

Gower AONB - Dark Sky Quality Survey



dark sky wales dywyllwch awyr cymru

Dark Sky Wales Training Services were commissioned in December 2017 by Swansea Council to undertake a baseline study of dark sky quality within the Gower AONB. The study was undertaken during December 2018 on clear and moonless nights. The following report highlights the findings from the study and includes recommendations for progressing Dark Sky activities in the area.

Introduction

Light pollution through inappropriate or excessive use of artificial light makes it increasingly difficult to observe the night skies; indeed, over 90% of the UK population now lives under highly light-polluted skies. Dark skies contribute significantly to human health and wellbeing with increasing evidence showing that sleep is often disturbed by a lack of proper darkness at night with adverse impacts for health. Light pollution also impacts adversely on around 60% of wildlife, which is most active at night. In addition, sympathetic and energy-efficient lighting in communities can satisfy community needs at lower cost whilst importantly reducing carbon emissions. Dark skies are increasingly important for tourism through landscapes that offer unblemished views of the night sky.

To support this aim, the AONB commissioned Dark Sky Wales in December 2017 to:

- Work closely with AONB staff to identify 40 locations evenly spread across the area of interest.
- Undertake study during moonless nights to ensure accurate readings are achieved without any natural influences.
- Monitor weather conditions and attempt to undertake study on clear nights (some cloud cover can be worked around)
- Use a minimum of two IDA¹ standard SQM² readers at each location
- Take three readings from each machine to derive an average for the site.
- Use two GPS units to provide accurate coordinates for each location.
- Tabulate data and include;
 - Location
 - Weather conditions
 - Moon Phase
 - Time
 - Temp
- Naked Eye Limiting Magnitude (NELM) for ease of understanding.

About Gower AONB

Chosen for its classic coastline and outstanding natural environment, Gower was the first AONB to be designated. Except for the small, urbanised eastern corner, the entire Gower peninsula is an AONB. Complex geology gives a wide variety of scenery in a relatively small area.

¹ IDA - International Dark Skies Association.

² SQM - Sky Quality Meter



It ranges from the south coast's superb carboniferous limestone scenery at Worms Head and Oxwich Bay to the salt-marshes and dune systems in the north. Inland, the most prominent features are the large areas of common, dominated by sandstone heath ridges including the soaring sweep of Cefn Bryn. Secluded valleys have rich deciduous woodland and the traditional agricultural landscape is a patchwork of fields characterised by walls, stone-faced banks and hedgerows.

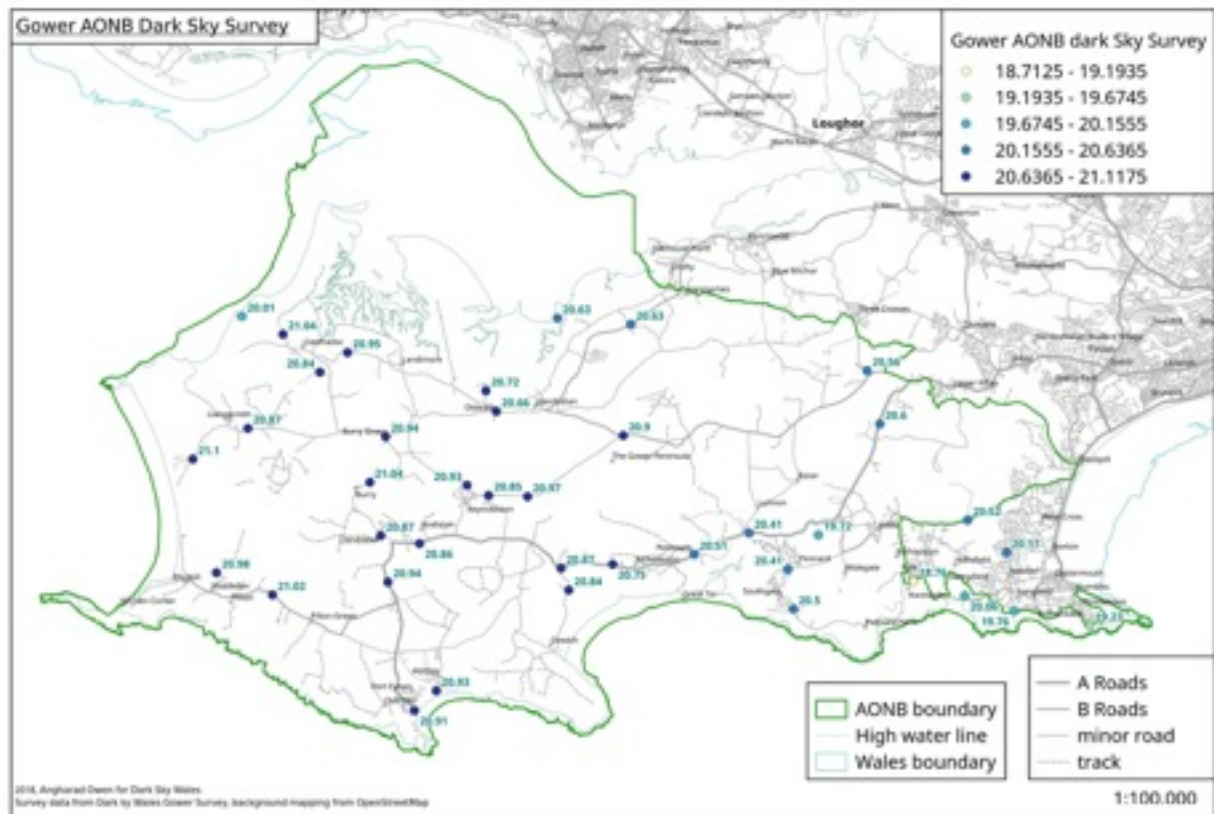
Gower's richly varied natural environment of heath, grassland, fresh and saltwater marsh, dunes and oak woodland, is internationally important. The AONB has five Special Areas of Conservation, three National Nature Reserves, two Local Nature Reserves and many Sites of Special Scientific Interest. Among the many fine natural habitats are the mud-flats and salt-marsh of the Burry Inlet (a Special Area of Conservation, Special Protection Area and Ramsar site) and the species-rich limestone grasslands of the south Gower coast. Gower has been settled since prehistoric times and has a high concentration of ancient sites. The western end of the Peninsula is listed in the Register of Landscapes of Outstanding Historic Interest in Wales for its Neolithic and Bronze Age features and its surviving medieval open field system. Almost all the coast is in the protective ownership of City and Council of Swansea, the National Trust, Natural Resources Wales or the Wildlife Trust of South and West Wales.

Gower is still traditionally farmed with small, mixed arable and livestock enterprises, many exercising ancient commons grazing rights. Many of the 10,000 population of Gower that are of working age commute to Swansea, the second largest city in Wales. The AONB lies entirely within the Swansea local authority boundary and added to retirement and holiday homes, this dormitory element has considerably altered the area's social balance.

Data Collection

Data collection was conducted in the most scientifically rigorous way possible during the duration of the study. 4 individual SQM readers were used at each location with 3 readings recorded from each machine with results averaged to provide a recordable result. These results

were again averaged to provide a definitive result for that location. Each location was recorded using a place name and appropriate coordinates. Temperature was also taken (using vehicles external thermometer) with weather conditions and moon phase recorded. A summary of the results is shown below and provides a good representation of the sky quality within the AONB.



Gower AONB - Dark Sky Survey								
Location	GPS	SQM 1	SQM 2	SQM 3	SQM 4	Average	NELM	Date
Mumbles Head	51.33.9 358.54	19.23	19.27	19.23	19.2	19.23	4.9	15/12/2017
Langland Bay	5134.05 4.00.51	19.77	19.79	19.72	19.77	19.76	5.3	15/12/2017
Caswell Bay	51.34.15 401.50	20.1	20.09	20.05	20.01	20.06	5.5	15/12/2017
Bishopston	51.34.25 402.51	18.74	18.95	18.89	18.45	18.76	4.6	15/12/2017
Kittle	51.34.57 4.04.45	19.78	19.84	19.44	19.81	19.72	5.3	15/12/2017
Pennard	51.34.48 4.01.2	19.92	20.32	20.18	20.23	20.16	5.6	15/12/2017

Gower AONB - Dark Sky Survey								
Southgate	51.34.31 4.05.20	20.39	20.45	20.37	20.45	20.42	5.8	15/12/2017
West Cliff	51.34.02 405.12	20.48	20.53	20.52	20.46	20.50	5.8	15/12/2017
Parkmill	51.34.57 4.06.07	20.47	20.35	20.46	20.37	20.41	5.8	15/12/2017
Penmaen	51.34.40 4.07.11	20.49	20.51	20.52	20.53	20.51	5.8	15/12/2017
Perriswood	51.34.31 4.08.47	20.72	20.79	20.77	20.73	20.75	6	15/12/2017
Penrice Castle	51.34.27 409.48	20.91	20.87	20.85	20.84	20.87	6	15/12/2017
Oxwich bay	51.34.11 4.09.38	20.85	20.84	20.82	20.83	20.84	6	15/12/2017
Knelston	51.34.42 4.12.36	20.94	20.93	20.79	20.77	20.86	6	15/12/2017
Scurlage	51.34.13 4.13.12	20.93	21	20.93	20.9	20.94	6.1	15/12/2017
Horton	51.32.54 4.12.11	20.98	20.91	20.98	20.85	20.93	6.1	15/12/2017
Port Eynon	51.32.39 4.12.36	20.91	20.89	20.9	20.92	20.91	6.1	15/12/2017
Middleton	51.34.11 4.16.26	21.11	21.13	21.14	21.09	21.12	6.2	15/12/2017
Rhossilli	51.34.16 4.16.35	21.02	20.91	21.01	21	20.99	6.1	15/12/2017
Pilton Green	51.34.01 4.15.28	21.04	21.01	21.04	21.01	21.03	6.3	15/12/2017
Llanddewi	51.34.47 4.13.22	20.85	20.87	20.86	20.88	20.87	6	15/12/2017
Burry	51.35.26 4.13.37	21.06	21.07	21.01	21.02	21.04	6.1	15/12/2017
Burry Green	51.36.00 4.13.20	20.92	20.95	20.94	20.96	20.94	6.1	15/12/2017
Llangennith	51.36.03 4.16.03	20.88	20.86	20.88	20.87	20.87	6	15/12/2017
Llangennith burrows	51.35.39 4.17.07	21.12	21.09	21.11	21.07	21.10	6.2	15/12/2017
Cefn Bryn Common	51.35.26 4.11.42	21.04	20.98	20.84	20.87	20.93	6.1	15/12/2017

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Reynolston	51.35.19 4.11.16	21.01	21	20.93	20.94	20.85	6	15/12/2017
Old Walls	51.36.21 4.11.10	20.76	20.69	20.61	20.57	20.66	5.9	15/12/2017
Cheriton	51.37.01 4.14.08	20.98	20.95	20.92	20.95	20.95	6.1	15/12/2017
Llanmadoc	51.36.46 4.14.40	20.9	20.88	20.79	20.79	20.84	6	15/12/2017
Cwm ivy	51.37.13 4.15.25	21.02	20.98	21.08	21.06	21.04	6.1	15/12/2017
Llanrhidian	51.36.36 4.11..23	20.85	20.62	20.71	20.71	20.72	6	15/12/2017
Wernffwrđ	51.37.28 4.08.34	20.57	20.69	20.62	20.65	20.63	5.9	15/12/2017
Crofty	51.37.31 4.10.01	20.61	20.65	20.61	20.65	20.63	5.9	15/12/2017
Three crosses	51.37.48 4.17.04	20.18	20.11	19.84	19.91	20.01	5.5	15/12/2017
Fairwood Common	51.36.59 4.03.53	20.61	20.59	20.54	20.51	20.56	5.9	15/12/2017
Pengwern common	51.36.29 450.05	20.58	20.48	20.57	20.71	20.60	5.9	15/12/2017
Cillibion	51.36.06 4.08.39	20.92	20.89	20.91	20.89	20.90	6.1	15/12/2017
Arthurs stone	51.35.19 4.10.30	20.98	20.99	20.97	20.94	20.97	6.1	15/12/2017
Swansea Airport	51.36.20 4.03.36	20.57	20.57	20.58	20.66	20.60	5.9	15/12/2017
Clyne common	51.35.11 401.49	20.52	20.47	20.56	20.51	20.52	5.8	15/12/2017
Clyne Valley country park	51.36.07 3.59.49	18.87	18.63	18.82	18.53	18.71	4.5	15/12/2017

Light Pollution Map Info (www.lightpollutionmap.info) is a mapping application that displays VIIRS/DMSP/World Atlas overlays and the user measurements overlay over Microsoft Bing base layers (road and hybrid Bing maps). Its primary use is to show VIIRS data in a friendly manner, but it also includes some other interesting overlays that deal with light pollution like SQM/SQC and World Atlas. We used the available 2017 data for this study to validate our findings.

The VIIRS/World Atlas overlays clearly show the areas of higher light pollution located to the East and North of the AONB (outskirts of Swansea and encroachment from Llanelli area). The

Image 1: VIRIS³ 2017 Light Pollution Data



darkest locations identified by the study again correlate well with the VIRIS/World Atlas overlays with the Rhossili area recording some of the darkest readings. The readings for the entire AONB are very encouraging with the majority in excess of 20 on the logarithmic scale used by the SQM which relates to a NELM of 5.5 and above. This equates to a Bortle Scale⁴ reading of 5 with some areas within the AONB of 4. Visually the unaided eye can recognise celestial features such as the Milky Way, M31 (Andromeda galaxy) and can make out M33 reinforcing the Bortle classification.

The human eye can perceive stars down to a NELM of 6, with areas above 4/5 generally considered as good. Therefore, it appears that dark sky quality at the majority of the AONB locations monitored is of a good standard. As shown, there are areas of higher light pollution that correspond to the more populated areas with the more rural locations showing better dark sky quality, as indicated in the original satellite data.

The study also revealed a distinct lack of street lighting within the AONB with exceptions being larger villages located again mostly towards the east and north. Even here lighting has been sympathetically installed and are mainly of the newer fully shielded LED type with only occasionally unshielded sodium lighting being identified. Housing within the AONB also demonstrate an understanding of correct lighting with many homes displaying low voltage lighting with only the occasional home requiring remediation to conform to IDA recommendations. Some inappropriate use of lighting was identified coming from playing fields but again this can be explained away due to the use of this lighting during sporting events.

³ Visible Infrared Imaging Radiometer Suite (VIIRS) is a satellite scanning radiometer which collects visible and infrared imagery and radiometric measurements of the land, atmosphere, cryosphere, and oceans

⁴ The Bortle scale is a nine-level numeric scale that measures the night sky's brightness of a particular location. It quantifies the astronomical observability of celestial objects and the interference caused by light pollution. An example can be found in the Appendix.

Unfortunately, there were instances of local authority run properties that did require attention such as public toilets near to the sea front at Port Eynon.

With altitude near to Arthur's Stone, orange halo's from Swansea and Llanelli areas could be seen on the horizon and would cause significant obstacles for those wanting to undertake astrophotography from that location. However, the SQM reading and visual observation demonstrated that the area was again providing a Bortle classification of 4 bordering on 5.

Overall the AONB has high quality dark skies and with the introduction of dark sky awareness education program the area could improve further.

Recommendations

The dark sky study has revealed the quality of the dark skies within the Gower AONB. To maintain and to hopefully improve upon this DSW recommend the following:

- Introduce an education program for;
 - General Public
 - Schools
 - AONB staff and volunteer groups
 - Swansea Council staff
- Conduct annual SQM studies to monitor light pollution levels.
- Enter into dialogue with representatives from Swansea Council to examine possible reductions in light pollution from the Mumbles/City area.
- Enter into dialogue with Camarthenshire County Council to examine the possible reduction in light pollution from Llanelli/Bury Port areas.
- Engage with business in the area to promote the use of dark skies during the shoulder months to increase economic prosperity in the area.

Dark Sky Status and Options

Currently, there are five International Dark-Sky Association designations

- International Dark Sky Communities
- International Dark Sky Parks
- International Dark Sky Reserves
- International Dark Sky Sanctuaries
- Dark Sky Developments of Distinction

Within the UK, a number of places are now recognised under these designations:

- **Snowdonia Dark Sky Reserve⁵**
- Exmoor Dark Sky Reserve
- **Brecon Beacons Dark Sky Reserve**
- Galloway Forest Dark Sky Park
- **Elan Valley Dark Sky Park**
- Northumberland Dark Sky Park
- Sark Dark Sky Island (Community)
- Coll Dark Sky Island (Community)
- Moffat Dark Sky Community

There is no indication that changes in designation categories were made at the first-ever international Dark Sky Park conference, which was held in the Galloway and Southern Ayrshire Biosphere, Scotland in September 2017.

Furthermore, there is a UK wide initiative for Dark Sky Discovery Sites that allow for quick registration of particular locations for observing the night sky. These are not internationally recognised but could be a quick way of establishing the dark sky quality of the AONB before any application is considered for IDA approval.

Dark Sky Status Proposal for the AONB

A key factor is the actual area of the AONB which, at 188 km², restricts the available status. Based on the desk-top mapping and the actual survey data obtained in this study, we believe that the two possible options for AONB designation are Dark Sky Community and Dark Sky Park designations since the land area and ownership requirements rule out other designations, certainly at this stage.

Designation as a Dark Sky Park, which is principally governed by the quality of the night and requires a brightness routinely darker than 20 magnitudes per square arc second cannot be ruled out in future. Further data will be required on the quality of the skies over coming years.

In July 2017, Bodmin Moor in Cornwall was officially designated an International Dark Sky Landscape. Cornwall Council's website indicates that the "Bodmin Moor International Dark Sky Designation covers the portion of the moor within the Cornwall Area of Outstanding Natural Beauty plus a two-mile buffer zone around it". As indicated above, there appears to be no official Dark Sky Landscape designation. Consequently, to ascertain whether this specific designation, as opposed to Community or Park, might be an available avenue for the Gower AONB, we sought clarification directly from the IDA with regard to the Dark Sky Landscape designation. Their response indicates Bodmin Moor in Cornwall is actually officially designated as a Dark Sky Park, but "in their application, (Cornwall) described themselves as a landscape so that is where that word is coming from." This indicates that the IDA is open to applicants

⁵ Bold indicates region within Wales.

proposing their own descriptions other than those officially designated although the actual process will be application for one of the official designations.

Dark Sky Status Recommendation

We propose at this stage that Dark Sky Community status is most likely and appropriate for the AONB. We believe the best option moving forward is to apply for Dark Sky Community status with a view to establishing long-term partnerships with adjoining areas to reduce encroaching light pollution. A long term view may be to work towards park status but a lot of work and time will be required to achieve this. The AONB may wish to approach the IDA to see if another description of its own is more appropriate than 'community'.

Appendix

Footnote 4 - Bortle Scale

Bortle Scale Number	Color on Map	Limiting Magnitude	Sky Type	Description
1		8	Excellent Dark Site	Airglow is very weak and near horizon Zodiacal Light is across the night sky Milky Way casts shadows
2		7.5	Dark Site	Airglow is weakly visible Zodiacal Light casts shadows Milky way is very detailed
3		7	Rural	Clouds are faintly lit at horizon Zodiacal light visible well above horizon Milky Way appears complex
4		6.5	Rural/ Suburban	Clouds are lit only at horizon Zodiacal Light is visible halfway above horizon Milky Way structure starts to show
5		6	Suburban	Clouds and ground are faintly lit Some Zodiacal Light Milky Way is slightly more visible overhead
6		5.5	Bright Suburban	The sky glows gray at horizon Constellations are visible Milky Way visible overhead
7		5	Suburban/ Urban	The sky has a gray/yellow glow Bright constellations are visible No Milky Way
8		4.5	City	The sky has an orangeish glow Brightest constellations are visible No Milky Way
9		4 at best	Inner-City	The sky has a bright glow Only bright stars are visible No Milky Way