Cranfield University

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Investigating the Environmental Sustainability of Cricket Clubs

School of Applied Sciences

MSc Thesis

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MSc by Research

August 2011

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Abstract

Cricket is a popular sport in England and Wales with 200,000 adult weekly participants (Sport England 2009) and 3951 registered clubs (source: ECB Play-Cricket database). Playing the game provides health and social benefits but also consumes natural resources. There is currently pressure on such natural resources and projections for population growth, urbanisation and climate change suggest this pressure may increase. Operational activities in preparing cricket surfaces contribute to greenhouse gas emissions and could lead to pollution, particularly of water courses. Cricket clubs would benefit from assistance in reducing their consumption, minimising their environmental impact and developing resilience to any future environmental challenges.

Forty-three cricket clubs, more than 1% of the total registered, from all levels and affiliations of the professional and amateur game were surveyed to benchmark existing practices and make recommendations towards improving their environmental sustainability. The survey sought to identify both activities and attitudes in respect of a range of factors related to natural resources. Analysis examined whether practices varied according to regional climates or if other factors may be determinate. Opportunities to provide advice and the nature of that advice were investigated.

Results allowed qualified identification of resource consumption but most frequently data could not be provided by clubs as their awareness of their own practices and the environmental implications were unknown to them. This is useful information and allows for the recommendation of greater knowledge and management of water, fuel and energy. Efficiency of existing operations should be maximised and alternatives to traditional mains supplied water and renewable energy examined. Playing surface preparations should consider research tested data and question some of the received wisdom prevalent in the practice of groundsmanship.

Acknowledgements

Thanks are due to a number of people for their assistance in the completion of this thesis.

The Institute of Groundsmanship led by Geoff Webb provided both sponsorship of the work via its 2012 fund and welcome advice in the form of Ian Lacy, Martin Ford and Ian Mather-Brewster.

Northumberland Cricket Board kindly offered financial assistance and a keen supporter in their Director of Cricket Ian Wardle.

Terry Charlton and Rod Heyhoe were very helpful with club contacts and local assistance.

Dr Iain James, my supervisor at Cranfield University, has provided the opportunity to be involved in such an interesting project, guidance during the work and a great deal of insight along the way.

And particular thanks are due to the many cricket club staff and volunteers who gave up their time to kindly take part in the survey, their assistance is very much appreciated.

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1.0 Introduction

1.1 About The Research Project

This MSc research study is being undertaken within the wider context of “The Environmentally Sustainable Cricket Project” that Dr Iain James is leading for Cranfield University under commission of the England and Wales Cricket Board (ECB). This project commenced June 2010 and the author’s wish to study advice on sustainable practices for cricket clubs was commensurate with this existing agenda. Consequently there are areas in which strategies and findings have been shared.

1.2 Background to the Research

Over 200,000 adults participate in cricket at least once per week (Sport England 2009) with many more younger players and interested spectators involved in the game. Modern living and alternative, more passive pursuits make sport an important tool in helping build social networks and increase physical activity and health amongst the population (Department of Health 2005). Yet providing and pursuing sporting activities consumes finite natural resources and reduces the availability of these for other areas of society. In addition the use of fertilisers, pesticides and fuel driven machinery can impact the environment with both groundwater and atmospheric pollution . It is the stated objective of the UK government to encourage greater sustainability in the environment, eliminating waste and making the economy resilient to climate change (Defra 2011). Government commissioned analysis suggests a lack of research on climate change within cultural activities, most particularly in the sport sector (DCMS 2008). The ECB are keen to ensure cricket maximises its potential in this area seeking to both educate the sport and inform future policy decisions (ECB 2010),

Temperatures in England and Wales are rising. The last ten years in the UK have been the warmest since instrumental measuring began in the 1850's (Met Office 2011). Many factors influence climate, but human activity is the main driver of climate change (IPCC 2007). Changes, for example, in the levels of atmospheric greenhouse gases and land use increase the probability of certain weather events, particularly at the extremes. In the last 45 years every region of the UK has witnessed increased heavy precipitation as a proportion of winter rainfall, whereas in summer this contribution has decreased for all regions except North East England and North Scotland (UKCIP 2011). The sea level around the UK rose approximately 1 mm/yr during the last century, with the last two decades recording an even greater rise (UKCIP 2011). There are fewer days of air frost now compared with 50 years ago and during that time average relative humidity has decreased in all regions of the UK, except Northern Ireland, by up to 5% (UKCIP 2011).

More frequent weather of this nature may successively influence human activity. Water companies, for example, now need to consider how such extremes and a rising population figure will impact their ability to offer enduring, sustainable supplies (Environment Agency 2008). More than five million people in England and Wales now inhabit buildings that may be at risk from flooding (Environment Agency 2011). Heat-wave and drought are now more likely (Defra 2011). Such instances are major challenges for cricket, a sport not usually played in adverse weather yet requiring water to enable participation. As regional climate districts in England and Wales vary (Appendix 1) it may be expected for practices to diverge in response. Less water for successful operations may be required in the cooler North East whilst regions of the South may need to combat water shortages. Wales, with frequent cloud, wind and rain, may necessitate greater energy use for heating buildings, whilst the Midlands may be a useful benchmark for activity. Cricket needs to plan a response to these challenges across its wide geographical distribution of clubs, one where resource use is responsible and efficient, and minimisation of waste is a priority.

1.3 Research Aim

The aim of this study is to investigate what advice would help encourage the adoption of environmentally sustainable practices by cricket clubs. Current practices are to be benchmarked in relation to club geography to ascertain if the prevailing climate of the region impacts upon the activities of the club.

It may not be that advice on greater environmental sustainability is universal. Indeed testing a hypothesis about climate as a determinant of cricket club practices may identify alternative explanations necessitating variant recommendations.

1.4 Objectives

The research objectives to achieve this aim are;

1. To measure current activities at a representative selection of cricket clubs with respect to:

    - management and use of water

    - management and use of fuel

    - management and use of energy

    - grounds practices that consume natural resources

2. To examine if these activities are related to regional climate.

3. To synthesise these results and produce recommendations for greater environmental sustainability within cricket clubs.

1.5 Outline of the Research Methodology

The methodology for achieving the research objectives is to:

1. Define and distinguish the terms of reference of the study.
2. Undertake a literature review on the possibilities for and encouragement of environmental sustainability.
3. Establish current practices via survey.
4. Establish advice groundstaff believe would help them in adopting more sustainable practices.
5. Collate and categorise survey responses.
6. Evaluate responses.
7. Discuss findings in relation to encouraging adoption.
8. Produce recommendations as to most appropriate provision of assistance.

1.6 Terms of Reference.

In conjunction with “The Environmentally Sustainable Cricket Project” this thesis concerns itself with the regions and club activity within England and Wales, the area governed by the England and Wales Cricket Board (ECB). The thesis will encompass all levels of club cricket from the First Class professional game to local amateur organisations.

2.0 Literature Review

2.1 Literature Review Methodology

The lack of similar work on this subject prompted expansion of searches beyond cricket ground management into two additional categories: literature encompassing environmentally sustainable practices within other sports, or sport in general, and literature illustrating findings on similar practices amongst disciplines or sectors of society that may be akin to this study's subject group. Thus the priority of these latter searches was 'not for profit', voluntary or outdoors working groups rather than commercial, legislative or household studies. The review is detailed under the two key components of the thesis; environmentally sustainable practice adoption and the provision of advice to encourage this end.

2.1.1 Electronic searches

Searches were undertaken using *Cranfield University "search point"* search engine – a repository of e-journal articles, databases, newspaper articles, e-books, dissertations, institutional repositories, conference proceedings & 'grey' literature).

- *Ebscohost GreenFile* – a research database focusing on environmental topics.
- *CSA illumina Natural sciences* - an amalgamation of databases covering various disciplines from environmental science and sustainability to ecology and biotechnology
- *Web of Knowledge* - a citation indexing and searchable database encompassing sciences, social sciences, arts and humanities.
- *Citation searching*
- *Google Scholar*

Keywords used in these searches were (in isolation and as combinations);

Cricket; Sport; Environment; Sustainability (caution is needed as 'sustainability' is a term much used in sport to describe a playing/financial legacy rather than in this study context); Water; Energy; Fuel; Volunteers; Education; Behaviour; Training; Learning.

2.1.2 Results

Priority was given to peer-reviewed publications, although the literature searches highlighted useful texts outside of this such as internal advisory documents in particular sports and government commissioned reports. Where results of searches were excessive, restriction was made via date, for example from publication of the most recent meta-analysis or review paper, or for practicality such as access to full text version.

2.2 Definitions

It is important for the context of the literature review, and indeed the study, to clarify the definitions of terminology utilised.

"Environmentally sustainable practices" – as Fenwick (2007) notes "sustainability has come to represent everything from economic development to environmental science." The EU (2008) definition is suitably concise; "The goal of environmental sustainability is to minimize environmental degradation and to stop and reverse the process that leads to environmental degradation." Due to its particular relevance that of the ECB is also useful; "Sustainable development has been defined as meeting the needs of present generations without compromising the ability for future generations to meet their own needs. In practise, this means minimising the environmental impact of buildings by efficiency in the use of space, energy and materials, but it also applies to the wider environment such as the construction process, demolition, waste, water use, pollution, employment, transport, building use, flexibility and adaptability" (ECB, 2009).

"Provision of advice" – is taken to mean the offering of evidential or requested suggestions that may help encourage adoption of environmentally sustainable practices. There is no attempt to identify what will *definitely* provide adoption, nor is there a desire to perform any cost-benefit analysis (CBA) of advice.

2.3 Environmentally Sustainable Practices

2.3.1 Cricket

The sport of cricket whilst widespread is not universal. There are only ten full member nations of the International Cricket Council (ICC) and whilst many more states play the game this number at the highest level is reflected in the volume of literature concerning cricket grounds management. Works from outside the UK additionally need reviewing with caution as their experience of a different environment and climate to this study group could make some advisory practices inappropriate for clubs in England and Wales.

2.3.2 Primacy of Pitch Preparation

Commercial publications concerning cricket grounds management are scarce. This may be due to the existence of literature produced by national governing bodies, such as the ECB's "TS4 Recommended Guidelines for the construction, preparation and maintenance of cricket pitches and outfields at all levels of the game" (ECB 2007). This work is freely obtainable from www.ecb.co.uk (1 Dec 2010) and as the title suggests provides a guide to all aspects of playing field management.

There are two elements to the cricket playing field – the 'pitch' and the 'outfield'. There are no laws governing height or type or condition of surface, simply whether the umpires deem it fit for play (law 7.2; MCC, 2010). In conjunction with the Institute of Groundsmanship (IOG) the ECB

has developed a series of performance quality standards (PQS), to benchmark surfaces, although they are not imposed or universally adopted by regional leagues. Groundstaff are expected to produce a pitch surface that is dry, firm and true with consistent bounce offering safety and appropriate ball movement for the skill of the bowler. This is achieved by first wetting, then allowing partially to dry, a grassed clay loam strip which is subsequently rolled, groomed and mown. The outfield is expected to be safe, relatively flat and allow good ball roll. The TS4 guidelines suggest that local knowledge and regional climate variations elevate the groundstaff to a position of judgement in respect of recommendations and the document's broad specifications cannot encompass such diversity. TS4 includes no specific consideration for sustainability.

Pre-dating TS4 but reinforcing it are the few available books on surface preparation. Evans (1991) provides advice from a somewhat traditional perspective, discussing the history of cricket ground preparation as well as suggesting management regimes for contemporary fields in the United Kingdom. Tainton and Klug's (2002) work is representative of the conditions in South Africa, one of the ten full member nations, a similar regional specialisation that exists in McIntyre and McIntyre's (2001) Australian published guide to cricket wickets. These latter two texts are significant in that given differing climates, soil clay contents and selection of grasses to grow in that environment subsequent management requirements differ to the Evans work. Whilst offering highly useful, practical introductions to many relevant topics of cricket grounds care all three texts illustrate the lack of exactitude that can accompany a non-legislated area of a game that promotes individuality of decision-making. Scientific analysis is accorded limited discussion, indeed Evans (1991), whilst not promoting such sentiments himself, reflects on ill-feeling between groundstaff and what he calls "boffins" who they perceive lacking appreciation of their work.

Adams and Gibbs (2004) include a part chapter on cricket pitches in their multi-sport study of fine turf, and provide for a more detailed analysis of, for example, fertiliser calculations but other practices such as irrigation merely refer the reader to general recommendations of the time. What is evident is that none of the identified texts mention any specific practices in respect of

environmental sustainability, nor provide a definitive programme of activity from which to benchmark. This highlights a potential difficulty for this study in trying to promote a management regime commensurate with enhanced environmental practices and the popular view of preparing a good playing surface in accordance with one's circumstances. It may be that a sustainable operations programme can identify generic practices considered suitable for adoption by all clubs but varying standards of play, budgets, availability of resources and, as this thesis seeks to investigate, possibly climate may result in different recommendations to meet different circumstances.

Peer reviewed research in the UK has been confined to a few institutions and individuals, some work being commissioned and well supported by the ECB and IOG. Field trials have tended to focus on specific tasks of pitch or outfield management and whilst not implicitly concerning sustainability have provided information that could allow for the adoption of less natural resource intensive practices. Where appropriate these have been detailed under the representative headings below.

2.3.3 Lessons from Wider Sport

Research output from other sports management is also selective. There is little volume of work concerning environmental sustainability within the discipline and what there is suffers deficiencies in the understanding of the considerations, obstacles, best practices, and information on the subject (Mallen et al 2010). And yet by 2015 research indicates an above-average priority for environmental sustainability within sport management (consensus of 90% of US sport facility manager respondents to Mallen et al 2010 survey). This dichotomy of subject importance matched by relative lack of successful implementation may, however, not be unique to sustainability as a variety of sports management issues experience this scenario (Costa 2005). As Schmidt (2006) highlights, sporting events and the environment are now indelibly linked yet face a challenge to progress as opinions differ on approaches to measurement. This

'benchmarking' of inputs and outputs is lacking, advances coming instead within operational tasks such as conserving electricity and recycling despite environmental sustainability investment having capacity for savings and efficiencies (Mallen et al 2010). Mallen et al's (2010) Delphi study into environmental sustainability in sport elicited a response from a facility manager respondent suggesting the impracticability of measuring such factors in the sport industry, an attitude of importance for this study if such a negative reaction to benchmarking raises the prospect of a deficiency of data and a struggle to successfully advise. However, an alternative view from the surveyed group (Mallen et al 2010) was that measurement of inputs and outputs would be valuable and highlight returns on investment. Thus it may be prudent to expect differing reactions to enquiries when embarking on this survey and the degree of optimism this project is accorded by participants.

Yet literary output is expanding in both specific sport sectors and generic sporting event discussion. Initiatives such as The R&A's 'Best Course for Golf' programme (www.bestcourseforgolf.org), attempts to measure the environmental sustainability of major events such as the FA Cup Final (Collins and Flynn 2008), and the London 2012 Olympics "one planet" strategy (www.london2012.com) may provide examples and case studies offering relevant suggestions for cricket in tackling a shared challenge. However, when identifying any redressive practices for cricket it should be remembered that the game's playing surface demands different husbandry from other turf sports. Evans (1991) identifies cricket's particularly problematic turf culture; the needs of the sward in direct conflict with the needs of the game. Few environments seek to stress the grass plant in a soaked, baked, heavily mown and intensively compacted clay loam like cricket.

Nevertheless the challenge exists, not least because of domestic and European legislation, such as the UK implementation of the Water Framework Directive (EU 2000/60/EC) and fulfilment of a commitment to UN Agenda 21 (United Nations 1992,) that will force stricter control and use of natural resources. For something such as sport to believe itself somehow beyond measures likely to affect the whole of society would be naive. As Beard (2008) notes,

turfgrasses use disproportionally large volumes of water, fertiliser and sometimes pesticides, disrupt landscapes, and unnecessarily consume time, funds and resources. In areas subject to environmental stresses this indulgence can seem a skewed priority and a heavy price to pay for one social group's enjoyment of sport. Yet sport is an important tool in seeking to tackle the nation's health issues, with 24 per cent of adults (aged 16 or over) in England classified as obese and 30% of adults not participating in active sport in 12 months (2005-2006) (TIC, NHS 2008). Thus it would be useful to develop a solution that sees an awareness of resource scarcity and responsible use matched with a continuing provision of facilities.

Advice encouraging greater consideration for the environment should, however, be aware of the primacy of the field preparation in literature and current philosophies in the sport. The ECB National Facilities Strategy (2000) lists improvement in the quality of match and practice grass pitches as its first priority. An environmentally beneficial regime which produces unsafe pitches will not be tolerated, nor one providing for significantly shortened games. There must be a balance struck. Suggestions for enhanced practices should be made in accordance with typical preparations as outlined by TS4 lest in seeking to make the game more sustainable it is actually rendered moribund. This suggests examination of groundstaff cultural activities for potential augmentation.

2.4 Grounds Management

2.4.1 Water Management

TS4 suggests there is no fixed period for watering a pitch. Both climate and pitch composition will influence preparations. Yet the recommendations also suggest that wetting to a depth of 75-100mm is essential to provide for a firmer, solid surface for play, so the period of watering is in fact prescribed as the period necessary to attain this depth. The factors determining this are

infiltration rate, hydraulic conductivity, application rate, precursory rainfall and existent soil moisture content,

Various cultural practices impact the volume of water required for turf management; mowing height and frequency, fertiliser use, topdressing and products such as plant growth regulators and pesticides. (Beard 1973; Turgeon 1996). Drought tolerant cultivars could potentially reduce turf water demand, cultivars rather than species as in recent years cricket in England and Wales has tended to utilise *Lolium perenne* as its preferred turfgrass (Adams and Gibbs 2004). *Lolium perenne* requires around 20% more water than the predominant Australian choice of *Agropyron repens* (Couchgrass,) however this warm-season species is ill-suited to UK use as it needs higher than average light intensities and temperatures than found in this environment (McIntyre and McIntyre 2001). Moreover, in cricket pitch preparation it is the clay loam being saturated prior to compaction, rather than any specific intention to irrigate the turfgrass. Yet currently there is no evidence to suggest that a pitch used purely for a single day game, perhaps eighty overs in duration, would be unsafe or unplayable without this saturation, remembering of course that it is entirely in the umpires' remit to make this decision. The official suggestion, however, remains to wet to a depth up to 100mm, 25mm beyond the depth at which a roller was found to be effective in trial (Shipton and James 2009). What may be of particular relevance is how this saturation is typically achieved. If water is being applied to pitches via inexact means such as hand held hose or static sprinkler there may be significant run-off and water loss to non-pitch areas as application exceeds infiltration. Timing of operation could be another factor, applications left running overnight with no supervision may produce a saturated pitch by morning but at a potentially high cost to both environment and finance. Cricket's lack of appreciation of this could be contrasted with many golf courses' sophisticated irrigation operations to optimise their use of water. Economic considerations are clearly relevant to investment in application systems but greater efficiency of current use may still return substantial savings.

For clubs irrigating their outfields, wetting agents (surface surfactants) could assist with the problems of hydrophobic soils and reduce otherwise futile attempts (and volumes of water) to overcome surface tensions. Modern cricket outfields tend to be sand based in contrast to pitch clay constructions as the enhanced drainage of a sandy loam can help play commence sooner after rainfall. However, research on application of two brands of wetting agent and a water control on sand and loamy sand trial plots) at Michigan State University (Leinauer et al 2001) found the type of wetting agent, rate of application and soil type all impact the level of soil moisture retention. One brand made no significant difference to the control when used on a sand based column, highlighting the importance of establishing evidence of success for the purpose required before considering the product as an aid to solving cricket's demand for water.

Whilst it seems greater water use responsibility should be the primary focus of suggested behavioural change one concession could be to change the water supply and seek to use non-potable water for grounds management. Demographic and environmental changes, combined with rising costs will provide significant future challenges for the supply of mains water (Walker 2009). Some water companies are already below targeted capacity for supply in a dry year with an additional 10 million people forecast to add to the population of England and Wales by 2031 (Environment Agency 2009). Non-essential services such as cricket need to understand this will impact on their likely access to their existing water supply. Most alternative sources to the mains supply can be considered suitable for turf irrigation (Beard 2008). However, caution has to be taken with some supplies, especially 'greywater' - waste water that has been treated for re-use. Greywater may not be suitable because of the potentially toxic contaminants of chemicals (Beard 2008). Even without such concentrations long term use may impair plant growth because reclaimed water high in sodium can imbalance the cation ratio in the soil and lead to flocculation or dispersion of clays and the associated soil structural problems (Evanylo et al 2010). The work of Qian and Mecham (2005) found that soil salinity, extractable sodium, phosphorus and calcium, and pH were all higher in a study of recycled waste water against

surface water irrigated Kentucky bluegrass on sand based golf courses. *Lolium perenne* is considered sensitive to salinity, tolerant to <3000 mS/cm (GHD 2007).

Abstraction from local water courses is sometimes used by golf courses to enhance alternative supply. Licences are usually required to take in excess of 20 cubic meters per day but this may offer a wholly adequate volume for a smaller cricket club. However, this situation is not static and the Environment Agency (2009) has acknowledged that abstractions actually need to fall in the next five years to reduce the risk to the environmental status of water bodies, an important demand of the Water Framework Directive (EU 2000/60/EC). Moreover, the pressure on water resources is estimated to increase significantly with rising population, housing stock expansion and lifestyle changes, with greater concentrations of these in existing supply stressed areas (Walker 2009). Walker (2009) further suggests that charges should actually be considered for the negative costs to the environment of not leaving abstracted water in situ.

Such potential for difficulties makes rainwater harvesting a possibly more attractive option. This is diverting rainwater from roofs, or other collection surfaces, to store in a tank for later use. It would be sensible for any potential user to check the state of their collected water prior to use but as an example the author's conversations with Northumbrian Water Limited (Waugh 2010) determined that potable water supplies for this region are treated primarily for safety and aesthetics, typically reducing organic components, lowering pH and removing odours. Unadulterated the region's rainwater is lower in cations than abstracted or treated water and easily assessed for content (Northumbrian Water 2010). As such it appears an entirely serviceable source of cricket field irrigation and given uncovered pitches one that may be acting on the surface regardless. Waugh (2010) declared company interest and support for rainwater harvesting initiatives and consideration should be made by clubs to approaching such bodies.

One benefit of rainwater harvesting of interest to all parties is the potential to divert fall from hard standing areas and the reduction of flood risk. A sustainable drainage system (SUDS) may incorporate roof collection of rainfall and store it in tanks thus attenuating peak flows,

diverting it away from impermeable areas and potential stress on the drainage network. Prevention of run-off across an area such as a car park with such a source control measure could additionally reduce the risk of pollution being collected by the water and deposited in the public system (Environment Agency 2011). More water flowing into the network results in additional cost of treatment and a potential cost for the club. A consultation exercise by Defra ending in October 2010 solicited the views of a wide range of bodies likely affected by proposed changes to surface water drainage charging. The "Guidance on Concessionary Schemes for Surface Water Drainage Charges" (Defra 2010) looked at the issue of whether community groups should be included in such schemes and the level of charging for their facilities. Cricket clubs should be aware that the outcome could support a cost increase as there is support to move to a system of charging based on drained area rather than rateable value which for many clubs was set at charitable values. Walker (2009) recommended to Ofwat and the UK government that due to the increased likelihood of flooding under climate change the charging system should consider incentivising customers to drain less rain water into public sewers. With the implementation of the Flood and Water Management Act (2010) there is a duty for Lead Local Flood Authorities to develop flood management strategies. Any proposals that would reduce pressure on the system and simultaneously provide a source of non-potable supply for operations would be an effective solution to some of the issues of water management in the future.

There are concerns with rainwater harvesting however; the lack of a predictable and reliable water supply based on a weather system, the duration to recoup cost of investment, and research that suggests carbon emissions for such systems are significantly higher than mains water delivery (Environment Agency 2010). Moreover, whilst rainwater harvesting does not currently incur additional water authority costs this may not be the case in the future. Sewerage charges are based on the supply of water to a property, harvesting reduces the need for mains supply and thus the costs of disposal, but Walker's independent review for Defra (2009) identified that the sewerage load remains at a higher level and that future pricing may need to

reflect this. Thus the priority of any organisation seeking to enhance their water management should be to reduce non-essential use rather than simply replace source.

GHD (2007),an international consultancy specialising in natural resources, produced a report for the municipal authority of Victoria, Australia on managing sports pitches in a dry climate. They conclude that successful water saving projects frequently require a range of strategies to achieve successful outcomes and reductions in potable water use at sports facilities in excess of 50% are achievable. That such significant reductions of use are achievable is encouraging but to achieve that a programme of measures embracing planning, understanding, replacement and turf management may be necessary to implement the best practice for a specific facility.

Evidence of water use reductions is highly relevant in light of drought order provisions. Whilst England and Wales' regional rainfall can vary quite significantly there exist measures to tackle supply pressures. The Environment Agency has power to grant drought permits, authorising a water company to take water from new sources or to alter restrictions on existing abstractions. Drought orders (Drought Direction 1991) can restrict non-essential use of water. Emergency drought orders can go even further providing water companies with powers to limit the use of water for any purposes it thinks fit (Ofwat 2011). Changing climate could be the cause of such action and in such circumstances it would be wrong for a relatively narrow sector of society (cricket players and officials) to believe that maintenance of their sport should take priority over domestic drinking or essential business supply. Given all these issues it is perhaps appropriate to conclude water use should be the primary focus for greater environmental sustainability in grounds management.

2.4.2 Rolling

In a study that examined optimum rolling practices for cricket pitches, Shipton and James (2009) concluded that in a UK summer ten passes with a two drum roller is sufficient to attain

the compactive potential of the roller. This provides clear reference for this practice and the potential for reducing time, fuel, emissions and cost for any existing activity beyond this period. However, the recommendations also suggest that there is an optimum soil moisture content for compaction that varies with soil but is typically 19 – 22% by mass. Awareness of the optimum moisture content is relevant. This requires of the groundstaff some means of ascertaining the soil moisture levels. It would be of merit to determine if clubs utilise tools that can perform this function or whether they have an established means of rolling at the correct time. If they do not then the application of water may have been baseless or of low precision.

2.4.3 Mowing

Mowing turfgrass not only impacts water requirements of the plant but produces greenhouse gas emissions and consumes fuel. As such any possibility of reducing the use of cutting machines would have a multiple effect on the environmental sustainability of cricket.

TS4 suggests a typical pitch mowing height between 3- 5 mm, or as low as possible, without scalping or disturbing the surface, whilst 10-12 mm should maintain a true outfield. Current consultative ECB/IOG PQS for the outfield suggests 20 mm as the measurement above which umpires subtract marks (personal communication ECB/IOG advisor).

An estimate for *Lolium perenne* growth in STRI trials in 2010 (cut at 12 -13 mm) averaged between 3 and 11 mm weekly depending on cultivar and weather (personal communication STRI agronomist). Aside from this there are few trials offering such measurement, this grass also being an agricultural feed tends to generate research focusing on yield. Elias and Chadwick (1979) record *Lolium perenne* ‘Stadion’ with a relative growth rate of 0.185 ± 0.024 g/day (under 20/15 °C day/night temperature in 500 cm^3 of washed sand with nutrient solution supplied every two days).

Reduced mowing frequency reduces fuel use and succulence of the plant (Beard 1973). This, however, could impact on turf height and possibly quality unless attempt is made to check sward growth via other means. Bartlett & James (2010) highlight Plant Growth Regulators, finding that one product, PrimoMaxx, significantly reduced the CO_2 footprint of $100m^2$ of amenity turf. The emissions reductions, due to reduced mowing frequency, outweighed emissions from production, distribution and application of the PGR. There was also a financial saving to use. The New Zealand Sport Turf Institute (2010) supports the idea that PGRs can enhance cricket outfield speed, trueness and consistency with its suppression of seedhead production, fewer clippings and repressed vertical leaf elongation. A danger of such products, however, could be a need to continually use them lest upon cessation growth accelerates beyond the control of reduced cultural activities.

Dwarf grass varieties can similarly reduce mowing, with no necessary reduction of performance. An ECB trial (ECB 2003) where the mean was calculated from performance characteristics of all the grasses in the trial found *Lolium perenne* 'Delaware Dwarf' covered surfaces registered slightly lower than average for 'surface hardness' (-0.37 from mean,) sward greenness (-0.38 from mean) and 'cracking' (-0.41 from mean) but higher for uniformity (0.07 above mean) and recovery (0.22 above mean) and much higher for ball rebound (1.27 above mean) from a vertical drop onto the flat. These seem entirely appropriate qualities for the expectations of the cricket surface.

2.4.4 Fertiliser Use

Fertiliser use has multiple impacts on the environment, from the high energy demands of production to the polluting effects of losses from the soil into water courses, long-term impairment of the soil and the release of greenhouse gases and ammonia into the atmosphere (Defra 2010). Good nutrient management can reduce environmental impacts with the benefit to the user of potentially saving money via maximised efficiency of use. Use of fertiliser is

dependent upon many factors Soil condition and nutrient levels, plant requirements and desired state, environment and cost are all factors (Beard 1973). Cricket additionally subjects the turfgrass to the stresses of saturation, compaction, close mowing and wear. Yet fertiliser application, and expenditure, may be based on little more than subjective, visual suggestions, sport having no quantitative goal such as yield (Turgeon 1996). Soil testing is something that can assist with this and nutritional analysis is essential according to TS4 (ECB 2007). Some suppliers currently offer such a service freely yet whilst identification of the levels of Phosphorus and Potassium in the sample are relatively simple processes ascertaining Nitrogen content are more difficult to manage and can vary with timing and temperature because of the microbial activity that creates additional reserves.

Nitrogen is, however, often researched. It is the mineral turfgrass requires most of, the subject of rapid leaching in certain environments and a link to increased disease incidence when applied excessively (Turgeon 1996). Nitrogen (in the form of nitrate) is also subject to specific pollution prevention by European Union directive (1991 Nitrates Directive 91/676/EEC). Nitrous oxide is a greenhouse gas 298 times more potent than carbon dioxide (Defra 2010) and approximately 1% of applied Nitrogen is emitted as N_20 (IPCC 2006). However, whilst a sandy soil may witness significant losses of nitrates to both groundwater and the atmosphere due to their low cation exchange capacity (CEC) and high hydraulic conductivity (Adams and Gibbs 2004) a turfgrass sward growing in a clay loam (possessed of the opposite CEC and conductivity) tends towards very little leaching of minerals (Turgeon 1996). Thus for clubs where the composition of the outfield differs significantly to that of the pitches management of fertiliser will need to be different across the two surfaces.

Removal of mown grass from the surface removes plant available nitrogen which requires compensation (Turgeon 1996). Kopp and Guillard's (2004) study on bluegrass-ryegrass-fescue (*Poa pratensis/Lolium perenne/Festuca rubra rubra*) trial plots on sandy loam supports the idea that leaving clippings on the sward offers a rapidly released level of nitrogen ultimately available to the plant without an increased thatch layer. This suggests this practice on the outfield should see some corresponding reduction of nitrogen application, although exactitude without specific

data would be impossible, and would more likely be visual and related to any performance quality standards. A consequence of this, however, may be the need for increased mowing frequency should the clippings provide a nitrogen based growth impetus for the turf. Leaving clippings on the cricket pitch would not be desirable as not only could the covering impact ball movement during play but grass leaves being incorporated into the pitch layers over time could cause reduced bounce and a 'cushioning' of the surface (Adams and Gibbs 2004).

Timing of applications is important, not only for climatic reasons but for the ambition to enhance the growing cycle of the turfgrass rather than any weed species (Beard 1973). Lloyd et al (2010) found late autumn application of N to be wasteful in that as temperature declined less N was taken by the plant – 73% in Sept, declining to 57% and 38% in October and November (*Agrostis stolonifera, Poa annua, Poa pratensis* grown on sand based rootzones in a controlled environment replicating forty year average conditions for 15 September (11°C low/19°C high), 15 October (6°C low/14°C high), and 15 November (-3°C low/5°C high) for Maddison, WI (USA) . Their recommendation was for an early autumn application if possible and never more than 49kg N/ha if having to apply in November in conditions similar to theirs. The UK mean temperature for November 1971 – 2000 was 3 °C low/8 °C high, November 2010 was 1.5 – 2 °C lower than this (UK Met Office 2011).

Given such variables there is little question of a definitive guide for fertiliser use but clearly it is an area that should be given much thought as ultimately with its consequences for turf management and product manufacture it impacts heavily on the environmental sustainability of cricket.

2.4.5 Aeration

Aeration of cricket pitches is a subject that has yielded very little research to date. This is being remedied in part by a current research project at Cranfield University that reports after the publication of this thesis. Whilst successful application of aerating machinery is suggested to

improve water infiltration, gas exchange and fertiliser ingress to the rootzone (GHD 2007) the current ECB advice to groundstaff seems too definite considering this absence of data. TS4 (ECB 2007) indicates general acceptance that roller drum style spiking machines with fixed tine depths can cause damage and long term problems for a cricket pitch, and doubts that hollow coring is the best method for removing unwanted elements of the soil profile. Whilst fraise topping is the suggestion as a replacement for core removal the guidelines also recommend a punch method of aeration using solid “pencil” tines at a minimum depth of 100 mm at 50–100 mm centres.

Until there is a larger body of peer-reviewed work on the subject the absence of cricket pitch aeration trial data should restrict any specific recommendations. The impact of this absence on environmental sustainability is that it is unclear if there may be potential wasted fuel use, as well as personnel hours, in aerating where there may be no discernable benefit.

2.4.6 Surface Stabilisation Agents

Surface stabilisation agents such as adhesives and enzymes have been evaluated as possibly providing longer lasting pitches (i.e. time before dangerous degradation of the surface) thus requiring reduced management. There is very limited research on such amendments yet TS4 (ECB 2007) publishes a suggested methodology for applying PVA glue, one such agent. It states “there has been no evidence to date of deterioration of growth or soil conditions by residual build-up although more research over time will allow for re-evaluation. However, with the contemporary restorative machinery available today, this should not be an issue” (ECB 2007). It may be that re-evaluation of the situation would be apposite and ECB recommendations could clarify whether any evidence of deterioration has been shown since publication. The existing advice seems not to suggest as much caution as the lack of published work on the subject may imply.

2.4.7 Artificial Pitches

No peer-reviewed research on the playing characteristics, maintenance and sustainability of artificial cricket pitches could be found, nor many wider points of reference. The ECB, however, not only include a section in TS4 detailing types of non-turf pitches, the guide describes an appropriate maintenance regime and includes a list of approved systems and suppliers. An additional document TS6 (ECB 2007) outlines performance standards for non-turf cricket pitches intended for outdoor use suggesting there is governing body encouragement for their utilisation in appropriate circumstances.

It would be of interest to see a field trial of these surfaces as they would appear to have the potential to reduce natural resource consumption and possibly allow for greater levels of participation. There may be a financial implication to this, a possible short-term cost offset by longer term gains but this remains speculation until evidence is presented.

2.5 Facilities

History, periods of financial stability, relative success and opportunity contribute to very different levels of facility provision across cricket clubs. Information towards these areas often appears as case study, or in the ECB's TS5 document (2009,) a guide for clubs regarding pavilions and clubhouses. In addition to attraction and quality, a good facility, they say, aims to be cost effective and seeks to embrace sustainability and its associated factors such as energy performance (TS5 ECB 2009). The document continues in suggesting the ECB should be first call for funding, early in any project and with the Commission for Architecture and the Built Environment (CABE) publication Creating Excellent Buildings in mind as a commitment to sustainability. Indeed such official support for responsible resource management is a strong theme throughout the recommendations, with mention of recycling, low energy use, reducing water consumption and a chapter which covers everything from materials for construction to reducing the impact of proposals. The ECB website (www.ecb.co.uk) highlights a working

example of sustainability; Lancashire CCC's 'The Point' venue, featuring rainwater harvesting, solar collectors and low energy lighting.

The 'essential' and 'desirable' listings of facilities in TS5, which are highly specific, could provide a benchmark for surveying existing provision, and should be considered when offering recommendations in this study. For example, the Northumberland Cricket Board facilities strategy 2008-2013 reveals 20% of the county's Premier League clubs fail to meet TS5 toilet facility desirability, 40% fail on shower requirements and 80% on disabled access. It may be that this study finds buildings constructed prior to TS5 guidance face sustainability challenges and potential difficulties in retro-fitting for greater efficiency.

Whilst TS5 identifies desirable characteristics of facilities it does not suggest means of achievement. Information about this is not the preserve of academic debate with a wide range of knowledge residing in the private sector. Strategies for attaining environmental sustainability via behavioural change are a topic of many social science papers but there is generally agreement about measures that can improve resource efficiency. Other studies may tackle the issue of funding and community involvement to make provisions financially sustainable, but it is important for this study to focus on achievable environmental goals and priorities.

2.5.1 Water Use

Whilst it has been noted that greywater may not be suitable for on-field use it may be appropriate for use in toilets. The Renewable Energy Centre advises (2011) that appropriate systems are required for filtration as stored greywater can be a haven for bacteria and compliance with the 1999 Water Supply (Water Fittings) regulations. Blackwater (the waste water from toilets themselves) can be used if appropriately treated but it is difficult to conceive of this being both achievable and cost effective at amateur club level, whilst ensuring adequate health and safety. Assessment of the potential value of a rainwater harvesting system would

need to consider current use volumes and spending against the costs of installation and maintenance. This may only be possible if a water meter is existent on site. A borehole could provide an alternative supply to either the mains or harvested water and a volume of up to $20m^3$ may be abstracted per day without penalty but in addition to the previously mentioned Environment Agency advice about reducing extractions borehole location and management would need investigating and drilling is usually expensive (Groundwork 2011).

There are numerous organisations and schemes that seek to enhance the education and reduce the consumption of water user. Suggestions range from information campaigns within the premises to replacement of simple but cumulatively effective devices such as plugs or cistern displacement devices.

Sedum or turf roof coverings (green roofs) offer both an ecological and aesthetic benefit to the wider community as well as providing the cricket club with potential advantages in combating storm level rainfall and carbon offsetting. Bauder, manufacturer of the Xero Flor blanket, claims (2011) that under maximal conditions, each square metre of single leaf surface on an established extensive type planted roof, with a 12 hour day length is estimated to take up 14.51g of carbon dioxide and release 9.68g of oxygen a day. Moreover, they argue the potential for reduced heating costs due to enhanced insulation, and the reduction of runoff from the roof which can be incorporated into a sustainable urban drainage scheme (SUDS). Sedum roofing appears within Defra case studies of successful projects (Defra 2011).

2.5.2 Energy

The need for action on energy consumption is both economic and environmental. Rising populations and developing nations demand greater volumes of fossil fuels and the ease and safety of extracting them can be difficult to ensure (DECC 2010). As UK owned oil and gas resources decline there will be greater pressure on UK consumers from rising and more volatile prices (DECC 2010). The need to adapt the way energy is considered and utilised is evident.

Yet the UK consumption of fossil fuels has increased from 147.5 million tonnes of oil equivalent (mtoes) in 1990 to 155.0 mtoes in 2008 (Office for National Statistics 2011).

Of the alternative energy sources available Photovoltaic (PV) systems, generating electricity from light, are relatively visible (quite literally) from their promotion to domestic property owners as well as organisations. The cost of installing such cells on roofs can be expensive, a cost often argued to be offset by selling subsequent energy generation back to the grid (Renewable Energy Centre 2011). The benefit of utilising a free natural resource that remains unaffected or depleted is clear. Case studies do exist, St Just CC in Cornwall and Bovey Tracey CC in Devon installed PV panels in 2008 and 2009 respectively utilising the Low Carbon Building Phase 2 initiative and both estimate significant yearly savings. However, this fund closed on 24 May 2010 and at time of writing there is no definitive replacement. Whilst grants may be available there is nothing certain, or legislated for, in pursuing these. Additionally, the electricity needs of many cricket clubs may not be significant (some are not even connected to the grid) and thus free installation or swift financial return is likely to be of consequence. In addition, as with rainwater harvesting, there is the varied and unreliable nature of weather. Whilst PV systems work on daylight rather than sunshine some areas of the country may still not receive sufficient hours of regular, predictable light to justify installation. Panels need to be south facing and not overshadowed to maximise potential efficiency although some systems allow for angling of the panels to compensate for roof alignments. Installations may require planning permission and the Buildings Regulations 2000 (UK S.I. 2000/2531) will need consideration because of the work involving electricity, increased weight on roofs, and other factors of construction. As such this is clearly an approach to sustainability to be considered in the longer term or by clubs with larger energy requirements and costs. The same approach should be regarded for wind generated power. Rather than trying to compensate use by generating additional electricity a more attainable goal for most clubs would be to reduce unnecessary consumption. Changing existing habits to reduce resource use is a more viable strategy than seeking finance to expand supply. To this end clubs could focus on more efficient lighting, heating, insulation and education of users.

The Carbon Trust (www.carbontrust.co.uk) believes that low and no cost measures can save at least 10 - 20% of an organisation's energy costs per year. Their priority for actions within an operation is to reduce consumption, improve efficiency and only then look to alternative sources of fuels (Carbon Trust 2010). The use of buildings accounts for nearly half of the UK's greenhouse gas emissions (Prasad 2008). As with water management raising awareness amongst users is an essential part of the process along with seemingly small steps such as switching off lights when not needed, keeping doors closed and adjusting appliance settings, that incrementally provide potentially large savings. The Carbon Trust publishes a guide to creating such a culture which can be obtained freely.

2.5.3 Recycling

Recycling appears straightforward when compared with resource challenges for cricket clubs. There are many schemes already in existence, both local authority collections and contracted removals offer separation of refuse and more remote clubs relying on groundstaff disposal of waste would be hard pressed not to find a convenient recycling point. The UK government has an aim of a 'zero waste' economy (Defra 2011) and the EU Directive (99/31/EC) has imposed targets on reducing landfill for more than a decade.

One organisation (Reciproc8 Recycling) offers equipment, transport and coaching sessions to sports clubs participating in their schemes. They currently have the support of numerous national and regional sport governing bodies. The difficulty of this subject appears not to be identifying what can be done but encouraging people to do it, particularly when there may be little financial or direct benefit discernable. Recycling, with its requirement for regular disposal in conjunction with a collection schedule is habitual, repetition leading to automatic action (Cotterill et al 2009). Research by Werner et al (1995) on U.S households indicated that a signed commitment to recycle by an individual had greater long term success than purely information based strategies. A more recent trial based in England (Cotterill et al 2009) found that recycling rose in the short term after people were canvassed, but longer term, without

additional encouragement, this rise diminished. This would indicate sustained intervention is required to make recycling routine.

2.6 Providing Advice to Clubs

In 2002 Cricket was the second largest volunteer sport in England; 238,000 volunteers giving 28 million hours (LIRC 2003). Information on these volunteers in the context of this study is scant. Ryan et al (2001) confirm that even in the wider environmental arena volunteer motivation is an area of very little research**.** The ECB require Focus level clubs to provide annual submissions of information relating to personnel, and similar data is collected when funding, or loan applications are forwarded, but it would be useful to have a clearer demographic of cricket groundstaff as advice offered may be impacted by employment status, age, experience and other factors. Existing data for the Northumberland region (NCB facilities strategy 2008-2013) shows how a seemingly homogenous group may have multiple differences. Of sixty three affiliated clubs, four have full time salaried groundstaff, five employ contractors, two are local authority operated, two play on other club grounds and the other fifty clubs rely on volunteers. Twenty-four groundstaff are IOG qualified, a requirement for accessing some county cricket board resources. Nationally, Shipton (2008) quotes 1100 people as having received IOG training by 2008 but this offers no indication of club numbers, level or location.

Coleman (2002) produced a cricket volunteer specific paper but omitted mention of groundstaff, instead focusing on team management and coaching. These are majority middle-aged males, with a slightly higher level of education, hours committed and tendency to be retired than other sports clubs volunteers. Additionally, he finds there is a difficulty in recruiting volunteers and increasing workloads are resulting in more hours for the current staff. Trioplus (2008) does identify sports groundstaff in a study but this is neither cricket specific nor discussive of employment status. These were a predominantly male, ageing group with limited training. Nichols et al (2005) studied sports volunteers from data from both Sport England and CCPR surveys but not exclusively groundstaff. Here they found a ‘professionalised’ voluntary sector

struggling with competing demands for leisure time, the need to take on new skills and legal requirements, with an over-reliance on core members, the understanding of whom was crucial to providing assistance. Such core volunteers, identifies the LIRC study (2003,) are the most influential in determining club response to external pressures and offers of support. If this group aspire for club success and they recognise change as inevitable they will be more receptive to advice. Darnton et al (2008) reinforce this with the belief that engaging and nurturing key individuals may be more effective in bringing about system-wide change than targeting the behaviour of all individuals. And yet, says the LIRC (2003) study, at the level of individual clubs, only 1% have formulated a volunteer strategy. Primmer and Karppinen (2010) looking at conservation and attitudes in the forestry industry believe low 'slack' is detrimental to environmental performance, 'slack' being a measure of resources in excess of those required for output (reserve capacity). If such motivations are evident across other outdoor working sectors then the aforementioned sports/cricket studies point to very low slack in groundstaff volunteering indeed.

If clubs may be prioritising efforts simply to retain volunteers then time spent adjusting to environmental practice may be very low concern. It is to be noted that the ECB does not have the power to compel local cricket clubs to act. They may direct certain choices via administration of funding or initiatives but if a club chose to ignore sustainability guidelines there is no power of sanction. Affiliation to the national governing body is not mandatory and league membership is a separate entity. Thus advice that is listened to becomes important, and helpfully evidence suggests environmental sustainability compliance does not always need to be mandated to be effective (Etzion 2007). This potentially frees a burden as organisational responses to imposition can be varied and regulation needs enforcement and policing, highly diverting of resources. Promotion of the reduced costs involved with more sustainable use of resources may prove to be the kind of advice that is listened to.

Caution clearly needs to be taken when discussing previous research that offers only a partial profile of this study's demographic. Wauters et al (2010) suggest that behavioural studies from

social psychology can be utilised because they possess appropriate theoretical and applied standards. Any such attempt to extrapolate from modelled studies needs to consider that models seek to predict an average behaviour across the individuals studied rather than identifying all responses, and there are limits to the usefulness of comparing different contexts (Darnton et al 2008). Possible indicators as to attitude towards advice and behaviour can be considered if reviewing populations with similar aims, interests and barriers to activity, however, few such peer-reviewed studies exist within the sportsturf discipline.

2.7 Summary

Three relevant areas have been identified by the literature review; grounds, facilities and people.

The government approach to policy for changing environmental behaviour proposes; “Enable, encourage, engage, exemplify” (Defra 2011). This requires data on the behaviour targeted for change. This data is in short supply within cricket grounds management. Recommended practices are often derived from experience, received wisdom and a small number of well conducted and promoted research projects. There is a lack of peer-reviewed information in popular circulation, nothing comparable to the golf industry which benefits from a significant research input from the United States and an almost universally paid employment sector. Information from such research can be utilised but because of its unique pitch demands and highly varied social and economic circumstances cricket needs to develop its own body of work. It may be that the current practices of groundstaff are maximising performance and efficiency, their experience identifying the best solutions but this cannot be judged while there remains a significant gap between established fact and club-based activity.

Given these gaps this study should consider; practices within cricket grounds management and any opportunities for enhanced sustainability based on the peer-reviewed work identified, the state of facilities and capacity for environmental improvement and the awareness and motivations of personnel.

3.0 Survey Methodology

3.1 Objectives of the Survey

The aim of the survey was to capture information, both quantitative and qualitative, about current practices at cricket clubs, the state and management of their facilities in respect of natural resource use. Such data has not previously been identified and will allow deductions to hypotheses (quantitative measurement) and inductions offering ideas and hypotheses (qualitative measurement) (Greenhalgh 2008).

The literature review illustrated how the activities of cricket clubs can be categorised as playing field or facilities based, with the primary consideration being surface integrity and sporting experience. Analysis identifies if the results of the survey suggest opportunities to reduce cricket's consumption of resources whilst maintaining the development of the sport at no loss to the quality of cricket. The geographical and representative diversity of the surveyed clubs offers both location and organisational comparatives to consider if these opportunities, and thus advice offered, may be impacted by climate or other factors.

3.2 Survey Design

The survey utilised was an existing design for the "Environmentally Sustainable Cricket Project". Discussion was held with project leader Dr Iain James and it was decided the format would be appropriate to this study's aims. The survey was not piloted but was discussed with experienced colleagues and took account of the volume and nature of recent questionnaires cricket clubs have been asked to complete.

The survey questions (Appendix 2) requested information on either club history or activities related to the environment, namely;

- *Environmental History*; past flooding or water restriction experiences
- *Facilities;* clubhouse use, heating and any efficiency measures,
- *Waste*; collection and management of clubhouse and grounds waste, including any recycling
- *Grounds*; management of the playing surface
- *Water*; water source, control, use and monitoring for both grounds and facilities
- *Energy*; energy source, efficiency and use
- *Policy*; club policies, attitudes and advice requested on consumption of natural resources

Requests for club location, affiliation and playing details provided a context for comparison. Questions requested information rather than agreement/disagreement, or rating of statements (such as with Likert analysis). Whilst some answers would necessarily be objective unit figures, the intention was to make the questions the basis of a discussion rather than closed response as it was necessary to gain an understanding as to what clubs may be doing, why and what could prompt them to change behaviour. For this reason the survey could not be a blind distribution, or a simple request for responses without additional communication. Respondents were offered anonymity from all but the author and Dr Iain James.

3.3 Survey Implementation

The requirement for detailed information made it inappropriate to use an opportunity, random or stratified random survey approach under which participants may not be characteristic of the types of cricket club in the catchment area. Instead a quota sampling of England and Wales was identified, the quota survey being best utilised for studies seeking to reflect outcomes closely representative of the wider sector being studied (Greenhalgh 2008).

To ascertain if climate was of significance in potentially differing cricket club practice responses it was necessary to divide and analyse England and Wales by representative regions.

“County” was chosen as the first level of differentiation (the ECB manages cricket via a county board structure) and then a larger geographical ‘Region’ was nominated (the ECB identifies counties as belonging to one of five regions). These regions are identifiable in UK Met Office data (2011) as having different climates allowing for comparison of results on a regional climate basis.

Clubs representing different playing levels were identified after discussion with county cricket boards and groundstaff associations. An objective of five clubs per county, comprising one First Class (if county possessed one,) one Premier League, two ‘Intermediate’ and one ‘Small’ was considered most representative by Dr Iain James and the ECB. The determination of these club ‘types’ was both objective and subjective. ‘First class’ and ‘Premier League’ are playing structure based and are thus identifiable by all. However, ‘Intermediate’ and ‘Small’ are descriptions assigned by the author and project lead against consideration of the relative size, facilities and participation of the club. An ‘Intermediate’ club is one in which activity is greater than a ‘Small’ club.

The number of facilities for cricket in England and Wales is 6807 (source: Sport England Active Places Power database + ECB Play-Cricket database) and the number of registered cricket clubs is 3951 (source: ECB Play-Cricket database). The number of clubs surveyed was just over 1% of registered clubs but represented 100% of the regional districts of the ECB (n=5) and 100% of the UK Met Office climate districts of England and Wales (n=6). The survey was standardised, every club being asked the same questions with clear accompanying instructions but not suggestion or discussion of previous responses. Standardising a survey increases its reliability (Greenhalgh 2008). Completion of the survey was author assisted in terms of question understanding only and no persons contacted refused to participate. Whilst data for this thesis was finalised for submission in August 2011 survey responses are still encouraged as the information provided will help aid future research work.

3.4 Weaknesses of the Survey

The survey can only establish what club staff *say* they do rather than what they *actually* do, thus the results claimed need to acknowledge this lack of observation (Greenhalgh 2008).

The implementation of the survey did not allow for a measure of 'non-response' as all clubs were pre-selected on the basis of likely assistance. This provides for the possibility of bias in the selection.

The respondent could have been influenced by the method of communication. For example, in one county the respondent request was made via personal contacts and league staff generating greater contact with club secretaries. In another county, of the same climate region, respondents were almost exclusively groundstaff as contact was made initially via the county groundstaff association. Counties do not necessarily possess identical management and representative body structures. For this reason, as well as the potential familiarity of the respondent with operational data, the analysis identifies the staff role of the respondents.

The survey instructions could have been more directive on unit calculations. Allowing free expression on this caused additional work during analysis. Whilst imperial measures can be converted to metric, time or activity frequencies need to be translated to the same comparable measurement. A standard activity duration can provide this and when used has been indicated.

3.5 Responses

Responses are identified as percentages to provide an overview of findings and general tendencies amongst the various categories of respondent.

A response of 'don't know' has been classified as a 'response' except for determining mean values. A non answer (occurring when respondents said they would need to establish data and subsequently failed to relay it) has not been classified a response and calculations have been

adjusted accordingly. The number of responses has been indicated next to any figures given, for example 50% (n=20) shows half the respondents (n=10) responded in the manner indicated.

Quantitative result means have been calculated along with standard deviations. Qualitative data is highlighted alongside these findings where it provides additional understanding of intention, practice or result.

4.0 Analysis and Discussion

4.1 Demographics of Respondents

43 cricket clubs were surveyed, representing eight counties in all five ECB regions (Appendix 3). The ECB regions of 'Midlands' and 'Wales' each correlate with a UK Met Office climate district of the same name, whilst the ECB regions of 'South', 'London & East' and 'North' each encompass two climate districts (Appendix 1). However, only two surveyed clubs in these regions were located in a different climate district to their regional colleagues (one in 'North' and one in 'London & East'). The location of the 'North' club is climatically similar to that of Welsh clubs so it was amalgamated into region 'Wales' for analysis purposes. The 'London & East' club was near the boundary of the climate districts so was placed into 'South' where all other 'London & East' clubs reside. Responses will be identified according to their UK Met Office climate reference.

ECB North	= 25 respondents;	*UK Met Office climate district*	North East
ECB Midlands	= 5 respondents;	*UK Met Office climate district*	Midlands
ECB London & East	= 4 respondents;	*UK Met Office climate district*	South
ECB Wales	= 5 respondents;	*UK Met Office climate district*	Wales
ECB South	= 4 respondents;	*UK Met Office climate district*	South West

Ultimately there were more respondents from climate district 'North East' as that is the author's location and there was a willingness of clubs in that region to become involved in the project once aware of it. Whilst this means caution has to be exercised when analysing 'North East'

figures in respect of other climate districts it was considered that the benefits of additional data and a wider survey sample surpassed this extra consideration.

Compositional details of respondents have been indicated in Appendix 4. These show the largest volume of responses was from 'Intermediate' clubs reflecting the intention to survey twice as many of this group than others. There was no intention to survey any specified numbers from affiliation, location or role categories thus the findings that more than half the respondents are Focus clubs could be reflective of the relative success of that ECB programme. Focus clubs by their definition have made a commitment to a series of criteria such as establishing development plans, appointing representatives and providing annual data to the ECB. There is no limit on their numbers. In return funding and development programmes are made available to Focus Clubs. Consequently they may be more participatory in initiatives mounted by their local cricket board thus making them more likely respondents to surveys seeking to assist the sustainability of the sport. Location of respondents identifies a near three to one ratio of urban to rural clubs. Clubs were not approached with an intention to save time or travel by clustering interviews, this was simply the geography of those believed likely to respond, but may be indicative of urban migration. The figure of groundstaff respondents (60.5%) could have been influenced by the author's knowledge and access to representative bodies. A number of interviewees completed responses to particular questions after consulting other members of staff. No personal contact was made with these secondary contacts so the respondent identification has remained as the original contact.

Some respondents were unable to complete responses (Appendix 5) and the correlation of club role and lack of proffered data could provide a useful tool for detailing the awareness of activities amongst specified role groups such as at one club in 'North East' where the respondent could not provide a single answer relating to the management of the playing surface. 'Knowledge gaps' such as these could be relevant to directing resources or initiating knowledge transfer and advice. It may be argued there is no need for such awareness, with specialism and division of labour representing appropriate management. Lack of appreciation, however, can lead to inefficiency (Anderson & Jessen 2005). This is lent credence by a

response from a different club in the same district indicating a degree of surprise and irritation about a colleague's resource use when data analysis showed the consumption was below the mean used by the total number of clubs surveyed and organisations of a comparable size. Darnton et al (2008) suggest that while 'change champions', individuals in organisations to promote pro-environmental change, are key to any success this should not be at the expense of information deficiencies. Groundstaff are the group who provided most responses to the survey questions, one section within the club survey document was grounds specific, the other six covered both grounds and facility based activities as well as policy, management advice and decision making.

In excess of 3,000 individual items of data were generated by the survey which provides the potential for numerous points of comparison and discussion. As the literature review has identified some areas of cricket club practices, and the natural resources they utilise, attain greater importance and potential for change in respect of environmental sustainability than others. Thus analysis is focused on these particular areas; practices relating to water management, fuel use and energy use. These areas are intrinsic to the management of a cricket pitch and associated facilities.

4.2 Water Management

The volume of data collected in relation to clubs' management of water signifies the importance of the resource not only in cricket grounds maintenance but for environmentally sustainable strategy. Water is central to both pitch preparation (its interaction with the soil particles providing the cohesion required to establish a solid surface) and facility provision. It is universally required. Some clubs may not choose to heat or light their clubhouses but they are required to use and provide water for at least the basic hygiene of toilets and washing. Additionally, whilst competition is being encouraged in the market (Ofwat 2011) there is not the

diversity of supply with public mains water as there is with other utilities or grounds products. The choices concerning water supply are largely related to the nature of the supply.

Table 4.01 highlights survey findings across these choices and awareness of supply. Public mains use is not below 75% for any climate district and rises to 100% for Wales (n=2) and the South West (n=4). Metering of water helps management of the resource and ensures a link between quantified usage and cost. Article nine of the Water Framework Directive (EU 2000/60/EC) requires member states to guarantee incentives to using water efficiently and the UK government has identified the need to establish almost complete metering in water supply stressed areas before 2030 (Defra 2008). The incidence of meters is relatively consistent across all climate groups, each district identifying between 75 – 80% of use. Collectively, 84.6% of respondents (n=39) use public mains and 78.6% (n=42) are metered. However, the mean percentage of clubs who actually knew their annual grounds use of water was only 19.5% (n=32) suggesting that whilst the capacity for knowledge of water use exists, it is far from being utilised. If the emphasis for changing practices is initially on more efficient water use there needs to be greater awareness of how much water is being used, otherwise there is no benchmark from which to work.

Practice of the alternatives to mains supply ranged from 0 for water abstraction ('South West' n=4) to 50% in 'Wales' (n=4) and 0 for rainwater harvesting ('South West' n=3, 'Midland's n=5) to 25% (n=4) in 'Wales.' The totals of 15% (n=40) abstracting water and 7.3% (n=41) harvesting rainwater are clearly smaller than those using public mains, possibly fewer people have the potential to initiate these supply alternatives, and as identified in the literature there are aspects of such schemes that may not make them suitable for all. However, it is the number of respondents aware of, or considering these alternatives, that are of consequence as they indicate a lack of knowledge within club water management and the options when considering current practices. Only 19.5% (n=41) of respondents knew that 20 m^3 of water per day was a permissible abstraction and whilst the number who had considered rainwater harvesting was nearly double this figure (36.6% n=41) this still represents just over a third of cricket clubs

surveyed. Whether this is due to an absence of information on alternative sources to mains water (the question of whether rainwater harvesting has been considered pre-supposes familiarity with the idea,) or a surfeit of knowledge about connecting facilities to the mains, should be a consideration when looking at the provision of advice to clubs. The cost to the club of complying with water regulations and plumbing a system to the mains possibly does not reflect the wider cost to society and so is perhaps the first, or only, consideration when looking at supply.

Table 4.01 Club awareness and practice of water supply management

Respondents	Use public mains	Are metered	Knew annual grounds use of water	Abstract water	Aware of extraction permitted	Harvest rainwater	Have considered harvesting rainwater
All clubs (43)	84.6% (n=39)	78.6% (n=42)	21.4% (n=33)	15.0% (n=40)	19.5% (n=41)	7.3% (n=41)	36.6% (n=41)
North East (25)	82.6% (n=23)	79.2% (n=24)	12.5% (n=24)	4.4% (n=23)	13.0% (n=23)	4.0% (n=25)	30.4% (n=23)
Midlands (5)	80.0% (n=5)	80.0% (n=5)	0.0% (n=5)	40.0% (n=5)	40.0% (n=5)	0.0% (n=5)	60.0% (n=5)
South (4)	75.0% (n=4)	75.0% (n=4)	50.0% (n=4)	25.0% (n=4)	25.0% (n=4)	25.0% (n=4)	50.0% n=4)
Wales (5)	100% (n=3)	80.0% (n=5)	40.0% (n=5)	50.0% (n=4)	40.0% (n=5)	25.0% (n=4)	50.0% (n=4)
South West (4)	100% (n=4)	75.0% (n=4)	50.0% (n=4)	0.0% (n=4)	0.0% (n=4)	0.0% (n=3)	25.0% (n=3)

The low number of clubs aware of their annual water use should not have precluded response to the discussion on water involved in pitch preparations as a duration was requested rather than a volume. The difficulty, however, in using a time based measure of watering practices for analysis is that the volumes of water applied over a period are a function of the water pressure at that particular club. Some clubs may have had a higher water pressure and flow rate than others resulting in a different volume of water being applied over an identical time period. This would render ‘duration’ as an inexact means of comparing actual water use for pitch preparation. Unfortunately, as club awareness of volumetric measures of grounds water use

was low (21.4% (n=33) Table 4.01) this was an expedient selection of question. Due to the timing of the survey flow rates were not calculated at every cricket club (some were surveyed during winter when pipes were inoperative) but of the number that were (every climate district was represented) there were no consistent geographical responses. This is not surprising across large geographical areas where height of location relative to water source and proximity to other users would typically be factors in supply dynamics but it makes it impossible to produce definite statements on this variable.

The duration figures that were supplied showed higher mean watering durations for pitch preparation in the 'North East' than any other region (Table 4.02). The respective climates of the regions (Appendix 1) would suggest that this should not be the case if water applied is simply compensating for a lack of rainfall or high evapotranspiration rate. Table 4.03 highlights the regional rainfall data for the cricket season 2010 and Table 4.04 the regional temperature readings for that period, upon which watering durations would be required and were provided. These figures do not suggest any anomalies that may have influenced groundstaff activities.

Table 4.02 Mean (± SE) duration of watering in pitch preparation, mean annual water use and water restriction history.

Respondents	Mean duration of watering for pitch preparation (hours)	Mean annual water use (m^3)	Experienced Water Restriction
All clubs (43)	2.92 ± 0.78 (n=19)	414.27 ± 120.27 (n=13)	25.6% (n=43)
North East (25)	4.0 ± 1.12 (n=12)	217.08 ± 96.24 (n=6)	12.0% (n=25)
Midlands (5)	0.33 ± 0.10 (n=3)	500.0 ± na (n=1)	60.0% (n=5)
South (4)	2.0 ± n/a (n=1)	433.33 ± 88.19 (n=3)	25.0% (n=4)
Wales (5)	0.5 ± n/a (n=1)	15 ± n/a (n=1)	40.0% (n=5)
South West (4)	2.0 ± n/a (n=1)	1133.50 ± 498.50 (n=2)	50.0% (n=4)

Table 4.03 UK Met Office Regional Rainfall Summaries During Cricket Season 2010

	Rainfall, mm						
Climate District	April	May	Jun	Jul	Aug	Sep	Total
E & N East	21.4	22.1	42.7	61.1	76.6	83.9	307.8
Midlands	24.7	31.6	40.7	53.1	98.5	67.4	316.0
SW & Wales	39.6	45.5	34.5	105.8	110.7	116.0	452.1
SE & Central S	22.6	30.2	32.9	26.1	100.1	50.9	262.8

Table 4.04 UK Met Office Regional Temperature Summaries During Cricket Season 2010

	Mean Temperature°C						
Climate District	April	May	Jun	Jul	Aug	Sep	Total
E & N East	8.2	9.8	14.3	16.4	14.6	13.4	12.8
Midlands	8.8	10.7	15.2	17.0	15.1	13.6	13.4
SW & Wales	8.6	10.7	14.8	16.2	15.0	13.6	13.2
SE & Central S	9.2	11	15.7	18.1	16.1	14.0	14.0

The scatter graphs (Figure 4.01 and 4.02) suggest a lack of climate/watering duration correlation ($r < 0.5$).

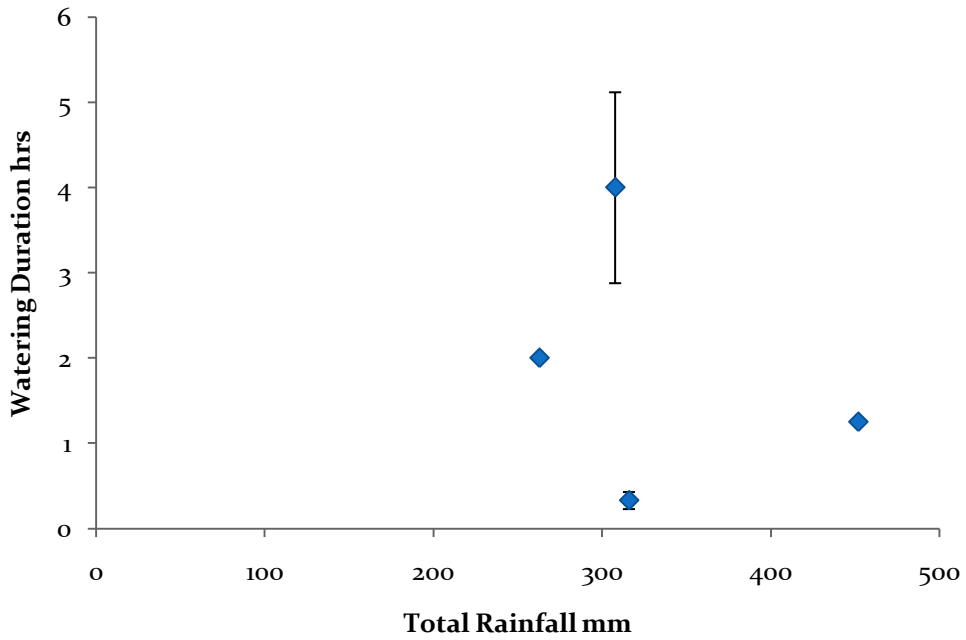

Figure 4.01 Scatter Graph for Total Rainfall (mm) and Watering Duration (hours) (± SE)

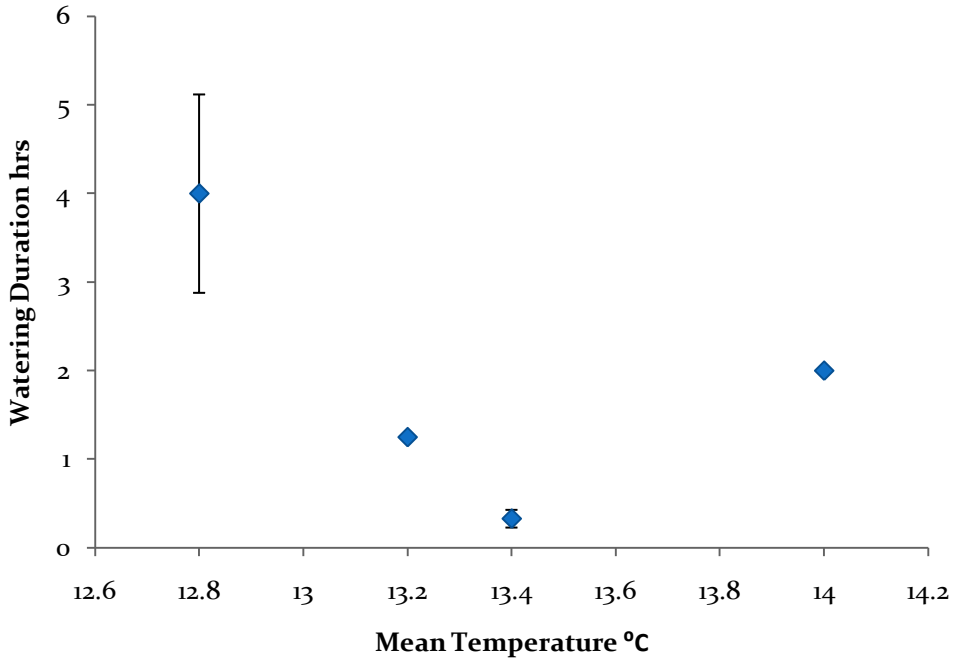

Figure 4.02 Scatter Graph for Mean Temperature (ºC) and Watering Duration (hours) (± SE)

Whilst the lack of water pressure data renders conclusion impossible it is still relevant to analyse potential causes of higher watering durations if not to highlight some of the variables that may need to be examined by future studies and recommendations. It is possible that watering duration may be a function of pitch management choices rather than external factors such as climate or water pressure. The emphasis (and guidance in TS4) when preparing a pitch is to soak the loam to a depth, rather than apply a specified volume of water. The type of loam may dictate this volume, different loams having different clay contents. Table 4.05 shows that of the responses that identified both loam used and a quantifiable watering duration that 'Surrey' loam users spent the greatest number of hours watering, 4.5 ± 1.88 (n=5). However, the clubs using 'Surrey' loam were all within the 'North East' climate district, that which had displayed the highest watering durations in a geographical comparison. This does not necessarily mean 'Surrey' loam required more water for pitch preparation than other loams as the 'North East' district also included clubs using different types of loam. Moreover, whilst it could be assumed groundstaff would water with the intention of achieving the recommended soaking depth,

inefficiencies of application method, personal preference and judgement could still be a factor in pitch preparation. Indeed the standard error for Surrey loam watering durations is ± 1.88 hours across just five respondents. The second highest mean watering duration for Mendip loam, 3 hours (n=3) shows an even greater diversity from fewer respondents (± 2.49 hours). The error and number of responses across this particular data set and the inability to separate factors does not, therefore, allow for definite statements on loam choice as a determinant of watering requirements.

Table 4.05 Mean (± SE) watering duration for pitch preparation for five loams

Loam used in pitch	Mean watering duration (hours)
Surrey	4.5 ± 1.88 (n=5)
Mendip	3.0 ± 2.49 (n=3)
Ongar	1.5 ± 0.49 (n=3)
Kaloam	1.0 ± n/a (n=1)
Banbury	0.3 ± 0.09 (n=3)

However, the reasons for higher watering durations may be more attitudinal than practical. Increased awareness of the value and scarcity of water illustrated by greater experience of use restriction could influence management. Table 4.02 does indeed show that the 'North East' has the lowest recorded history of curtailed water supply 12% (n=25), so a geographical correlation to water use volumes may exist but it may not be a simple correlation of rain falling to water applied but that a higher volume of rainfall results in a reduced requirement and awareness of the need to restrict water use in times of drought, the 'North East' also being served by a very large reservoir (Kielder). Figure 4.03 illustrates the Environment Agency's (2007) assessment of the area served by each water company, showing the 'North East' exhibiting equal lowest water stress.

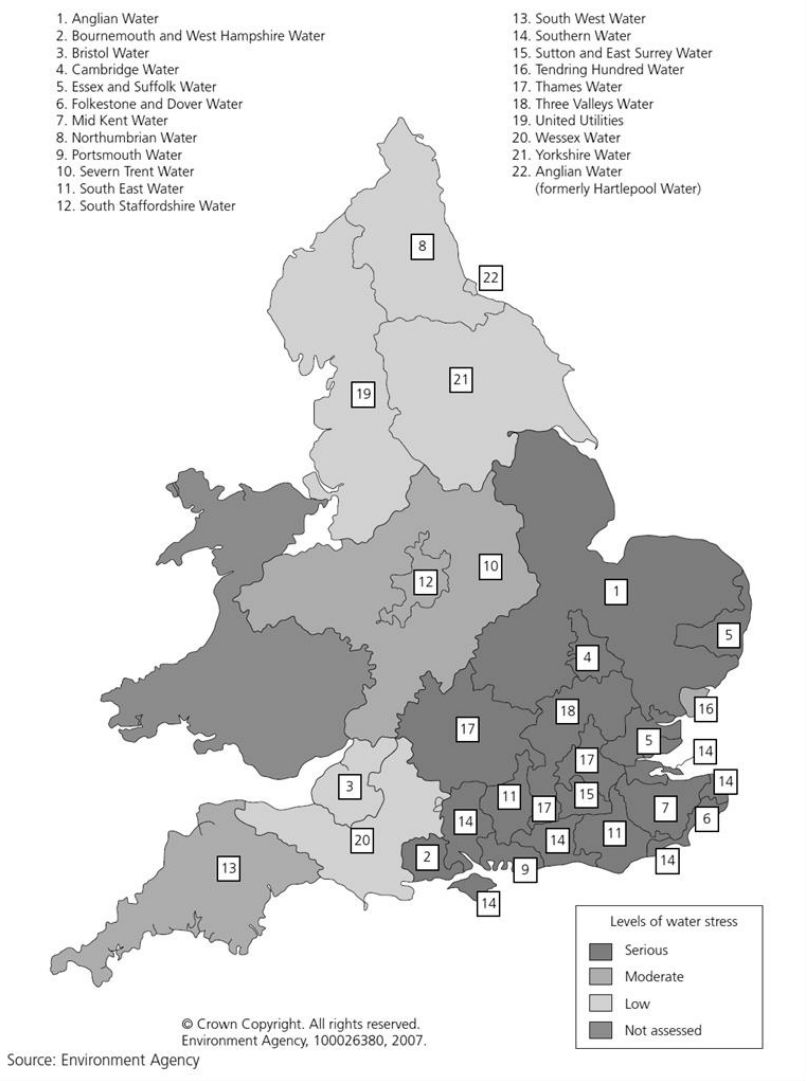

Figure 4.03 Map of relative water stress by company area (Environment Agency 2007)

A further consideration of geography is differentiated water company pricing. Ofwat (2011) records that three of the four cheapest volumetric charges for non-household supply (p/m^3) by the water and sewerage companies in England and Wales are all within the 'North East' climate district (Table 4.06). The lowest charge is almost one third the cost of the highest. A pound sterling effectively buys clubs in the 'North East' more water than most other regional consumers.

Table 4.06 England and Wales water and sewerage company volumetric charges (non-household supply)

Water and Sewerage Company	Volumetric Charge (p/m^3)
Hartlepool/Anglian Water	60.80
York/Yorkshire Water	63.40
Southern Water	94.90
Northumbrian Water	99.02
Essex	109.93
Thames	115.83
Dŵr Cymru	123.58
Severn Trent	136.51
United Utilities	137.40
, South West	167.95
Wessex	174.83

Yet it remains difficult to ascribe a correlation between watering durations and climate, or indeed any other single factor, based on this data set. The considerations of water restriction history and relative cost of water appear possible mitigating reasons to higher watering durations if, as suggested with the consideration of alternatives to public mains supply, both the perceived and actual cost of water may to some be cheap. However, the total response volume to the question of water use serves perhaps best purpose not in attempting to use it for analysis and benchmarking but to highlight the limited consideration clubs are according this natural resource, its value and availability. Climate change data suggests there may need to be a greater degree of resilience to the supply of water. Collectively, responses to watering duration were less than 50% of the possible total (n=19 of a survey total of n=42). Non-responses did not altogether fail to answer this question, rather some of them gave a non-quantifiable answer. 'As required' was such a response. This seems logical if pitches are exposed to variable weather, and the advice is to focus on depth of wetting. However, the common method of measuring the extent of soil moisture whilst based on knowledge and experience is unscientific, usually a combination of visual recognition and indentation of the soil (two respondents, one in 'North East' and one in 'Midlands' identified this knowledge gap with their request for a soil moisture meter). Yet clubs with water meters could be aware of applied volumes (providing the meter is accessible and legible) and this would provide them with the opportunity to manage the

resource more accurately with greater control over their costs. Even clubs without meters could establish the water applied to a pitch by calculating watering duration multiplied by water flow rate. That they do not seek to know such information suggests behavioural challenges in attempting to create a culture of understanding of possible future climate impacts on water use.

A respondent in the 'South' suggested that currently watering recommendations and irrigation technology for sportsturf tend to be based on advice for sand construction golf greens rather than cricket pitch clay loams, thus rendering such information of limited relevance. This is an area that the ECB TS4 recommendations could seek to enhance. With greater awareness of the role of water possibly groundstaff may seek to become better informed about their usage. Clubs' watering activities are not only relevant for management of their resource and expenditure but have wider financial and resource use implications. Water authorities are mandated to provide a safe, clean drinking supply, they cannot provide water of variable quality to different users. Any water that collects pollutant residues and enters the drainage network sees water authorities investing additional time and expense in treating those volumes back to potable supply levels. This subsequently impacts on the cost and availability of water to all. This disposal of trade effluent into public drains without permission is illegal (Environment agency PPG13 2007). Almost one third of clubs who responded (32% n=25) admitted they washed down machinery in the car park. There is a clear need for better guidance on this issue.

Water management does not just concern itself with use. The treatment of exceptional rainfall and flooding is of particular relevance given recent UK Government consultation on surface water drainage rates and reported club losses in recent years. Clubs in this survey appear to have limited consideration of flood defence (Table 4.07). Despite flooding being a highly topical and potentially serious economic and environmental threat, it is a small minority of clubs (23.8% n=42) that have taken measures to combat flooding. The two districts with the greatest percentage experience of flooding ('Midlands' 80% n=5, 'South West' 50% n=4) also have the greatest percentage of flood mitigation (60% n=5 and 75% n=4 respectively,) these clubs also

registering as being at 'significant' flood risk (> 1.3% 1/75 years Environment Agency NAFra 2008 Flood Risk Database). These two groups are also the only ones registering a flood policy, suggesting that previous and likely incidence is related to activity, although it is unknown if either mitigation or policies were developed in response to a flooding event. Whilst this is a geographical feature it is not climate specific as location of clubs within districts differs markedly, from those built on flood plains to inner cities and even high moorland. Surprisingly none of the clubs in the districts with most experience of flooding make use of the Environment Agency's flood alert scheme. This alert is a free service which sends warning of likely flooding, giving recipients time to move equipment that may otherwise be damaged. As it is reinforced by live river level data hosted on the agency's website it would seem a useful partner to any flood policy.

Collectively more clubs have experienced flooding (43.9% n=41) than have mitigation (23.8% n=42) and even fewer clubs have a policy (7.1% n=42) or flood alert subscription (5.7% n=35). The two clubs that do subscribe to flood alert have different experiences of flooding, one has been extensively affected, the other has no recorded history of any incident. That only 9.8% (n=41) of clubs overall believe flooding affects their insurance would seem to be at odds with the 45% (n=42) that have found their ground under water. It is possible that whilst they may have experienced flooding the extent is confined to areas that would not require a compensatory claim, for example the pitch, thus there has been no activity to impact on insurance premiums. However, given that climate change data identifies that anomalies of extreme weather are increasing it is an area to monitor. Larger clubs that generate significant revenues via their bar and function areas should consider if they could afford for these to be decommissioned for any length of time, even if they may not be directly affected by flood water they may suffer a fall in trade if cricket cannot be played. A respondent in the 'North East' with a large hard surface car park potentially at risk of flooding dismissed the need for advice, believing the club was such a popular social venue they did not want building work disrupting the status quo. Given the stakes this could perhaps be managed to minimise inconvenience. Such is the potential impact of flooding that one 'North East' club reported damaged buildings as being unusable for three months.

Table 4.07 Respondent experience of, and attitude towards, flooding

Respondents	Have experienced flooding	Believe flooding affects their insurance	Have flood mitigation	Have flood policy	Are signed up to flood alert
All clubs (43)	45.0% (n=42)	9.8% (n=41)	23.8% (n=42)	7.1% (n=42)	5.7% (n=35)
North East (25)	36.0% (n=25)	4.4% (n=23)	4.2% (n=24)	0.0% (n=24)	4.2% (n=24)
Midlands (5)	80.0% (n=5)	60.0% (n=5)	60.0% (n=5)	40.0% (n=5)	0.0% (n=4)
South (4)	33.3% (n=3)	0.0% (n=4)	50.0% (n=4)	0.0% (n=4)	0.0% (n=2)
Wales (5)	40.0% (n=5)	0.0% (n=5)	20.0% (n=5)	0.0% (n=5)	25.0% (n=4)
South West (4)	50.0% (n=4)	0.0% (n=4)	75.0% (n=4)	25.0% (n=4)	0.0% (n=1)

The experience of exceptional rainfall is an opportunity for the secondary functions of alternative water supplies. Table 4.01 detailed how 36.6% (n=41) of clubs had considered rainwater harvesting, yet Table 4.07 showed 45% (n=42) had experienced flooding. Instead of excessive rainfall potentially overwhelming existing drainage diversion of this fall into storage tanks by a collection system could provide both flood mitigation as well as the water itself for use. An event of, for example, 30 mm rain per hour falling across a rooftop with a 75 m^2 footprint would collect 2.25 m^3 (or 2250 litres) of water. Such a system would need to stem from roof collection as runoff from hard standing areas may carry pollutants into the tanks, however if such pipework proved unviable a runoff drainage collection system could alleviate flooding providing there is adequate prevention of backflow. Such measures represent an investment but could ultimately save costs to the club of remedial work and mitigation measures to stop repetition. There is also the water authority charges for disposing of the excess water, Ofwat (2011) recommending that non-household customers are charged for surface water drainage based on area of a site (four of the water companies covering surveyed clubs currently do that; Severn Trent, Yorkshire, Northumbrian and United Utilities). If it could be demonstrated that surface water was being diverted away from drainage systems there may be potential for relief on these charges. The suitability of such work cannot be determined by climate or geography, in addition

to likely incidence there needs to be consideration of the cost and ease of construction and the ability of the club to sustain both maintenance and cricket at the facility.

4.3 Fuel Use

When asked about any fuel saving procedures in operation 45% (n=40) highlighted their transport arrangements for players on match days (Table 4.08) in contrast to 7.5% (n=40) responses outlining efforts to reduce fuel consumption at the club ground. More efficient car sharing or use of economical coaches would reduce fuel use and emissions, however this is usually an initiative by players rather than a club policy and clubs should consider whether this individual altruism perhaps every two weeks during the playing season negates the need to consider saving fuel and finance by adjusting (where possible) grounds practices that may be taking place every few days, often beyond the duration of the season.

Table 4.08 Adoption of fuel saving measures

Respondents	Fuel Saving Measures for Player Transport	Other Fuel Saving Measures	No Fuel Saving Measures
All clubs (43)	45.0% (n=40)	7.5% (n=40)	47.5% (n=40)

On-site fuel use is a product of club practices and the frequency of those practices. There are multiple consequences of fuel use; consumption of a non-renewable resource, the financial cost of consumption, the emissions produced, the way these emissions accelerate the accumulation of greenhouse gases in the atmosphere accelerating climate change, and the time engaged by groundstaff in fuel consuming practices. Traditional fuel use is an increasing expense for clubs and evidence suggests conventional oil production will peak by 2030, or even 2020 under certain circumstances (UK ERC 2009). Thus any opportunities for reducing fuel use have multiple benefits for both cricket clubs and wider society. Moreover, some of the reductions may

allow for other savings, such as the relationship identified in the literature between mowing frequency and plant requirement for water.

The survey results showed a wide range of annual fuel use (Table 4.09). Regional means for diesel varied from 118.2 L to 813.8 L, petrol displaying even greater diversity with 56.0 L to 866.3 L. The higher figures were both found in the 'Wales' climate district, but standard errors were of such magnitude as to suggest examination of possible outliers.

Table 4.09 Mean (± SE) annual fuel use

Respondents	Mean annual diesel use (L/y)	Mean annual petrol use (L/y)
All clubs (43)	383.3 ± 105.4 (n=26)	224.0 ± 83.9 (n=27)
North East (25)	118.2 ± 32.0 (n=12)	95.0 ± 20.3 (n=12)
Midlands (5)	608.5 ± 124.0 (n=4)	193.8 ± 81.2 (n=5)
South (4)	250.0 ± 50.0 (n=2)	56.0 ± 36.0 (n=2)
Wales (5)	813.8 ± 563.4 (n=4)	866.3 ± 475.9 (n=4)
South West (4)	589.5 ± 301.8 (n=4)	90.8 ± 56.7 (n=4)

Histograms (Figures 4.04 & 4.05) highlight that the data is distorted by such outliers and that the majority of respondents use 0 – 400 litres of diesel per annum (73% n=26) and 0 – 300 litres of petrol over the same period (89% n=27). Of the clubs that lay beyond these ranges First class clubs comprised 50% (n=6) in the case of diesel and 100% (n=3) for petrol use. Removing the outliers from regional calculations, however, would result in small response rates from some climate districts ('Midlands', 'Wales' and 'South West' would all be n=2), again awareness of use

being the difficulty in collecting sufficient data to render geographical comparison of value.

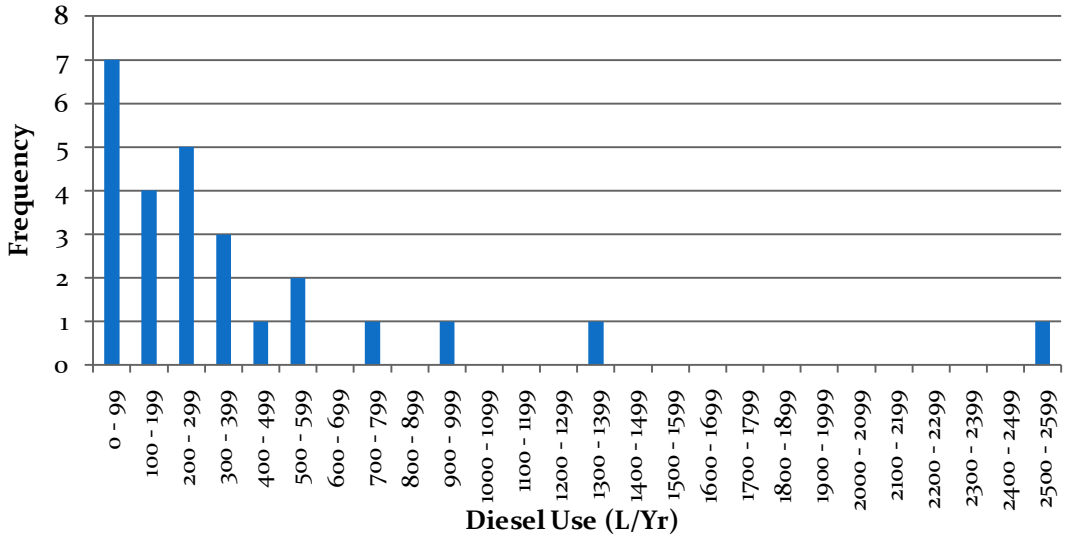

Figure 4.04 Diesel Use (L/Yr) frequency histogram

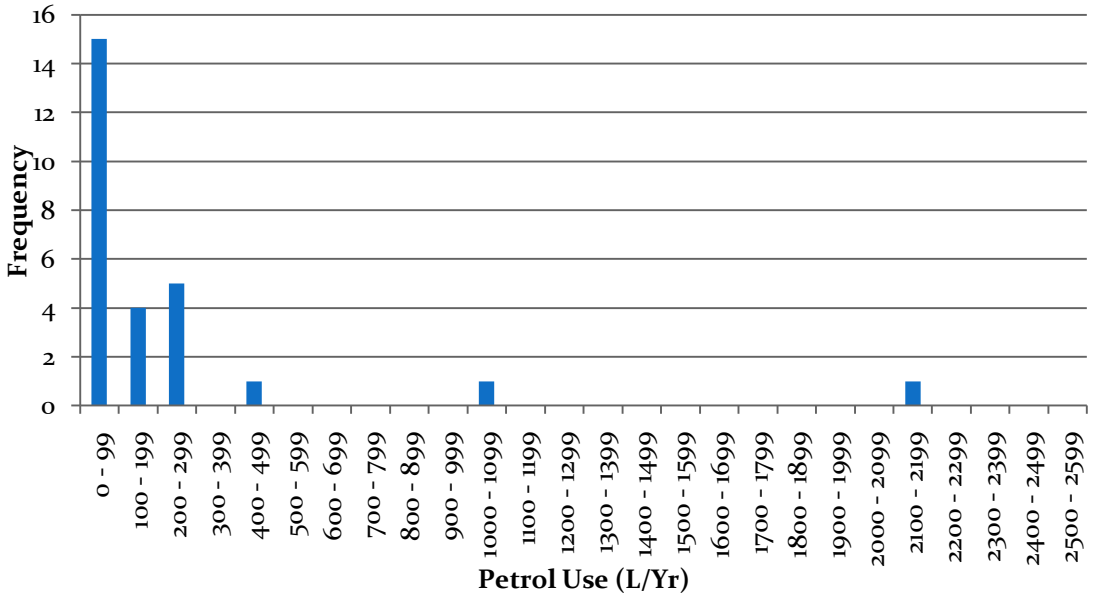

Figure 4.05 Petrol Use (L/Yr) frequency histogram

That the histograms show First class clubs use higher than mean volumes of fuel could possibly be due to their frequent operations in pursuit of highest standards of playing surface. If this is

the case it would be expected to see this reflected in analysis of club groundscare practices, possibly suggesting areas in which changes and fuel savings may be made.

4.3.1 Rolling

Every survey respondent was aware of the rolling recommendations produced by Cranfield University/ECB (Shipton and James 2009) and 70% (n=43) could specify the duration of their rolling, the mean of which was 2.33 ± 0.24 hours (n=30) per pitch preparation (Table 4.10). Summer pre-match rolling figures collected by Shipton (2008) prior to his study showed a mean of 3.8 hours per pitch (n=130) indicating a post rolling recommendation fall in hours based on a comparison with this survey data. However, following the Cranfield University/ECB advice accurately requires knowledge of both soil composition and moisture content and whilst 80.9% (n=42) of clubs identified the loam they use the difficulty at present with determining soil moisture has been discussed. Greater knowledge of soil moisture levels could potentially reduce rolling durations further..

Mean rolling durations did not display more than an hour of variation across the climate districts (Table 4.10) when discounting 'South West' which only registered one response. However, as was suggested by the mean annual fuel use analysis First class clubs did roll for a greater duration per pitch preparation than other types of affiliated club (Table 4.11). As the rolling guidelines are based on environmental rather than playing factors the logic for this is not entirely clear, particularly when Table 4.12 highlights that First Class clubs play fewer days of cricket than either Focus clubs or clubs with youth sections. Focus clubs not only host the most days of cricket but they roll for the second lowest number of hours which may suggest at a willingness to embrace new rolling guidelines but as data was not collected regarding their habits prior to the new guidance this can not be confirmed.

Table 4.10 Mean (± SE) rolling duration for pitch preparation

Respondents	Mean duration of rolling for pitch preparation (hours)
All clubs (43)	2.33 ± 0.24 (n=30)
North East (25)	2.65 ± 0.31 (n=17)[1]
Midlands (5)	1.75 ± 0.75 (n=4)
South (4)	1.83 ± 0.72(n=3)
Wales (5)	2.25 ± 0.67 (n=5)
South West (4)	1.00 ± n/a (n=1)

[1] Six clubs gave answers in terms of number of 'passes' (a complete roll in one direction the length of the pitch) – see Appendix 6 for standard duration of activity calculations.

Table 4.11 Mean (± SE) rolling duration for pitch preparation by club affiliation

Respondents	Mean duration of rolling for pitch preparation (hours)
First Class (5)	3.83 ± 0.44 (n=3)
Focus Clubs (25)	2.28 ± 0.33 (n=18)
Club with Youth (6)	1.58 ± 0.28 (n=5)
Club (6)	2.34 ± 0.64 (n=4)

Table 4.12 Mean (± SE) number of fixtures per season by club affiliation

Respondents	Mean number of fixtures per season
First Class (5)[1]	54.8 ± 2.6 (n=5)
Focus Clubs (25)	80.0 ± 8.6 (n=25)
Club with Youth (6)	67.5 ± 16.4 (n=6)
Club (6)	48.0 ± 11.3 (n=6)

[1] First class clubs are measured as 'days of cricket' as they also host four day fixtures. There is one non-affiliated club

4.3.2 Mowing

Mowing is an intrinsic feature of cricket pitch preparation but frequency is a product of grass growth, desired characteristics and human interaction. These determinants are not fixed and can be adjusted towards a specific aim, such as the intention to reduce mowing frequency.

62.8% of those surveyed (n=43) (Table 4.13) were able to provide an indication of pitch mowing frequency, which contrasts with 97.6% (n=43) able to identify outfield mowing frequency. The ability to specify only one practice by more than a third of respondents is to some extent due to

the variable timetabling of pitch management, a surface frequently cut as prevailing weather conditions allow combined with the ground staff's estimation of need ('as required' was given by 11.6% n=43 as an answer to pitch mowing frequency). Outfield mowing takes longer, the surface is not covered in the event of rain and may be seen as requiring less skill than pitch management thus the operation may tend towards a regular schedule. Respondents were not directed to provide pitch mowing durations in any specified units as it was of interest how they viewed these activities. The majority (n=15) of clubs (n=27) gave a response of hours engaged in the activity but frequency per week and number of passes were also used, figures which can be standardised (Appendix 7) to provide time data. Responses to the question of outfield mowing were entirely in frequency per week. It is more difficult to identify hours taken for outfield mowing as, unlike pitches, outfield areas are not prescribed and may vary in magnitude according to ground size, league rules or location of the pitch in use. However, using the programs Google Earth and GEPath 1.4.4a it was possible to quantify the outfields of the individual clubs involved in this survey. These areas were then multiplied by their frequency of cut to produce a total mown area per week. Standard activity durations (Appendix 8) were subsequently used to calculate the number of hours per week each club engaged in this activity.

The mean mowing durations and standard errors in Table 4.13 appear not to support any determination of the practices in respect of climate district locations. 'Wales' had the highest duration of both pitch and outfield mowing however as with the rolling analysis this could be due to the presence of two First class clubs in the region, a factor that might support the finding of those clubs using the greatest volumes of fuel. Table 4.14 shows that more hours were spent by First class clubs engaged in mowing both pitches and outfields, more than four times as many hours in regard to the latter. The differences between the other types of affiliated club were smaller and do not appear to indicate any particular variability of operation. Combined with the analysis of rolling by club affiliation the data suggests that fuel use is influenced by the level of club rather than any climate related factors.

Table 4.13 Mean (± SE) mowing duration for pitch and outfield preparation

Respondents	Mean mowing for pitch preparation (hours)	Mean outfield mowing per week (frequency)	Mean outfield mowing per week (hours)
All clubs (43)	1.92 ± 0.28 (n=27)	2.13 ± 0.22 (n=42)	6.08 ± 1.0 (n=42)
North East (25)	1.36 ± 1.36 (n=18)	1.90 ± 0.26 (n=24)	5.13 ± 1.09 (n=24)
Midlands (5)	No data (n=0)	2.6 ± 0.25 (n=5)	9.25 ± 1.39 (n=5)
South (4)	2.75 ± 0.25 (n=2)	1.38 ± 0.24 (n=4)	3.78 ± 1.02 (n=4)
Wales (5)	3.70 ± 0.83 (n=5)	3.10 ± 1.09 (n=5)	11.58 ± 4.9 (n=5)
South West (4)	1.75 ± 0.25 (n=2)	2.63 ± 0.85 (n=4)	7.44 ± 2.99 (n=4)

Table 4.14 Mean (± SE) mowing duration for pitch and outfield preparation by club affiliation

Respondents	Mean mowing for pitch preparation (hours)	Mean outfield mowing per week (frequency)	Mean outfield mowing per week (hours)
First Class (5)	3.83 ± 1.63 (n=3)	5.10 ± 0.84 (n=5)	20.12 ± 3.13
Focus Clubs (25)	1.81 ± 0.32 (n=16)	1.75 ± 0.13 (n=24)	4.95 ± 0.37
Club with Youth (6)	1.51 ± 0.36 (n=4)	1.83 ± 0.31 (n=6)	4.52 ± 0.77
Club (6)	1.36 ± 0.37 (n=4)	1.67 ± 0.35 (n=6)	4.04 ± 0.85

There is one non-affiliated club

The mean figures illustrate a potential for increasing sustainability. The example growth rate for *Lolium perenne* identified in the literature gives an in-growing season, one week, range of height between 15 - 24mm according to conditions (STRI 2010). It is important not to stress turf excessively, a requirement which has produced a generally accepted 'no more than one third of plant removal in one cut' rule (Turgeon 1996). Therefore, cutting the surface once per week under this rule would see a reduction of height of 5 – 8mm, leaving a playing height of between 10 – 16mm. This would be too long for the cricket pitch but the suggested range for the outfield is between 12 - 13mm (ECB TS4 2007) and 20mm (ECB consultative PQS for outfields 2011). Given these growth rates cutting the outfield multiple times per week appears to use additional fuel, time and produce extra emissions to no playing height reduction requirement. At the highest levels of the game it could be argued that appropriate reward for well executed batting is managed by a shorter, quicker outfield. Yet an appropriate outfield height could be achieved with one weekly cut. At 2.13 (± 0.22) times (n=42) the survey mean is more than twice that which could aid both grounds practices and sustainability. Moreover, the mean number of hours

spent engaged in this task by groundstaff, 6.08 ± 1.0 (n=42), could be halved, depending upon growth rate.

If the motivation for multiple weekly cuts is aesthetic it may be that cutting the outfield is best performed the day prior to the match (although this may be difficult to schedule for local authority, contractor maintained or multi-sport use surfaces). The consultative outfield PQS (2011) grading criteria “very good” requires the outfield to be striped which is entirely achievable in one cut and may also be best undertaken close to play.

In addition to time savings, standard fuel efficiencies (Appendix 9) for different cutting machines allow for calculation of weekly fuel use. Table 4.15 shows how based on the mean outfield mowing frequency of 2.13 ± 0.22 times per week, halving this frequency would save 8.81 ± 1.43 litres of fuel per club using a Triple style mower (Bartlett and James 2011).

Table 4.15 Mean outfield mowing areas, duration and fuel use (± SE) of three machines

Respondents	Mean outfield area (ha)	Mean outfield area mown per week (ha)	Mean duration of outfield mowing per week (hours)	Mean weekly use of fuel (triple mower) (Litres)	Mean weekly use of fuel (pedestrian mower) (Litres)	Mean weekly use of fuel (fairway mower) (Litres)
All clubs (43)	1.03 ± 0.05 (n=42)	2.19 ± 0.35 (n=42)	6.08 ± 0.98 (n=42)	17.62 ± 2.84 (n=42)	7.96 ± 1.28 (n=42)	6.34 ± 1.02 (n=42)

4.3.3 Fertiliser

Demand for fertiliser impacts the production and trading of the commodity and the consequences of this will be felt in commercial fuel consumption. However, as a plant supplement, fertiliser also impacts club fuel consumption as its influence on turf health and growth influences the frequency and duration of operational practices. This use of resources occurs in addition to the previously identified greenhouse gas emissions involved in manufacture and application of the fertiliser itself. It is a product with many ramifications for environmental sustainability.

Unit variations of fertiliser products caused difficulties in securing higher response rates, for example five 'North East' respondents use liquid fertiliser rather than granular product, a volume in contrast to a weight. Even allowing for these variations the number of clubs unable to provide either fertiliser use quantities was in excess of 40% and fertiliser content almost half those surveyed (48.8%) (Table 4.16). As this could be an example of a 'knowledge gap' amongst non-turf personnel the percentage of groundstaff unable to respond was analysed and found to be 11.5% (n=26) unaware of fertiliser content and almost one quarter (26.9% n=26) unable to state the volume applied of either liquid or solid fertiliser. Unlike the question of water use awareness the non-response figure was not affected by non-quantifiable replies, the 26.9% were entirely uncertain how much fertiliser they applied. Given the advice and encouragement the ECB offers in relation to soil analysis for better informed fertiliser management regimes, and the suggested availability of testing, the number of groundstaff unaware of application figures suggests an opportunity to raise the level of understanding in this area.

Table 4.16 Awareness of Applied Fertiliser Content and Volume

Respondents	Unable to provide Fertiliser Content	Unable to provide Fertiliser Use Volume
All respondents (43)	48.8% (n=43)	41.9% (n=43)
Groundstaff (26)	11.5% (n=26)	26.9% (n=26)

As was identified in the literature it is difficult to be prescriptive about fertiliser regimes, and the results from the survey (Table 4.17) highlight a degree of variation not only across climate districts but within districts. 'South West' is the largest mean total user of both fertiliser (456.25 ± 145.19 kg (n=4)) and Nitrogen (95.0 ± 59.0 kg (n=2)) but the standard errors illustrate the width of these variations. As response volumes are small, individual choices rather than climate driven requirements appear to be the determining factor.

Table 4.17 Mean (± SE) Fertiliser Use

Respondents	Mean Total Fertiliser Use (kg)	Mean Total Fertiliser Use per pitch (kg)	Mean Total N Fertiliser Use (kg)	Mean N use g/m^2
All clubs (43)	228.63 ± 55.41 (n=20)	12.11 ± 2.08 (n=20)	23.89 ± 8.63 (n=17)	21.57 ± 11.35 (n=17)
North East (25)	133.57 ± 30.41 (n=7)	10.54 ± 1.76 (n=7)	11.54 ± 2.04 (n=7)	15.42 ± 2.85 (n=7)
Midlands (5)	281.25 ± 206.5 (n=4)	8.26 ± 4.12 (n=4)	12.63 ± 7.93 (n=4)	6.70 ± 2.66 (n=4)
South (4)	181.25 ± 118.75 (n=2)	12.6 ± 7.40 (n=2)	19.88 ± 16.12 (n=2)	22.11 ± 17.02 (n=2)
Wales (5)	108.33 ± 30.05 (n=3)	8.75 ± 5.00 (n=3)	22.5 ± 7.50 (n=2)	33.83 ± 27.31 (n=2)
South West (4)	456.25 ± 145.19 (n=4)	20.98 ± 7.17 (n=4)	95.00 ± 59.00 (n=2)	60.0 ± 40.44 (n=2)

The mean annual N use of 21.6 g/m^2 (n=17) is comparable to the suggestion of 20g/m^2 annually for a clipping removed fine turf surface (Adams and Gibbs 2004), yet the standard error of ± 11.35 g/m2 illustrates the degree to which some clubs may be apart from this. Should fertiliser applications prove above optimum for soil conditions and turf health there are greater consequences than just the cost implication to the club. Production of Nitrogen fertiliser has environmental impacts, excess application could leach or run off piled clippings and 1% of applied Nitrogen is emitted as N_2O to the atmosphere (Bartlett and James 2011). Whilst it has been identified that it is difficult to test exactly for soil Nitrogen requirements those unaware of volume applied will find it entirely impossible to ascertain if this is the required level.

Four of the clubs surveyed (9.3% n=43) identified PGR use. There are implications for environmental sustainability in contrasting ways with such a product. Any restriction of plant growth could aid reduction of mowing and thus fuel use and emissions. However, the regular use of PGRs would have a footprint of production, delivery and financial cost to the club. The positive responses were from different climate districts and the merits of use are best weighed against individual club savings. At venues with high mowing frequencies PGRs may offer considerable benefits and awareness of the opportunities afforded would be sensible.

4.3.4 Aeration

When asked about end of season works no club proffered information on aeration practices. It is possible this is due to the practice tending to take place after remedial works, and is often dependent upon availability of equipment and soil conditions. As a research project is already progressing in this area it may be useful to note the findings in a climatic context.

4.4 Energy Use

Similar to survey responses regarding other natural resource usage, the awareness of energy consumption amongst clubs was limited. More respondents either failed to answer, or did not know their consumption, than could provide energy use figures (Table 4.18); 17 positive responses were given for electricity usage (n=37 have electricity) and 10 for gas (n=24 have gas,) with a further three using liquid gas. Clubs were given time to check figures and update their answers but only two (included in these calculations) did so. 50% of the mean annual electricity use and 60% of the mean annual gas use figures were supplied by non-groundstaff compared with their 39.5% composition of the total respondents (Appendix 4). This could be an example of the previously suggested 'knowledge gaps' through compartmentalisation within clubs or incomplete communications between colleagues. Energy use information should be available from club billing and finance documents and the lack of awareness amongst some personnel suggests information is not routinely shared or promoted throughout the club. Collective action to reduce energy consumption could be encouraged by greater knowledge of what is being consumed.

Table 4.18 Awareness and Mean (± SE) Use of Electricity/Gas

Respondents	Have electricity	Know annual electricity use	Mean electricity use (kWh/y)	Have gas	Know annual gas use	Mean gas use (kWh/y)
All clubs (43)	88.1% (n=42)	56.7% (n=30)	64,283 ± 48,841 (n=17)	61.5% (n=39)	54.2% (n=24)	138,096 ± 76,017 (n=10)
North East (25)	79.2% (n=24)	42.1% (n=19)	120,896 ± 99,874 (n=8)	65.2% (n=23)	53.3% (n=15)	252,850 ± 138,076 (n=5)[1]
Midlands (5)	100% (n=5)	75.0% (n=4)	11,196 ± 5,540 (n=3)	80.0% (n=5)	100% (n=3)	6,106 ± 4,033 (n=3)
South (4)	100% (n=4)	100% (n=2)	3,311 ± 2,888 (n=2)	50.0% (n=4)	100% (n=1)	415 ± n/a (n=1)
Wales (5)	100% (n=5)	50.0% (n=2)	2,000 ± n/a (n=1)	50.0% (n=4)	0.0% (n=1)	No data (n=0)
South West (4)	100% (n=4)	100% (n=3)	27,812 ± 20,314 (n=3)	33.3% (n=3)	100% (n=1)	97,981 ± n/a (n=1)

See Appendix 10 for standard calculations

[1] n=8 knew their annual gas use but n=3 of these were liquid gas users

Annual mean energy use figures cover wide ranges, from the smallest consumption of electricity in 'Wales' at 2,000 kWh/y (n=1) up to 120,896± 99,874 kWh/y (n=8) in the 'North East' and 415 kWh/y for gas (n=1) in the 'South' to 252,850 ± 138,076 kWh/y (n=5) again in the 'North East'. Correlation for climate and energy use figures is, however, made impractical by the large standard errors of the data and the small response volumes provided by cricket clubs. In order to perform an appropriate test of the hypothesis for energy clubs respondents would need to be more aware of their consumption and able to detail these figures. This lack of awareness, of what may be a substantial element of a club's budget and a potentially significant future challenge in the light of climate change and fossil fuel availability projections, is thus of note when seeking to determine recommendations.

It may be that energy use could be considered as a product of heating requirements. However, analysis of the 18.6% (n=43) of clubs who use electricity as their source of heating in

comparison to the non-electricity heating users shows the mean annual electricity use of the former is 8150 ± 3034 kWh/y (n=6) much less than the total mean annual electricity use, 68,176 ± 48841 (n=17), suggesting that this practice is not something that necessarily produces high electricity use relative to other factors.

One of these factors may be facility size as whilst one of the electricity heating users was a Premier League club the remainder were either 'Intermediate' or 'Small' clubs with limited social functions on site. This hypothesis can be used to analyse gas use figures for Premier League facilities to identify if a similar correlation between consumption and facility size exists. The mean annual gas use of Premier League respondents was 105,190 ± 37,986 kWh/y (n=4) against the 'Intermediate' and 'Small' clubs mean annual gas use of 32,440 ± 18,892 kWh/y (n=5), seemingly suggesting that operational requirements may cause energy use divergences, although again the volume of responses renders conclusion uncertain. There was digression on the frequency of facility use amongst the surveyed group. Whilst some respondents identified their clubhouses as providing year round social functions (for non-members as well as club personnel,) others are unheated, unlit and for 29.7% of respondents (n=37) closed outside of match times. This should not impact on the aim to make smaller clubhouses more environmentally sustainable but it should be recognised that there may be a bigger 'footprint' and greater potential for change from the 70.3% (n=37) of structures used perennially. A response to clubhouse discussion from a 'North East' club was that location provides a barrier to greater use. Migration from rural to urban areas has left few members residing near the cricket ground and any funds devoted to improving facilities are likely to find these clubs will still remain closed outside of playing times with their use of energy remaining commensurate with this part time occupancy.

Table 4.19 suggests a varied attitude or capability to make energy savings. The collective number of respondents reporting rising combined bills is higher, 79% (n=38), than the collective number of respondents who have implemented saving measures for energy as a part of this, 61.1% (n=36). Whilst it was suggested that climate was not the primary factor in higher energy

use that region 'North East', which according to its climate summary experiences frequently cool temperatures, sees 85.7% (n=21) report higher bills but only 57.1% (n=21) implement energy saving measures appears to be a sizeable discrepancy. As was identified in the literature, alternative sources of energy may not be appropriate either financially or structurally for a number of clubs and emphasis should be placed on greater efficiency of existing use rather than transferring the source of continued unrestrained consumption. The only way to identify whether greater efficiency is being achieved, however, is if usage is being recorded and noted by club personnel.

Table 4.19 Utility Bill History and Energy/Fuel Saving Measures

Respondents	Have seen combined (water/energy/fuel) bills rise	Have energy saving measures
All clubs (43)	79.5% (n=39)	59.5% (n=37)
North East (25) [1]	85.7% (n=21)	57.1% (n=21)
Midlands (5)	60.0% (n=5)	60.0% (n=5)
South (4)	50.0% (n=4)	100% (n=4)
Wales (5)	60.0% (n=5)	50.0% (n=4)
South West (4)	100% (n=3)	33.3% (n=3)

[1] Two North East clubs have neither electricity nor gas, One has no clubhouse

4.5 Recycling

Collectively waste recycling is practiced by nearly three quarters of all respondents 74.4% (n=43) and more than half compost or recycle their green waste 55.8% (n=43). This is an area where intervention has been shown in the literature to be of variable success and whilst encouragement for recycling would be positive with such existing levels of practice it has to be considered what success directing resources to this area would achieve. However, there are a number of points that clubs should be aware of. Separate collection of waste paper, glass, metal and plastic will be required from 1 January 2015 under the Waste (England and Wales) Regulations 2011, an Act which already demands application of a waste hierarchy on business

disposal in order to meet the UK implementation of the EU Waste Framework Directive (2008/98). If clubs were actively turning green waste and using the compost for dispersal on their land they would need to complete a T23 exemption form available from the Environment Agency, simply allowing the waste to decompose negates this. It should also be noted that washing off grass clippings from machinery into surface water drains is illegal, as outlined in guidance PPG13 (Environment Agency 2007), and isolation or designated area collection of run off water should be maintained.

4.6 Provision of Advice

Analysing requests for advice represents an opportunity to try and discern respondents' attitudes towards the existing and future natural resource consumption of their cricket clubs. Whilst understanding attitudes is not a definite solution to formulating a strategy for greater sustainability, acting on attitudes and intentions requires total control over behaviour (Hagevik and Sheehan 2008) (Wauters et al 2010,) it nonetheless identifies what may be of concern to the target group and how advice may be best directed. Moreover, it may help identify where activities may be constrained by practicalities, or barriers, rather than any intent or aim. As it is it is the role of policy makers to remove these barriers and encourage self-change amongst participants (Darnton et al (2008) citing Stern (2000)) this will better inform recommendations.

No club in the survey responded as being a member of an environmental scheme (n=24) and less than one fifth identified themselves as having an environmental policy (19% n=42). The schemes in mind when asking this question were both national such as ISO 14001, an environmental standard requiring of participants an identification, assessment and plan to reduce their environmental impact, and more local, community based ones possibly requiring less administration yet still demonstrating an attempt to implement a strategy. Yet schemes involving financial cost to the organisation and commission of third party services may not be suitable for smaller cricket clubs, an environmental policy, however, is free and can be

developed internally with the benefit of demonstrating thought has been given to club activity, future development and contingency planning. If, as identified in the literature, there are recruitment and retaining issues across volunteers in sport it is important that club operational details are not the preserve of one or two key personnel. For environmental sustainability to function clubs first need to ensure they are organisationally sustainable. Commitments to responsible progress and interaction with the local environment could additionally act as an aid to promotional and community participation efforts. Less than 20% of surveyed clubs making positive statements in this area provides an opportunity for growth.

To ascertain where clubs may feel they lack knowledge or practical solutions to sustainable issues the question was asked "what advice would help you as a club reduce consumption and costs," allowing for open responses encompassing a potential range of subjects. These responses were divided initially into those believing advice would help and those who considered it would not (Figure 4.06). This latter response was sub-divided into the reasons why respondents did not think advice would help (Figure 4.07), thus highlighting any barriers. Resources would be wasted if they were directed at organisations with challenges beyond the scope of environmental sustainability.

Figure 4.06 shows 67.4% of clubs (n=43) requested advice in managing their resource consumption and expense, 16.3% (n=43) said they did not need advice, with 71.4% of this latter group (n=7) (Figure 4.07) believing this was because nothing would help them achieve the aim of reducing usage and costs. All the respondents of this final group were from climate region 'North East' but this is the largest group of respondents in the survey and these respondents were more likely to be known to the author prior to survey so may have felt better able to reply negatively. Negative responses were received from every type of club except First Class. 4.7% (n=43) did not know what advice would help them and 11.6% (n=43) were no responses. (Appendix 11 highlights advice requests relative to role and proportional representation amongst survey respondents).

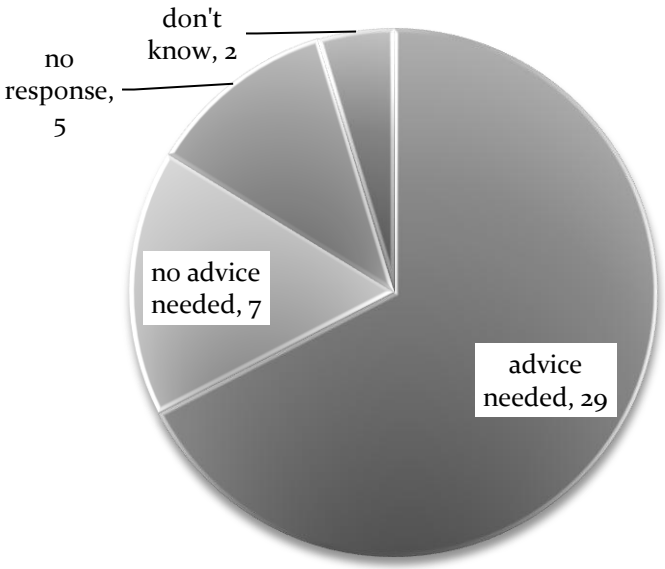

Figure 4.06 What advice would help you as a club reduce consumption and costs?

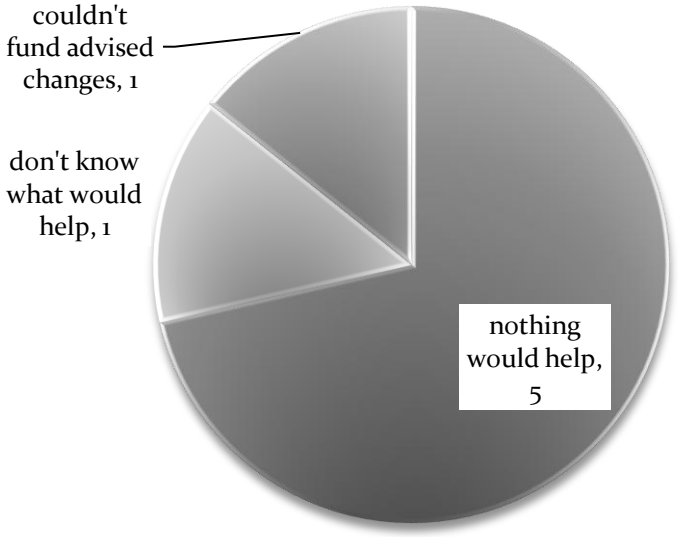

Figure 4.07 Clubs Suggesting No Advice Was Needed

Those who responded with requests for advice were identified by any natural resources they specifically mentioned and keywords regarding practical assistance they felt may be useful (Figure 4.08). Some clubs requested multiple support. These resources and keywords were derived from the areas identified by the literature and survey results as representing

opportunities for enhanced environmental sustainability. By utilising such identifiers it was possible to analyse the responses.

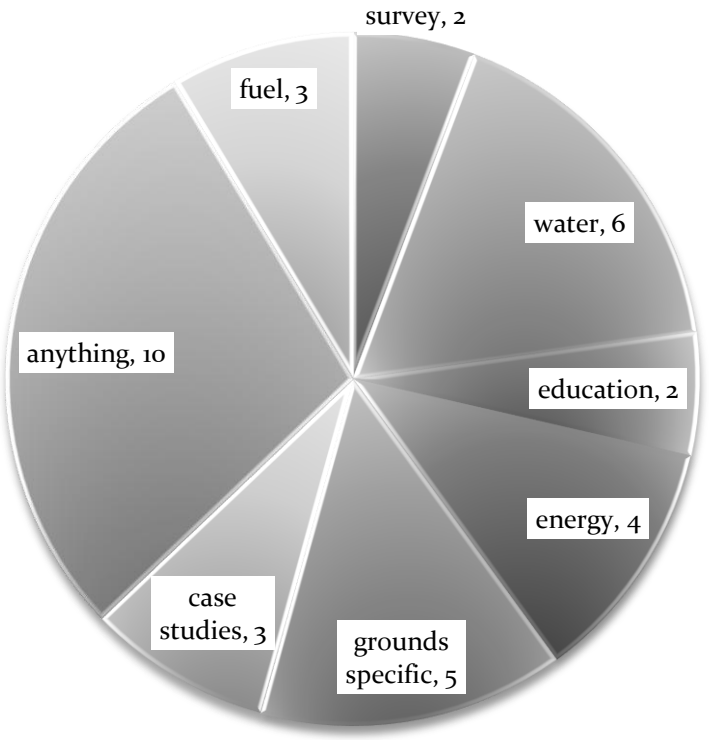

Figure 4.08 Areas Identified By Those Clubs Needing Advice

Keyword; *'Anything', indicating respondent was receptive to any advice*

Such a wide ranging statement suggests a high degree of receptiveness towards advice. To consider that 'anything' would be useful is a positive attitude. Yet a lack of specific detail also implies that these clubs have limited awareness of natural resource challenges and where efforts could be directed to maximise potential for change. 'Anything' could also indicate they have not yet attempted or investigated possibilities themselves. The composition of these responses did not provide any climate based insights, measuring four from 'North East', one from 'Midlands', two from 'South' and three from 'South West.' Club categories of these ten

respondents was similarly varied with four Premier League, three Intermediate, two Small and One First Class affiliation.

Resource; *'Water', indicating specific advice concerning water use was requested*

Two clubs each from three different climate districts requested water advice, encompassing rainwater harvesting, abstraction, more efficient systems and pitch moisture determination. As with the water use survey data these responses were not apparently determined by geography, however, four of the six were Intermediate clubs (the other two were a Small club and a First Class club). An important consideration with water solutions for Intermediate clubs is whether they have the potential to support the requested enhancements. Clearly more efficient systems should be the goal of all clubs but some will involve greater levels of cost and maintenance than others. There seems little strategy in providing a club with a below mean membership and participation level an expensive improvement of facilities, whereas some Intermediate organisations may be on the verge of Premier status and are active Focus clubs with the capability to develop . Whilst any water saved is beneficial, the goal of assistance should be to lead to club self sufficiency which would only be possible with a vibrant structure. Yet it is of benefit to discover that despite the water use awareness figures this topic is the most raised specific suggestion.

Resource; '*Energy', indicating specific advice concerning energy use was requested*

As with water advice, the four requests for energy advice were divided between three different climate districts, and as previously this seemed less relevant than the fact that three of those four were Intermediate clubs (the other was Small, although it does need to be remembered twice as many Intermediate clubs were approached). Solar and underground sources for heat were considered useful to know by one club (and the author is aware they are subsequently tendering for the supply of PV panels). Other suggestions were reducing consumption and more efficient heating, which as with water advice should be priority as the debate is not simply about using alternative sources of energy but lessening the impact club activity has on the environment.

Keyword; *Grounds Specific; anything connected with playing surface operations*

Five requests for surface specific assistance came from three climate districts , two of them were First Class clubs (two Intermediate and one Small comprised the others). Particular turfcare practices such as growing plant stock and management of ball contact areas were raised alongside aeration advice. The former two are perhaps less important to environmental sustainability than the latter which has the potential to reduce fuel use and well-intentioned but possibly misguided efforts. Alternatives to pesticides were mentioned by one respondent and this is an area that would be worthy of further investigation. UK Plant Protection Product Regulations (2005) implement domestic obligations of EU decisions, particularly directive 91/414. Regulation 1107/2009 will be enacted in June 2011 and the Sustainable Use directive (2009/128) will similarly need to be implemented by 14 December 2011. The net effect of these pieces of legislation is to regulate the supply, use, and management of chemicals that may be employed in, amongst others, the groundscare industry. This is a potentially complex area for clubs with considerable legislative information to consider. The Chemicals Regulation Directorate (CRD) maintains a website containing all the details at www.pesticides.gov.uk and it is imperative that clubs realise that anyone using pesticides must be appropriately qualified to do so and responsibility for management of the substances is theirs. The CRD can provide a free code of practice to assist. This thesis did not attempt to examine specific chemical use by clubs but 82.5% (n=40) of clubs indicated they use pesticides.

Resource; 'Fuel'; indicating specific advice concerning fuel use was requested

As with grounds specific advice requests there were three climate districts seeking assistance and again of the three respondents two were First class clubs (the other was Intermediate). This perhaps reflects the near constant daily challenges of maintaining a professional game surface and the demands that places on machinery and fuel use. Whilst First class clubs may be the ones best placed to benefit from newer technology other levels of cricket club could still seek to implement efficiency and their lack of requests on this along with their limited

implementation of measures (Table 4.08) suggests it is not occupying a prominent position in club thinking.

Keyword; Case studies; request for examples of environmental sustainability in similar organisations

Two North East and one South club asked for case studies demonstrating successful implementations of measures specifically in cricket clubs rather than other bodies. Two were Intermediate clubs and the other First Class suggesting that any such studies would need to be operational level appropriate.

Keyword; Club Survey; request for review by external parties of club's practices

Both respondents requesting what would effectively be an audit of existing facilities, operations and management were in the North East; one Premier League club, one Intermediate. The author is aware of a current project within Northumberland Cricket Board (NCB) seeking to provide exactly this; environmental awareness sessions for member clubs and specific club reviews to highlight where management of natural resources could be improved. This could be a useful test case for similar schemes in other counties and a measure of likely national success for recommendations and initiatives.

Keyword; Education; request for education of personnel

Again both respondents seeking enhanced education were in the North East, both were Intermediate clubs. What both expressly asked for was "education of users" which is not something currently within the remit of IOG training courses, which understandably focus on the management of playing surfaces and the education of groundstaff. Whilst the previously mentioned NCB project does seek to link club member attendance at awareness –sessions to any support offered this is clearly not something the game's managing bodies can compel and it should in any case be a central tenet of club self-sufficiency that they seek greater responsibility for the club's consumption from those personnel belonging to it. It would be

remiss to ask for assistance if club members were the source of a problem and had failed to address their attitudes.

5.0 Capacity of Respondents to Manage Change

Recommendations derived from the survey analysis do need to consider the potential of the clubs to make such change. Whilst it is understood that this is an evidence based analysis and should be seeking to promote appropriate solutions based on that evidence, there were factors uncovered during survey discussions that highlight potential barriers to some clubs altering existing activities. If the surveyed group are seen as a microcosm of the cricketing community it is important to identify where success may be achievable and where efforts may need to be directed to allow for that success. There may be many things that could be done to enhance crickets' environmental sustainability but in times of finite resources there have to be priorities and it is of no benefit to squander such resources in pursuit of unobtainable targets.

Ground tenure status of clubs is of interest, not only for the improbability of undertaking improvements on a rented site with an uncertain future, but because applications for funding are often required to confirm security of tenure for a specified duration. The ECB minimum tenure for grant or loan assistance is five years (ECB 2009). Table 5.01 shows almost twice as many respondents rent than own. Table 5.02 suggests that duration of tenure might not be of concern, presenting the mean number of years remaining on respondents (n=26) leases as 105.5 years. However, as the standard deviation (± 262.5) highlights there is a large variation in the responses. Analysing these identified that two clubs had leases of 980 and 999 years respectively, as shown on the histogram Figure 5.01. Removing these two clubs from the calculations provided a mean tenure figure of 31 ± 7 years (n=25). Further examination of the composition of leases in increments of ten years (Figure 5.02) revealed a number of clubs currently operating with fewer than ten years of confirmed ground status, some 26% (n=27) in the situation of requiring an annual lease or indeed possess no lease at all, a 'grace and favour' arrangement. According to existing criteria these clubs would be ineligible for many sources of funding for improvements and given their invidious position should the landowner require alternative use of the site it would be difficult to make a case for changing these criteria. The ECB's National Facilities Strategy (2000) acknowledges that cost effective development is reliant on long term security of tenure and thus recommends prioritising the safeguarding of

facilities threatened by either non renewal of leases or sale of grounds. It is this thesis' suggestion that the opposite should be the case and that priority is given to clubs with existing secure tenure and it is the responsibility of threatened clubs to stabilise their situation before seeking external funding for facility improvements. Resources are finite, they could not afford to be wasted and participation levels may not ultimately be at risk. There is no suggestion that clubs should share facilities as this could provide difficulties for pitch and facility management which ultimately could affect the quality of play and experience but amalgamation or absorption of one club into another could be considered. Ultimately it may be easier for one organisation to support multiple teams with a sustainable policy and a greater number of volunteers rather than two clubs struggle to meet the challenges suggested.

Table 5.01 Ground ownership status of respondents

Respondents	Ground Owned	Ground Leased	Don't know/no answer
All clubs	32.5% (n=43)	62.8% (n=43)	4.7% (n=43)

Table 5.02 Mean (± SE) Ground Tenure

Respondents	Mean tenure (years)
Clubs with leases	101.96 ± 49.7 (n=27)
Clubs with leases outliers removed [1]	30.96 ± 7.3 (n=25)

[1] Two clubs had leases of 980 and 999 years and were removed.

One of the clubs surveyed did not have a club house, and six others were part of multi-sport occupancy of a ground. These clubs may exert limited control over activities within buildings and experiencing shared use of premises can impact on storage of equipment and thus grounds practices. Similarly, older buildings may be less spacious or suitable for purpose. The mean age of clubhouse from n=34 responses was 51 (± 69) years. Original constructions may have been extended but some remain little altered structurally from the middle of the last century. This could pose difficulties for attempted modernisation ('retro-fitting') or provide the clubs with the problem, as one respondent identified, of fundraising not to enhance facilities but to repair and simply survive. Funding bodies, including the ECB, need to consider such clubs

participation rates, commitment to their county structure and importance in the community when deciding whether these are appropriate venues to provide with what could be significant support.

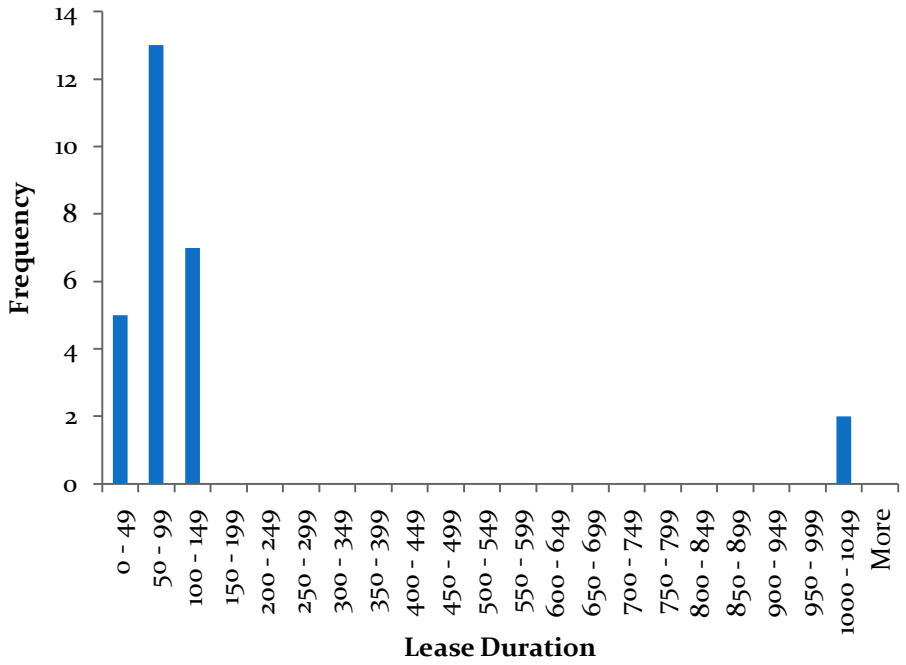

Figure 5.01 Club Lease Duration Frequency

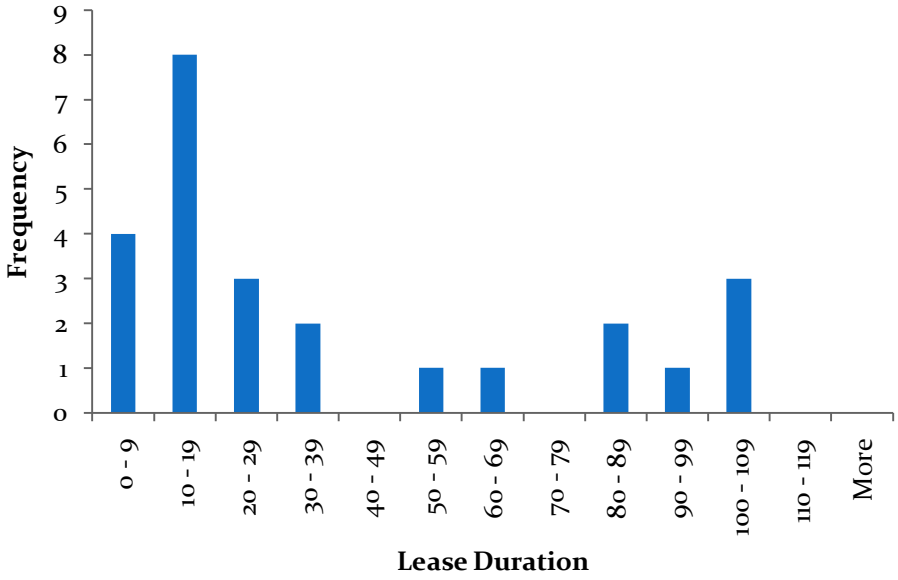

Figure 5.02 Club Lease Duration Frequency outliers removed

Included in the survey was a discussion of club income. Clubs provided membership figures with their subscription payments and fixture details with corresponding match fees (Table 5.03). This enables a calculation of revenues which, while not definitive as the club may have ad hoc charges for coaching events or net sessions for example, give an indication of income separate from any social, fundraising or grant income. This is effectively the income generated by the playing of cricket and could serve as an indicator to the potential some clubs have for initiating change and self-sufficiency should other revenue streams be made unavailable. Moreover, the table indicates the relative levels of participation amongst the study groups (first class club figures were excluded from the analysis due to their high levels of non-playing members and likely distortion of analysis). As previously discussed difficult questions regarding funding sustainability improvements could be informed by such data. Clearly there are significant differences in both cost to play cricket and numbers engaging in the sport across the regions. Further research in this area could provide useful behavioural data.

Table 5.03 Mean (± SE) Membership Income

Respondents	Mean Senior Membership Fee £	Mean Senior Match Fee £	Mean Number of Senior Members	Mean Junior Membership Fee £	Mean Number of Junior Members
All clubs (43)	43.0 ± 6.0 (n=31)	4.3 ± 0.4 (n=28)	125.4 ± 22.0 (n=33)	16.8 ± 4.4 (n=27)	77.9 ± 10.9 (n=36)
North East (25)	29.4 ± 4.2 (n=22)	3.5 ± 0.4 (n=19)	163.7 ± 31.5 (n=21)	8.5 ± 2.1 (n=20)	61.3 ± 7.4 (n=23)
Midlands (5)	55.0 ± 20.0 (n=2)	7.5 ± 0.5 (n=2)	55.0 ± 8.6 (n=4)	17.5 ± 12.5 (n=2)	87.5 ± 26.6 (n=4)
South (4)	103.7 ± 26.2 (n=3)	7.3 ± 0.7 (n=3)	61.3 ± 15.6 (n=4)	54.0 ± 14.0 (n=2)	130.0 ± 76.3 (n=4)
Wales (5)	33.0 ± n/a (n=1)	2.0 ± n/a (n=1)	65.0 ± n/a (n=1)	10.0 ± n/a (n=1)	100.0 ± 40.0 (n=2)
South West (4)	66.7 ± 22.0 (n=3)	5.3 ± 0.9 (n=3)	56.7 ± 27.3 (n=3)	65.0 ± 35.0 (n=2)	108.3 ± 58.1 (n=3)

Clubs' management of their cricket pitch schedule not only has implications for their capacity for change but also the demands placed upon the groundstaff to provide a surface to fulfil fixtures.

Frequent and intensive games increase these demands and potentially limit the choices in respect of sustainability, for example greater use of fertiliser, loam and seed to counter pitch wear. Sometimes, however, it may be the reverse and the lack of time between games renders activities such as watering or cutting outfields impossible.

Clubs were asked the number of pitches they possessed and the number of fixtures played in 2010. A 'fixture' was classified as either a 40-60 or a 20 over game, in either circumstance this would equate to that pitch being utilised for that day (unless clubs sought to play consecutive 20 over fixtures within a single day). Where fixtures may have lasted longer (First class county championship games) the number of days cricket was used to calculate the fixture days. The mean of fixtures per pitch was calculated for each club, and the mean of these calculated (Table 5.04).

A mean number of fixtures of 70.79 (± 39.81) were played by respondents in the 2010 season, a season covering approximately 147 days, depending on regional variations. Almost one fixture every two days would require good planning and management and care should be taken that any recommendations of this project are not lost amidst suggestions of existing commitments.

Whilst it is understood that these fixtures would not simply be averaged across the mean of 14.4 ± 5.22 (n=42) pitches (those on the extremities of a square would tend to be used more for junior cricket than senior games) if a pitch receives no use it has no place existing. That it exists indicates it is used. A figure of 5.23 fixtures/days ± 3.06 (n=42) per pitch (removing First class clubs with their typically greater number of pitches changes the figures to 5.6 fixtures/days ± 3.07 per pitch) does not seem likely to produce excessive wear and use of surface agents such as PVA glue in seeking preserve the integrity of the pitch would seem unnecessary, thus rendering the debate within the ECB's TS4 document about short term gain versus unknown long term impact on soil beyond the data identified in this thesis.

However, there are possible resource use implications in using surface agents. The mean loam use per pitch was 212.91 ± 75.73 kg (n=34,) mean watering duration for pitch preparation 3.06 ± 3.46 hours (n=18). It would be of interest to see if a field trial incorporating surface stabilising

agents and reduced resource inputs could produce surfaces commensurate with performance quality standards.

Given the reported difficulties in recruiting and maintaining volunteers identified in the literature review it is important that too much expectation not be placed on the small core of personnel who run many cricket clubs, avoiding a scenario where environmental sustainability is equated with increased hours for the groundstaff a prominent consideration. The example of the Cranfield rolling guidelines helps identify that recommendations can actually mean a reduced schedule, something fewer outfield cutting suggestions would enhance. This point should be emphasised in proposing recommendations.

Table 5.04 Mean (± SE) Cricket Pitch and Fixture Schedules

Respondents	Mean Number of Pitches	Mean Number of Fixtures	Mean Number of Fixtures per Pitch
All clubs (43)	14.4 ± 0.8 (n=43)	71.4 ± 6.0 (n=43)	5.3 ± 0.5 (n=43)
North East (25)	13.4 ± 0.9 (n=25)	75.3 ± 8.3 (n=25)	5.8 ± 0.7 (n=25)
Midlands (5)	18.6 ± 1.9 (n=5)	64.6 ± 9.2 (n=5)	3.8 ± 0.9 (n=5)
South (4)	13.8 ± 2.5 (n=4)	62.3 ± 16.9 (n=4)	4.4 ± 1.0 (n=4)
Wales (5)	14.0 ± 2.0 (n=5)	54.6 ± 11.8 (n=5)	4.0 ± 0.8 (n=5)
South West (4)	16.5 ± 4.7 (n=4)	85.3 ± 32.2 (n=4)	6.0 ± 2.2 (n=4)

6.0 Survey Review

The lack of data in certain sections of the survey, particularly water and energy use figures, provided difficulty for analysis and mitigated against forming conclusions. However, the main reason for this was respondents' inability to provide the data rather than any survey data capture design flaw and is in itself valuable information in relation to the current state and likelihood of benchmarking club information. Nevertheless, with the benefit of implementation a number of adaptations could enhance the survey and potentially improve the quality of responses;

- The number of clubs per ECB region approached to complete the survey should have been greater so as to compensate for any limited responses. In choosing five per region (and thus climate district) it was considered that a representative sample of clubs in that region would be analysed but when none of the five were able to provide response to certain questions analysis was rendered impossible. In the case of both 'South' and 'South West' only four clubs of the five clubs responded to requests to organise a survey visit. Surveying more clubs would not necessarily elicit this data but it would increase the possibility of it being provided. Time was, however, a factor in this decision and the duration of the survey, and this thesis, would have to have been longer to allow for a higher number of club visits.

- Similarly, caution must be exercised when examining region 'North East' against other climate district data because of the greater number of responses from this area. As discussed previously the higher volume of data this generated was considered to outweigh the concerns over the proportionality of results but again given time an equitable number of clubs from each region would have been sought.

- Unit measurements required from responses could have been more directive. Specifying these may have generated more quantitative data allowing for a larger response size from which to benchmark but this would have been at the expense of the qualitative data,

itself useful in identifying awareness of natural resource consumption, and may perhaps have not provided an accurate reflection of club attitudes.

- It would have been beneficial to have included a requirement to interview specified personnel for each survey as the data supplied by two different people at a club may have been influenced by their particular role at the organisation. Attempt was made to counter this interviewee bias by requests to forward data when obtained, and as previously highlighted it is in itself a useful measure of the compartmentalisation/awareness gap within a group, however there may have been non-responses that could have been answered if an alternative point of contact had been approached. Some clubs were staffed by multiple personnel others saw one person fill many roles, it may have been useful to request organisational details.

- The timing of the survey needed to avoid placing excessive demands on clubs during the busy cricket season but by the time the thesis was commissioned and the survey designed and ready to implement it was too far beyond the end of the cricket season. Those clubs that are only occupied during playing time were closed for the winter and access to water in particular unavailable. This made measurement of flow rates and water pressure unachievable and consequently caused problems for the analysis of watering durations. Had this element of the survey been undertaken during the season it would have been possible to observe and measure watering patterns and timing and thus increase the volume of data in respect of this factor. As with a number of other survey comments the duration of this thesis would not have provided for such latitude.

- The open ended nature of some questions did provide a high volume of qualitative data but also caused additional consideration of how to analyse this. There was limited consensus on exact responses, hence the need to group responses by keywords or specific natural resource. A number of other suggestions were forthcoming but these were unique, highly club specific and unrelated to the topic under examination. It is also noted that there is a wide and detailed literature on behavioural theory that could perhaps contribute to the discussion of club attitudes, motivations and actions but could not be explored within the time limitations of this

thesis. It is felt there is additional research that could be undertaken with regard to the behaviour of cricket club staff in relation to environmental sustainability and attempts to modify that behaviour.

7.0 Recommendations

No attempt has been made to put a specific costing on any recommendations; the aim is to produce a series of proposals that would outline the best course of action as identified by literature review and the survey data analysis. However, consideration of data concerning club finances and practicability of certain options have been accounted for. Clearly there are numerous differences between clubs; economic, social, historical and other such constituents, and advice needs to be targeted towards those able to use it rather than a universal promotion of single solutions. Similarly, recommendations that reduce pitch playing quality are at odds with the safety of the game and the ECB's promotion of PQS and are therefore excluded. To suggest a reduction in the volume of cricket played is not harmonious with promoting the game, meeting developmental targets or encouraging a more active society. Furthermore, it is imperative to recognise that the vast majority of cricket club staff are unpaid and voluntary, altruism is at the heart of the club system. Such people should not be dissuaded from continuing their efforts by any proposed changes. As Defra (2011) suggest of governmental target groups for environmental action, the aim is to enable, encourage, engage and exemplify.

Advice required by clubs to assist with environmental sustainability was the subject of specific questioning, yet the wider survey data has provided for opportunities to highlight advice that clubs were possibly not aware might be useful. Recommendations embrace both.

Water management

With regard to both pitch preparation and facility use, water management is central to these recommendations. Respondents' appreciation of the value, likely future cost, pressures and challenges of the UK water supply is minimal and could be the basis of a significant shock for many cricket clubs necessitating major cultural change.

As Walker (2009) identifies, equipment is not enough, a range of measures are required to increase water efficiency now and in the future.

- Clubs need to become more aware of water issues and establish a water policy that encourages everyone involved with the club to use the resource responsibly. Business Link, in conjunction with Defra and the Environment Agency, publishes a free guide to creating a water use reduction plan (Business Link 2011). This would typically state the scope of the policy (does it relate to both grounds and facilities for example), the personnel responsible for activities, what those activities may be (such as monthly meter readings and promotion of identified savings), future plans and any contingencies should there be interruption of supply. These need not be arduous demands on already active volunteers but a simple regular commitment demonstrating the responsibility of the club to the community.
(A guide to writing a wider environmental policy is also available online at the Business Link website.)

- Greater control of water needs to be exercised. This should include examination of the way water is applied to the cricket pitch to determine if significant volumes are being wasted with a delivery rate far in excess of the infiltration. Clubs could observe this phenomenon and advice could be provided by the sport's governing and consultative bodies.

- Groundstaff should be monitoring the volumes of water being used in surface preparations and if possible have the means of establishing moisture content of pitches. Several companies offer moisture measuring devices and should these become available at cost effective rates it would be useful to organise a performance trial. Research examining pitch quality in respect of reduced applications of water would be useful.

- Movement from the high dependency on mains supply should be promoted and enabled by expert advice, case studies of both large and small solutions and access to opportunities to replicate this success.

- Rainwater harvesting systems may be beneficial installations at some clubs but the provision of such solutions needs to be differentiated according to current and likely use, suitability of premises for installation and club ability to maintain the system. Water abstractions should not be promoted given current Environment Agency concern regarding overuse.

- Qualitative responses suggested negative reactions to water authorities seeking to uphold the legislative requirements of the Water supply (Fittings) Regulations 1999, particularly inspections pertaining to non-return valve installation (the author had to categorically promise one club that their local water company would not be viewing data in order for the survey to be returned). Club compliance is not optional and solutions should be sought in consultation with such bodies to best maximise expert knowledge and awareness. County cricket boards and groundstaff associations could play a role in organising these and efforts be made to bring together repositories of knowledge on relevant water subjects.

- The consultation on Guidance on Concessionary Schemes for Surface Water Drainage Charges (Defra 2010) seems to have passed the attention of those surveyed and yet could have significant financial impacts on clubs. Only 18 individual cricket clubs in England and Wales (plus the ECB) responded to Defra's invitation for comment, none of those in this survey. It is not realistic to expect volunteers to scrutinise every environmental development on the chance they impact on their cricket club, however that such an important measure seemingly attracted so little interest appears reflective of the lack of awareness of environmental issues found in this thesis. If the ECB was effectively representing the sport of cricket perhaps subsequent communication could be examined to provide for greater success in future.

- Awareness and planning for flood events needs to improve. If extremes of weather are to become a more recognisable feature of the climate of England and Wales clubs need to be prepared not just for warmer, drier summers but potentially damaging rainstorms. Flood policies should be ubiquitous and greater attention given to the work being done by the Environment Agency, particularly utilisation of the Flood Alert scheme by clubs in flood threatened locations.

A free to download flood planner is available on the Environment Agency (2011) website alongside a community group flood policy pack. Clubs failing to take such pre-emptive action should not expect to be funded back to a state of health.

Fuel

As the majority of fuel consumption is from grounds maintenance, that is the practice that should be targeted for promotion of greater awareness and planned reduction of fuel. It is noted that there may be reluctance to embrace some recommendations given the variance they represent to established culture and received wisdom. It should be emphasised that changes do not necessarily result in increased workloads or expectations of groundstaff, indeed some suggestions would see fewer hours using machinery. . Case studies represent a useful means of demonstrating successful implementation of such recommendations. Highlighting previous adopters of measures increases the likelihood that non-adopters become aware of the measures and realise the costs and benefits of any adoption whilst reducing the need for internal knowledge (Lenox and King 2004).

- The cutting frequency of cricket outfields mown in excess of twice per week at a non-professional level should be reduced. It would be useful to have additional research data to confirm *Lolium perenne* growth rates in a playing situation but based on existing information outfields are being cut too frequently at obvious cost to clubs and the environment. Whilst acknowledging that elite and high standard playing levels may expect frequently mown surfacesthe recommendation based on this thesis data is that once per week is sufficient for many clubs, twice would allow for no cause for complaint.

- Research would be welcome into *Lolium perenne* growth rates at a maintained height of 3-5mm in a heavily compacted clay loam (pitch conditions), potentially in conjunction with reduced water use. The standard error of ± 0.36 hours (n=27) on a mean of 2.15 hours per preparation identifies some clubs are managing their pitches with far less cutting than the mean.

It would be useful to know if their pitch reports were significantly different to those cutting either on or above the mean.

- Fertiliser awareness and management needs to be significantly improved. The potential environmental and economic savings make more efficient use a highly valuable commodity. However, it is acknowledged that information is already made readily available by the game's advisory bodies.. Groundstaff have opportunities to be informed on fertiliser decision making and access to soil analysis testing. This subject is routinely addressed on IOG cricket training courses, often discussed in their monthly publications to members and is further supported by the work of ECB county pitch advisors. Ultimately the market and club finances may dictate choices and lead to greater awareness. Rather than additional funding be risked in support of yet more such advice it may be valuable to consider alternative strategies with evidence taken from behavioural studies and similar work in the agricultural sector.

- Additional research on the potential of PGRs for cricket grounds preparation would be useful to ascertain if there is opportunity for reducing inputs and consumption of resources. It would be necessary to show that the environmental and economic cost of production, purchase and continued use by the cricket club would be exceeded by the savings from reduced water, fertiliser and mowing activity.

- The promotion and use of non-turf pitches should be investigated. There is possibly the potential to reduce levels of both fuel and water consumption by having more fixtures staged on non-turf surfaces. Research in this area would be sensible.

Energy

- Any resources towards providing enhanced energy measures for clubhouses should be targetted towards specific venues rather than available to all. . The analysis showed.that 40.5%

(n=37) clubhouses had no energy saving measures but 29.7% of clubhouses (n=37) were not used outside of matches, some of these clubs stating they did not have energy saving measures as there was little usage to save on. Clearly greater efficiencies could be attained from those venues that are used year round but have been unable to initiate renovations that would help reduce waste. Similarly some of the seasonally used clubhouse may be brought into more frequent operation given assistance; this could keep revenue within the game rather than any expenditure that may currently be directed to alternative social centres. Clubs using limited energy, with no desire to operate year round, could remain potential recipients of assistance in other areas, such as reducing their water consumption.

- Funding from within the game should initially focus on assisting clubs to reduce energy consumption and improve efficiency of usage prior to any schemes seeking to develop renewable energy solutions. Buildings and personnel need to minimise waste before they request what may be high initial cost, longer term investments in features such as PV panels. The recommendations of the Carbon Trust to small businesses in the sports sector are to; introduce an energy efficient culture, monitor heating and cooling basics and install lighting controls. With a finite budget these measures could be implemented in many more cricket clubs than could receive alternative energy provision.

- Alternative energy solutions such as PV panels need to be properly costed to gauge expense of installation against likely returns in terms of both financial savings and earnings from any feed in tariff arrangements. The Energy Saving Trust www.energysavingtrust.org.uk provides calculators of such but points out that various options of installation make generic determination impossible. It is also of note that the Department of Energy and Climate Change is currently conducting a review into this area with the results due by the end of 2011.

- Any funded measures for energy improvements should, as with other areas of provision, establish that the recipient club has the means to maintain the improvement.

If clubs are to benefit from funding and the assistance of their county cricket board it may be necessary to prioritise the deployment of resources. The findings of this survey identify that Focus clubs provide the greatest participation levels within the affiliated club structure by hosting the most days of cricket. Focus clubs play an average of 80 ± 8.6 fixtures (n=25), compared with 67.5 ± 16.4 (n=6) for Club with Youth sections and 48 ± 11.3 (n=6) for Club affiliations. Focus clubs represent the key intervention of the 'Strategic Club Network' (Sport England Cricket Progress Report 2010) as the sport seeks to raise particpation levels. However, there may be the potential for clubs currently outside this, the 'Wider Club Network' (Sport England Cricket Progress Report 2010) to increase their playing numbers and role within the game if they were given access to advice and investment programmes. Prioritisation may therefore be best identified by well-informed local boards, assisting clubs according to their potential to become self-sufficient and develop the club accordingly.

8.0 Conclusion

It is possible to demonstrate success in meeting the stated objectives of this thesis and gauge accuracy of the hypothesis.

The measurement of current activities at a representative selection of cricket clubs with respect to management and use of water established that the mean annual water use was 414.27 ± 120.27 m^3 (n=13) and that mean watering duration for pitch preparation was 2.92 ± 0.78 hours (n=19). Regional data was correlated with seasonal weather and a consideration of climate but found to be inconclusive, as was the type of loam used for pitches. However, whilst these figures may be useful in providing a limited benchmark for mean behaviour across all levels of club cricket a more important series of indicators for the recommendations in this thesis were the non-responses, the responses unable to provide quantitative data and the responses indicating clubs had no knowledge of an issue. These figures; 78.6% (n=42) of clubs being metered but only 21.4% (n=33) being aware of annual grounds use of water, 19.5% (n=41) aware of the possibilities of water extraction and 36.6% (n=41) having considered rainwater harvesting highlighted the lack of appreciation for some of the key challenges identified in the discussions of climate change.

The measurement of current activities at a representative selection of cricket clubs with respect to management and use of fuel identified a mean annual diesel use of 383.3 ± 105.4 litres (n=26) and a mean annual petrol use of 224.0 ± 83.9 litres (n=27). Rather than usage being related to climate district it was established that a First class club affiliation and frequency of operations provide a more likely correlation, the mean of First class club fuel use, rolling, pitch mowing and outfield cutting being higher than other levels of club.

The measurement of current activities at a representative selection of cricket clubs with respect to management and use of energy did provide a mean annual electricity usage figure of 64,283 ± 48,841 kWh (n=16) and a mean annual gas usage figure of 138,096 ± 76,017 kWh (n=10), however standard errors and response volumes are of such magnitude as to render benchmarking using these numbers a potentially inaccurate depiction. As with water use the

analysis of energy consumption by clubs would have benefitted from greater respondent awareness of operations, leaving this lack of appreciation for the activity as perhaps the most important result of the survey. 59.5% of clubs either failed to answer or could not identify their electricity use and 66.6% of clubs did not or could not respond to request for gas use figures. The limited comparison these omissions allowed seemed to suggest size of club and facilities were more of a determining factor towards energy usage than climate.

The measurement of current activities at a representative selection of cricket clubs with respect to grounds practices that consume natural resources was suggested to be a determining factor behind fuel use figures. Only 7.5% (n=40) of clubs had attempted to implement fuel saving measures for practices other than car sharing. The lack of awareness of fertiliser use content (11.5% n=26) and volume (26.9% n=26) amongst groundstaff was considered notable.

The analysis of the relationship between these activities and regional climate variations was restricted by a lack of quantitative data but from the results that were provided the suggestion was it was inconclusive.

The recommendations for greater environmental sustainability within cricket clubs are;

- Raise water use awareness and management.
- Improve the efficiency of water use.
- Encourage alternatives to main supplied water.
- Raise flood awareness and planning.
- Improve the efficiency of grounds operations.
- Greatly increase fertiliser use awareness and management.
- Invest in research on; PGRs, non-turf surfaces and reduced water applications for pitch preparations.
- Raise energy use awareness and management.
- Improve the efficiency of energy use.
- Consider any investment in club facilities concerning natural resource use against their commitment to improving awareness and efficiency, their ability to maintain the facility,

their opportunity to increase their participation in cricket and their likelihood of becoming self-sufficient.

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Appendices

Appendix 1 UK Met Office Climate Districts 2011

There are 11 UK climate districts. Scotland (n=3) and North Ireland (n=1) have been excluded as they are not within the jurisdiction of the ECB. North-West England & IOM (n=1) and Eastern England (n=1) have not been detailed as none of the surveyed clubs were located in these districts for analysis purposes.

UK Met Office 2011 details regional climates summaries that aim to describe the main features of each region's climate, focusing on the latest 30 year averaging period of 1971-2000 (http://www.metoffice.gov.uk/climate/uk/regional/

Appendix 2 Club Survey

Preparing for Discussions for the Sustainable Cricket Project

Thank you for agreeing to meet for a discussion on the Sustainable Cricket Project. Now that we have confirmed a date you might find it helpful to read through this document, which has been written to help you get the most out of our meeting.

As I am sure you are aware, the Sustainable Cricket Project aims to develop guidance for cricket clubs on how to reduce the impact of weather and climate on cricket clubs and how to reduce the impact of cricket on the climate. The project has three key themes:

1. Managing flooding
2. Managing water shortages
3. Managing resource consumption

Over the next two cricket seasons we shall be gathering data from a range of clubs who have kindly volunteered to take part in the project. These data will include:

- How much water you are using, where it comes from and when.
- How much electricity and gas are used.
- How much fuel is used.
- How much fertiliser, pesticides and loam is used per year.
- Flood/drought history and strategies to prevent/overcome.
- What advice would help you?

What is the meeting for
To develop effective guidance for cricket clubs and a strategy to improve the environmental sustainability of cricket, we need to benchmark how resources such as water, energy, fuel, chemicals and loam are used in cricket. This information is not known currently but is essential to develop advice that can be used at a regional and national level. We don't have the data we need to answer these questions – we really need your help. We are expecting to find a huge range in the data, reflecting the size of the cricket club, the amount of cricket played and in particular regional variations in weather. We need to capture that variation – this isn't an audit exercise, it's more of a fact finding mission to answer the questions: 1. What is cricket doing well? Can we learn from best practice? 2. What would help cricket improve their sustainability and reduce costs? 3. How does cricket compare to other sports/industries?
What is the plan for the meeting? (including 'How much time will it take?')
The meeting should take around 1.5 hours, depending on what you would like to contribute and how easy it is to access the data we need. To help keep your time commitments to a minimum we have included some 'prep' that will help speed the meeting up and get the most useful data (see the next section). I will come and visit you at your club at the arranged time. I would like to start the meeting by finding out a bit about your club. I'll then ask you a series of questions such as 'How many cubic meters of water do you use per year?', 'How much fuel do you use on your grounds' and 'How many units of electricity do you use per year?' We will then look at a few standard questions I have and discuss aspects of how the weather affects your club in particular.

How can I prepare for the meeting?

There are some really useful documents that would help with data gathering that you will probably be able to put your hands on. These include

- Water bills
- Electricity bills
- Gas bills

Please note – we don't need to know how much you pay (we won't record any information about that), just how many units were used.

- The amount of diesel and petrol used on site.
- The quantity of fertiliser used every year (and the N:P:K specification)
- The quantity and types of sprays used on site (if you use contractors for spraying, this information might well be on invoices)
- The amount of loam used in top dressing renovations and constructions
- Where your irrigation water comes from

Invoices are usually the best source of information for these data

- How big is the hot water tank (or how long do the showers last)?
- How many pitches do you have on your square
- How many fixtures do you have on your square(s) per season (including youth).
- How many sides do you put out?
- How many do you have in your youth section?
- Do you maintain non-turf pitches (either on the square or in nets)?

If you could have a think about these numbers and what they have been over the last five years that would really help. Don't worry if you don't have the exact numbers – we have a series of questions that will help us estimate.

Some questions to think about

Some other things to think about would be:

1. Are your facilities just used for cricket or are they shared?
2. What events other than cricket do you use your facilities for?
3. How many fixtures have you lost to the weather over the last 5 years?
4. Have you ever been affected by flooding?
5. Have you ever been affected by water shortages (e.g. watering bans)?
6. What percentage of your annual costs are spent on the grounds and facilities?
7. What advice in this area would help you?
8. How could the ECB help you with 'Sustainable Cricket'?

What will we be doing with the data?

We shall be analysing the data to look at regional trends and trends in similar clubs across England and Wales. We will never publish your data on its own or identify your club in anyway – your confidentiality is important to us.

The project aims to benefit all cricket and works at a range of club levels from First Class to the small club.

Your input will benefit all cricket but it will also benefit your club directly:

- By helping us, we can provide data that will help you manage your resources and potentially cut costs at your club.
- The project is being conducted on a regional basis so guidelines will be specific to your region
- We will be developing strategies and guidance to help with flooding and with water shortages that will be of direct use for your club.

We will be forecasting future changes due to climate change – this will help your club plan for the future.

Data Management

Please note: All data will be treated in the strictest confidence. We shall not identify your club on any paperwork associated with the data (we will use a coding system with a key that will not be published or shared with anyone, including the ECB). We will only report data as an aggregate

of clubs, we will never report on an individual club basis.
Contact in case of queries
All enquiries to: Dr Iain James, Head of the Centre for Sports Surface Technology Building 42, Cranfield University, Cranfield, MK46 4EU i.t.james@cranfield.ac.uk 01234 750111 (ask for extension 2736)

About the Club			
Club ID number			
Date			
Time			
Held with			
Location	Club / Home / Work		
Adult XI's (men)	Saturday	Sunday	Midweek
Adult XI's (ladies)	Saturday	Sunday	Midweek
Number of adult fixtures	20 overs/side	40-60 overs/side	Other:
Junior section	U8 U9 U10 U11 U12 U13 U14 U15 U16 U17 U18		
Junior numbers			
Junior fixtures			
Membership			
ECB affiliation	Non / Club / Club with Youth / Focus Club		
Tenure	Owned / Leased (specify period remaining: years)		
Other information:			

Environmental History	
Have you ever been affected by flooding?	When? Duration under water? Impacts on grounds? Impacts on facilities? Financial impacts. Emotional impacts. Impact on cricket programme.
Does flooding affect your insurance?	
Are you at risk of flooding according to the Environment Agency?	
Are you signed up to their alert scheme?	
Do you have flood mitigation measures on site?	Eg raised pavilion, flood prevention bunds
Do you have a flooding policy?	
Have you ever been subject to a water use restriction?	E.g. Hosepipe ban When? How long? Impact:
Other information:	

Facilities	
Clubhouse	
Age	
Bar	
Use during season	
Use out of season	
Heated out of season	
Heating system	
Energy saving measures?	
Flood mitigation measures?	
Water harvesting measures?	
Other information	
Waste	
What happens to your sewerage?	
What happens to your storm water?	
What happens to refuse?	
Do you recycle?	If yes what:
What do you do with grass clippings?	
What do you do with waste soil?	
What do you do with machinery after life?	

Grounds	
Number of grounds	
Square managed by:	Club / Contractor / Local Authority / Other (specify):
Number of pitches:	
Typical pitch prep:	Watering: Days/ Duration/ Quantities/ Source Rolling: Days/ Duration/ Roller type/ Aware of guidelines? Mowing: Days/ Duration/ Mower type
Closed season renovations	
Annual fertiliser use	Including fertiliser specification: N: P: K: Or brand/product
Annual grass seed use	
Annual loam / topdressing use	
Pesticide use	
Outfield managed by:	Club / Contractor / Local Authority / Other (specify):
Irrigated outfield	
Cutting frequency	
Fertiliser /Pesticide use?	Usage: Type: Storage:
How do you maintain your machinery?	
Where do you wash down machinery?	
Fuel and chemical storage?	Location: Quantities:
Other information	

Water	
Is mains water use metered?	
If metered what is annual usage?	
What is annual usage by grounds?	
Is public mains water used for irrigation/watering?	If yes – estimate quantity (look at flow rates on site and ask for typical durations)
Is on-field water supply protected by non-return valves?	
Other use for public mains	Bars and catering Showers Other
Do you abstract water?	
Source	River/stream (name)/Borehole/Other
What is the cost?	
Abstraction method	
Licensed quantity	
Storage capacity	
Abstracted quantity	Summer: Winter:
How monitored?	
Used for:	
Is the ground drained?	
Where is discharge?	
Other information	

Energy	
Annual electricity consumption	If last year, is this typical?
Annual gas consumption	If last year, is this typical?
Is gas from mains or LPG tank?	
Liquid fuels for heating / hot water?	
Energy saving measures?	
Fuels for machinery and equipment	Diesel Petrol Other (if unknown, look for machinery specs and typical refilling behaviour)
Fuel saving procedures? (e.g. carshare /mowing patterns)	
Other information:	
Policy, procedure and awareness	

Have your energy/water/fuel bills gone up in recent years?	
Have you taken measures to address this?	
What percentage of annual budget is spent on fuel/ water/energy?	
Does the club have an environmental policy	
Is the club a member of an environmental scheme (eg ISO 14001)	
Have you considered energy saving measures in the club house and buildings?	
Have you considered energy saving measures on the grounds?	
Have you considered water harvesting?	From roofs? From waste water sources?

Were you aware that you could abstract 20 m^3 / day without a licence?	
What advice would help you as a club reduce consumption and costs?	
Other information	

Appendix 3 ECB Regions

Region (5)	County Cricket Boards (39)
South	Berkshire, Buckinghamshire, Cornwall, Devon, Dorset, Gloucestershire, Hampshire, Isle of Wight, Oxfordshire, Somerset and Wiltshire (11)
London and East	Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Huntingdonshire, Kent, Middlesex, Norfolk, Suffolk, Surrey and Sussex (11)
Midlands	Derbyshire, Herefordshire, Leicestershire (& Rutland), Lincolnshire, Northamptonshire, Nottinghamshire, Shropshire, Staffordshire, Warwickshire and Worcestershire (10)
North	Cheshire, Cumbria, Durham, Lancashire, Northumberland and Yorkshire (6)
Wales	Cricket Board of Wales (1)

Appendix 4 Respondents by club status, affiliation, location and respondent role

Club Status	ECB Affiliation[1]	Location	Role of Respondent
First class	First class	Urban[2]	Groundsman
5/43 (11.6%)	5/43 (11.6%)	26/43 (60.5%)	26/43 (60.5%)
Premier League	Focus	Semi-urban	Club Secretary
8/43 (18.6%)	25/43 (58.1%)	8/43 (18.6%)	8/43 (18.6%)
Intermediate	Club with Youth Section	Rural	Chairman
23/43 (53.5%)	6/43(14.0%)	9/43 (20.9%)	4/43 (9.3%)
Small	Club		Other[3]
7/43 (16.3%)	6/43(14.0%)		5/43 (11.6%)
	Not affiliated		
	1/43 (2.3%)		

[1] The ECB has its own designation of clubs depending on the commitments they have made.

[2] Urban as defined by UK Office for National Statistics (2001)

[3] Cricket coach, operations manager, local authority or grounds contractor

Appendix 5 Lack of response by role

Role of Respondent	Groundstaff 25/42 (59.5%)	Club Secretary 8/42 (19.1%)	Chairman 4/42 (9.5%)	Other[3] 5/42 (11.9%)
Number of Non-Responses	n=97	n=50	n=38	n=55
Non-responses per respondent	3.88	6.25	9.5	11

[3] Positions such as cricket coach, operations manager or grounds contractor

Appendix 6 Standard duration of rolling calculations

Shipton (2009) calculated (based on Baker et al's 2001 rolling trial) that assuming a 1.2m wide roller moved at 1km/h the total passes per hour of a 1.42t and 1.93t roller across 238m^2 would be 5.05 passes. 238m^2 = 3.88 cricket pitches, giving a sum of 19.59 passes across a pitch per hour. Shipton's own survey data (2009) identified a mean club rolling (spring) of 51 passes per pitch and 2.3 hours per pitch. This is 22.17 passes per hour. Mean club rolling (summer) in the same survey was 77 passes and 3.3 hours. This is 23.33 passes per hour. Total mean of these means plus the mean of the calculation after baker is 21.7 passes per hour. This figure has been used to convert this survey's 'passes' responses to hours.

Appendix 7 Standard fuel efficiencies of outfield mowing machinery (Bartlett & James 2011)

'Triples greens mower' 8.047 L/ha

'Fairway mower' 2.895 L/ha

'Pedestrian mower' 3.636 L/ha

Appendix 8 Standard duration of pitch mowing calculations

Using Spon's External Works and Landscaping (2003) a sum of £4.01 is given as chargeable rate for "cutting 100m2 of fine turf, using pedestrian guided machinery; arisings boxed and disposed of off site." Maintenance contract rates are provided as £12 per hour. This allows a calculation for the expected duration of the 100m2 cutting of 20.1 minutes. A cricket pitch is 66.31m2 which equates to 13.3 minutes of Spon's estimate. This figure was used as the standard figure for conversion of non-time responses.

Appendix 9 Standard duration of outfield mowing calculations

Using Spon's External Works and Landscaping (2003) a sum of £0.33 is given as chargeable rate for "Grass cutting; 100m2 standard turf, using self propelled 3 gang machinery per occasion." Maintenance contract rates are provided as £12 per hour. This allows a calculation for the expected duration of the 100m2 cutting as 1.67 mins (or 100 seconds). The mean outfield area mown is 1.03 ha and it is mown a mean of 2.13 times per week giving 2.19ha or 21,900m^2 in total. Cutting this area equates to 21900 seconds of Spon's estimate, or 6.08 hours

Appendix 10 Standardisation of energy calculations

Where unit response given was either units or £ data was standardised to kWh using figures for mean pricing/ being obtained from the Dept of Energy and Climate Change (2011) (£0.123 per kWh for category "very small non-domestic user" electricity use in 2010 and £0.032 per kWh for "very small non-domestic user" gas use in the same period).

Appendix 11 Analysis of request proportionality to percentage respondents

Respondent	Number of Advice Requests	Percentage of advice requests to respondents
First class 5/42 (11.9%)	7 advice requests	140%
Premier League 8/42 (19.1%)	5 advice requests	62.5%
Intermediate 22/42 (52.4%)	17 advice requests	77.27%
Small 7/42 (16.7%)	5 advice requests	71.43%

Back cover