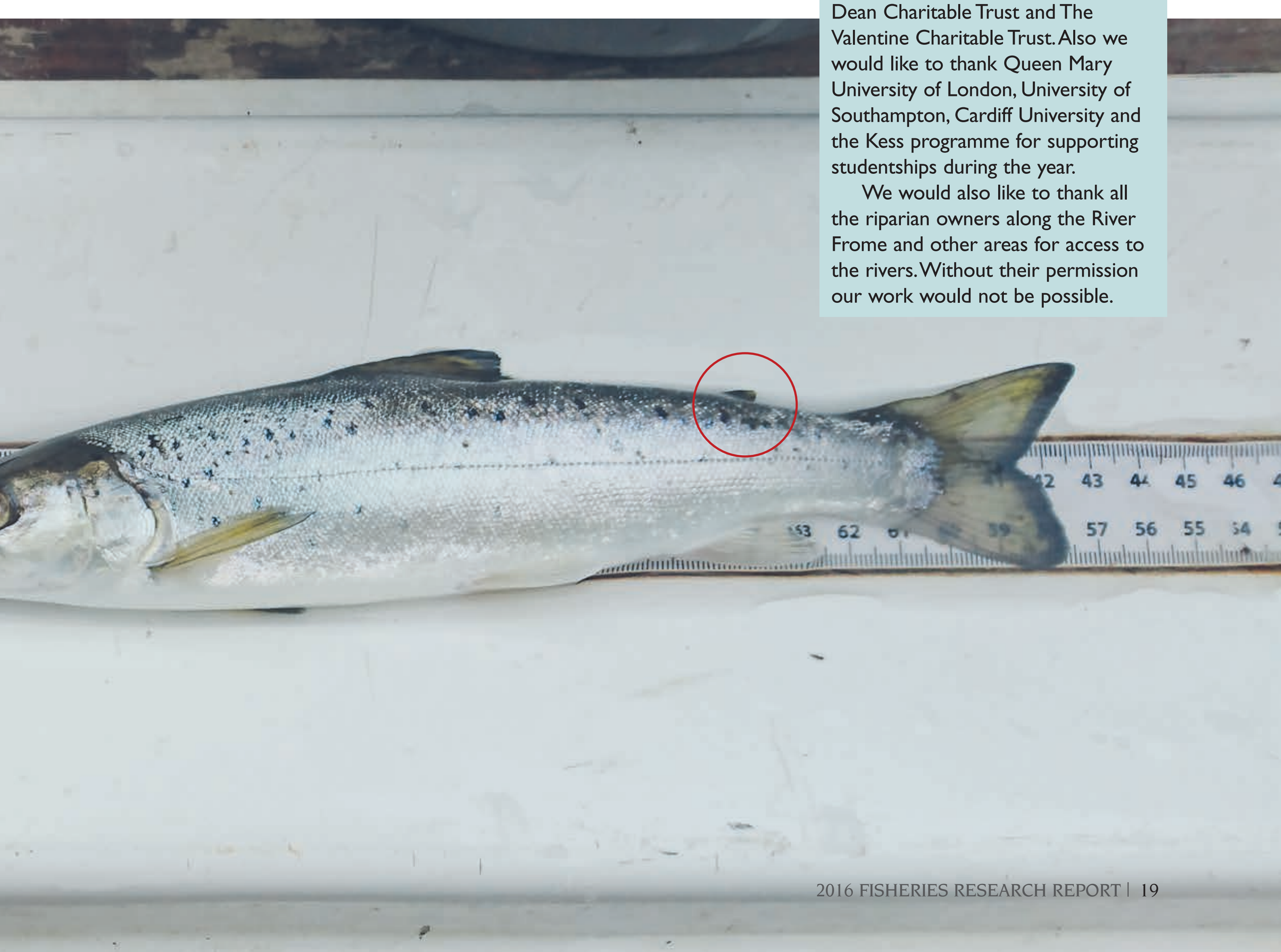
Game & Wildlife CONSERVATION TRUST

Cefas

Fisheries research acknowledgements

The GWCT would like to acknowledge the financial support for all of the fisheries projects from the Environment Agency, Cefas, Defra, EU Interreg Channel Programme, David Mayhew, Jock Miller, Anthony Daniell and Winton Capital, G&K Boyes Trust, The Alice Ellen Cooper Dean Charitable Trust and The Valentine Charitable Trust. Also we would like to thank Queen Mary University of London, University of Southampton, Cardiff University and the Kess programme for supporting studentships during the year.

We would also like to thank all the riparian owners along the River Frome and other areas for access to the rivers. Without their permission our work would not be possible.



The Game & Wildlife Conservation Trust

For over 80 years our scientists have been researching why species like the grey partridge, corn bunting and black grouse have declined. We are continually developing practical measures to reverse these declines.

Our aim is simple – a thriving countryside rich in game and other wildlife.

We are an independent charity reliant on voluntary donations and the support of people who care about the survival of our natural heritage.

Our science is funded by our members. Be the first to know about our new research and call 01425 651010 to join us today.

Game & Wildlife
CONSERVATION TRUST

Salmon & Trout Research Centre,
East Stoke, Wareham,
Dorset, BH20 6BB
Tel: 01929 401894
Email: fisheries@gwct.org.uk

www.gwct.org.uk

Editing, design and layout: Louise Shervington
Printed on FSC accredited paper