North Norfolk Dark Sky Survey

Initial Survey Results Phase 1, March to May 2010.

The work is being carried out by members of the **North Norfolk Astronomy Society** (**NNAS**) with help and co-operation from **Norfolk Coast Partnership** (**NCP**). Our equipment was purchased from funds provided by the **Big Lottery Fund** and **NCP's sustainable development fund.**

Survey Team J.Prockter, D.Waites, C.Hards, M.Green, J.Ramm

Introduction

The quality of our night sky is very important, not just to astronomers but to anyone who appreciates the beauty of night-time features like star constellations and the milky-way. Norfolk and particularly North Norfolk have some of the best quality night skies in England, a point appreciated by residents and the local tourist industry.

The purpose of the survey is to establish a benchmark for the night sky quality, defined by the absence of light pollution, along the North Norfolk Coast.
As most of this location is also classed as an Area of Outstanding Natural Beauty, it has been given priority for the initial work. Future work will extend further inland and ideally more of North Norfolk will be surveyed if we have the facilities.
Alongside the quality readings, a series of 360 deg. photographs are being taken to identify light pollution sources. These need to be seen as part of the overall exercise.

Method

The readings are recorded using a Sky Quality Meter (SQM). There are two types of SQM available to us,
1) a manually held device with a visible digital display and
2) a fixed device that is attached to the roof of a vehicle with a USB readout that is fed into a laptop computer.
We now have two manual and one fixed meters.
The SQM records the light from the night sky and is calibrated to give a reading from 1 to 23. Normal night conditions will range from about 15 in a town to 21 or more in a very dark open area. The units of measurement are magnitudes per square arcsecond. The method used is to point the meter straight upwards and press a button to take a reading. The reading is prominently displayed and written down on a record sheet. Eight readings are taken at each location, the highest and lowest are discarded and the remaining six are averaged to obtain a final reading for the site. At present, readings have been taken at about one km intervals in an East to West direction with further sites inland. For convenience all readings have been taken in close proximity to roads.
Photographs have been taken using a high quality Digital Camera and Fisheye lens. As the intention is to record light sources as far as the horizon, high points have been chosen for this work.
A full description of survey methodology is held on the NNAS website.

Readings

A sample set of readings for one night's work is shown on the Chart 1. This shows a set of 20 final readings and their locations. The full set of readings is held on the NNAS website and at other secure locations.

Chart 1 shows the location using the Ordnance Survey grid system and the averaged reading for the site in magnitudes per square arc second (mas). This term is more fully explained in the appendix.

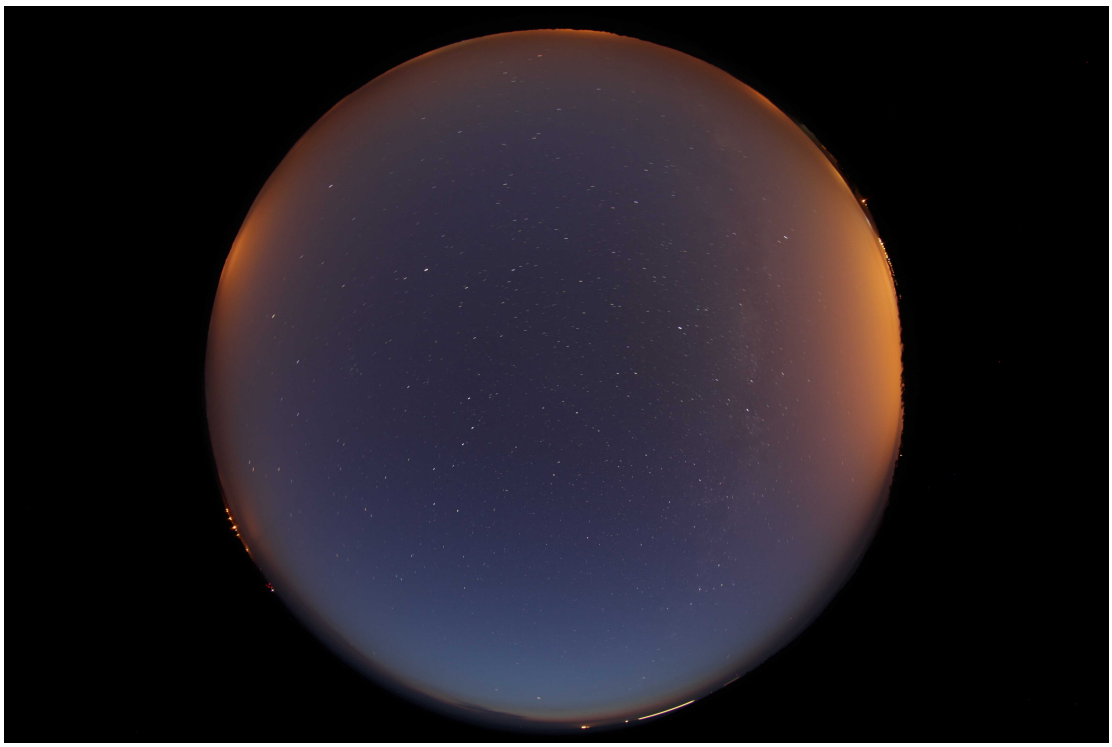
The mas scale goes up to 23 with the higher reading showing greater darkness and hence better night sky quality. So far, few of our mas readings are below 20. In fact the meter readings are to two decimal places but we round the final results to one decimal place, typically 21.6 which was recorded at Cley.

It is worth noting that these readings have a logarithmic basis, each mas magnitude lower means that just over 2.5 times more light is being received. A change of 5 mas means a 100 times increase of sky brightness. Therefore, a reading of 21.0 would be about 100 times darker than a reading of 16.0.

Photography.

This photograph was taken from the top of the Gazebo in Sheringham Park. This clearly displays light pollution from the horizon, the largest source of sodium light coming from the direction of Cromer. As the Pole star is discernable, it is possible to accurately orient the photograph on a map of Norfolk to identify the pollution sources.

S



N

Permission has been given to take the next picture from the tower of Langham Church.

A series of photographs taken from strategic high points will pinpoint the light pollution sources and help assess their magnitude.

Conclusions

In this initial phase we have made a total of 114 readings over a distance of about 60 km from East to West. These readings are the start of the database which will be expanded later this year. It will also need to be checked by taking spot readings to confirm the accuracy and to monitor any longer term trends in sky quality.

From the initial spring results, the coastal area has a very good quality and it has become evident that further work inland is needed to find how far this high quality extends. So far, few recordings have been made in illuminated urban areas, some of the readings are unnecessarily close together and one area is rather barren. We need to take account of this in future planning with a likely objective of making one reading within every square kilometre.

Readings can only be made when a) there is no twilight b) no moon and c) when there is no cloud. Although we can plan for night time with no twilight or moon, cloud is fairly unpredictable. These restrictions have seriously hampered the survey. Because the survey equipment was not available until the beginning of March there was limited time available before it became impractical to take readings. In the period between March and early May when the survey ceased, although there were 48 possible nights, less than10 had clear skies. Having said this, the first group of readings cover most of the area that was initially identified and the process has been tested and refined so that Phase 2 commencing in September 2010 can be better planned and carried out.

In this context, it is essential that we can adopt a method of identifying a suitable night. When readings have been re-taken on different nights there have been some variations in the readings suggesting that sky conditions, although looking similar were in fact different. This is a very subjective area and the meters are very sensitive but the important action seems to be identifying cloudless periods. Also, there are slight differences between the three metering devices which suggest we need to produce a simple calibration method.

The conditions are not so critical for the photographic work although a starry night helps to orient the direction by way of the pole star.

Inevitably, the question is asked "how does North Norfolk compare with other British dark skies?" The highest readings in this first phase were 21.6 at Cley and 21.7 at Langham airfield. The average of all readings taken was 21.07 although this average over such a large area is probably meaningless. There are various ways to display the numerical results and the method finally chosen is in the accompanying chart, titled **Mapped Results.**

As an example of other locations in the UK, the best reading recorded at Galloway National Park in Scotland is 22.7 and in Exmoor, as far as I know just below 22.0. However, these are by definition, National Parks with far less if any, urban content and stricter control of road/street lighting. A survey around Buxton gave results in the 20.5s.

So, considering the size of the Norfolk Coastal area, the number of roads and villages with associated small industry, these results are good. One surprise was a reading of 20.1 within a mile of the Bacton gas terminal, suggesting that some effort has been put in here to mitigate the pollution from such a large industrial site. It now seems unlikely that a darker location than 21.7 will be found in Norfolk but there is good reason to at least try to maintain the overall dark level even if it cannot be improved. Subsequent work, deeper into Norfolk may allow some contours of darkness to be mapped around towns.

John Prockter
JPDarkSkies@aol.com

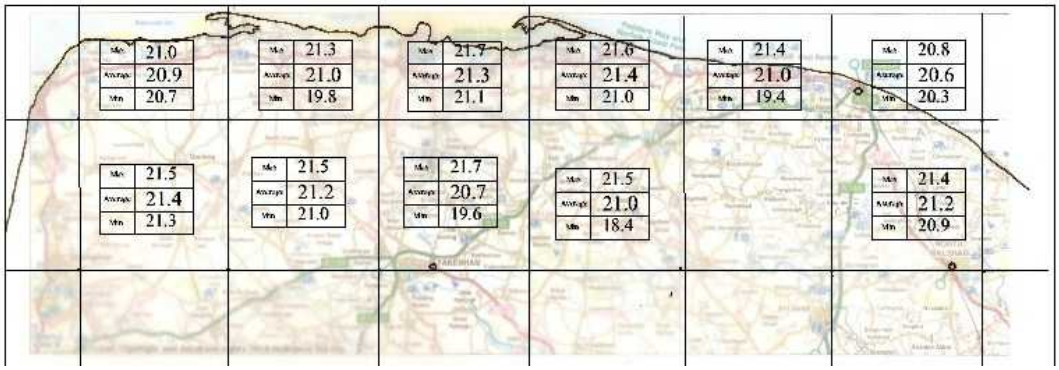
Chart 1

This shows a **typical** set of readings with the location, grid reference and meter reading.

05/04/2010	USB SQM		
LOCATION	MAP REFERENCE		READING
Cromer	TG	233410	20.93
Overstrand	TG	242409	20.82
Sidestrand	TG	262395	20.93
Tringham	TG	271393	21.01
RadarSite	TG	287384	21.19
HotelWindcliff	TG	298377	21.07
Paston	TG	325346	20.73
Bacton Green	TG	337344	20.16
Swafield	TG	284324	21.05
Trunch	TG	284360	21.29
Southrepps	TG	267363	21.35
Southrepps	TG	245366	21.40
Roughton	TG	215375	20.91
FelbriggRoad	TG	214378	21.42
FelbriggRoad	TG	207397	21.34
Grove Farm	TG	181407	21.36
Sheringham	TG	147410	21.43
Bodham	TG	133405	21.38
Kelling	TG	110400	21.44
Holt	TG	94393	21.23

Mapped Results

This is a map of the North Norfolk coast based on the Ordnance Survey grid system. Each grid box covers an area of 100 square km. Results in the grid show Average, Minimum and Maximum readings from Phase 1 of the exersize. No readings were taken within town boundaries. The mapping system will be expanded in Phase 2 to provide greater detail and accuracy and will allow results close to, and within towns and villages.



Appendix

Magnitudes

Magnitudes are a measurement of an objects' brightness, for example a star that is 6th magnitude is brighter than one of 11th magnitude. The typical limiting magnitude of the human eye is around 6.5 to 7.0.
Quite often astronomers will refer to a 5th magnitude sky. In that case you can see 5th magnitude stars and nothing dimmer like 6th magnitude stars. The term 6th magnitude is very subjective, for example an adult might say "6th magnitude skies" while a child with better vision might say "7th magnitude skies"

Mags/arc.sec

The term arcsecond comes from an arc being divided into seconds. There are 360 degrees in a circle, each degree is divided into 60 minutes and each minute into 60 seconds. A square arc second has an angular area of one second by one second.
The term magnitudes per square arc second (M/sAsec) means that the brightness in magnitudes is spread over an arcsecond of the sky. If the SQM gives a reading of 20.00, that would be like saying that a light of one 20th magnitude star brightness was spread over one square arcsecond of sky. More information is on the NNAS website.

Sky Quality Meter

This meter is produced by the Canadian company Unihedron. The UK agent is Altair Astro in Aylsham, Norfolk.

Links

North Norfolk Astronomy Society	www.nnas.org
Norfolk Coast Partnership	www.norfolkcoastaonb.org.uk
Unihedron	www.unihedron.com
AltairAstro	www.altairastro.com
Sky Brightness Nomogram	http://www.darkskiesawareness.org/nomogram.php