Investigating patterns of straying and mixed stock exploitation of sea trout (Salmo trutta L.) in rivers sharing an estuary in southwest England

Journal:	*Fisheries Management and Ecology*
Manuscript ID	Draft
Manuscript Type:	Article
Keywords:	genetic stock identification, microsatellite, recreational fishery, anadromy, sea trout, straying

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Abstract

For effective management, information on the stock composition of a fishery is essential. Here, we highlight the utility of a resident trout microsatellite baseline to determine the origins of sea trout entering the Rivers Tamar, Tavy and Lynher in southwest England – all share a common estuary and have major runs of sea trout. There is a high degree of geographical structuring of the genetic variation in the baseline rivers. Testing with simulated and real datasets showed fish can be assigned to reporting group with a high degree of accuracy. Mixed stock analysis of over 1000 sea trout showed that fish entering the Tamar and Tavy constituted mixed stocks. Significantly, in the Tamar, non-natal origin sea trout are restricted to the lower catchment. As well as providing insight into sea trout behaviour, this study also has important implications for the management of recreational rod-and-line fisheries.

Key Words: genetic stock identification, microsatellite, recreational fishery, anadromy, sea trout, straying

Introduction

The perceived wisdom is that anadromous species such as salmon and trout, after spending time feeding at sea, return to their natal river to spawn. This homing fidelity can lead to reduced gene flow between rivers and gives rise to the strong genetic structure found in many salmonid species (Dionne *et al.* 2008; Lohmann *et al.* 2008).

However, straying is known to occur and is thought to be an important evolutionary feature of salmonids, playing an adaptive role over both short and long time scales. Straying is especially important in colonization, re-colonization and range expansion (Quinn 1984; Tallman & Healey 1994; Griffiths *et al*. 2011), may help reduce inbreeding depression within populations (Keefer & Caudill 2014) and can give rise to spatially structured metapopulations (Schtickzelle & Quinn 2007). However, the extent of straying is often difficult to determine, especially into already established populations. In the case of trout, tagging studies have shown that, while the majority of sea trout remain in coastal waters close to their natal rivers, many smolts and adults can make long distance movements (Fournel *et al*. 1990; Pratten & Shearer 1983).

Straying, therefore, is an important part of salmonid behaviour and as such can have consequences for the management of coastal, estuarine and in-river fisheries. However, what is not clear is whether recoveries of tagged individuals from non-natal rivers represent temporary straying or potentially true reproductive (spawning) straying (Keefer & Caudill 2014).

Traditionally, the presence of various external (i.e. Carlin tags) or internal (i.e. Coded-wire Tags (CWTs)) tags has been used to determine both the marine spatial distribution of different salmonid stocks and the mixed stock nature of fisheries (Potter & Moore 1992; Hansen & Jacobsen 2003). While tagging approaches are 100% successful in assigning fish back to their river of origin, such studies do have their drawbacks. Typically, they involve fish from only a small number of rivers, they are usually restricted to fish of hatchery origin and they generally suffer from low levels of recapture despite the often large numbers of fish that are tagged (Candy & Beacham 2000; Degerman *et al*. 2012; Trudel *et al.* 2009).

However, since the late 1990s there has been an increase in the use of DNA markers in fisheries research as an alternative to traditional tagging studies. Extensive microsatellite

DNA baseline databases now exist for genetic stock identification (GSI) of Pacific salmonid species (e.g. Beacham *et al*. 2006; 2014) and for Atlantic salmon (e.g. Griffiths *et al*. 2010; Ellis *et al.* 2011a; Bradbury *et al*. 2015). DNA approaches have the advantage over tagging studies, in that all fish can potentially be included as any captured fish can be screened for the genetic markers being used. However, molecular approaches also have their potential drawbacks and the success of DNA-based assignments is dependent on a number of factors including the number of microsatellite loci utilized and their levels of polymorphism, and levels of genetic differentiation between populations (Hansen *et al*. 2001). Additionally, due to the metapopulation structure of many salmonid species, assignment is usually more successful to regional groupings of rivers than to a single river of origin (*e.g.* Beacham *et al*. 2006). Despite these potential drawbacks, DNA-based approaches have become the method of choice in mixed stock fishery studies (Ensing *et al*. 2013).

However, while there have been extensive studies on the mixed stock nature of commercial open water and estuarine salmonid net fisheries (Griffiths *et al.* 2010; Ensing *et al.* 2013; Koljonen *et al.* 2014), there have been few such studies on recreational, in-river fisheries (Warnock *et al.* 2011).

The River Tamar, in southwest England, is one of three UK Environment Agency 'Index Rivers' and as such is subject to intensive monitoring programmes in order to develop an understanding of salmonid stock and fishery processes, and to improve the wider management of sea trout and salmon. The Tamar monitoring programme includes extensive juvenile electrofishing surveys, the trapping and tagging of smolts during their spring migration and the trapping of returning adults in a trap immediately below a fish pass adjacent to a weir at the tidal limit of the river (Gunnislake). Harris (2006) has provided a detailed description of the rod-caught sea trout stock within the River Tamar. Tamar sea trout typically smolt after two years in the river. The majority of the rod catch represents fish that returned to the river in the same year that they smolted (known variously as school peal, finnock or whitling). Of the repeat spawning fish, some were found to have spawned up to four times, however, the majority had only a single spawning mark (Harris 2006). There is also temporal variation in the composition of the sea trout run – multiple spawning fish enter the river early in the year, while finnock start to return in July.

In this study we utilize an extensive resident trout microsatellite baseline of rivers in southwest England to address two key questions: 1. do the rod and line fisheries within each river represent mixed stock fisheries, capturing straying fish from other rivers, and 2. if strays are present, can we distinguish if they are transient/temporary or is their position of capture within the river suggestive of an intention to spawn?

Materials and Methods

For the initial genetic baseline, individual resident trout were sampled from 82 populations from 29 rivers in Devon and Cornwall, southwest England (Table 1). Fish were caught during routine electrofishing surveys between 2010 and 2014. The sampling scheme was designed to reduce the collection of potentially related individuals by targeting 1+ or older fish. However, to increase sample size, fry were collected from some sites. An additional sample from the River Tamar consisted of smolts caught in a rotary screw trap during their downstream migration in April 2007. Fish were anaesthetised using either clove oil or MS-222 (10 mg/l) prior to removal of adipose fin clips according to UK Home Office guidelines. Fin clips were transferred immediately into tubes containing absolute ethanol. Sea trout scales were obtained from an Environment Agency fish trap on a weir at the tidal limit of the River Tamar (Gunnislake), as well as from fish caught in recreational rod fisheries within the Tamar, Lynher and Tavy. Genomic DNA was extracted from both fin tissue and scales following the method of Montero-Pau *et al*. (2008).

Samples were screened for variation with 18 nuclear microsatellite primer sets: SsosL311, SsosL417 (Slettan *et al* 1995), SsaF43 (Sánchez *et al*. 1996), BG935488, CA048828, CA060208, CA060177 (Vasemägi *et al*. 2005), SSsp2213 (Paterson *et al*. 2004), Ssa407UOS (Cairney *et al*. 2000), One102 (Olsen *et al*. 2000 using the primers of Keenan *et al*. 2013), SsaD58, SsaD157 (King *et al*. 2005), sasaTAP2A (Grimholt *et al*. 2002), STR3QUB (Keenan *et al*. 2013), Ssa85, Ssa197 (O'Reilly *et al*. 1996), SS11 (Martinez *et al*. 1999) and BHMS362 (also known as Ssa52NVH (Gharbi *et al*. 2006); AF256702). Five loci (Ssa85, BG935488, CA060208, CA060177 and sasaTAP2A) show non-overlapping size ranges in trout and Atlantic salmon (*Salmo salar* L.) and are therefore useful for the identification of salmon and trout x salmon hybrids. Polymerase chain reactions (PCRs) and genotyping were performed as described in Paris *et al*. (2015).

The program COLONY v 2.0 (Jones & Wang 2010) was used for sibship reconstruction. This program implements a maximum-likelihood method to assign sibship to individuals based on their multilocus genotype. To check for consistency of results, the program was run twice using different random number seeds. Conditions were: high precision, medium length run, assuming both male and female polygamy without inbreeding and a 1% error rate for both scoring error rate and allelic dropout rate. Fish were considered members of a full-sib family if the probability of exclusion as full-sib families was > 0.9. Only a single individual of each full-sib group was retained in the data set for subsequent analyses.

Micro-Checker v 2.2 (Van Oosterhout *et al*. 2004) was used to detect the presence of large allele dropout, stuttering and null alleles at each locus. Genepop v 3.4 (Raymond & Rousset 1995) was used to test for linkage disequilibrium (LD) between all pairs of loci within each population and for deviation from Hardy-Weinberg Equilibrium (HWE) for each locus and population. Significance was estimated using a Markov-chain method (1000 de-memorisations, 100 batches and 1000 iterations). False Discovery Rate (FDR, Benjamini & Hochberg 1995) was used to correct significance levels for all multiple comparisons.

Baseline reporting groups were identified from population groupings determined from a neighbour-joining dendrogram based on Cavalli-Sforza and Edwards (1967) chord distance (D_{CE}). The dendrogram was constructed using Populations 1.2.32 (Langella 1999) and visualised using MEGA v. 6 (Tamura *et al*. 2013). A second analysis was conducted, incorporating seven of the baseline test samples (see below). The majority of these were collected during previous projects and provided a test of the temporal stability of the baseline (Table X).

Mixed stock analysis (MSA) was conducted using the Bayesian procedure of Pella & Masuda (2001) as implemented in cBayes (Neaves *et al*. 2005). For the estimation of stock composition, ten 20 000-interation Markov Chain Monte Carlo (MCMC) chains were run, with initial values set at 0.9 for each chain for different samples. Stock estimates were considered to have converged if the Gelman-Rubin shrink factor (Gelman and Rubin 1992) was <1.2. The final 1000 iterations from each chain were combined to determine the means and 95% confidence intervals of the estimated stock contributions to the mixtures from both individual rivers and reporting groups.

Simulated mixtures were used initially to test the accuracy of stock compositions derived from the baseline. Such simulated data sets are acknowledged to be a general gauge of baseline accuracy (Griffiths *et al*. 2010). We generated three sets of simulated datasets. The first consisted of 150 simulated genotypes from each of the 29 rivers in the baseline. Next, we simulated single reporting group mixtures, each consisting of 200 genotypes, with equal contribution from each of the rivers in that group. Finally, we simulated multi-group mixtures focusing on each of our three focal rivers. These mixtures contained 500 genotypes consisting of a 60% contribution from one focal river, 10% from each of the other two focal rivers and the remaining 20% from rivers outside of the Tamar estuary. Simulation of genotypes was carried out using ONCOR (Kalinowski *et al*. 2008).

Simulated mixtures can sometimes lead to over-confidence in the accuracy of assignment, as they can only consider the allele frequencies of the sampled baseline populations. A more realistic assessment of baseline accuracy can be obtained from the analysis of real fish of known origins (Ensing *et al*. 2013). Samples were available for resident trout from 11 of the rivers in our baseline (Table 2). These samples were chosen to represent the major sea trout rivers in the region, but were collected from sites that were not included in the baseline sample for each river. The data for resident trout caught in the Tamar was augmented with genotypes for 60 sea trout caught in the Gunnislake trap (n=54) and in the Tamar rod fishery (n=6). These fish possessed either microtags or had their adipose fins clipped, indicating that they must have been trapped as smolts in the lower Tamar rotary screw trap during their outbound migration.

To investigate the origins of sea trout entering each of the focal rivers we utilized two sources of scales. Scale samples were obtained from sea trout caught in the trap at Gunnislake Weir from 2010 (April to October, n=479) and 2011 (June to August, n=286). Collections represented both repeat spawning fish and within-year returnees. Fishermen also provided scales from sea trout caught in the recreational rod fishery of the Lynher, Tamar and Tavy between 2010 and 2014. The majority of rod-caught fish were caught between June and August in all years. For the Tamar, collections represented fish caught in the lower main river and also from a tributary, the Lyd, in the upper catchment. On the Tavy, fish were caught between the tidal limit and the confluence of the main river and the River Walkham.

Results

A total of 3601 resident trout and smolts were sampled from 83 sites from 29 rivers in Devon and Cornwall. The number of sample sites per river ranged from one to eight. Hybrid individuals (n=31) were collected from 16 sites and were removed from the dataset. After COLONY analysis, a further 274 individuals belonging to full-sib families were also removed.

The 18 primers sets amplified a total of 19 loci. The primers for One102 amplified two loci with non-overlapping size ranges and were designated One102a and One102b. A total of 517 alleles were found (average 27.21 alleles per locus, 2 (One102a) – 58 (SsaD58) alleles per locus). Evidence of null alleles, long allele drop-out and stuttering were not consistently detected in any loci. Tests for linkage disequilibrium found 332 out of 14193 population-locus pair tests were significant after FDR correction. Of the significant tests, 146 were found in the TOR.PUT sample. This sample was removed from the final baseline. Significant deviations from HWE, after FDR correction, were found for 22 tests comprising eight loci and 21 populations. As none of these significant results were consistent across loci or populations, all loci were retained for further analyses. The final baseline comprised a total of 3265 fish from 82 sample sites.

There was a high degree of genetic structuring of the baseline samples with geographically proximate rivers being genetically similar (Fig. 1). This allowed populations from the 29 rivers to be clustered into ten groups (reporting groups) for assignment purposes. Two of the reporting groups contained only a single river (Camel and Tamar). The number of rivers in the remaining reporting groups ranged from 2 – 6 (Fig. 1). This analysis also suggested a high degree of temporal stability in the baseline – all temporal samples used in baseline testing grouped with the baseline samples from the same river and in many cases the same tributary (Fig. 1).

MSA of simulated mixtures showed a high degree of self-assignment, especially to reporting group. For simulated single-river samples, average correct assignment to river and group of origin was 98.20% (range 94.45% – 99.18%) and 98.61% (range 96.21% – 99.38%), respectively (Appendix 1). Likewise, simulated single reporting group mixtures generally showed high levels of self-assignment, especially to reporting group (average = 98.29%, range 95.49% – 99.49%, Appendix 1). Analysis of multi-reporting group mixtures, concentrating on the three focal rivers showed that it was possible to assign complex mixtures to the baseline reporting groups with a high degree of accuracy (Appendix 1).

Simulated datasets can give a good idea of baseline accuracy only if the populations sampled from each river to construct the baseline are representative of these catchments as a whole. Assignment of the fish of known origin to river of origin showed that, in general our baseline samples were representative of their catchments with self-assignments generally in excess of 90% (Appendix 2). There were however some clear exceptions to this. For example, self-assignment to river of origin for samples from the Taw and Torridge was 86.39% and 57.66%, respectively. However, self-assignment of these samples to a Taw/Torridge reporting group was over 92% in both cases. For nine of the 11 test samples, assignment to the correct reporting group was greater than 90%. In the remaining two test samples, there was a high degree of mis-assignment of Looe samples to the South Hams reporting group (8.31%, 95% CIs 0% - 30.01%) and of Avon fish to the Exe/Otter/Axe reporting group (6.12%, 95% CIs 0.2% - 19.81%). Importantly, mis-assignment to our three focal rivers and their corresponding reporting groups was uniformly very low (river average 0.26%, range 0.08% – 0.89%, group average 0.46%, range 0.08% - 0.91%, Appendix 2).

Results indicate that there was high degree of straying for fish entering the River Tamar. A significant proportion (>10%) of the sea trout caught in the Gunnislake trap were strays, mainly from the Lynher and Tavy, but also from other rivers in south Devon and Cornwall (Fig. 2). This result was consistent across the two years and also when considering whether the fish were repeat spawning sea trout or within-year returnees (Appendix 2). However, there was considerable variation in the levels of straying across each individual year. Contributions of non-Tamar fish to the monthly totals ranged from virtually zero in June 2010 to almost 50% in October 2010 (Fig. 3).

The assignments of fish from the in-river rod fisheries also showed varying degrees of straying. For the Lynher, there was a high degree of self-assignment with minor contributions from rivers in the South Cornwall and South Hams reporting groups (Fig. 4, Appendix 2).

Within the Tamar, straying appears to be restricted to the lower catchment with non-natal fish not penetrating into the upper catchment. For the tidal limit trap and lower catchment samples, there was a ~10% contribution from the Lynher and Tavy with small contributions from the South Cornwall, South Hams and Dart/Teign reporting groups (Fig. 4, Appendix 2). However, for the upper catchment sample, there is virtually no contribution from the Lynher and Tavy (0.20% and 0.29%, respectively), with the majority of fish being assigned to the Tamar.

For the Tavy, assignment of rod-caught fish to other rivers exceeded 70% (Fig. 4, Appendix 2) with significant numbers of Tamar and Lynher sea trout being caught. Interestingly, there was a high contribution of fish from the Dart/Teign group (13.6%) to the rod fishery of the lower Tavy, despite a marine separation of their river mouths of more than 80 km.

Discussion

The power of assignment and accuracy of assignment to genetic baselines depends on a number of factors. One of the key aspects is that the baseline is representative of the set of populations likely to contribute to the mixtures to be assigned (Pella & Masuda 2006). The UK Environment Agency, based on rod catches, has designated 18 principal and 6 minor sea trout rivers in the area covered by this baseline. Of these rivers, samples are included from all except one minor river. Another potential source of bias is that the populations sampled for the baseline may not, in terms of allele frequencies, be representative of the catchments from which they are taken (Koljonen *et al.* 2007). This includes both temporal stability of allele frequencies and accounting for the presence of different genetic groupings within catchments. We tested for both these potential sources of bias by querying the baseline with fish of known origin, including samples contemporary with the baseline samples but from sites/tributaries not included in the baseline; we also included samples one to three generations removed from the baseline collections. These test samples group with their rivers of origin in the neighbour-joining tree (Fig. 1), in some cases with samples from the same tributary, showing that our baseline is both representative of catchments as a whole and temporally stable over a time scale of at least one to three generations. This is in agreement with other studies in salmonid species that have shown temporally stable patterns of genetic diversity and population structure over short- (Griffiths *et al.* 2009), medium- (Van Doornik *et al*. 2011) and long-term (Charlier *et al*. 2012) time scales.

The accuracy of assignment is also dependent on the levels of genetic divergence between populations. Araujo *et al.* (2014), using simulated data, found that deviations from true mixture proportions were minimized at F_{ST} values greater than 0.03. The average pairwise

F_{ST} found in this study was 0.028 and is comparable to other similar studies on brown trout (e.g. Carlsson *et al*. 1999; Griffiths *et al.* 2009; Paris *et al*. 2015), though markedly greater than values detected between Atlantic salmon populations in the Tamar catchment (Ellis *et al.* 2011b). Testing of the baseline with samples of known origin showed that in general we were able to assign fish to their reporting group of origin with a higher degree of certainty than to river of origin. This is highlighted by several of the test samples, *i.e.* the Torridge and Exe, where assignment to river of origin was poor while assignment to the reporting group was over 90% in both cases (Appendix 2). There are several factors that could account for the poor assignment to river of origin in some of the baseline test samples.

The Torridge baseline test samples showed a high level of mis-assignment to the Taw. Both these rivers share an estuary and samples from each river were not monophyletic in the neighbour-joining tree, suggesting that the two rivers should be considered as a single genetic population.

Some sites had small sample sizes. For example, the South Hams region comprising the rivers Plym, Erme, Yealm and Avon, and would benefit from additional sampling. In general, small sample sizes result in reduced accuracy of assignment (Griffiths *et al.* 2010), with only modest gains in accuracy with sample sizes greater than 150-200 (Beacham *et al.* 2006). However, the Beacham *et al*. (2006) study was conducted over a wide geographical range (the northern Pacific Rim) and the average level of genetic differentiation (F_{ST} = 0.063) was higher than found in the present study. Over smaller geographic regions, where populations are likely to be genetically more similar, sample sizes larger than 200 may be required in order to achieve high assignment accuracy.

These results highlight an interesting aspect of sea trout biology, namely that non-natal fish frequently entered the freshwater reaches of the three focal rivers. Straying appears to be an integral part of salmonid biology but it is unclear whether straying is a failure of fish to home accurately or whether it is an alternative dispersal strategy that has long term evolutionary advantages (McDowall 2001). When at sea, sea trout are generally assumed to stay close to their natal rivers but tagging and genetic studies have shown that sea trout readily move away over both short- and long-distances and can stray into non-natal rivers. For example, Jensen *et al*. (2015) showed that sea trout from the River Halselva in northern Norway strayed more readily into neighbouring watersheds than sympatric Arctic char. Data on tagged sea trout smolts from the River Axe (Devon, UK) showed that the majority of captures outside of the Axe were from the River Otter (20km west of the Axe), with some fish being caught as far west as the River Camel and as far east as the Hampshire Basin rivers (Solomon 1994). Similarly, some tagged River Axe kelts made longer distance movements with recoveries from rivers entering the North Sea and the Bristol Channel (Solomon 1994). In the Baltic, genetic assignments to a baseline comprising trout from rivers flowing into the Gulf of Finland found that significant numbers of Russian and Estonia sea trout were being caught in commercial net fisheries on the south Finnish coast (Koljonen *et al.* 2014).

One possible explanation for the occurrence of high numbers of non-natal sea trout in the lower reaches of the Tamar and Tavy is that the fish may be choosing to overwinter in freshwater. For instance, Degerman *et al*. (2012) found a peak in temporary straying of tagged sea trout of hatchery origin to rivers in the northern Baltic during September to December. Similarly, using genetic assignments, Moore *et al*. (2013) found high numbers of Arctic char overwintering in non-natal rivers. The sea trout stock in southwest Britain is dominated by fish that have spent less than a year at sea (known as 'finnock'; Harris 2006). The reason why these fish should spend such a short time at sea is not fully understood, but is a common feature of many sea trout stocks (Degerman *et al*. 2012). It may be that the propensity for sea trout to move away from their natal rivers coupled with the 'need' to return to freshwater during the winter could account for the high levels of straying found in this and other studies.

Significantly, for the Tamar, straying fish do not appear to migrate into the upper catchment and presumably do not contribute to the spawning population of the river. Thus, for the Tamar at least, we are able to distinguish temporary straying from true reproductive straying. Moore *et al*. (2013) also found that the majority of Arctic char strays were non-reproductive individuals. However, Degerman *et al*. (2012) found that it was older fish that were more likely to overwinter in freshwater. The majority of the sea trout entering the Tamar from June onwards will have spent only a few months in the marine environment and it is likely that the majority of these fish are not yet mature. Indeed, for the River Axe it was found that only 14%-31% of finnock had spawned when trapped migrating downstream the following spring (Solomon 1994).

It is interesting to note the very high levels of straying of non-natal sea trout into the lower Tavy, with significant contributions from both the Tamar and the Dart/Teign reporting group.

Natal homing fidelity is thought to be driven by multiple processes, including olfaction, with fish recognizing the chemical signature of the water on which they imprinted as juveniles (Keefer & Caudill 2014). It is possible that Tamar and Dart/Teign fish are being 'confused' into entering the wrong river by chemical cues. The sources of the Tavy, Dart and Teign rise on same area of Dartmoor, with the headwaters of the Tavy and Dart being less than 1 km apart (Appendix 3) meaning that the two rivers are likely to have similar water chemistry. This may be attracting Dart sea trout into the lower reaches of the Tavy. The situation is complicated for Tamar fish due to the presence of a hydroelectric power station (Morwhellam Quay) on the Tamar estuary. The water for this power station is taken from a tributary of the River Tavy and a plume of water in the Tamar estuary with a Tavy 'scent' may cause some Tamar fish to return to the lower estuary and then to enter the Tavy instead of continuing up the Tamar.

The high levels of straying found in this study demonstrate that the rod fisheries in the Tamar and Tavy rivers constitute mixed stock fisheries. Up until now, much of the focus of GSI in salmonid species has been the stock composition of commercial fisheries in the high seas and in estuarine areas (Griffiths *et al.* 2010, Ensing *et al.* 2013, Beacham *et al.* 2014, Koljonen *et al.* 2014, Bradbury *et al.* 2016) and little attention has been paid to the stock composition of recreational rod fisheries. Warnock *et al.* (2011) found that two of five bull trout (*Salvelinus confluentus* (Suckley)) rod fisheries on the Oldman River (Alberta, Canada) were catching fish from more than one stock. Similarly, Bott *et al.* (2009) showed the presence of non-targeted and numerically depressed stocks in a lake sturgeon sports fishery in Lake Michigan. The presence of non-target stocks has implications for the management of these recreational fisheries. Moreover, in the case of the Tamar, substantial monthly variations in straying rates further complicate management and there does not appear to be a consistent time when the fishery could be closed.

From a management point of view, our results indicate that the sea trout rod fisheries in the lower Tamar, Tavy and Lynher should constitute mixed stock fisheries (MSF). This would be an extension of the current management practice for the estuary net fisheries, which are managed to protect the weakest of the three main contributing river stocks, in line with NASCO guidance (NASCO 2009, 2014). Our microsatellite data supports this approach by showing clearly that they are genetically distinct entities and highlights the need to take account of genetic evidence in current MSF definitions.

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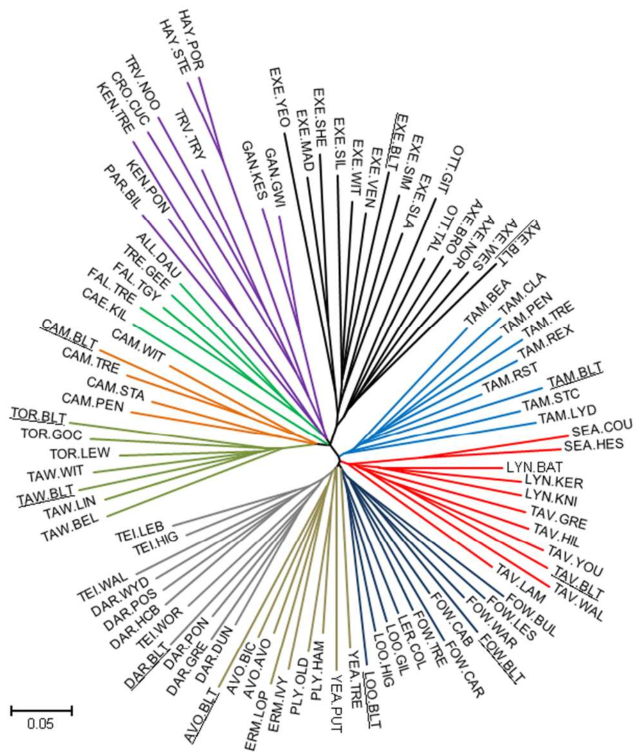
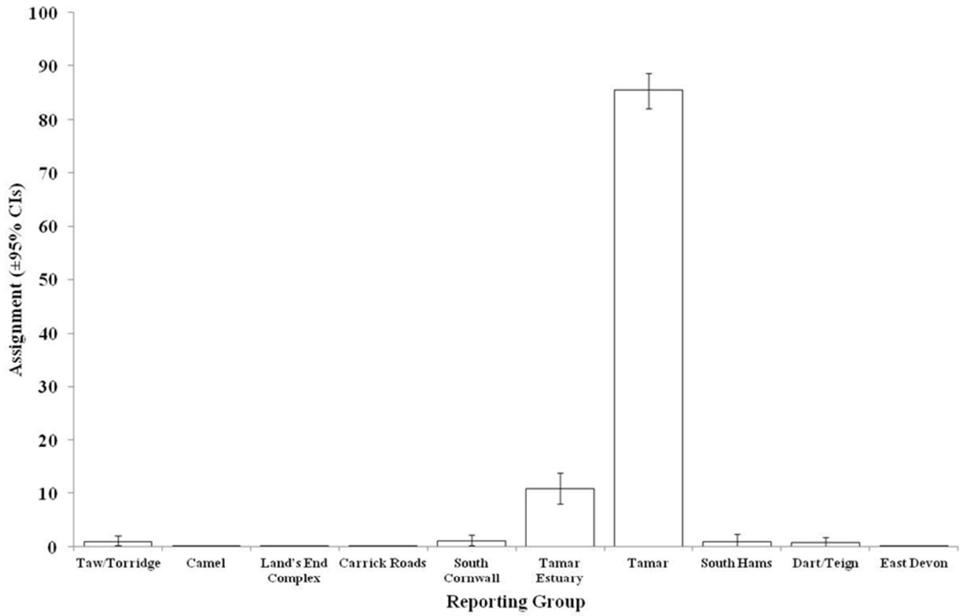
Figure 1. Unrooted neighbour-joining dendrogram, based on Cavalli-Sforza and Edwards' chord distance (D_{CE}), showing relationships between the resident trout populations sampled for the genetic baseline. Sample site abbreviations are as given in Table 1. The 11 baseline test samples (XXX.BLT, Table 2) are underlined.

Figure 2. Mean estimated stock composition assigned to reporting group of origin, with 95% confidence intervals, for 765 sea trout caught entering the River Tamar at Gunnislake weir.

Figure 3. Temporal variation in monthly stock composition of sea trout caught entering the River Tamar at Gunnislake weir (columns 1–7 = April – October 2010; columns 8–10 = June–August 2011. Fish were assigned to reporting group of origin; Full results, with 95% confidence intervals are given in Appendix 2.

Figure 4. Mean estimated stock composition of sea trout caught in the Rivers Tamar, Lynher and Tavy; fish were assigned to reporting group. Pie-charts show proportions of sea trout: A) trapped at Gunnislake weir between June – August in 2010 and 2011 combined; B) caught in the lower Tamar rod fishery; C) caught in the upper Tamar rod fishery; D) caught in the Lynher rod fishery; and E) caught in the Tavy rod fishery. Full results, with 95% confidence intervals are given in Appendix 2.





Assignment (±95% CIs)
100
90
80
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20
10
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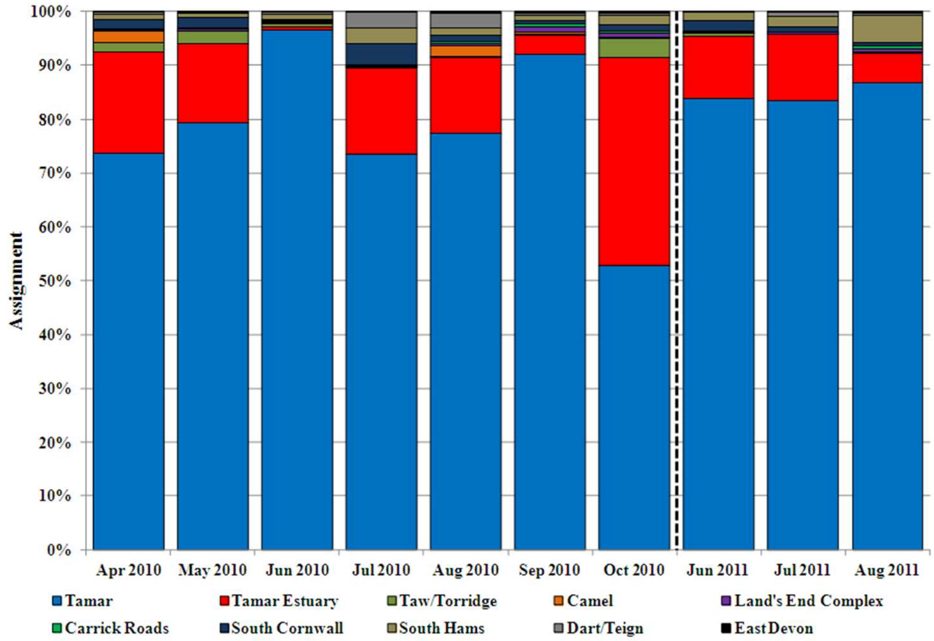
Taw/Torridge
Camel
Land's End Complex
Carrick Roads
South Cornwall
Tamar Estuary
Tamar
South Hams
Dart/Teign
East Devon
Reporting Group


100%
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Assignment
Apr 2010
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Aug 2010
Sep 2010
Oct 2010
Jun 2011
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Tamar
Tamar Estuary
Taw/Torridge
Camel
Land's End Complex
Carrick Roads
South Cornwall
South Hams
Dart/Teign
East Devon

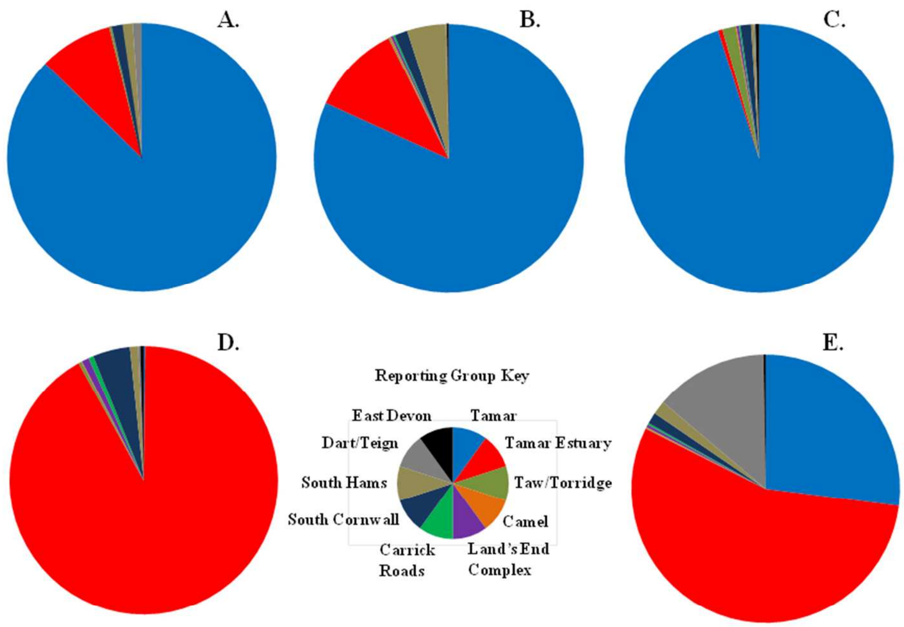

A.
B.
C.
D.
E.
Reporting Group Key
East Devon
Tamar
Dart/Teign
Tamar Estuary
South Hams
Taw/Torridge
South Cornwall
Camel
Carrick Roads
Land's End Complex

Table 1. Details of sampling sites for resident brown trout and smolts.

Reporting Group	River	Subcatchment	Site	Code	n_1	n_2
Taw/Torridge	Taw	main river	Belstone	TAW.BEL	39	35
		Holewater	U/s Linkleyham Bridge	TAW.LIN	50	46
		Little Dart	Witheridge	TAW.WIT	33	33
Taw/Torridge	Torridge	West Okement	Golf Course	TOR.GOC	49	35
		Lew	U/S Kennel Bridge	TOR.LEW	46	46
		main river	Putford Bridge	TOR.PUT	31	31
Camel	Camel	main river	Pencarrow	CAM.PEN	44	43
		Stannon Stream	Stannon	CAM.STA	46	43
		Allen	Trehannick	CAM.TRE	49	47
		Ruthern	Withiel	CAM.WIT	47	42
Land's End Complex	Gannel	main river	Gwills	GAN.GWI	50	49
		main river	Kestle Mill	GAN.KES	50	50
Land's End Complex	Hayle	main river	Porthcollum	HAY.POR	48	40
		main river	St Erth	HAY.STE	44	42
Land's End Complex	Trevaylor	main river	Trythogga	TREV.ONE	49	49
		main river	Noongallas	TREV.TWO	50	50
Land's End Complex	Crowlas	main river	Cuccurian	CRO.CUC	49	45
Land's End Complex	Kennal	main river	Tregolls	KEN.TRE	41	35
		main river	Ponsvale	KEN.PON	50	47
Carrick Roads	Allen	main river	Daubauz's Moor	ALL.DAU	50	47
Carrick Roads	Tresillian	main river	Geen Mill	TRE.GEE	48	45
Carrick Roads	Fal	main river	Tregony	FAL.TGY	47	43
		main river	Trenowth	FAL.TRE	36	34
Carrick Roads	Caerhays	main river	Kilbol	CAE.KIL	50	48
Land's End Complex	Par	main river	Bridges Moor	PAR.BIL	41	36
South Cornwall	Fowey	main river	Bulland Farm	FOW.BUL	50	43
		main river	Cabilla Wood	FOW.CAB	44	38
		Cardinham	Cardinham Bridge	FOW.CAR	40	37
		main river	Leskernick	FOW.LES	39	36
		Trenant	Wortha	FOW.TRE	50	49
		Warleggan	Temple	FOW.WAR	48	43
South Cornwall	Lerryn	main river	Collon	LER.COL	50	49
South Cornwall	Looe	West Looe	Gillhill Wood	LOO.GIL	50	49
		East Looe	Highwood	LOO.HIG	49	46
Tamar Estuary	Seaton	main river	Courtney's Mill	SEA.COU	36	34
		main river	Hessenford	SEA.HES	35	35
Tamar Estuary	Lynher	main river	Bathpool	LYN.BAT	50	45
		main river	Kerney Mill	LYN.KER	49	43
		main river	Knighton	LYN.KNI	39	37
Tamar	Tamar	Inny	Bealsmill	TAM.BEA	29	27
		Claw	D/S Clawford Vineyard	TAM.CLA	37	37
		Lyd	Lydford Gorge	TAM.LYD	49	40
		Penpont Water	Trerithick	TAM.PEN	39	38
		Wolf	Rexon	TAM.REX	41	39
		Inny	St Clether	TAM.STC	37	36
		Ottery	Trengune	TAM.TRE	37	36

		main river	Smolt trap	TAM.RST	72	72
Tamar Estuary	Tavy	Walkham	Grenofen Bridge	TAV.GRE	44	39
		main river	Hill Bridge	TAV.HIL	31	31
		Lumburn	Lamerton	TAV.LAM	45	40
		Wallabrook	Wallabrook	TAV.WAL	33	26
		Youlden Brook	Youlden	TAV.YOU	30	29
South Hams	Plym	main river	Ham	PLY.HAM	49	46
		Meavy	Olderwood	PLY.OLD	50	38
South Hams	Yealm	main river	Puttapool	YEA.PUT	23	23
		main river	Treby Ham	YEA.TRE	38	38
South Hams	Erme	main river	D/S Ivybridge STW	ERM.IVY	34	28
		main river	Lower Piles	ERM.LOP	26	24
South Hams	Avon	main river	Avonwick Station	AVO.AVO	43	38
		main river	Bickham Bridge	AVO.BIC	29	28
Dart/Teign	Dart	East Webburn	U/s Dunstone Br	DAR.DUN	50	48
		West Webburn	Grendon Bridge	DAR.GRE	50	46
		Cherry Brook	Higher Cherry Brook Bridge	DAR.HCB	50	44
		West Webburn	Ponsworthy Bridge	DAR.PON	49	40
		East Dart	U/s Postbridge	DAR.POS	36	33
		Swincombe	Wydemeet	DAR.WYD	50	39
Dart/Teign	Teign	Blackaton Brook	Highbury Bridge	TEI.HIG	50	46
		South Teign	Leigh Bridge	TEI.LEB	50	46
		Walla Brook	U/S Walla Brook Bridge	TEI.WAL	50	45
		Bovey	D/S Wormhill Bridge	TEI.WOR	49	49
East Devon	Exe	Yeo	Hittisleigh Mill	EXE.YEO	30	26
		Little Exe	Silly Bridge	EXE.SIL	41	41
		Barle	Simonsbath	EXE.SIM	38	31
		Barle/Dane's Brook	Slade Bridge	EXE.SLA	43	32
		Haddeo/Pulham	Venn Farm	EXE.VEN	40	40
		Quarme	U/S Witheridge Ford	EXE.WIT	35	32
		Culm/Madford	Holcombe House	EXE.MAD	50	46
		Culm/Sheldon	Craddock House	EXE.SHE	39	34
East Devon	Otter	Gittisham Stream	U/S Gittisham	OTT.GIT	40	28
		Tale	Taleford	OTT.TAL	36	34
East Devon	Axe	Kit Brook	Brockfield	AXE.BRO	43	41
		Blackwater River	Northay	AXE.NOR	50	40
		Yarty	Westwater	AXE.WES	50	37

n_1 = sample size

n_2 = sample size after removal of full-sibs and salmon x trout hybrids

Table 2 Details of 11 baseline test samples.

Reporting Group	River	Subcatchment	Site	Code	n	Year
Taw/Torridge	Taw	Mole	Heasley Mill	TAW.BLT	23	2006
Taw/Torridge	Torridge	East Okement	A30 bridge	TOR.BLT	21	2003
		Okement	Monkokehampton Weir		10	2012
Camel	Camel	Allen	Lamellen	CAM.BLT	21	2003
South Cornwall	Fowey	Warleggan	Maidenhead	FOW.BLT	24	2003
		main River	Palmersbridge		10	2015
South Cornwall	Looe	West Looe	Trussel Bridge	LOO.BLT	22	2003
Tamar	Tamar	main river	Rods	TAM.BLT	23	2003
		Penpont Water	Trerithick		10	2010
Tamar estuary	Tavy	main river	Creasons	TAV.BLT	19	2003
South Hams	Avon	main river	Hatch Bridge	AVO.BLT	17	2012
Dart/Teign	Dart	East Webburn	Cockingford	DAR.BLT	23	2014
East Devon	Exe	Bathern		EXE.BLT	10	2013
		Lowman			6	2013
East Devon	Axe	Yarty	Longbridge	AXE.BLT	14	2012

n = sample size

	Lynher		Confidence Intervals		Tamar		Confider Interval
River	**Expected**	**Mean**	**2.50%**	**97.50%**	**Expected**	**Mean**	**2.50%**
Taw	0	0.019	0	0.1	0	0.031	0
Torridge	0	0.015	0	0.1	0	0.027	0
Camel	0	0.093	0	0.7	0	0.163	0
Gannel	0	0.018	0	0.1	0	0.016	0
Hayle	0	0.016	0	0.1	0	0.016	0
Trevaylor	0	0.015	0	0.1	0	0.016	0
Crowlas	0	0.015	0	0.1	0	0.015	0
Kennal	0	0.015	0	0.1	0	0.019	0
Allen	0	0.026	0	0.2	0	0.036	0
Fal	0	0.015	0	0.1	0	0.016	0
Tresillian	0	0.017	0	0.1	0	0.018	0
Caerhays	0	0.017	0	0.1	0	0.019	0
Par	0	0.016	0	0.1	0	0.016	0
Fowey	4	5.034	2.9	7.6	4	5.008	2.9
Lerryn	0	0.043	0	0.5	0	0.022	0
Looe	4	3.682	1.9	5.9	4	3.972	2.1
Seaton	0	0.016	0	0.1	0	0.026	0
Lynher	60	58.926	54	63.9	10	9.858	7.1
Tamar	10	10.402	7.5	13.7	60	57.564	52.9
Tavy	10	10.275	7.1	13.8	10	9.849	7
Plym	1.4	0.889	0	2.4	1.4	1.571	0.5
Yealm	1.4	0.456	0	1.9	1.4	1.41	0.1
Erme	1.6	1.077	0.2	2.302	1.6	1.84	0.7
Avon	1.6	1.873	0.7	3.5	1.6	2.275	0.9
Dart	3	4.285	2.4	6.6	3	3.713	2
Teign	3	2.376	1	4.3	3	2.412	1
Exe	0	0.016	0	0.1	0	0.021	0
Otter	0	0.076	0	0.7	0	0.024	0
Axe	0	0.277	0	1.3	0	0.026	0

			Confidence Intervals				Confider Interval
Group	**Expected**	**Mean**	**2.50%**	**97.50%**	**Expected**	**Mean**	**2.50%**
Taw/Torridge	0	0.03	0	0.2	0	0.055	0
Camel	0	0.093	0	0.7	0	0.163	0
Land's End Complex	0	0.06	0	0.3	0	0.063	0
Carrick Roads	0	0.059	0	0.4	0	0.07	0
South Cornwall	8	8.762	6	11.9	8	9.006	6.2
Tamar Estuary	70	69.24	64.6	73.7	20	19.74	16
Tamar	10	10.405	7.5	13.7	60	57.577	52.9
South Hams	6	4.322	2.3	6.8	6	7.129	4.5
Dart/Teign	6	6.673	4.4	9.302	6	6.136	3.9
East Devon	0	0.356	0	1.3	0	0.061	0

nce ls	Tavy		Confidence Intervals	
97.50%	Expected	Mean	2.50%	97.50%
0.3	0	0.017	0	0.1
0.3	0	0.019	0	0.2
1.3	0	0.179	0	1.1
0.1	0	0.016	0	0.1
0.1	0	0.015	0	0.1
0.1	0	0.016	0	0.1
0.1	0	0.015	0	0.1
0.1	0	0.015	0	0.1
0.3	0	0.018	0	0.1
0.1	0	0.015	0	0.1
0.1	0	0.017	0	0.1
0.1	0	0.017	0	0.1
0.1	0	0.016	0	0.1
7.5	4	4.115	2.1	6.5
0.2	0	0.027	0	0.2
6.3	4	4.232	2.3	6.6
0.2	0	0.067	0	0.5
12.9	10	9.164	6.1	12.7
62.3	10	10.294	7.4	13.502
12.9	60	58.707	53.6	63.7
3.1	1.4	2.078	0.7	4
3.2	1.4	1.006	0.1	2.5
3.4	1.6	1.218	0.4	2.5
4.1	1.6	1.961	0.7	3.7
5.8	3	3.78	2	6
4.3	3	2.927	1.4	4.9
0.2	0	0.017	0	0.1
0.2	0	0.015	0	0.1
0.2	0	0.016	0	0.1

nce ls			Confidence Intervals	
97.50%	Expected	Mean	2.50%	97.50%
0.4	0	0.033	0	0.2
1.3	0	0.18	0	1.1
0.3	0	0.059	0	0.3
0.4	0	0.05	0	0.3
12.2	8	8.377	5.6	11.5
23.7	70	67.954	63.4	72.4
62.3	10	10.295	7.4	13.502
10.1	6	6.294	3.8	9.2
8.7	6	6.719	4.4	9.4
0.4	0	0.039	0	0.2

	Taw n=23			Torridge n=31		
		Confidence			Confidence	
River	Mean	2.50%	97.50%	Mean	2.50%	97.50%
Taw	86.39	57.698	99.8	34.516	13.595	57.607
Torridge	9.286	0	38.805	57.655	35	80.005
Camel	0.139	0	1.302	0.239	0	2.9
Gannel	0.137	0	1.6	0.085	0	1
Hayle	0.095	0	1	0.102	0	1
Trevaylor	0.163	0	1.305	0.132	0	1.302
Crowlas	0.153	0	1.702	0.103	0	1.102
Kennal	0.16	0	1.802	0.105	0	1
Allen	0.115	0	1.102	0.109	0	1.1
Fal	0.138	0	1.202	0.092	0	0.702
Tresillian	0.141	0	1.302	0.859	0	6.607
Caerhays	0.18	0	1.902	0.098	0	1.1
Par	0.194	0	2.302	0.126	0	1.5
Fowey	0.132	0	1.605	0.14	0	1.4
Lerryn	0.116	0	1.202	0.162	0	1.902
Looe	0.169	0	2.102	0.163	0	2.302
Seaton	0.156	0	1.102	0.126	0	1.202
Lynher	0.152	0	1.3	0.122	0	1.102
Tamar	0.234	0	2.602	0.868	0	8.705
Tavy	0.099	0	1.1	0.124	0	1.3
Plym	0.169	0	2.2	0.109	0	1.3
Yealm	0.143	0	1.8	0.086	0	0.9
Erme	0.165	0	1.9	0.116	0	1.302
Avon	0.139	0	1.502	0.098	0	1.3
Dart	0.15	0	1.202	0.143	0	1.302
Teign	0.161	0	2.1	0.13	0	1.402
Exe	0.122	0	1.2	2.813	0	11.402
Otter	0.151	0	1.502	0.131	0	1.402
Axe	0.453	0	5.5	0.45	0	5.6

		Confidence			Confidence	
Group	Mean	2.50%	97.50%	Mean	2.50%	97.50%
Taw/Torridge	95.779	84	99.9	92.273	79.198	99
Camel	0.139	0	1.302	0.239	0	2.9
Land's End Complex	0.865	0	6.202	0.618	0	4
Carrick Roads	0.554	0	4.102	1.137	0	8.6
South Cornwall	0.412	0	3.402	0.456	0	4.11
Tamar Estuary	0.398	0	4.005	0.365	0	3.202
Tamar	0.234	0	2.602	0.869	0	8.705
South Hams	0.596	0	4.705	0.389	0	3
Dart/Teign	0.306	0	3.202	0.267	0	2.602
East Devon	0.716	0	7.21	3.387	0	12.715

Camel	n=21		Fowey	n=32		Looe	n=22	
	Confidence			Confidence			Confidence	
Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean	2.50%	97.50%
0.58	0	6.805	1.421	0	9.3	0.127	0	1.5
0.196	0	1.7	0.1	0	1	0.232	0	2.805
94.914	81.695	99.9	0.121	0	1.002	0.26	0	3.5
0.22	0	2.802	0.122	0	1.502	0.155	0	1.6
0.139	0	1.402	0.1	0	1	0.132	0	1.5
0.17	0	1.6	0.125	0	1.902	0.187	0	2.007
0.141	0	1.7	0.105	0	1.1	0.175	0	2.002
0.149	0	1.7	0.107	0	1.2	0.189	0	2.405
0.141	0	1.602	0.107	0	0.902	0.186	0	1.9
0.18	0	2.202	0.084	0	0.902	0.11	0	1.2
0.166	0	2.102	0.207	0	2.7	0.164	0	1.8
0.142	0	1.3	0.145	0	1.8	0.158	0	1.5
0.144	0	1.602	0.163	0	1.702	0.175	0	1.8
0.128	0	2.002	95.007	84.8	99.8	0.318	0	3.105
0.169	0	1.802	0.2	0	2.4	0.236	0	2.702
0.208	0	2.1	0.343	0	3.6	86.375	63.298	99.5
0.161	0	1.502	0.157	0	1.8	0.356	0	4.002
0.139	0	1.502	0.09	0	0.9	0.208	0	2.5
0.165	0	1.9	0.084	0	0.8	0.892	0	10.402
0.168	0	2.3	0.142	0	1.602	0.235	0	2.607
0.208	0	1.902	0.118	0	1.302	0.205	0	2.2
0.149	0	1.5	0.127	0	1.902	0.701	0	8.417
0.127	0	1.4	0.099	0	1	6.711	0	25.607
0.19	0	2.305	0.098	0	0.902	0.703	0	9.505
0.168	0	1.7	0.114	0	1	0.183	0	2.2
0.178	0	1.902	0.14	0	1.6	0.201	0	2.2
0.178	0	2.002	0.128	0	1.3	0.131	0	1.2
0.175	0	1.4	0.116	0	1.302	0.146	0	1.802
0.203	0	2.005	0.128	0	1.402	0.148	0	1.7

	Confidence			Confidence			Confidence	
Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean	2.50%	97.50%
0.773	0	7.702	1.518	0	9.312	0.356	0	3.705
95.028	81.695	99.9	0.121	0	1.002	0.26	0	3.5
0.927	0	6.6	0.687	0	4.807	0.979	0	7.107
0.609	0	6.3	0.523	0	4.712	0.599	0	4.81
0.497	0	4.307	95.653	86.198	99.9	87.026	63.993	99.6
0.459	0	4.002	0.381	0	3.502	0.785	0	6.7
0.165	0	1.9	0.084	0	0.8	0.893	0	10.402
0.654	0	5.607	0.422	0	3.5	8.309	0	30.01
0.344	0	3.602	0.249	0	2.402	0.379	0	3.6
0.546	0	5.9	0.361	0	3.202	0.414	0	3.902

Tamar BT plus	**n=91**		**Tavy**	**n=19**		**Avon**	**n=17**
	Confidence			**Confidence**			**Confi**
Mean	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**	**2.50%**
0.162	0	2.3	0.139	0	1.7	0.177	0
0.213	0	2.502	0.211	0	2.5	0.268	0
0.231	0	2.602	0.164	0	1.8	0.24	0
0.05	0	0.5	0.252	0	2.605	0.18	0
0.054	0	0.5	0.208	0	1.902	0.17	0
0.041	0	0.402	0.156	0	1.905	0.215	0
0.063	0	0.7	0.175	0	2	0.164	0
0.041	0	0.3	0.17	0	2.2	0.219	0
0.047	0	0.302	0.162	0	1.8	0.272	0
0.054	0	0.5	0.162	0	2.2	0.165	0
0.071	0	0.802	0.213	0	1.802	0.219	0
0.037	0	0.4	0.194	0	2.102	0.193	0
0.042	0	0.3	0.153	0	1.802	0.175	0
0.32	0	4.602	0.232	0	2.402	0.277	0
0.059	0	0.5	0.184	0	1.9	0.234	0
0.105	0	1.3	0.173	0	2.1	0.141	0
0.045	0	0.3	0.288	0	3.51	0.19	0
0.25	0	2.602	0.5	0	6.012	0.227	0
97.209	90.7	99.9	0.151	0	2	0.183	0
0.273	0	3.5	94.44	79.793	99.9	0.497	0
0.133	0	1.3	0.239	0	3.005	0.154	0
0.074	0	0.802	0.163	0	2.105	5.017	0
0.059	0	0.6	0.131	0	1.502	0.215	0
0.057	0	0.5	0.138	0	1.5	83.619	59.498
0.057	0	0.5	0.31	0	3.2	0.197	0
0.094	0	1	0.154	0	1.502	0.272	0
0.051	0	0.6	0.142	0	1.502	5.786	0.198
0.047	0	0.5	0.18	0	2.4	0.157	0
0.059	0	0.5	0.217	0	2.2	0.179	0

	Confidence			**Confidence**			**Confi**
Mean	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**	**2.50%**
0.37	0	3.602	0.346	0	3.902	0.44	0
0.231	0	2.602	0.164	0	1.8	0.24	0
0.254	0	1.8	1.075	0	7.902	1.09	0
0.197	0	1.4	0.714	0	6.102	0.829	0
0.473	0	4.802	0.581	0	5.302	0.644	0
0.556	0	4.402	95.322	82.585	99.9	0.905	0
97.32	90.7	99.9	0.151	0	2	0.183	0
0.302	0	2.6	0.658	0	5.81	89.09	70.198
0.148	0	1.502	0.46	0	4.015	0.465	0
0.15	0	1.3	0.527	0	5.005	6.115	0.2

dence	Dart n=23	Confidence		Exe n=16	Confidence		Axe
97.50%	Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean
2.1	0.149	0	1.702	0.259	0	3.005	0.364
3.202	0.164	0	1.602	0.257	0	2.81	0.371
2.902	0.175	0	2.2	0.183	0	1.902	0.272
2	0.137	0	1.5	0.269	0	3.1	0.244
1.802	0.208	0	2.7	0.23	0	2.5	0.226
2.402	0.141	0	1.8	0.204	0	2.602	0.285
1.8	0.182	0	2.002	0.237	0	2.7	0.228
2.102	0.181	0	1.905	0.26	0	3.2	0.213
2.407	0.167	0	1.8	0.24	0	2.602	0.277
1.702	0.144	0	1.402	0.653	0	8.5	0.357
2.602	0.116	0	1.102	0.259	0	2.602	1.001
1.8	0.158	0	1.205	0.194	0	2.1	0.223
1.902	0.124	0	1.3	0.189	0	1.802	0.274
3.3	0.153	0	1.602	0.231	0	3.002	0.29
2.502	0.183	0	1.8	0.202	0	2.302	0.22
1.7	0.143	0	2.1	0.155	0	1.8	0.225
2.002	0.163	0	1.9	0.306	0	3.102	0.208
2.602	0.212	0	2.205	0.175	0	2	0.191
1.6	0.205	0	2.105	0.203	0	2.402	0.561
5.102	0.225	0	2.602	0.191	0	2.1	0.212
1.702	0.153	0	1.502	0.198	0	2.3	0.242
23.1	0.163	0	1.4	0.304	0	3.7	0.254
2.3	0.173	0	2.7	0.217	0	2.7	0.219
98.2	0.575	0	7.407	0.212	0	2.002	0.198
2.302	93.956	80.6	99.9	0.14	0	1.3	0.229
3.4	1.167	0	10.002	0.243	0	2.905	0.353
19.307	0.18	0	2.002	76.974	54.998	93.905	0.301
1.9	0.149	0	1.4	0.661	0	7.905	0.594
2.2	0.155	0	1.802	16.157	2.3	37.207	91.367

dence		Confidence			Confidence		
97.50%	Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean
5.002	0.308	0	3.002	0.512	0	5.81	0.731
2.902	0.175	0	2.2	0.183	0	1.902	0.272
8.9	0.941	0	6.602	1.355	0	10.002	1.431
7.705	0.569	0	4.607	1.327	0	11	1.841
6.407	0.47	0	4.21	0.579	0	4.9	0.725
7.905	0.59	0	5.6	0.662	0	6.302	0.602
1.6	0.206	0	2.105	0.203	0	2.402	0.562
98.7	1.045	0	9.3	0.911	0	7.207	0.892
4.4	95.223	82.5	99.9	0.383	0	4.005	0.58
19.81	0.473	0	4.802	93.885	78.693	99.9	92.363

n=14

Confidence	
2.50%	**97.50%**
0	3.8
0	4.602
0	3.202
0	2.302
0	2.2
0	3.1
0	2.902
0	2.305
0	3.4
0	4.407
0	10.902
0	2.502
0	3.607
0	2.7
0	2.705
0	2.202
0	2.102
0	2.3
0	6.205
0	2.202
0	2.602
0	3.7
0	2.5
0	2.3
0	3.302
0	4.005
0	3.602
0	8.302
71.6	99.8

Confidence	
2.50%	**97.50%**
0	8
0	3.202
0	9.5
0	12.722
0	7.007
0	5.807
0	6.205
0	7.2
0	6.3
72.78	99.9

	All	Confidence	n=765	2010	Confidence	n=479	2011
River	Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean
Taw	0.869	0.2	1.9	0.953	0.2	2.1	0.108
Torridge	0.132	0	0.9	0.133	0	1	0.057
Camel	0.021	0	0.2	0.037	0	0.4	0.023
Gannel	0.014	0	0.1	0.016	0	0.1	0.021
Hayle	0.014	0	0.1	0.016	0	0.1	0.02
Trevaylor	0.013	0	0.1	0.015	0	0.1	0.023
Crowlas	0.014	0	0.1	0.018	0	0.1	0.02
Kennal	0.014	0	0.1	0.016	0	0.1	0.019
Allen	0.014	0	0.1	0.016	0	0.1	0.029
Fal	0.015	0	0.1	0.019	0	0.1	0.02
Tresillian	0.014	0	0.1	0.017	0	0.1	0.023
Caerhays	0.014	0	0.1	0.019	0	0.1	0.025
Par	0.015	0	0.1	0.016	0	0.1	0.025
Fowey	0.116	0	0.7	0.02	0	0.1	0.918
Lerryn	0.066	0	0.6	0.025	0	0.2	0.278
Looe	0.836	0.1	1.9	1.223	0.3	2.7	0.049
Seaton	0.013	0	0.1	0.016	0	0.1	0.024
Lynher	9.109	6.5	12.1	9.822	6.5	13.8	8.936
Tamar	85.413	82.1	88.6	83.633	79.2	87.8	87.102
Tavy	1.632	0.5	3.2	2.307	0.7	4.5	0.264
Plym	0.15	0	1	0.452	0	2	0.026
Yealm	0.686	0	1.9	0.074	0	0.8	1.538
Erme	0.016	0	0.1	0.021	0	0.1	0.025
Avon	0.018	0	0.1	0.028	0	0.2	0.046
Dart	0.558	0	1.5	0.978	0.1	2.5	0.062
Teign	0.179	0	1.1	0.058	0	0.6	0.228
Exe	0.015	0	0.1	0.017	0	0.1	0.024
Otter	0.015	0	0.1	0.016	0	0.1	0.022
Axe	0.015	0	0.1	0.019	0	0.1	0.044

		Confidence			Confidence		
Group	Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean
Taw/Torridge	0.999	0.3	2	1.085	0.3	2.3	0.161
Camel	0.021	0	0.2	0.037	0	0.4	0.023
Land's End Complex	0.05	0	0.2	0.063	0	0.3	0.093
Carrick Roads	0.042	0	0.2	0.054	0	0.3	0.081
South Cornwall	1.011	0.2	2.2	1.253	0.3	2.7	1.236
Tamar Estuary	10.764	8	13.8	12.158	8.5	16.5	9.222
Tamar	85.494	82.1	88.6	83.722	79.2	87.8	87.207
South Hams	0.851	0	2.3	0.554	0	2.202	1.612
Dart/Teign	0.734	0.1	1.8	1.031	0.1	2.5	0.286
East Devon	0.035	0	0.2	0.043	0	0.3	0.08

n=286		2010 ST	n=292		2010 Peel	n=187	
Confidence			Confidence			Confidence	
2.50%	97.50%	Mean	2.50%	97.50%	Mean	2.50%	97.50%
0	1	1.92	0.5	4	0.03	0	0.3
0	0.7	0.095	0	1	0.029	0	0.2
0	0.2	0.043	0	0.5	0.163	0	1.9
0	0.2	0.02	0	0.1	0.027	0	0.2
0	0.1	0.02	0	0.1	0.026	0	0.2
0	0.2	0.02	0	0.1	0.027	0	0.2
0	0.1	0.028	0	0.3	0.026	0	0.2
0	0.1	0.02	0	0.1	0.027	0	0.2
0	0.3	0.021	0	0.1	0.031	0	0.3
0	0.1	0.022	0	0.2	0.04	0	0.4
0	0.2	0.026	0	0.2	0.03	0	0.3
0	0.2	0.025	0	0.2	0.03	0	0.2
0	0.2	0.02	0	0.1	0.027	0	0.2
0	3.2	0.027	0	0.2	0.044	0	0.4
0	1.8	0.031	0	0.3	0.05	0	0.5
0	0.5	1.313	0.1	3.4	0.79	0	3.7
0	0.2	0.021	0	0.1	0.053	0	0.5
4.9	13.502	8.569	4.9	13.2	12.271	7	18.5
82.1	91.7	83.009	77.5	88.2	81.675	74.6	88.1
0	2.3	2.873	0.8	5.9	2.93	0	7.6
0	0.2	0.083	0	0.9	0.731	0	3.7
0.3	3.5	0.081	0	0.9	0.11	0	1.3
0	0.2	0.042	0	0.5	0.033	0	0.3
0	0.5	0.027	0	0.2	0.088	0	1
0	0.7	1.407	0	3.6	0.088	0	1.1
0	2	0.162	0	1.3	0.535	0	3.2
0	0.2	0.023	0	0.2	0.032	0	0.3
0	0.2	0.023	0	0.2	0.027	0	0.2
0	0.5	0.028	0	0.2	0.028	0	0.2

Confidence			Confidence			Confidence	
2.50%	97.50%	Mean	2.50%	97.50%	Mean	2.50%	97.50%
0	1.2	2.012	0.6	4.1	0.056	0	0.5
0	0.2	0.043	0	0.5	0.163	0	1.9
0	0.6	0.094	0	0.6	0.122	0	0.8
0	0.6	0.076	0	0.5	0.114	0	0.8
0	3.6	1.357	0.2	3.5	0.874	0	3.8
5.3	13.7	11.476	7.3	16.4	15.269	9	22.2
82.1	91.7	83.097	77.5	88.2	81.762	74.6	88.1
0.3	3.6	0.214	0	1.5	0.943	0	4.1
0	2	1.567	0.2	3.702	0.617	0	3.3
0	0.6	0.065	0	0.5	0.078	0	0.6

2011 ST	n=137		2011 Peel	n=149	
	Confidence			Confidence	
Mean	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**
0.367	0	2.9	0.036	0	0.4
0.159	0	1.6	0.063	0	0.7
0.044	0	0.5	0.035	0	0.3
0.045	0	0.4	0.034	0	0.4
0.035	0	0.3	0.032	0	0.3
0.037	0	0.4	0.032	0	0.3
0.037	0	0.3	0.031	0	0.2
0.027	0	0.2	0.031	0	0.2
0.125	0	1.3	0.037	0	0.3
0.03	0	0.3	0.031	0	0.2
0.041	0	0.3	0.068	0	0.8
0.046	0	0.5	0.037	0	0.3
0.025	0	0.2	0.031	0	0.3
0.975	0	4.4	0.519	0	3.9
0.129	0	1.5	0.253	0	2.2
0.045	0	0.4	0.175	0	1.8
0.055	0	0.6	0.031	0	0.3
13.704	7.6	20.702	4.995	0	11.7
82.04	73.7	89.202	88.172	81	94.1
0.07	0	0.9	2.599	0	7.4
0.056	0	0.6	0.038	0	0.4
0.6	0	3.6	2.074	0.3	5.102
0.04	0	0.302	0.033	0	0.3
0.036	0	0.3	0.173	0	1.7
0.975	0	4.202	0.036	0	0.3
0.085	0	0.8	0.286	0	2.6
0.037	0	0.3	0.037	0	0.3
0.035	0	0.3	0.044	0	0.402
0.1	0	1.3	0.038	0	0.4

	Confidence			Confidence	
Mean	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**
0.521	0	3.1	0.095	0	0.9
0.044	0	0.5	0.035	0	0.3
0.17	0	1.3	0.157	0	1
0.224	0	1.5	0.153	0	1.3
1.134	0	4.702	0.937	0	4.602
13.829	7.6	20.702	7.629	2.5	14.6
82.141	73.7	89.202	88.266	81	94.1
0.718	0	3.8	2.301	0.4	5.7
1.056	0	4.4	0.319	0	2.7
0.162	0	1.4	0.109	0	0.9

2010& 2011 J,J,A combined **n=532**

Mean	**Confidence 2.50%**	**97.50%**
0.179	0	1.1
0.097	0	0.8
0.023	0	0.2
0.015	0	0.1
0.015	0	0.1
0.015	0	0.1
0.015	0	0.1
0.015	0	0.1
0.017	0	0.1
0.018	0	0.1
0.019	0	0.1
0.015	0	0.1
0.017	0	0.1
0.188	0	1.1
0.1	0	0.8
0.925	0	2.2
0.015	0	0.1
7.922	5.1	11.2
87.189	83.5	90.7
0.868	0	2.6
0.057	0	0.6
1.131	0	2.6
0.023	0	0.2
0.028	0	0.3
0.709	0	2
0.332	0	1.7
0.017	0	0.1
0.016	0	0.1
0.022	0	0.2

Mean	**Confidence 2.50%**	**97.50%**
0.27	0	1.2
0.023	0	0.2
0.059	0	0.3
0.052	0	0.3
1.209	0.1	2.8
8.811	5.9	12.2
87.271	83.5	90.7
1.216	0	2.8
1.041	0.1	2.6
0.046	0	0.3

River	Apr-10 Mean	n=81 Confidence Interval 2.50%	97.50%	May-10 Mean	n=98 Confidence 2.50%	97.50%	Jun-10 Mean
Taw	1.792	0	5.9	2.182	0.2	5.9	0.503
Torridge	0.04	0	0.4	0.114	0	1.4	0.047
Camel	2.092	0	8.3	0.053	0	0.5	0.098
Gannel	0.051	0	0.5	0.047	0	0.4	0.042
Hayle	0.047	0	0.4	0.039	0	0.4	0.052
Trevaylor	0.043	0	0.4	0.037	0	0.3	0.041
Crowlas	0.039	0	0.4	0.192	0	2	0.036
Kennal	0.049	0	0.5	0.043	0	0.4	0.048
Allen	0.062	0	0.6	0.043	0	0.4	0.064
Fal	0.043	0	0.4	0.039	0	0.3	0.046
Tresillian	0.053	0	0.5	0.106	0	1.2	0.043
Caerhays	0.048	0	0.4	0.042	0	0.4	0.042
Par	0.056	0	0.4	0.05	0	0.5	0.046
Fowey	0.221	0	2.702	0.085	0	1	0.05
Lerryn	0.075	0	0.702	1.417	0	8.2	0.148
Looe	1.362	0	5.7	0.458	0	3.9	0.042
Seaton	0.046	0	0.5	0.045	0	0.4	0.045
Lynher	9.749	3.5	18.1	14.006	5.8	24	0.074
Tamar	73.805	61.895	84.6	79.199	68	89.2	96.569
Tavy	8.774	2.8	18.002	0.736	0	6.5	0.427
Plym	0.348	0	3.9	0.504	0	3.8	0.067
Yealm	0.4	0	4.3	0.103	0	1.3	0.762
Erme	0.265	0	2.7	0.064	0	0.6	0.047
Avon	0.059	0	0.7	0.064	0	0.7	0.167
Dart	0.141	0	1.7	0.061	0	0.7	0.248
Teign	0.168	0	1.9	0.05	0	0.5	0.047
Exe	0.078	0	0.8	0.046	0	0.4	0.086
Otter	0.049	0	0.402	0.062	0	0.6	0.056
Axe	0.047	0	0.4	0.115	0	1.4	0.057

Group	Mean	Confidence Interval 2.50%	97.50%	Mean	Confidence 2.50%	97.50%	Mean
Taw/Torridge	1.826	0	5.9	2.291	0.3	6	0.546
Camel	2.094	0	8.3	0.053	0	0.5	0.098
Land's End Complex	0.252	0	1.802	0.366	0	2.5	0.23
Carrick Roads	0.186	0	1.5	0.21	0	1.7	0.179
South Cornwall	1.647	0	6.7	1.95	0	8.8	0.231
Tamar Estuary	18.589	10.198	28.7	14.795	6.4	25.2	0.536
Tamar	73.882	61.895	84.6	79.3	68	89.2	96.674
South Hams	1.056	0	6.9	0.718	0	4.3	1.023
Dart/Teign	0.305	0	2.5	0.107	0	1	0.29
East Devon	0.163	0	1.4	0.211	0	2	0.191

n=96		Jul-10	n=94		Aug-10	n=56		Sep-10
Confidence			Confidence			Confidence		
2.50%	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**
0	3.8	0.041	0	0.402	0.06	0	0.6	0.14
0	0.302	0.043	0	0.4	0.212	0	2.602	0.147
0	0.902	0.062	0	0.7	2.121	0	11.002	0.281
0	0.402	0.052	0	0.5	0.072	0	0.702	0.142
0	0.5	0.043	0	0.4	0.081	0	0.9	0.21
0	0.4	0.047	0	0.4	0.066	0	0.702	0.169
0	0.3	0.042	0	0.4	0.078	0	0.8	0.133
0	0.5	0.039	0	0.3	0.066	0	0.602	0.176
0	0.702	0.047	0	0.4	0.079	0	0.805	0.125
0	0.5	0.039	0	0.3	0.158	0	1.9	0.15
0	0.4	0.073	0	0.8	0.087	0	0.702	0.172
0	0.4	0.045	0	0.4	0.068	0	0.7	0.149
0	0.5	0.039	0	0.4	0.068	0	0.7	0.168
0	0.6	0.073	0	0.7	0.25	0	2.702	0.223
0	1.802	0.075	0	0.9	0.138	0	1.407	0.298
0	0.4	3.851	0.5	9.8	0.768	0	5.707	0.187
0	0.4	0.047	0	0.5	0.406	0	3.105	0.122
0	0.8	13.697	6.3	22.702	12.988	4.098	24.1	2.878
89.8	99.7	73.603	62.4	83.6	77.459	63.698	89.102	91.944
0	5.2	2.034	0	9.1	0.43	0	5.002	0.522
0	0.6	2.33	0	8.2	0.21	0	2.605	0.251
0	3.8	0.073	0	0.6	0.843	0	7.102	0.253
0	0.5	0.475	0	3.602	0.135	0	1.602	0.194
0	1.8	0.158	0	2	0.084	0	0.8	0.16
0	3.2	2.234	0	7.2	0.12	0	1.302	0.166
0	0.5	0.59	0	4.7	2.605	0	10.3	0.223
0	1	0.049	0	0.5	0.138	0	1.5	0.133
0	0.7	0.046	0	0.4	0.128	0	1.4	0.145
0	0.6	0.051	0	0.5	0.082	0	0.902	0.136

Confidence			Confidence			Confidence		
2.50%	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**
0	4	0.081	0	0.8	0.268	0	2.8	0.282
0	0.902	0.062	0	0.7	2.123	0	11.002	0.282
0	1.6	0.225	0	1.7	0.397	0	3	0.966
0	1.502	0.188	0	1.6	0.372	0	3.1	0.579
0	2.1	3.988	0.5	10	1.146	0	7.4	0.697
0	5.6	15.791	7.7	26	13.828	4.695	25.505	3.512
89.8	99.7	73.688	62.4	83.6	77.551	63.698	89.102	92.05
0	4.002	3.018	0	9.2	1.255	0	8.102	0.844
0	3.2	2.823	0.1	8.4	2.722	0	10.602	0.387
0	1.8	0.137	0	1.2	0.336	0	2.7	0.402

n=23		Oct-10	n=31		Jun-11	n=136	
Confidence Interval			Confidence Interval			Confidence Interval	
2.50%	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**
0	1.1	0.089	0	0.9	0.449	0	3.302
0	1.205	3.759	0.1	13.702	0.164	0	1.702
0	3.602	0.183	0	2	0.044	0	0.4
0	1.402	0.086	0	1.1	0.03	0	0.3
0	2.3	0.122	0	1.2	0.036	0	0.4
0	2.202	0.123	0	1.302	0.029	0	0.2
0	1.302	0.117	0	1.202	0.045	0	0.5
0	2.305	0.126	0	1.005	0.036	0	0.2
0	1.402	0.153	0	1.702	0.072	0	0.9
0	1.5	0.113	0	1.002	0.033	0	0.3
0	2	0.111	0	1.102	0.047	0	0.402
0	1.5	0.117	0	1.202	0.037	0	0.3
0	1.8	0.129	0	1.2	0.035	0	0.3
0	2.202	0.326	0	3.5	1.691	0	6.702
0	3.202	0.56	0	7.7	0.138	0	1.7
0	2.2	0.195	0	2.502	0.037	0	0.3
0	1.5	0.173	0	2.2	0.033	0	0.3
0	13.902	37.913	20.598	57.702	11.35	5.4	18.105
75.983	99.7	52.795	32.1	72.302	83.732	75.8	90.9
0	5.307	0.32	0	4.002	0.206	0	2.102
0	2.8	0.122	0	1.2	0.044	0	0.4
0	2.602	1.208	0	13.5	1.415	0	4.9
0	2.102	0.119	0	1.305	0.041	0	0.3
0	2.002	0.398	0	4.702	0.033	0	0.3
0	2.2	0.112	0	1.602	0.063	0	0.5
0	2.802	0.141	0	1.4	0.046	0	0.6
0	1.5	0.108	0	0.9	0.04	0	0.4
0	1.7	0.171	0	2.102	0.032	0	0.3
0	1.4	0.112	0	1.102	0.045	0	0.5

Confidence Interval			Confidence Interval			Confidence Interval	
2.50%	**97.50%**	**Mean**	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**
0	2.802	3.845	0.1	13.702	0.609	0	3.402
0	3.602	0.183	0	2	0.044	0	0.4
0	6.8	0.669	0	4.902	0.172	0	1.1
0	4.5	0.479	0	4.1	0.169	0	1.402
0	6.405	1.071	0	8.907	1.854	0	7.1
0	15.905	38.438	20.8	58.2	11.588	5.5	18.5
75.983	99.7	52.854	32.1	72.302	83.84	75.8	90.9
0	6.91	1.832	0	14.1	1.511	0	5.202
0	4.302	0.249	0	2.4	0.104	0	0.8
0	3.5	0.38	0	3.502	0.108	0	0.9

Jul-11	n=114		Aug-11	n=36	
	Confidence	Interval		Confidence	
Mean	2.50%	97.50%	Mean	2.50%	97.50%
0.039	0	0.4	0.085	0	0.9
0.045	0	0.4	0.074	0	0.602
0.041	0	0.4	0.142	0	2
0.037	0	0.3	0.11	0	1.102
0.041	0	0.5	0.102	0	1.2
0.066	0	0.6	0.085	0	0.7
0.039	0	0.4	0.088	0	0.805
0.038	0	0.4	0.1	0	0.9
0.033	0	0.3	0.103	0	1.3
0.04	0	0.4	0.116	0	1.005
0.051	0	0.5	0.435	0	5.002
0.049	0	0.5	0.099	0	1
0.041	0	0.4	0.098	0	1
0.563	0	4.3	0.113	0	1.202
0.143	0	1.9	0.108	0	1.202
0.168	0	2.2	0.266	0	3.005
0.043	0	0.5	0.105	0	1.1
9.961	4	17.3	4.903	0	17.202
83.432	74.5	91	86.711	71.998	98.3
2.239	0	6.902	0.376	0	4.4
0.055	0	0.7	0.206	0	2.5
1.721	0.1	4.7	0.557	0	6.502
0.053	0	0.4	0.131	0	1.402
0.061	0	0.8	4.096	0	13.702
0.386	0	3	0.12	0	1.5
0.509	0	3.9	0.335	0	3.902
0.036	0	0.3	0.114	0	1.005
0.035	0	0.3	0.086	0	0.9
0.037	0	0.3	0.136	0	1.702

	Confidence	Interval		Confidence	
Mean	2.50%	97.50%	Mean	2.50%	97.50%
0.081	0	0.7	0.155	0	1.602
0.041	0	0.4	0.143	0	2
0.224	0	1.5	0.555	0	4.102
0.153	0	1.2	0.73	0	6.202
0.867	0	4.5	0.48	0	4.002
12.256	5.7	20.5	5.378	0	17.705
83.518	74.5	91	86.806	71.998	98.3
1.873	0.1	5.1	4.978	0	15.402
0.891	0	4.4	0.451	0	4.307
0.096	0	0.7	0.325	0	3.102

	Lynher n=23			All Tamar n=160		
		Confidence			Confidence	
	Mean	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**
Taw	0.272	0	3.2	0.598	0	2.9
Torridge	0.099	0	1	0.092	0	1.1
Camel	0.083	0	1	0.074	0	0.7
Gannel	0.134	0	1.6	0.026	0	0.2
Hayle	0.16	0	1.9	0.029	0	0.3
Trevaylor	0.149	0	1.7	0.028	0	0.2
Crowlas	0.161	0	1.8	0.039	0	0.4
Kennal	0.159	0	1.8	0.032	0	0.2
Allen	0.169	0	2.2	0.046	0	0.5
Fal	0.193	0	2.1	0.104	0	1.1
Tresillian	0.138	0	1.8	0.034	0	0.3
Caerhays	0.12	0	1.205	0.03	0	0.3
Par	0.148	0	1.5	0.029	0	0.2
Fowey	4.058	0	22	0.054	0	0.6
Lerryn	0.17	0	1.402	0.368	0	3.1
Looe	0.254	0	3.602	3.139	0	7.9
Seaton	0.087	0	0.9	0.025	0	0.2
Lynher	91.299	73.4	99.8	4.334	1.1	9.1
Tamar	0.175	0	2.102	90.14	84.2	95.3
Tavy	0.28	0	3.5	0.074	0	1
Plym	0.126	0	1.4	0.06	0	0.7
Yealm	0.584	0	7.707	0.224	0	2.3
Erme	0.152	0	1.6	0.035	0	0.4
Avon	0.144	0	1.6	0.036	0	0.3
Dart	0.148	0	1.9	0.049	0	0.402
Teign	0.118	0	1.1	0.069	0	0.7
Exe	0.159	0	1.4	0.118	0	1.2
Otter	0.136	0	1.202	0.038	0	0.3
Axe	0.125	0	1.4	0.075	0	0.9

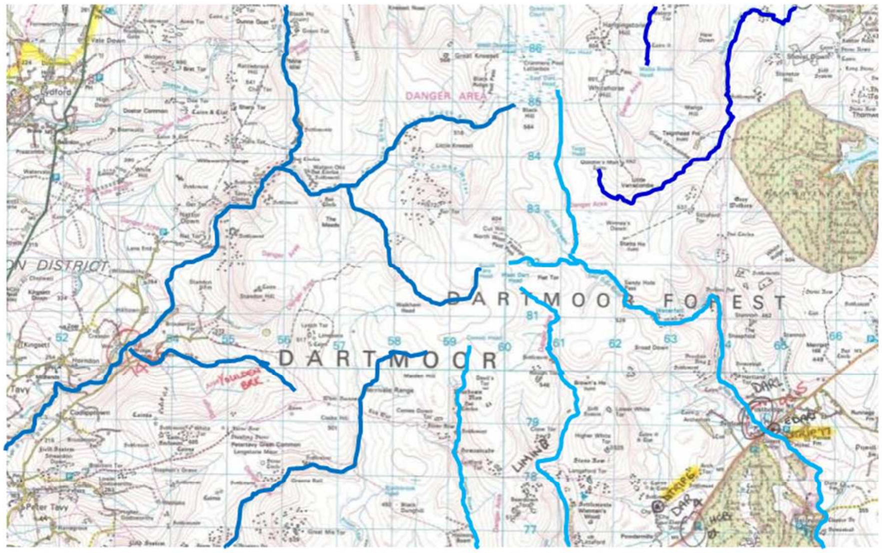
		Confidence			Confidence	
	Mean	**2.50%**	**97.50%**	**Mean**	**2.50%**	**97.50%**
Taw/Torridge	0.368	0	3.7	0.687	0	3.1
Camel	0.083	0	1	0.074	0	0.7
Land's End Complex	0.872	0	5.81	0.152	0	1
Carrick Roads	0.601	0	4.8	0.198	0	1.5
South Cornwall	4.475	0	22.605	3.557	0	8.5
Tamar Estuary	91.764	73.4	99.9	4.421	1.1	9.1
Tamar	0.175	0	2.102	90.24	84.2	95.3
South Hams	0.989	0	8.3	0.339	0	2.5
Dart/Teign	0.263	0	3	0.112	0	1.2
East Devon	0.41	0	4	0.219	0	1.6

Lower Tamar	n=78		Upper Tamar	n=82		Tavy	n=74
	Confidence			Confidence			Conf:
Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean	2.50%
0.051	0	0.5	1.546	0	5.3	0.059	0
0.134	0	1.6	0.064	0	0.7	0.055	0
0.147	0	1.8	0.117	0	1.6	0.097	0
0.057	0	0.5	0.053	0	0.5	0.092	0
0.05	0	0.5	0.048	0	0.5	0.057	0
0.051	0	0.5	0.049	0	0.4	0.055	0
0.052	0	0.5	0.048	0	0.4	0.057	0
0.05	0	0.5	0.068	0	0.6	0.051	0
0.05	0	0.4	0.057	0	0.7	0.06	0
0.052	0	0.4	0.058	0	0.5	0.053	0
0.071	0	0.7	0.038	0	0.302	0.054	0
0.05	0	0.5	0.05	0	0.4	0.056	0
0.048	0	0.4	0.042	0	0.4	0.051	0
0.186	0	2.2	0.104	0	1.107	0.597	0
0.382	0	4.4	0.508	0	4.802	0.283	0
1.005	0	7.1	0.667	0	4.702	0.5	0
0.051	0	0.5	0.051	0	0.5	0.076	0
10.733	3.7	20	0.204	0	2.202	29.748	17.4
81.645	70.6	90.8	94.938	87.8	99.4	26.991	16.3
0.092	0	1.002	0.288	0	3.2	25.49	13.5
0.242	0	2.5	0.069	0	0.6	0.2	0
0.704	0	6.1	0.158	0	1.602	0.732	0
0.057	0	0.5	0.065	0	0.502	0.479	0
3.655	0	10.4	0.081	0	0.8	0.246	0
0.06	0	0.6	0.113	0	1.3	13.02	5.1
0.091	0	0.9	0.07	0	0.702	0.573	0
0.061	0	0.6	0.229	0	2.2	0.113	0
0.074	0	0.7	0.081	0	1	0.092	0
0.098	0	1.1	0.136	0	1.4	0.064	0

	Confidence			Confidence			Conf:
Mean	2.50%	97.50%	Mean	2.50%	97.50%	Mean	2.50%
0.182	0	1.9	1.605	0	5.6	0.11	0
0.147	0	1.8	0.117	0	1.6	0.097	0
0.272	0	2	0.272	0	2	0.328	0
0.204	0	1.8	0.187	0	1.5	0.206	0
1.563	0	8.4	1.27	0	6.3	1.37	0
10.875	3.8	20.2	0.533	0	4.2	55.372	42.4
81.742	70.6	90.8	95.05	87.8	99.4	27.017	16.3
4.647	0.5	11.3	0.354	0	2.902	1.641	0
0.147	0	1.5	0.18	0	1.802	13.601	5.4
0.223	0	2	0.433	0	3.3	0.259	0

idence
97.50%
0.6
0.5
1
1
0.5
0.6
0.6
0.5
0.6
0.5
0.5
0.5
0.5
5.8
3.402
5.1
0.8
43.8
40.1
39.5
2.5
5.5
4
2.7
23
5.2
1.2
1
0.702

idence
97.50%
1
1
2.3
1.7
8.2
68.6
40.1
7.5
23.9
2.3



Scale: 1 km

Appendix 3. Map showing the location of the headwaters of the Rivers Tavy (▬), Dart (▬) and Teign (▬).