New Forest fish population report, 2019

Introduction

We conduct fish population surveys on the Lymington and Beaulieu Rivers with the primary aim of monitoring the abundance and spatial distribution of juvenile wild brown trout, a large proportion of which are destined to become smolts and migrate to sea as sea trout, returning to the rivers each autumn to spawn.

The surveys also provide us with important information on other species, particularly eels, coarse fish (e.g. roach, chub and pike) and the "minor" fish species: brook lamprey, bullhead, minnow, stone loach and three-spined stickleback.

Methods

The Lymington and Beaulieu fish monitoring programme consists of two components: firstly, the temporal component, where two sites on each river are surveyed biennially; these are Withybed Bottom and Blackensford-Bratley confluence on the Lymington River, and Penerley Bridge and Matley Passage on the Beaulieu River. These surveys keep track of changing fish abundance over time. Secondly, the spatial component, where a further 12 sites on each river are surveyed once every six years, to assess changes in spatial distribution of fish communities over time. 2019 was the third time that both the temporal and spatial components have been completed.

All surveys consist of a single pass with a battery-powered, backpack electric fishing unit fishing 100m of channel length. A stopnet is set at the upstream end, unless the site terminates at a shallow riffle. Fish of all species are captured by hand net and retained in an aerated container. Once fishing is complete, larger fish species are measured, while minor species are counted. Average channel width is measured, allowing calculation of the number and weight of fish per unit area (i.e. density and biomass).

A juvenile brown trout from the Ober Water at Turfcroft, in July.

The parents of this fish spawned in autumn 2018 and the egg hatched in spring 2019.

If this fish is female, it will probably become a smolt, migrate to sea and become a sea trout. If male, it may still migrate, but there is a greater chance that it will remain in freshwater.

Results

Overall fish community:

Table 1 presents the total numbers of each species caught in the 14 surveys completed on each river in 2019. Although each survey is exactly 100m long, widths differ, so for comparison we need to assess the catch in terms of fish per unit of area, known as "density". The *"Av. dens."* columns give the average number of each species caught per 100m^2. Note that these are single-run surveys and indicate a minimum population level, rather than a total population estimate. Individual site details and results are given in Appendix 1.

Table 1: Lymington and Beaulieu total catches and average densities

	Lymington		Beaulieu	
	Total	*Av. dens.*	**Total**	*Av. dens.*
Minnow	511	*17.6*	460	*26.2*
Brown / sea trout	239	*8.9*	72	*4.4*
Stone loach	161	*3.5*	217	*7.4*
Bullhead	119	*3.7*	153	*5.5*
Brook lamprey	64	*2.0*	222	*8.7*
Chub	11	*0.2*	0	*0.0*
Eel	8	*0.2*	8	*0.3*
Pike	2	*0.0*	0	*0.0*
Gudgeon	1	*0.0*	0	*0.0*
3 sp. stickleback	0	*0.0*	88	*4.5*
Roach	0	*0.0*	25	*0.8*

Figure 1 shows the average catch per site on the two rivers. Note that the species list on the right hand side is in descending order of abundance.

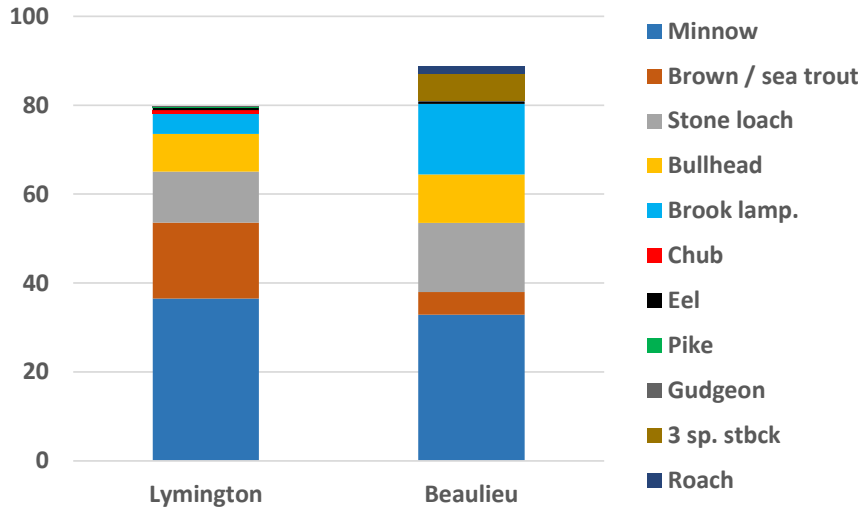


Figure 1: Average catch per site

Brown / sea trout

Juvenile brown / sea trout are the main focus of this monitoring programme. The principal questions we aim to address are:

- Has overall brown trout abundance changed over time?
- Has brown trout spatial distribution changed over time?
- If so, what are the most likely causes?

Map 1 shows the locations of the 14 survey sites on each river (same locations for 2007, 2013 and 2019). Green markers indicate surveys where brown / sea trout were caught in 2019 and red markers where they were not. Green markers are sized according to the numbers caught, in order to give an indication of relative abundance in different parts of each catchment.

Map 1: Survey locations and brown / sea trout catches, 2019

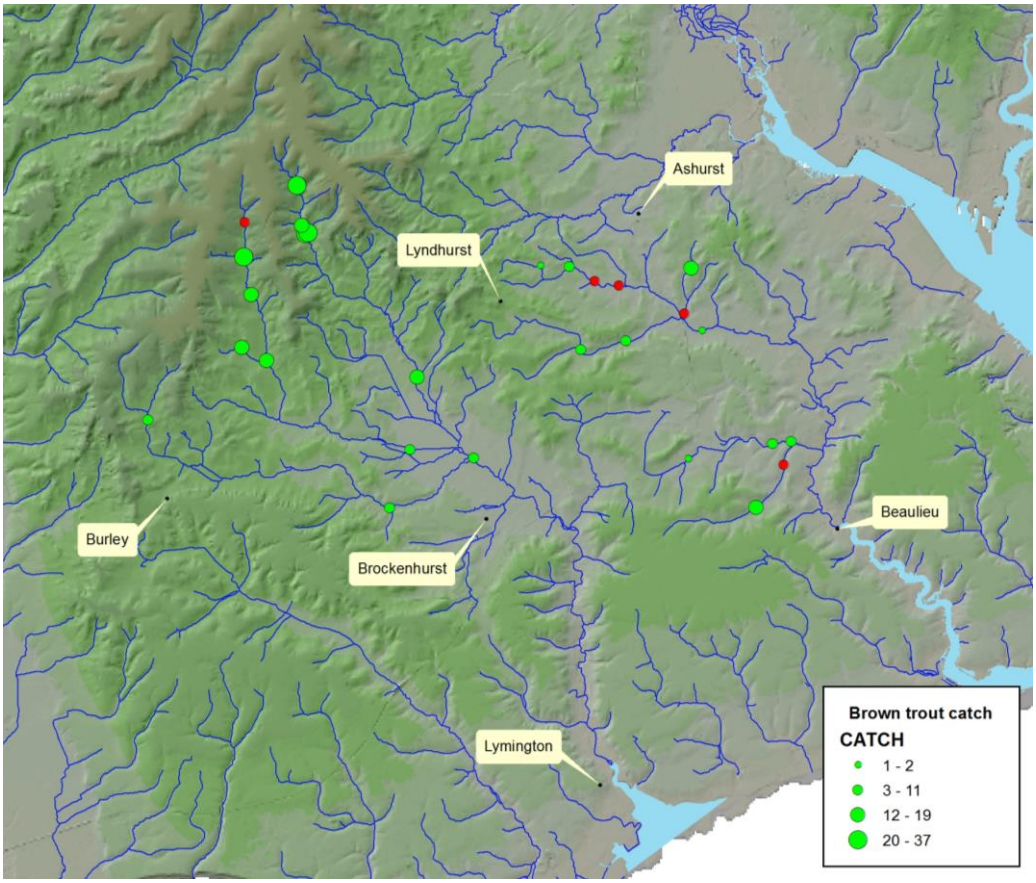
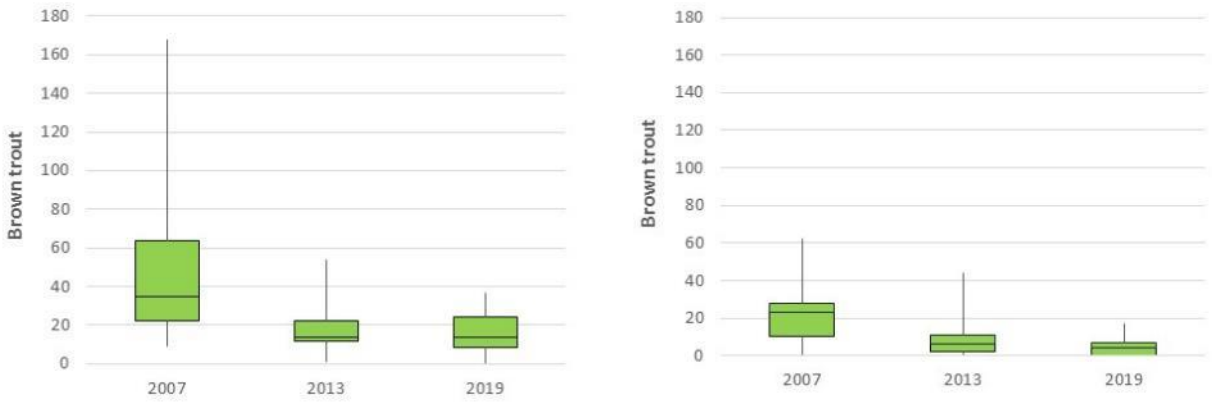


Figure 2 consists of boxplots representing the brown trout catch data, for all sites, for each of the survey years for both rivers. The bars, or whiskers, show the maximum and minimum catches in that year; the bottom and top of each box represents the 1st and 3rd quartiles, respectively, and the line in the middle of each box is the median value.



Lymington **Beaulieu**

Figure 2: Brown / sea trout catch data box-plots

Figure 3 is a group of trout length-frequency histograms, showing the numbers of trout caught in 5mm length categories caught in 2007, 2013 and 2019 on the Lymington and Beaulieu Rivers. The shapes of these histograms indicates the age structure of each trout population in each year (principally the ratio of juveniles to adults) and its overall size.

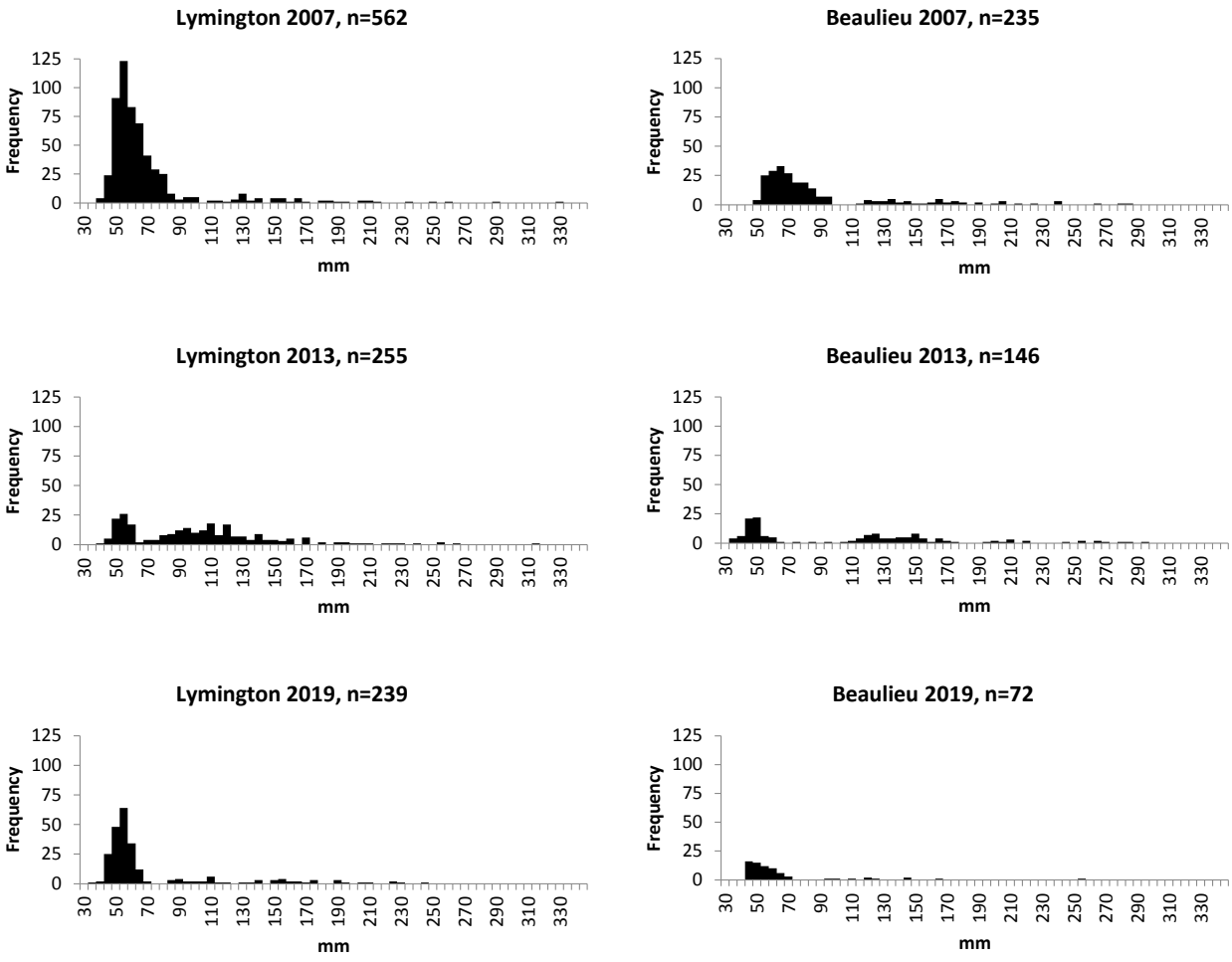


Figure 3: Brown / sea trout length-frequency histograms

Figures 4 and 5 show the total brown / sea trout catch at the two Lymington temporal survey sites, Withybed Bottom and Blackensford-Bratley confluence, and the two Beaulieu temporal survey sites, Matley and Penerley, for every survey occasion since 2007: note that the frequency of surveys has been variable. The figures also show the minimum recorded flow at Brockenhurst gauging station (lower Lymington River) in each summer, with trendlines. Note that the figures have differing y-axis ranges.

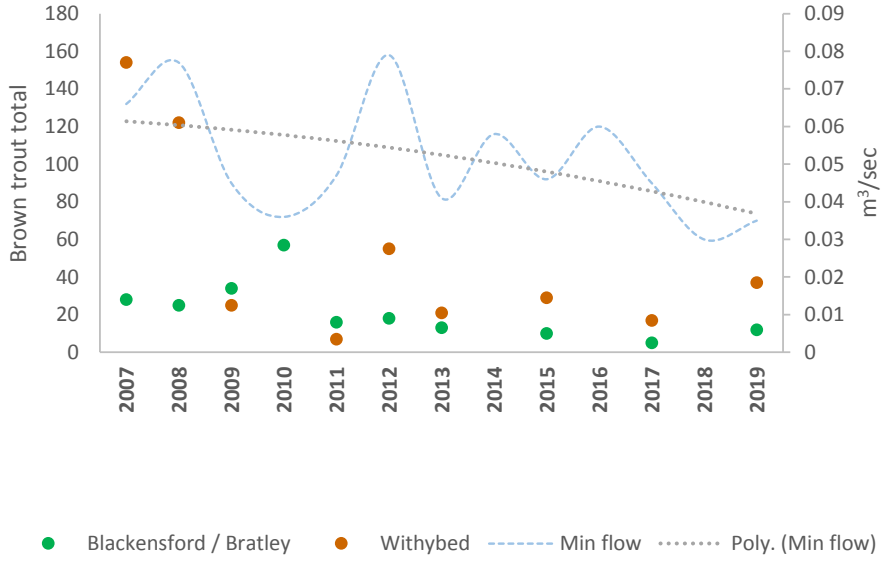


Figure 4: Brown trout catches at Lymington temporal survey sites, 2007-2019

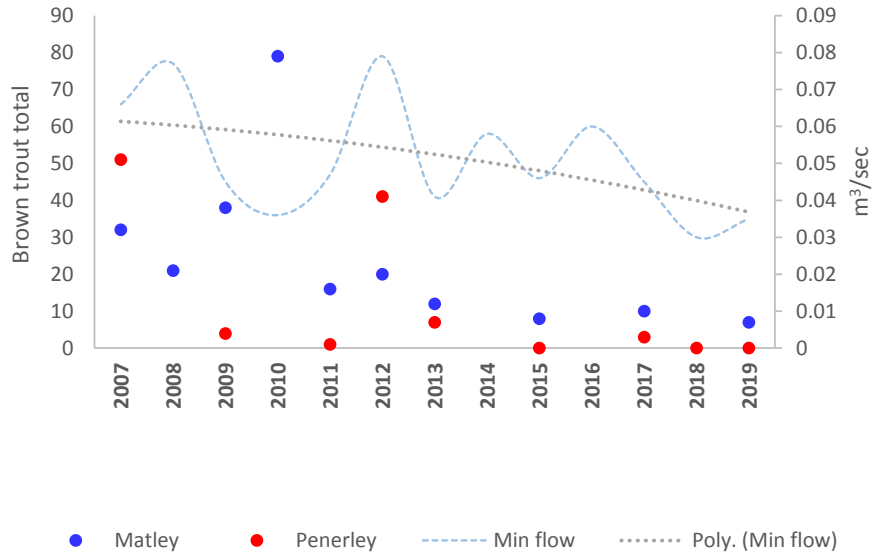


Figure 5: Brown trout catches at Beaulieu temporal survey sites, 2007-2019

Figure 6 gives the highest daily maximum air temperature recorded in the Met Office's Central England Temperature dataset for each year (red line, left-hand vertical axis) and also the average daily summer temperature (June, July and August; blue line, right-hand vertical axis). Polynomial trendlines are included for both graphs.

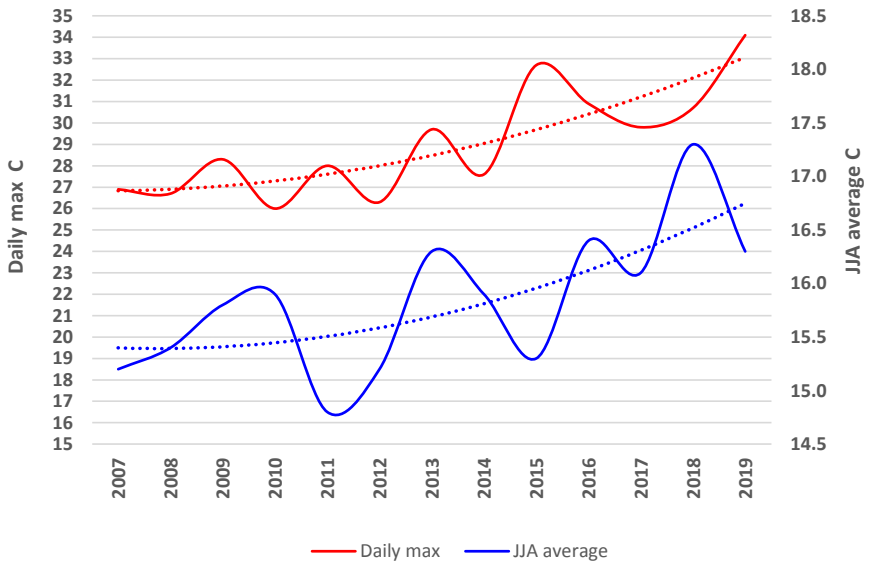


Figure 6: Daily maximum and mean summer Central England Temperature (Hadley), 2007-2019

Observations and discussion

Table 1: species assemblages

– Nine species were recorded on the Lymington and eight on the Beaulieu. Three-spined sticklebacks and roach were not recorded on the Lymington; chub, pike and gudgeon were not recorded on the Beaulieu. Roach have been recorded on the Lymington previously and, on both rivers, they probably originate from privately owned pools connected to the watercourses.

– Average brown / sea trout density on the Lymington was double that of the Beaulieu.

– Average densities of all minor species were higher on the Beaulieu, particularly brook lamprey and minnow.

Map 1: catches at individual sites

– Brown / sea trout were not caught at one site on the Lymington (Slufter's Passage) and four sites on the Beaulieu (Ashurst Lodge, Longwater Lawn, Longdown Inclosure and Penerley Bridge).

Figure 2: time series of brown / sea trout abundance in major survey years

– Figure 2 indicates similar brown / sea trout abundance on the Lymington in 2019 and 2013, but with a lower maximum catch: both years show substantially lower abundance compared with 2007. For the Beaulieu, Figure 2 indicates relatively low abundance in all years and a decline between 2007 and 2019.

Figure 3: brown / sea trout age structure

- The length-frequency histograms in Figure 3 reflect the same declines in abundance indicated in Figure 2.
- The Lymington histogram for 2007 is fairly typical for a sea-trout dominated trout population, with a dominant class of juveniles in their first year and far lower numbers of a range of older year classes. The histograms for the Lymington in 2007 and for all three years on the Beaulieu show much lower abundance of young-of-the-year trout.
- The 2013 Lymington histogram suggests a relatively strong year class the previous year.

Figures 4 and 5: time series of brown / sea trout abundance at temporal survey sites

- Both figures suggest generally low trout abundance at the temporal sites in recent years.
- Minimum flow at Brockenhurst correlates strongly with trout abundance at Withybed and Penerley, which have ephemeral flows, but less well with Matley and Blackensford-Bratley, which are less ephemeral in nature.

Figure 6: trends in summer air temperature

- Figure 6 illustrates the trend towards increasing average and peak summer central England air temperatures since the first survey of the Lymington and Beaulieu fish communities as part of the present programme. These trends are of critical importance to the conservation of the highly temperature-sensitive brown / sea trout populations of both rivers.
- The ephemeral nature of summer flows at the majority of survey sites means that trout abundance is closely linked to rainfall. However, survival under low flow conditions can be reasonably good, as long as the physical habitat provides abundant and effective sources of thermal refuge and water temperature is maintained below the species' critical threshold of 19.5°C. Maximum growth in brown / sea trout occurs at 13°C and growth ceases altogether at 19.5°C. The species' seven-day upper lethal limit is 25°C, so water temperatures between 19.5-25°C are critical and are likely to result in stress, disturbance to normal behaviour, higher susceptibility to disease and pollutants and reduced survival.
- For sea trout, elevated water temperature in both freshwater and marine environments can have significant effects on a range of behaviours and survival rates at other life stages, such as the development of smolt characteristics, the timing of smolt migration, passage through estuaries (out as smolts and return as adults), feeding and growth at sea and egg development in returning females.

Conclusion

The fish population data we have collected from the Lymington and Beaulieu Rivers between 2007 and 2019 strongly suggests that brown / sea trout populations on both rivers are under increasing pressure as a result of climatic trends. The most easily measured impact is on juvenile abundance, but the warming trend is most probably having a generally negative impact at various other life stages. Trout populations in these small, rain-fed rivers, with highly variable flow regimes are acutely vulnerable to climate related pressure compared with neighbouring chalkstreams with relatively stable, spring-fed flows.

The same trends are likely to be favouring species better suited to elevated water temperatures, such as minnow, stone loach and three-spined stickleback - unlike trout, these species are effective thermal stress tolerators.

There is evidence that the impacts of increasing summer temperatures and more prolonged periods of low flow have, to date, had a greater impact on the Beaulieu River than the Lymington.

Recommendations

1. **Thermal refugia:** during periods of low flow and elevated air temperature, juvenile brown / sea trout can only survive in Forest streams where effective thermal refugia are abundant. The most effective refugia are associated with mature, bankside trees and shrubs, particularly roots and large woody debris - these features are far more frequent in unmodified reaches and they are an essential component of any restoration design.
2. **Mire restoration to provide consistent water release:** in the New Forest, the upland mires are the equivalent of the chalkstream aquifers: mires collect and store rainwater and the more slowly and consistently they release this water to the stream channels, the more stable the river flow regimes, mitigating the effects of drought and elevated air temperature.
3. **Identify "warming" reaches and consider mitigation**: there are specific reaches on both rivers that are likely to contribute to water warming to a disproportionate degree; these are the reaches with least tree cover, such as lawns and clear-felled areas.
4. **Timber operations:** the creation of new areas of high insolation should be avoided, so timber felling operations should be designed to retain all the features that protect watercourses from thermal impact.
5. **Reduce additive impacts from other pressures: abstraction, discharge, pollution:** aquatic organisms stressed by low-flow and elevated temperature are more vulnerable to other pressures- rising temperature increases the value of mitigating such additive pressures.

Survey photographs

The survey site at Matley contains abundant woody debris and several riffles, used as spawning sites by sea trout and brook lamprey.

The survey site at Penerley Bridge has been dry more frequently in recent years, including 2019 - the straightened channel provided no refuge pools at all.

Despite being some distance upstream from the Penerley reach, the site at Worts Gutter contained many shaded refuge pools in 2019 and 13 trout were caught. Unlike Penerley, it has not been straightened and largely retains its complex channel form.

The survey team at Blackensford - Bratley confluence, a sinuous, shady site that rarely dries.

An adult, non-migratory brown trout from Blackensford-Bratley.

Fletchers Water on a hot day and with no flow but several extensive refuge pools containing a range of fish species.

Finding juvenile trout among woody debris at Lucas Castle.

Ocknell Inclosure: when air temperature drives water temperature to lethal levels in isolated pools, it's not uncommon to observe asphyxiated juvenile and adult trout at the water's edge. The arched back and flared gills indicate the cause of death. Naturally, poorly-shaded pools are more vulnerable.

Following timber harvesting several years ago, the open, unshaded character of the channel in this section of Slufter's Passage, and various other reaches, results in an almost complete absence of thermal refuges: only minnow and stone loach were caught here in 2019.

Thick diatom growth on the riverbed in the headwaters of the Beaulieu River suggests a degree of organic enrichment.

Appendix 1: Individual survey details

NB: Beaulieu sites were surveyed in the week beginning 1st July; Lymington sites were surveyed in the week beginning 8th July.

Table 2: Individual survey details and results

		NGR	Site av. width m	Brown / sea trout	Chub	Gudgeon	Roach	Pike	European eel	3-spined stickleback	Bullhead	Minnow	Stone loach	Brook lamprey
Lymington	Blackensford lawn	SU2306606999	2.1	19	0	0	0	0	0	0	13	45	9	0
	Blackensford-Bratley	SU2372406651	2.6	12	1	0	0	0	0	0	1	8	2	1
	Bolderford Bridge	SU2916104102	5.5	8	0	0	0	1	4	0	9	42	57	5
	Bratley Arch	SU2312009365	2.2	37	0	0	0	0	2	0	3	35	0	4
	Bratley Wood	SU2331308388	2.8	15	0	0	0	0	0	0	3	24	1	5
	Fletcher's Water	SU2749304316	3.2	8	2	1	0	1	0	0	1	29	44	2
	Forest Gate	SU2767106214	3.4	13	0	0	0	0	0	0	19	23	2	5
	Long Brook	SU2480409998	1.8	31	0	0	0	0	0	0	14	43	0	1
	Lucas Castle	SU2464710200	1.6	17	0	0	0	0	0	0	7	49	6	19
	Ocknell	SU2451211249	1.1	26	0	0	0	0	0	0	7	14	0	0
	Puttle's Bridge	SU2694702782	3.9	7	8	0	0	0	2	0	22	20	38	12
	Slufter's	SU2314210274	1.8	0	0	0	0	0	0	0	0	47	2	0
	Turfcroft	SU2060805091	1.9	9	0	0	0	0	0	0	10	82	0	7
	Withybed Bottom	SU2474209975	2.5	37	0	0	0	0	0	0	10	50	0	3
Beaulieu	Ashurst Lodge	SU3297108622	2.4	0	0	0	0	0	0	11	0	31	8	1
	Deerleap	SU3488409077	0.6	17	0	0	0	0	0	3	0	0	0	0
	Dunce's Arch	SU3090709128	1.5	1	0	0	0	0	1	17	0	0	0	0
	Holmhill Passage	SU3198406940	2	6	0	0	3	0	1	10	31	8	13	150
	Longdown Inclosure	SU3468607881	0.6	0	0	0	0	0	0	1	0	0	0	1
	Longwater lawn	SU3233808728	2.7	0	0	0	11	0	0	21	1	117	42	5
	Mallard Wood	SU3167609114	1.5	7	0	0	1	0	0	8	11	37	15	15
	Matley	SU3316307170	2.3	7	0	0	10	0	2	5	17	33	46	8
	Penerley Bridge	SU3730703902	Dry	0	0	0	0	0	0	0	0	0	0	0
	Penerley Water	SU3750904529	1.7	7	0	0	0	0	0	0	3	50	21	16
	Shepton Water	SU3701704466	2	11	0	0	0	0	2	0	29	55	29	4
	Upper Shepton Water	SU3479904071	1.2	2	0	0	0	0	0	7	0	66	2	0
	Withycombe Shade	SU3515007436	2.9	1	0	0	0	0	2	5	26	32	40	14
	Worts Gutter	SU3658802795	1.7	13	0	0	0	0	0	0	35	31	1	8