Test & Itchen Catchment

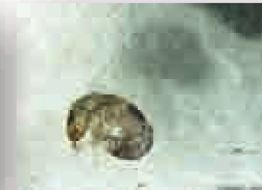
Catchment Invertebrate Fingerprinting Study

CATCHMENT INVETEBRATE FINGERPRINTING STUDY

Invertebrate Fingerprinting:

The evaluation of invertebrate communities living in a river or stream is one of the best methods available for assessing the impacts of environmental stress on the health of an aquatic ecosystem. Invertebrates that spend all, or part, of their lifecycle living in a river are constantly exposed to changes in the structural composition of the river bed, in the volume of water in the river and in the chemical composition of the water flowing over them.

To assess the health of the invertebrate communities in a river, samples are collected using a standardised method and the organisms found are identified to the taxonomic level of family or species. In addition, the approximate abundance of each group found in the sample is also recorded and this combined data is used to calculate so–called biotic indices, which are used to draw conclusions about the condition of the river and to make comparisons between sites on the same or different rivers.



Catchment Invertebrate Fingerprinting (CIF) Study:

The CIF study is examining the responses of aquatic invertebrate communities, throughout the river catchments of Wessex, to four environmental stresses; **sedimentation**, **phosphate pollution**, **organic pollution** and **low-flow** impacts.

The first phase of the study examined historic invertebrate sampling data, supplied by the Environment Agency. The community structure at each sampling site was analysed, essentially to **family level***, for four biometric indices: PSI (fine sediment), TRPI (total reactive phosphorous index), Saprobic (organic pollution) and LIFE (low-flow impacts).

For each of the indices, an invertebrate group is allocated a score according to its sensitivity to the particular environmental stressor. When a river becomes polluted the most sensitive and highest scoring groups are the first to be lost and the average score falls. Where the average score of the groups found is high, it indicates that the most sensitive groups are present in the river and that, by inference, the pollution levels are low.

The second phase of the study used the same set of biometric indices to provide a more detailed examination, at the **species level**, of a smaller number samples which were taken by the WCSRT and the Environment Agency, at targeted sites, during autumn 2014 and spring 2015.

This booklet looks at each of the four environmental stress signatures individually and maps the results of the first phase analysis and the more detailed species level analysis. Together the results help provide an overall picture of water quality across the Test and Itchen catchment.

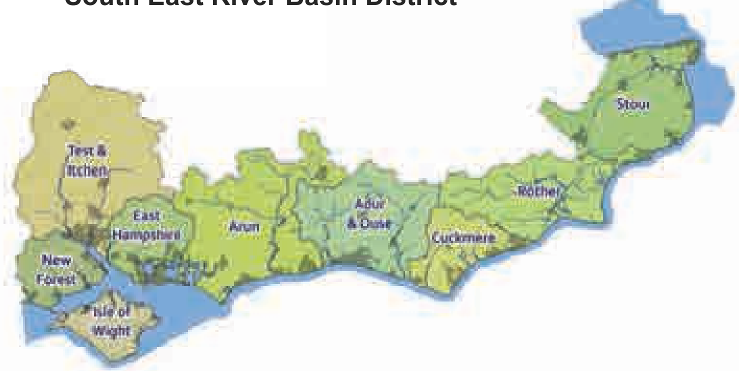
**The latter part of the EA data period, will have contained some species data which means our analysis will have provided some mixed family/species biometric predictions (as RICT does).*

CATCHMENT BACKGROUND

TEST & ITCHEN CATCHMENT: Principal catchment features

The Test and Itchen catchment covers an area of ~1760 sq. km and contains two rivers that are widely considered to be amongst the finest chalk streams in the world. Both rivers rise from springs on the chalk downs near Ashe and Hinton Ampner, respectively. The upper and middle reaches of the catchment are predominantly rural and the landscape is characterised by the underlying chalk geology. Through the lower reaches both rivers begin to flow over tertiary geology and into the more heavily populated areas, of Romsey, Eastleigh and Southampton, before reaching a shared estuary in Southampton Water.

South East River Basin District



ENVIRONMENTAL STRESSOR 1:

SEDIMENT

Sediment

'Sediment' is the mineral and organic material that is eroded, from all across a catchment (**source**), transported via rills, gullies, drains etc (**pathway**) and eventually deposited into the river network (**receptor**). Naturally occurring sediment is an important part of a healthy river system and is an essential component of many aquatic ecosystems. However, problems arise when human activity increases the amount of sediment entering the watercourse, impacting on the river's natural processes.

What is the problem?

Increased levels of sediment can have a number of impacts on our river catchments. In particular, sediment is known to damage **Aquatic Ecosystems** by blocking light to aquatic plants, clogging the gills of fish and smothering benthic habitats, suffocating the organisms and eggs that reside in the substrate. Similarly, sediment is often a contributor to increased nutrients and chemical contaminants that can cause **Water Pollution** and impact on the provision of clean **Drinking Water**, increasing the associated costs of water treatment and price to the consumer. Sediment is also known to impact on **Flood Risk,** reducing the rivers carrying capacity of water and slowing down and in some extreme cases blocking conveyance through the river catchment. Finally, chalk river catchments are renowned for the amenity value they provide for recreational angling and the associated economic benefits that this delivers. **Fisheries,** Salmon fisheries in particular, are vulnerable to the impacts of sediment on water quality and ecosystems that underpin a healthy fishery.

What are the solutions?

There are a range of well established measures for reducing sediment loads entering rivers and streams. These measures are primarily aimed at mitigating the availability of sediment sources, decreasing the likelihood of material being mobilised and disconnecting pathways via which particulate matter (mainly soil) is carried to watercourses. In the Test & Itchen catchment there are mechanisms to deliver these mitigation measures, including initiatives that assist landowners with improving land use and soil management to deliver benefits to farm businesses as well as the environment. Further information and advice for landowners is available from:

Wessex Chalk Stream & Rivers Trust

Contact: Rupert kelton
Catchment Officer, Test & Itchen
Email: info@wcsrt.org.uk

Sediment – Family Level Results

In map 4, some reaches of both rivers show increasing biological signatures for sediment stress (red arrows) and some reaches of these rivers also show decreasing fingerprints (blue arrows) for sedimentation over time. Some of these increasing signatures for sedimentation will have been associated with population expansion plus the associated human pressures on the rivers in the form of e.g. agriculture, abstraction, discharges and both man-made and natural bank erosion. In map 3, there remains today a mix of slightly impacted to impacted biological signatures of sedimentation in the Rivers Test and Itchen. Here greater sediment impacts are evident towards the mouth of these rivers as accumulating sediment inputs away from the headwaters and natural gradient or hydro-geomorphology encourages deposition of greater sediment load in the river beds.

Index: Proportion of Sediment-sensitive Invertebrates (PSI)

Extence et. al. (2010) proposed the use of a sediment-sensitive macro-invertebrate metric, PSI (Proportion of Sediment-sensitive Invertebrates) which can act as a proxy to describe temporal and spatial suspended sediment ecological impacts on a river catchment scale.

The PSI score describes the percentage of sediment-sensitive taxa present in a kick/sweep net sample and the metric is calculated using scores for the differing invertebrate groups.

PSI scores range from 0 (entirely silted river bed) to 100 (entirely silt-free river bed).

Sediment – Species Level Results

The targeted investigational surveys for the biological signatures of sediment stress shown in map 5 and 6 indicated a number of essentially sediment un-impacted or only slightly impacted reaches and a number of localised potential sources of sedimentation in these rivers with moderately to impacted sediment conditions. These and larger scale species level fingerprinting of these rivers has shown that moderately to impacted sediment signatures do not associate with good riverfly species richness and abundance at the base of these fishery food chains.

5 Autumn 2014

6 Spring 2015

Invertebrates most susceptible to sediment increases:

The Blue Winged Olive
(*Serratella ignita*)

The Southern Iron Blue
(*Baetis niger*)

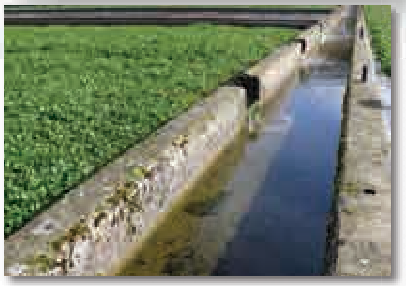
ENVIRONMENTAL STRESSOR 2:

PHOSPHATE

Phosphate

Phosphate is a naturally occurring compound derived from phosphorus, a mineral which is essential to human, animal and plant life. It is a fundamental component of a healthy water environment, supporting aquatic plants which produce oxygen and create habitats needed by other aquatic organisms, such as invertebrates and fish. However, phosphate is also commercially processed and used in many cleaning, industrial and agricultural production processes. Excess phosphate acts as a pollutant and although it can't be seen in the water, it makes its presence plain by triggering algal blooms.

There are many potential sources of phosphate in river catchments; including diffuse sources such as fertiliser applied to agricultural land, sewage discharges, domestic waste water and agricultural point sources such as cress farms and slurry stores.



What is the problem?

Human activity within our river catchments can cause an increase in the accumulation of commercially produced phosphate in the freshwater environment. This leads to unbalanced and uncontrolled growth of aquatic plants and algae in a process known as 'eutrophication'. Eventually the mass of plants and algae die back and are decomposed by oxygen-consuming bacteria which use up the available oxygen in the water. This lack of oxygen, needed for invertebrates, fish and other aquatic organisms to survive, can have a severe impact on the ecological health of the ecosystem in a waterbody. It will also have detrimental impacts on humans who depend on the water for drinking water, recreational use and the production of food such as fish.

What are the solutions?

Tighter regulation has led to activity from water companies, cress farmers and the farming industry to address some of the major sources of phosphate. However, large numbers of small sources from domestic waste water and septic tanks are still a significant problem.

Householders can help reduce their impact on the water environment by using low phosphate or phosphate free products and ensuring septic tanks are properly maintained.

Diffuse agricultural sources of phosphate are still a significant issue but there are a number of well established soil, land and fertiliser management solutions available to help improve farm business efficiencies and reduce the impact of farming activities on the environment.

Catchment Based Approach
Partnerships for Action

For further information, contact:
Test & Itchen Catchment Partnership
Contact: Ali Morse – HIWWT
Contact: Rupert Kelton – WCSRT
www.ticp.org.uk

Phosphate – Family Level Results

In map 8, some reaches of the River Test and the River Itchen show increasing biological signatures for phosphate stress (red arrows) and some reaches of these rivers also show decreasing fingerprints (blue arrows) for eutrophication over time. Some of these increasing signatures for eutrophication will have been associated with population expansion plus the associated human pressures on the rivers in the form of e.g. agriculture, abstraction and discharges. In map 7, there remains today a mix of slightly impacted to impacted biological signatures of phosphate stress in the Rivers Test and Itchen. Here, like with and potentially associated with the previous sediment fingerprints, the greater eutrophication signatures are evident towards the mouth of these rivers as accumulating phosphate inputs away from the headwaters encourages the build up of phosphate in the rivers.

Index: Total Reactive Phosphorous Index (TRPI)

Eutrophication, the enrichment of waters by nutrients resulting in an array of biological changes, is widespread in the lakes and rivers of industrialised countries. Typical symptoms include algal blooms and sometimes enhanced growth of higher aquatic plants. A new phosphorus index has been developed by Dr Nick Everall and co-workers where the Total Reactive Phosphorous Index or TRPI, uses sensitive invertebrate groupings present in a sample to calculate scores across five groups of invertebrate taxa (A to E, where A taxa are very TRP sensitive through to E taxa which are relatively insensitive).

Sediment – Species Level Results

The targeted investigational surveys for the biological signatures of sediment stress shown in maps 9 and 10 indicated a number of essentially phosphate un-impacted or only slightly impacted reaches and a small number of localised potential sources of eutrophication in these rivers with moderately impacted phosphate conditions. The current and other large scale species level fingerprinting of these rivers has shown that moderately to impacted phosphate signatures do not associate with good riverfly species richness and abundance at the base of these fishery food chains.

9 **Autumn 2014**

10 **Spring 2015**

Invertebrates most susceptible to phosphate increases:

The Blue Winged Olive
(*Serratella ignita*)

ENVIRONMENTAL STRESSOR 3:

ORGANIC POLLUTION

Organic Pollution

Organic pollution is caused by human activities which introduce highly degradable material into the watercourse. Typically, the most common sources of organic pollution are sewage works, sewage misconnections, farm waste and organic fertilisers such as farmyard manure.

What is the problem?

Organic pollutants are principally a problem because they increase the activity of aerobic bacteria which decompose organic waste and, in doing so, use up more oxygen from the water as they respire. This increase in Biochemical Oxygen Demand (BOD) puts pressure on other aquatic organisms such as invertebrates and fish which also depend on oxygen for respiration. Organic pollution can also lead to a number of other problems such as physically smothering the stream bed, exacerbating eutrophication where plant communities benefit from residual nutrients left behind after organic material has been decomposed and finally, increased levels of ammonia, which is toxic and harmful to aquatic life.

What are the solutions?

Over the past twenty years there has been a steady reduction in organic pollution, largely due to investment from water companies and improved farming practices from the agricultural sector.

Investment from water companies to improve treatment at sewage treatment works is on-going and includes efforts to address sewage misconnections in urban areas.

Farmers are required to meet regulations on storing silage and slurry (SSAFO Regulations) as well as basic standards linked the the basic payment scheme, with additional compliance measures for farmers in Nitrate Vulnerable Zones (NVZs).

Advice and support to help farmers meet the various standards and regulations is available through Catchment Sensitive Farming, as well as advice and capital grants to contribute towards capital works including; watercourse fencing, yard infrastructure, cattle tracks and numerous other capital items.

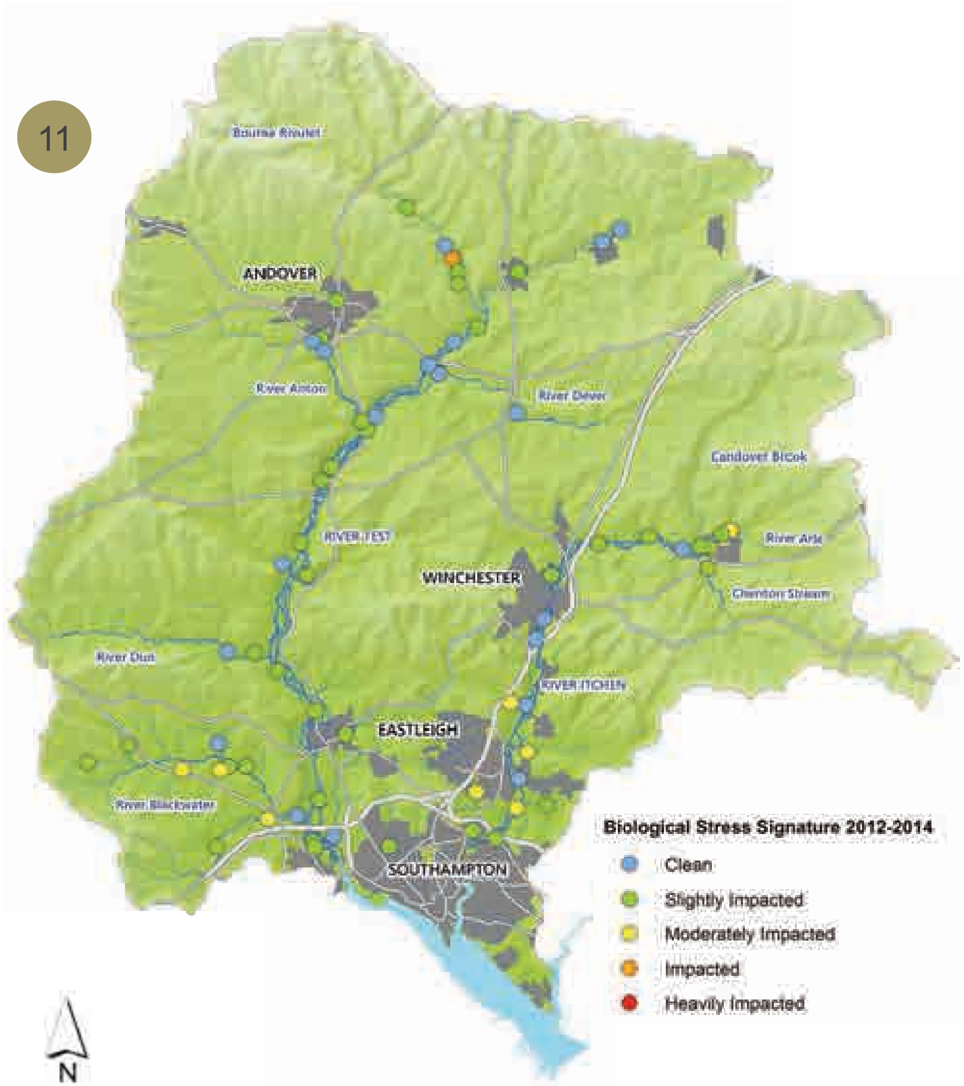
Further information is available from:

A clear solution for farmers
CATCHMENT SENSITIVE FARMING

Contact: Natural England
Catchment Officer, Test & Itchen

Organic Pollution – Family Level Results

In map 12, most of the reaches of the River Test and the River Itchen show longer-term un-changed or decreasing biological signatures for organic pollution which has resulted from successful control and abatement of the sources of organic inputs to these watercourses over time. In map 11, there remains today a mix of mainly clean or slightly impacted biological signatures of organic enrichment in the Rivers Test and Itchen. There was greater organic enrichment evident in a small number of tributary watercourses towards the mouth of these rivers.



Index: Saprobic Index

Saprobic indexing at the species and family level allows for a more revealing insight into the nature and quantum of organic pollution in watercourses than other methods, as it accounts for species differences in tolerance to organic pollutants (e.g. elevated ammonia and lowering dissolved oxygen regimes).

Organic Pollution – Species Level Results

In map 13 and 14, most of the reaches of the River Test and the River Itchen showed clean or slightly impacted biological signatures for organic pollution, as for the relatively recent 2012-2014 fingerprints on the previous page. However, a (green circle) slightly impacted biological signature for organic enrichment is not clean or un-impacted and represents a mild organic load with BOD typically in the range of 2-6 mg/l. While not by itself a threat to aquatic life these mild organic loads in additive combination with other stresses like sediment and phosphate can quicken the 'tipping point' for combined environmental impacts versus a background of clean or un-impacted (blue circle) conditions. It is therefore important to continue to maintain the drive towards controlling and abating organic enrichment and pollution in these watercourses.

13 **Autumn 2014**

14 **Spring 2015**

Invertebrates most susceptible to organic pollution:

ENVIRONMENTAL STRESSOR 4:

LOW-FLOWS

Cracked soil
Photo: Terry Freedman

Low-Flows

Chalk streams can derive as much as 80% of their annual stream discharge from groundwater, stored in chalk aquifers. Overland flow is therefore only a relatively small component of natural stream flow, meaning that chalk streams benefit from a relatively stable hydrological regime. However, human activity through historic management practices and increasing abstraction have caused changes to the natural flow regime which do not always support a healthy ecology.

What is the problem?

Abstraction is the removal of water, permanently or temporarily, from a water body. It can alter the natural flow regime either directly on surface water flows or indirectly by groundwater pumping, depleting groundwater levels. Other human activity which regulates flow e.g. by physically modifying rivers with impounding structures such as weirs and sluices can similarly alter natural flow regimes. The changes brought about by these human activities can have a number of subsequent effects on the in-river ecology, including; increasing sedimentation rates, loss of habitats, loss of in-channel geo-morphological diversity and hindering the passage of migratory fish.

What are the solutions?

Abstraction of water is controlled through a licensing system operated by the Environment Agency. Recent changes to this system has seen a drive towards more sustainable abstraction and a regime that meets the environmental obligations set by the Water Framework Directive. Similarly, water companies have responsibility for planning how they can meet future customer demand, whilst maintaining an affordable price and not damaging the environment. Finally, as consumers we are all responsible for saving and using water more efficiently and can seek information and advice from local water companies on improving efficiencies in homes and businesses.

Southern Water

Portsmouth Water

In addition to reducing demand and making the abstraction of water more sustainable, there are also a number of opportunities for using natural processes to mitigate the impacts of human activity:

River Restoration:

Improving river habitats and restoring natural process, e.g. removing impoundments, can help reduce the physical effects of low flows and support the recovery to a more naturally functioning ecosystem.

Wetland Restoration:

Wetland restoration can increase the attenuation of water, which can benefit groundwater recharge, support summer base flows to rivers and improve water quality and sediment retention at some locations.

Catchment Management:

Changes in land management practices can alter the way water moves through or is retained in the catchment. Similarly, soil management practices can have a significant influence on the volume and rate at which water infiltrates through the catchment.

Flow – Family Level Results

In map 16, most of the reaches of the River Test and the River Itchen show increasing biological signatures (red arrows) or no change (black crosses) for flow velocity over time. In map 15, there remains today a mix of clean to slightly impacted biological signatures of flow velocity throughout much of the middle to upper Rivers Test and Itchen with some flow issues evident in the upper Itchen. There was also flow stress evident in a number of tributary watercourses towards the mouth of the River Test and particularly the River Itchen.

Index: Flow velocity conditions from Lotic Flow Evaluation (LIFE)

Many freshwater invertebrates have precise requirements for particular current velocities or flow ranges, and certain taxa are ideal indicators of prevailing flow conditions.

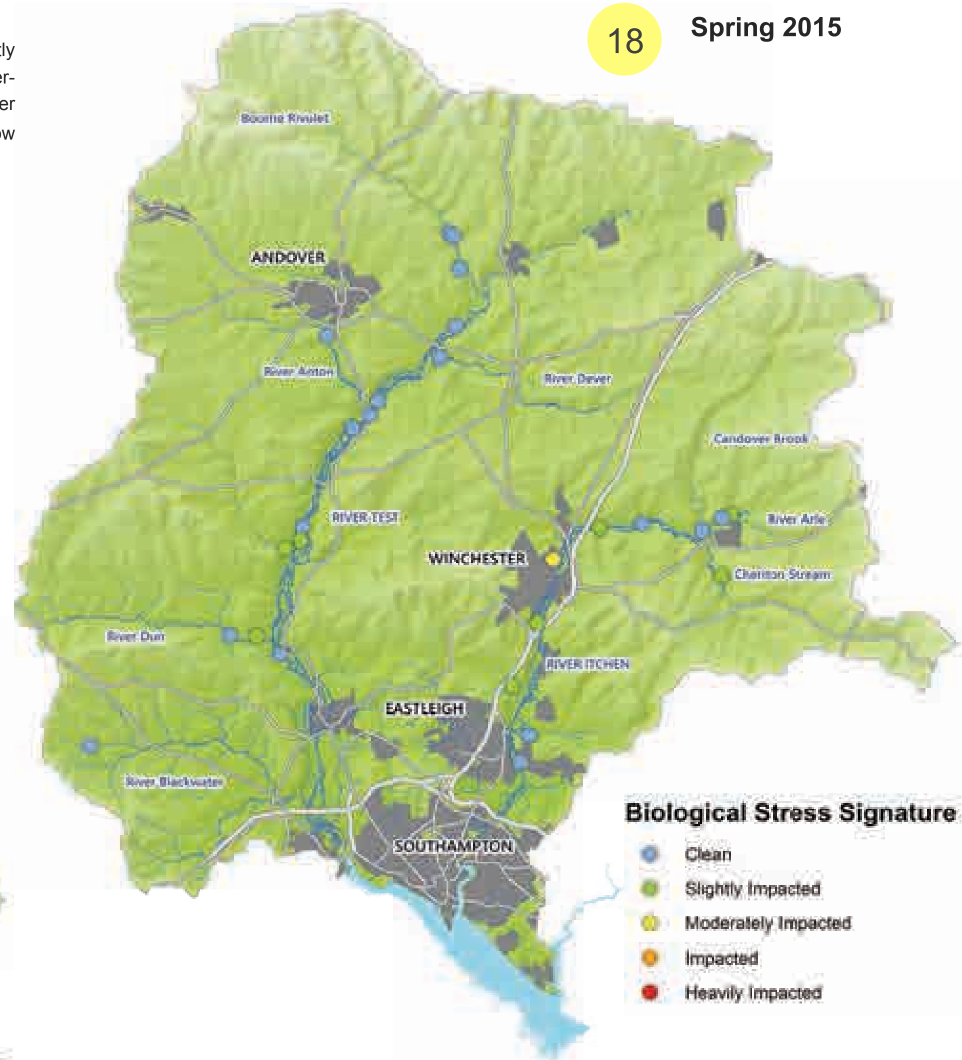
The LIFE technique is based on data derived from standardised 3 minute kick-sweep net sampling of macro-invertebrates in order to assess the impact of variable flows on benthic populations (Extence et. al.,1999). The higher the LIFE score in comparable flow-habitat sections of watercourse the higher the prevailing flow conditions and vice versa.

Flow – Species Level Results

In map 17 and 18, most of the reaches of the River Test and the River Itchen showed clean or only slightly impacted biological signatures for flow. However, the relatively high rainfall patterns of recent varied summer-autumn-winter periods had done much to augment groundwater and maintain flow regimes in these river catchments. It is probable that such augmented flows were manifested in the recent biological signatures of flow captured in the 2014-2015 species level stress fingerprinting.

17 **Autumn 2014**

18 **Spring 2015**



Invertebrates most susceptible to low-flows:

Wessex Chalk Stream & Rivers Trust

CATCHMENT INVETEBRATE FINGERPRINTING STUDY

Summary of Results:

Some reaches of the River Test and River Itchen exhibited variably impacted biological signatures for sediment and phosphate stress which are associated with reduced riverfly species richness and abundance. Conversely, some reaches of the River Test and Itchen produced clean or only slightly impacted biological signatures for sediment and phosphate stress associated with better riverfly species richness and abundance.

Where these key environmental stresses of sediment, flow, phosphate and organic enrichment produce biological signatures at or above moderately impacted then they associate with impacted ecological condition in those river reaches. These stresses, however, seldom act in isolation and the combined and additive impacts of raised signatures for sediment, flow, phosphate and organic enrichment are found to be greater than the individual stresses. These are also not 'anecdotal' impacts since the bands of biological signatures for these stresses relate directly to chemical bands of e.g. ammonia and BOD for organic enrichment and phosphate levels for phosphates.

Tackling the problem – a partnership approach:

It is the clean or slightly impacted reaches of these rivers that hold the answers to protecting and improving them under a catchment management umbrella including e.g. in-stream habitat management to enhance flow regimes, targeted agricultural investment (e.g. Catchment Sensitve Farming), regulatory discharge control, planning permissions and litigation where required.

We are certainly not residing in a time for complacency since the findings in this report and that of other workers is showing a direct link between raised biological signatures of sediment and phosphate stress, plus their associated chemical levels, with loss of riverflies in both rivers and matching laboratory controlled studies. Angler's have long recognised the plight of riverflies in some reaches of UK rivers which we are now seeing from the scientific data given the move towards species level invertebrate fingerprinting of river samples.

We must all work together to control and reduce these stress signatures for 'pollutants' like flow, sediment, organic and phosphate enrichment in reaches of the River Test and Itchen exhibiting above clean or slightly impacted fingerprints. Where there is evidence of discharge causes for impacted ecological condition then all of the regulatory and non-regulatory stakeholders need to work together to mitigate these inputs. Where flow is a factor, it may be that the current and often historically human engineered profiles of the river are a pre-cursive factor to, e.g. a lack of pollutant dilution and flushing, such that working with land and riparian owners in-stream could do much to improve the scenario.

There is much that we can do with a collective mindset and we owe it to future generations to do so. As with other rivers throughout the UK the stress fingerprints being detected in some reaches of these rivers are reversible, where the aquatic invertebrate communities have responded well to the control and amelioration of sediment, flow, organic and phosphate enrichment.

The WCSRT would like to thank the following organisations for their generous support:

AquaScience Consultancy Limited

Environment Agency

Esmée Fairbairn Foundation

Test & Itchen Association


www.wcsrt.org.uk