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# STARLIGHT FOUNDATION

## *Astronomical Audit Report*

### *Starlight Reserve*

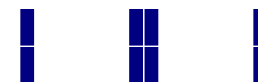
**Destination ID: Arcadian Skies & Mi'kmaq Lands, Nova Scotia.**

**Ref AP: 006/2014**

**Auditor: Antonia M Varela Pérez**

**Date: 13 November 2014**

Max. Score	Score obtained
25	19



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## Overview

The region proposed for certification as a Starlight Reserve is in south-west Nova Scotia, Canada.

Nova Scotia is one of the ten provinces of Canada, one of the Maritime Provinces. It comprises a long, narrow peninsula, called the Nova Scotia Peninsula, and the island of Cape Breton at the northern tip.

The area to be certified as a Starlight Reserve includes the municipalities of Yarmouth, Clare and Argyle and the Tobeatic Wilderness Reserve (south-west Nova Scotia).

The core of the area is the Tobeatic Wilderness Reserve (a protected provincial area: see Minutes 1998, c. 27, s.1 of the protected areas in Nova Scotia in the documentation sent to the Starlight Foundation). A large part is located in the county of Yarmouth (in the municipalities of Yarmouth and Argyle) and a lesser part in the municipality of Clare. The Tobeatic Wilderness Reserve covers 103,780 hectares which is expected to be extended in 2013. See map in Figure 1.

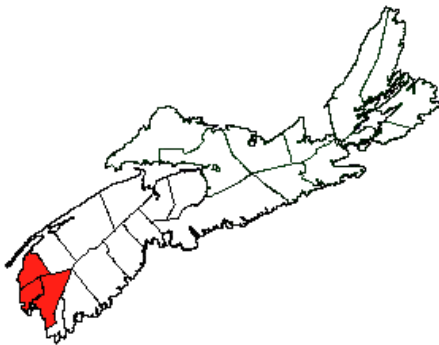


Figure 1

Figure 1. Map of the area to be certified in the south-west of Nova Scotia. The three municipal areas, Yarmouth (excluding the town of Yarmouth, the port of entry to Nova Scotia), Argyle and Claire are marked in red. The three have competences in the Tobeatic Wilderness Reserve (which is the proposed core zone of the Reserve).

It is the largest area of wilderness remaining in the Maritime Provinces. The region is characterised by unique arid and semi-arid landscapes with outstanding areas of unspoiled glacial relief including eskers, moraines, kettles and plains. The habitat of the fauna and flora and the headwaters of the 9 main river systems, which flow into the Atlantic and the Fundy, are remotely protected. Together with the neighbouring Kejimikujik National Park, the Tobeatic Wilderness Reserve forms the central core of a protected landscape which is being expanded through the south-west of Nova Scotia ([http://www.gov.ns.ca/nse/protectedareas/wa\\_tobeatic.asp](http://www.gov.ns.ca/nse/protectedareas/wa_tobeatic.asp)).

Fishing and tourism are vital to the economy of the province. Tourism has become increasingly important over the second half of the 20<sup>th</sup> century.

There are Mi'kmaq indigenous reserves in the region and, towards the coast, are the Arcadians.

## **ASTRONOMICAL PARAMETERS AND SURVEY AREAS**

The applicants provided measurements of the four parameters required for the Astronomical Audit requested of Allan Rahill of the Canadian Meteorological Center (CMC). The data provided was obtained from numerical prediction models and has been specially calculated at the request of the astronomers. (See website: [weather.gc.ca/astro/index\\_e.html](http://weather.gc.ca/astro/index_e.html))

Figure 2 shows a satellite image of **sky brightness** in the V band in the south-west of NS. The black zone indicates a sky brightness of 21.99 to 22.00 mag/arcsec<sup>2</sup>, and the grey area represents a range from 21.89 to 21.99 mag/arcsec<sup>2</sup>. It can be deduced that light pollution in the area is insignificant and comparable to areas such as La Palma.

The areas of risk, those with higher pollution, are concentrated around the towns of Yarmouth and Shelburne and, to a lesser extent, Barrington, though all fall outside the Starlight Reserve.

Figure 2. Sky background brightness map of the south-west of NS proposed as a Starlight Tourist Destination. Source: Canadian Meteorological Center (CMC). The most polluted areas are the larger towns, such as Yarmouth (left) and Shelburne (right). To the south, Barrington, also outside the area to be certified. The town of Yarmouth is outside the certification zone, but within the area of the Reserve, and so it has been differentiated as an area where lighting must be improved, and is in what we call the buffer zone of the Reserve.

Monthly statistical values for clear nights, temperature and rainfall over a whole year were used.

Also used were publications with historical data (1982-1912, <https://weatherspark.com>) in the Yarmouth area, where the percentage of nights lost to cloud and fog is, presumably, higher than inland and in the Tobeatic Wilderness Reserve.

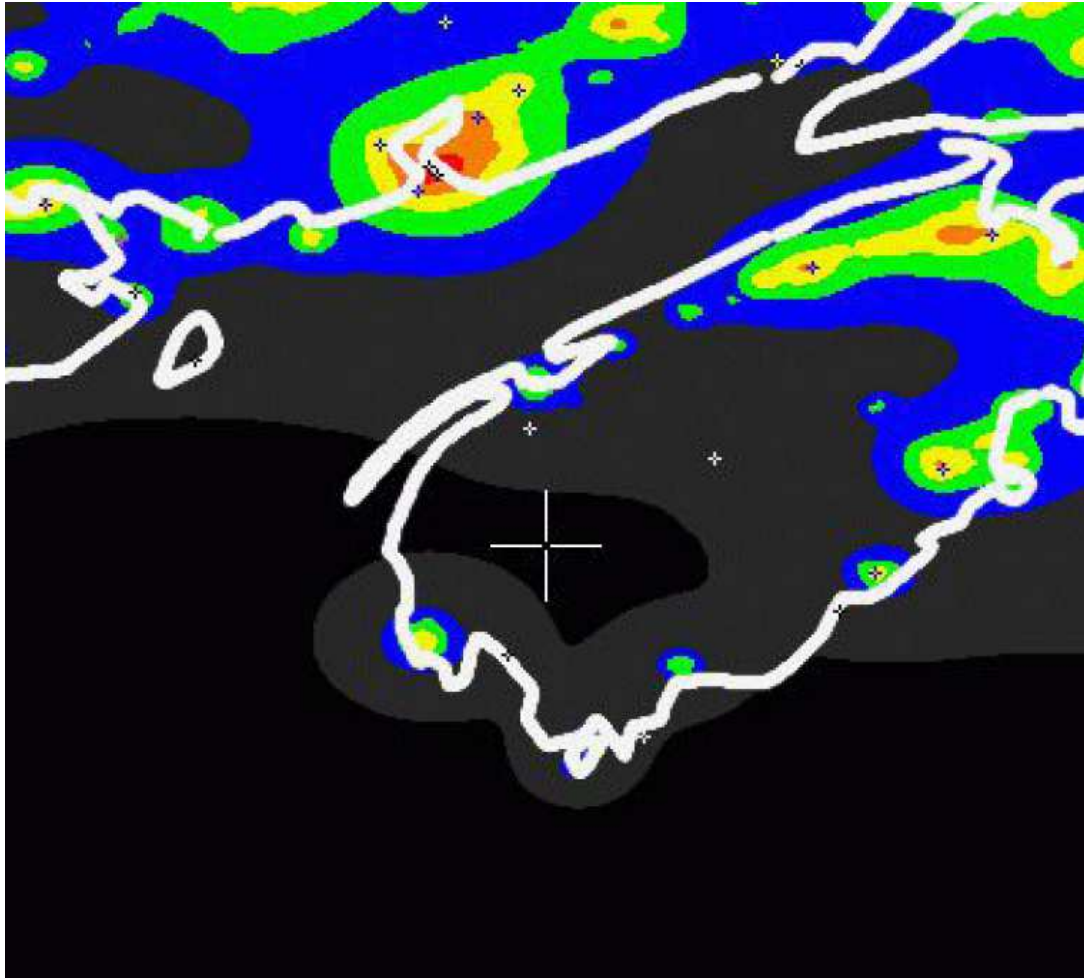


Figure 2

#### Summary of climatic conditions in the town of Yarmouth –maritime-:

Climatic conditions are highly seasonalized. The proportion of generally clear days is less than 50% in all months, with the clearest being August, September and October. The peak is in September and periods of clear + mainly clear + partially clear weather are around 44%. Outside these months, therefore, it is recommended that astrotourism activities not be programmed, and that they should be concentrated in inland areas (Ellenwood, Indian Reserves and the Tobeatic Wilderness Reserve).

The proportion of days with light rain is at a minimum in July and August (around 43%) and is highest in December and January (80%). Storms are infrequent with respect to days with rain or light snow. There is hardly any snow between May and October, the highest probability being in the cold months, with a maximum in February (45% probability). Winds are generally light throughout the year, with an average speed of 4 to 9m/s.

#### Summary of climatic conditions in Clare –maritime-:

There are no values for cloudiness or rainfall here. Humidity is generally high, ranging between 61 and 99% throughout the year. The driest month is March and the most humid, July. The temperatures in the warmest months are 13-17°C and between 8 and -8°C in the coldest (minimum in January).

#### Summary of conditions in Kejimikujik (the weather station closest to the Tobeatic Wilderness Reserve, with similar natural and geographical conditions):

90% forest and 10% lakes.

Summer temperatures between 15 and 25°C and in winter between 3 and –10°C (minimum in January). In general, humidity is lower than on the coast, and is of the order of 50-60%.

#### Summary of climatic conditions in the Tobeatic Wilderness Reserve –inland-:

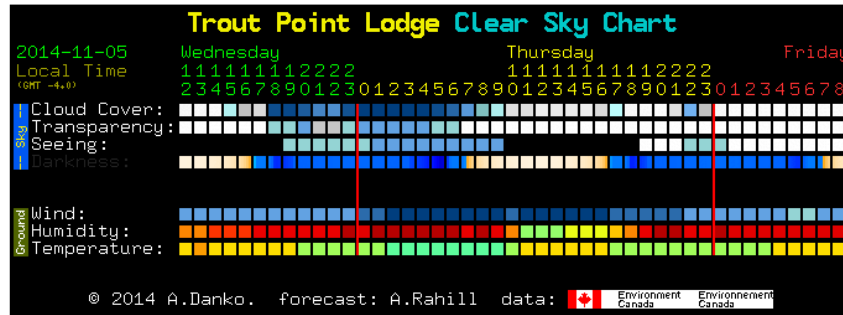
The data provided on cloudiness in the Tobeatic Wilderness Reserve shows an average of 75.09% of clear nights. In the warm months the average temperature is around 20°C and rainfall is less than 90mm.

Information about Trout Point Lodge at night can be found at: [www.cleardarksky.com/TrtPtLgNSkey.html?1](http://www.cleardarksky.com/TrtPtLgNSkey.html?1) (see interface in Figure 3).

# Trout Point Lodge Clear Sky Chart

legend page

Last updated 2014-11-05 12:34:39. No Image below? Read [this](#). Not showing todays data? [Clear your cache](#).



A [resort](#) with astronomy excursions for guests.

<b>Nifty Links:</b>	<a href="#">Sun &amp; Moon Data</a>	<a href="#">Road Map</a>	<a href="#">Sat Image</a>	<a href="#">Topo Map</a>	<a href="#">Satellite Predictions</a>
	<a href="#">Star Map</a>	<a href="#">CalSky</a>	<a href="#">Light Pollution map</a>		

Figure 3

Figure 3. Website of the forecasts for cloud cover, transparency, seeing, wind, humidity and temperature at Trout Point Lodge provided by the CMC. This information allows observations to be planned almost three days in advance.

With respect to cloudiness, therefore, only Trout Point fully meets the clear time conditions required of a Reserve, of over 60%.

The CMC was asked to expand the sampling and take in situ measurements of sky brightness, transparency and seeing. In situ measurements were taken at five sites (see map in Figure 4). The average results are shown in the following table.



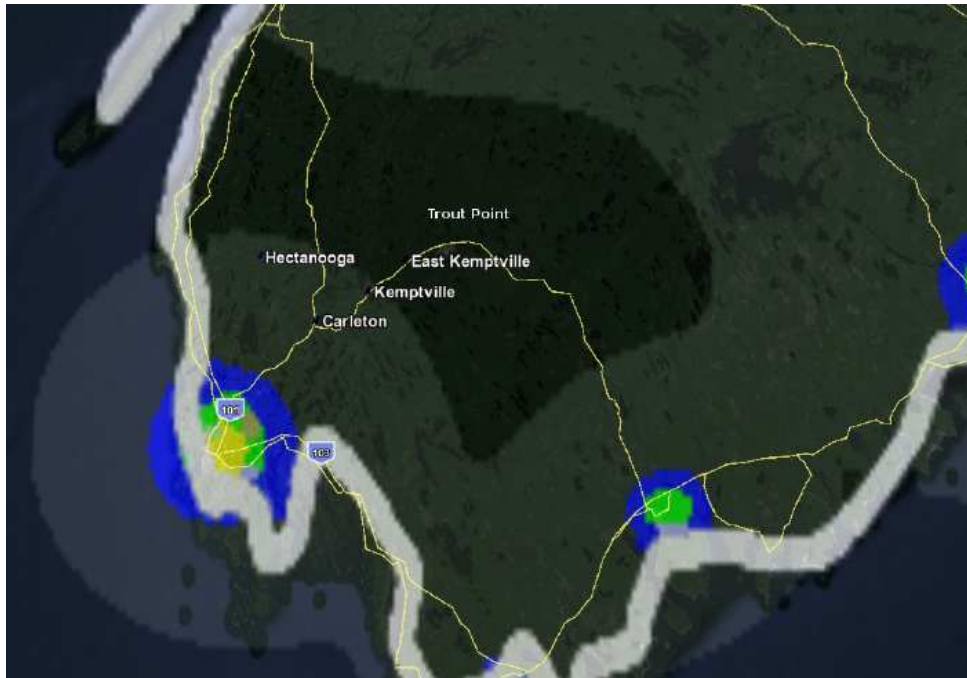


Figure 4

Figure 4. Map of the 5 sites where measurements were taken of the astronomical parameters (brightness, transparency and seeing), using the methodology recommended by the Foundation Starlight.

The main focuses of light pollution are the town of Yarmouth (left) and Shelburne (right). The latter is outside the Destination and its area of influence.

The sampling period was from 14 July to 15 August 2013. Samples were requested from the cold months; the difficulty was that Trout Point Lodge closes during this period and so the logistics of the personnel responsible for the observations and the astronomical and tourist activities were interrupted.

Site	Sky brightness (mag/acrsec <sup>2</sup> )	Transparency Magnitude)	(Limiting Seeing
Hectanooga	21.55±0.40	Between 6.1 and 6.5 magnitudes	Binary stars STT410 and STT403 distinguished at all sites, distance: 0.8"
Carleton	21.62±0.29		
Kemptville	21.68±0.38		
East Kemptville	21.82±0.36		
Trout Point	21.88±0.40		

As regards the other astronomical parameters, the conditions required to be a Starlight Reserve were met in all of the zone. The maximum value of sky brightness (that is, the lowest light pollution) was at Trout Point. This is in line with the results given in Figure 4.

Using the map in Figure 4 as a reference, it can be predicted that the thresholds required for both transparency and sky brightness in order to obtain the certificate as a Reserve are met in all of the territory.

Seeing values are shown only for the 5 survey points. The only evidence for the rest of the territory are the images obtained by astro-photographers in Yarmouth, Tusket and Quinan, which are of excellent quality, and the forecasts of the CMC.

## ZONING

A map is attached (Fig. 5) of the south-west area of Nova Scotia with the Arcadian Skies and Mi'kmaq Lands Starlight Reserve (in orange).

The town of Yarmouth (grey circle) is outside the Destination.

Figure 5. Zoning of the Starlight Reserve showing the core (of the Tobeatic Wilderness Reserve) and the buffer zone.



## **WEAKNESSES:**

- Little sampling of the astronomical certification parameters during the cold months.
- The climate of the maritime zone of Clare, Yarmouth and Pubnico) have frequent fog and the observation of the skies is therefore impossible.
- No climate study of seasonality and useful time in order to draw up a more realistic schedule of astronomical activities.
- Little astronomical training or awareness among the general public regarding the significance and implications of Starlight Certification.
- Few archaeological or palaeontological resources to link with astronomy, except for those in the Tobeatic Wilderness Reserve (petroglyphs).

## **STRENGTHS:**

- The very low level of light pollution. Except for the town of Yarmouth (where there are already regulations in place to change/adapt public lighting) and Shelburne (outside the Destination), the entire Starlight Reserve has an average sky brightness of over 21mag/arcsec<sup>2</sup>.
- Since this is a UNESCO Biosphere Reserve, regulations are enforced to guarantee respect for and conservation of the environment and landscape in the zone.
- There are no polluting industries, and so the sky is characteristically clear and transparent.
- The numerous natural, cultural, gastronomic and geological resources, as well as biodiversity and fauna (bears, moose, beavers, flying squirrels, raccoons, bald eagle, blue jay, etc.) and the astronomical resources of Nova Scotia are favourable to the development of multidisciplinary tourism activities related to astronomy.
- The low population density avoids the medium and short-term risks of an undesirable increase in light pollution.
- The presence and cohabitation of indigenous peoples in protected areas (the Mi'kmaq and the Arcadians). Their origins, settlements, language and customs are an important historical/cultural legacy in the zone.
- Frequent astro-photographic activities led by Tim Doucette and Bill Curray. Both have websites to announce and promote astronomy-related activities and events.
- The creation and equipping of exhibition areas, museums and interpretation centres, such as those in Pubnico and Yarmouth, could be important points for the centralisation of dissemination and training activities.
- Availability of astronomical infrastructure and instruments for the continuous monitoring of optical sky quality parameters (currently concentrated in Trout Point).
- The existence of a nucleus in the Reserve (Tobeatic Wilderness Reserve, Trout Point Lodge) consisting of a platform on a 4-5m tower and telescopes for monitoring and astronomical activities.

- High level of interest in involvement in the project among both public and private organisations, which could facilitate funding and the execution of corrective and preventive light pollution measures.
- Permanent availability of measurements of astronomical and climate parameters thanks to the Canadian Meteorological Center (CMC), which makes and publishes forecasting models and climate studies of Canada, including NS, and in particular of the area to be certified.
- In general, a relatively underdeveloped industrial sector in comparison with other parts of Canada.
- Participation of universities such as the Sainte Anne University in Clare in the dissemination of astronomy and in the organisation of training courses for Starlight guides and monitors, as well as training courses for entrepreneurs and the general public.
- Collaboration with the Department of Astrophysics and Physics of the University of St. Mary's (in Halifax) in the dissemination of the Starlight project and training in astrophysics.
- Presence in Halifax of one of the country's most important astronomical associations, the Royal Astronomical Society of Canada (RASC), whose members play an important role in NS in the organisation of astronomical activities (e.g. in Kejimkujik, but which could be extrapolated to the Tobeatic Wilderness Reserve or any other part of the Destination) and in the promotion of astronomy. Among its publications, the Observer's Handbook 2014 (Ed. D. M.F. Chapman) stands out, having been published for 106 years.
- Significant involvement in this project of the authorities of the tourist sector in NS and of the Natural Parks. Possibility of enlarging these Natural Parks in the very near future.
- Regular participation of the managers in issues related to light pollution and sky protection measures.

## **OPPORTUNITIES:**

- Support and funding for this project from the public administrations.
- The Tobetic Wilderness Area and Kejimikujik Biosphere Reserve and the Lake Ellenwood Natural Park have excellent potential for active tourism which can be related to astronomy.
- Starlight Certification could make this a reference point to demonstrate that integrated management of natural resources cannot ignore the problem of light pollution and the consequent waste of energy.
- The historical and biological environment and the landscape are a cultural asset.
- Being the first Starlight Reserve in Canada and North America could provide a significant economic boost for the region and, at the astronomical level, it could be an important incentive for the application of environmental protection regulations.
- The possibility of running coordinated activities with the Universities of Sainte Anne and St. Mary's, as well as with amateur astronomers from the region. These activities could be related both to the measurement of astronomical parameters which guarantee the conditions required to be a Starlight Tourist Destination and to the creation of competitive, high-quality astrotourism products.
- The availability of funding to adapt or replace public lighting in all of the built-up areas of the certified zone. The immediate application of a plan for the adaptation/replacement of public lighting in Yarmouth will be of special importance.
- The existence of Native American reserves where special conservation regulations for both the population and the environment are applied, guaranteeing the conservation and sustainable development of the region and, therefore, of a clear, pristine sky.

## **THREATS:**

- The climate of the maritime zones, with a high number of cloudy nights and low fog throughout the year, even in the warm months when most tourists are received.

## **IMPORTANT NOTE:**

**Although the Starlight Certification awarded is global, rather than seasonal, it must be borne in mind that fog is frequent in the Maritime Provinces. It is recommended that alternative plans always be available (which we call the Plan B or inland plan), or that astrotourism activities be focused on inland areas (in Ellenwood, the Tobeatic Wilderness Reserve or any other areas or routes which might be proposed).**

- No regulations governing light pollution.
- The lack of information and activities related to astronomy among entrepreneurs, stakeholders and the general public.
- The lack of trained tourist guides with the necessary astronomical knowledge and training to run these activities.
- The lack of a technical plan for the modification of public lighting in the risk zones and for the promotion of astronomical activities.
- Given the impetus already enjoyed by Trout Point, thanks to its promoters, too many resources and activities are focused or centred on this zone.

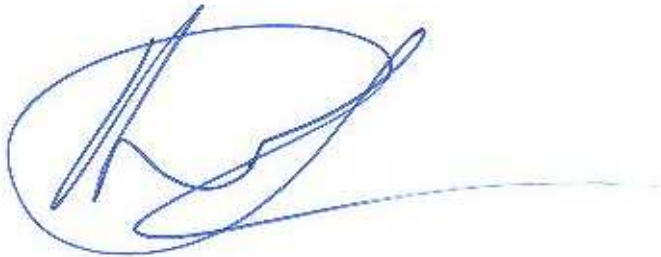


## EVALUATION – PARAMETERS

COD. (1)	PROCESS/ SUBPROCESS/ REQUIREMENT (2)	Value (3)	Degree (4)						Comments (5)	S (6)
			0	1	2	3	4	5		
<b>4.</b>	<b>ENVIRONMENTAL, TECHNICAL AND SERVICE REQUIREMENTS</b>									
<b>4.2.</b>	<b>Sky quality parameters</b>									19
4.2.1.	Useful time for observing (cloud coverage)	3			X				Little information on this item, especially close to the coast. Existing climate studies and data provided by the CMC show a high percentage of clear nights in the core of the Reserve (>60%), but significant medium-high cloud cover and fog in the maritime zones and, in general, in the buffer zone within the Reserve.	2
4.2.2.	Sky brightness	3					X		Use of SQM at 5 sites, CMC data and satellite images. All of the certified area meets the threshold value for a Reserve, up to 0.8 mag/arcsec <sup>2</sup> higher in the core of same. There are areas of risk –the town of Yarmouth- in the buffer zone.	5
4.2.3.	Image sharpness	3					X		Use of the DIMM technique. Average seeing values equal to or better than required, but it is also necessary to apply these measurements in other areas of the proposed Destination zone and extend them to the cold season.	4
4.2.4.	Sky transparency	3					X		The limiting magnitude values meet those required for a Starlight Reserve, a result to be expected due to the low levels of light and atmospheric pollution. It is recommended that geographical distribution and timing of the sampling be improved.	4
4.2.5.	Light pollution control actions	3					X		Actions to control sky brightness and the adaptation of public lighting in different municipalities have been taken into account.	4

- (1) Identification code
- (2) Name of the process/subprocess/requirement
- (3) Importance level of the process/subprocess/requirement (1=Minimum, 2=Median, 3=Maximum)
- (4) Measurement data (quality level)
- (5) Relevant Comments
- (6) Score

Signature:

A handwritten signature in blue ink, consisting of a large, stylized initial 'A' followed by a cursive 'V' and a long horizontal flourish extending to the right.

Dr. Antonia M. Varela

Site Characterization Group of the IAC.