

A night sky photograph of the Milky Way galaxy, appearing as a dense band of stars and dust, arching across the dark blue and black sky. Below the sky, a beach scene is visible, featuring a large sand dune in the foreground. A fence made of wooden posts and wire runs along the edge of the dune. The ocean is visible in the distance under a dark, starry sky.

# Guide To Milky Way Photography

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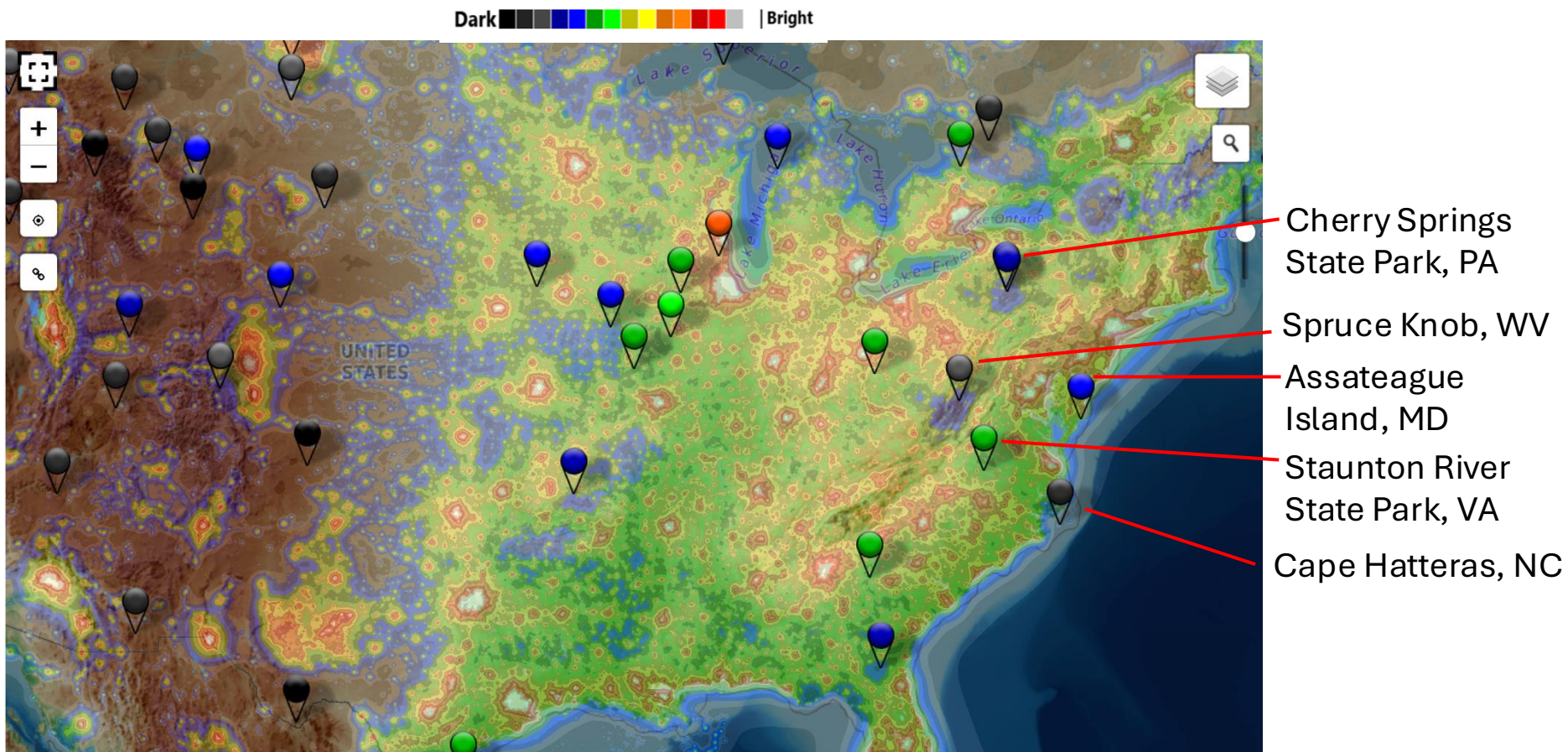
Image by allen arnold

# Outline

- Where to go for Milky Way Photography
- When is a good time to do it?
- Gear to Bring
- Lens Selection
  - Focal Lengths
  - Selecting a Shutter Speed: 500 Rule vs NPF Rule
  - Selecting an Aperture Size
  - Lens Heaters
- Camera Settings
  - Composition
  - Focusing
  - Image Stacking

# Where to go?

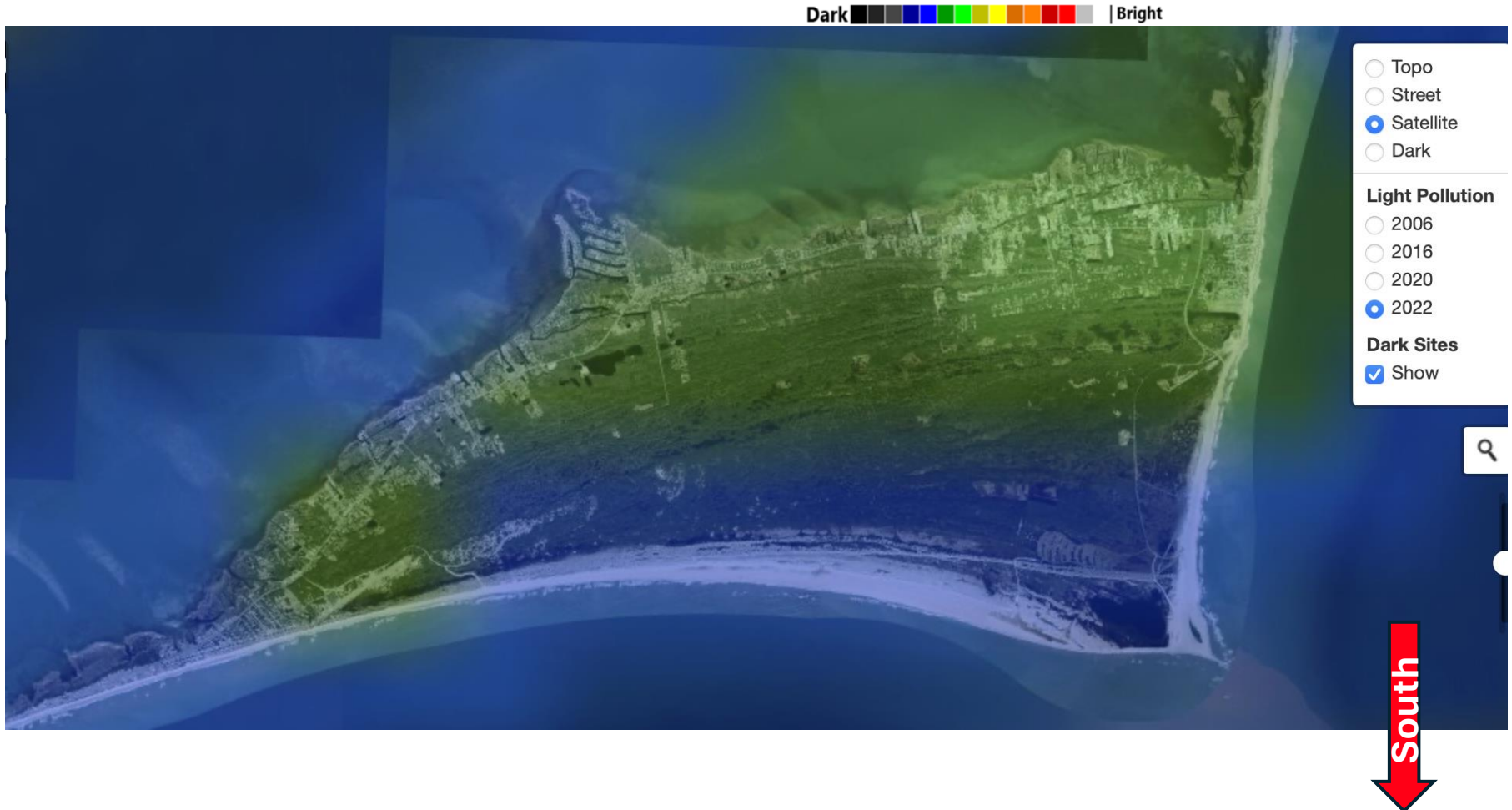
Want dark skies with little light pollution, especially to the south of your setup. The following is from Dark Site Finder, and color codes the light pollution. The pins are color coded at specific locations.



<https://darksitefinder.com>

# Dark Site Finder

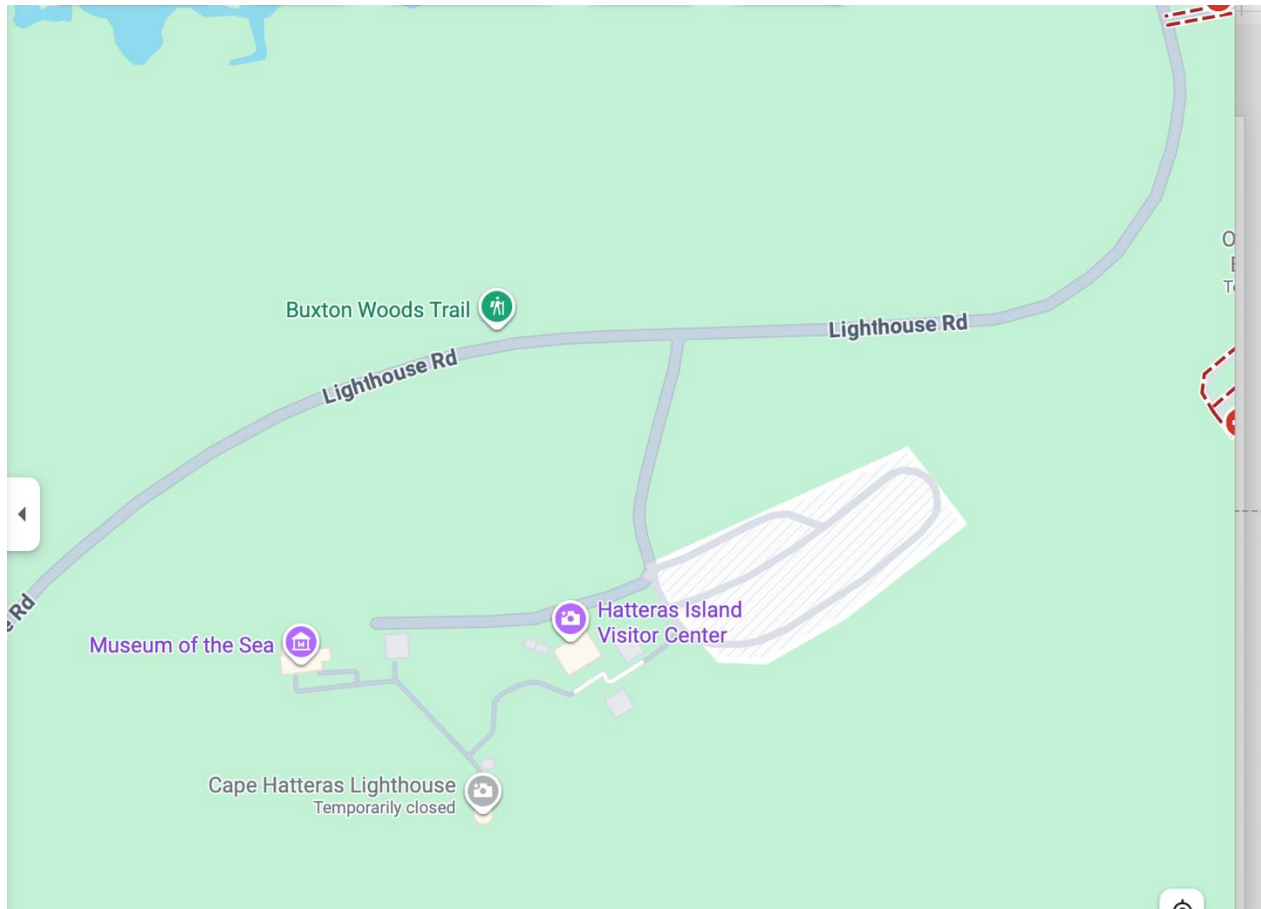
Can zoom in for a detailed map anywhere, select topo, street, satellite, or darkness overlays: e.g. **Hatteras Island**.



<https://darksitefinder.com>

# Detailed Planning

Can then use mapping tools like Google Maps. Here is the location of the Hatteras Lighthouse (in the dark green area of the Dark Site Finder). Park in the lot at night to do Milky Way photography (it's OK per Google AI).



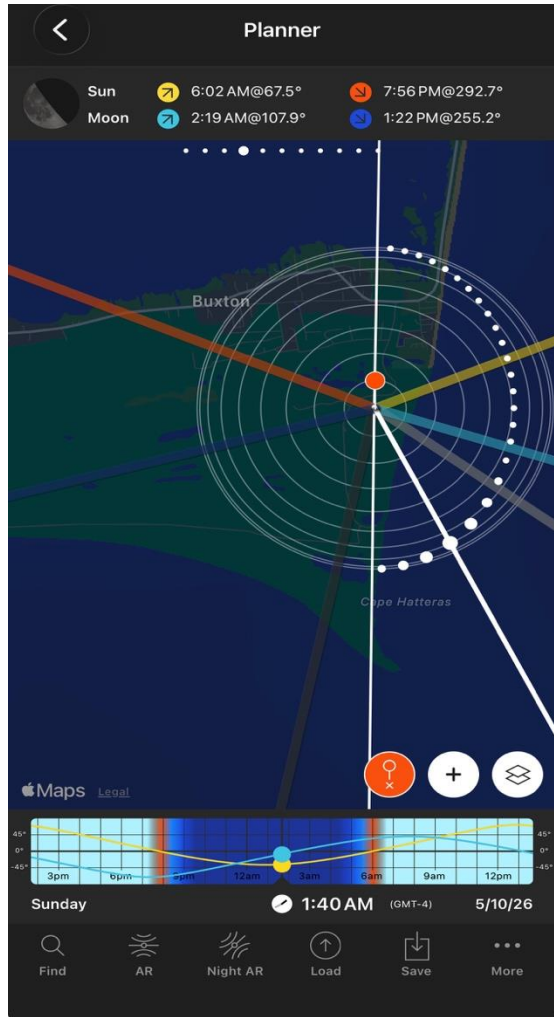
Look online for other's images from the locations you find

\* Note: Hatteras Lighthouse not operating through the end of 2026 🙄

# When is a good time?

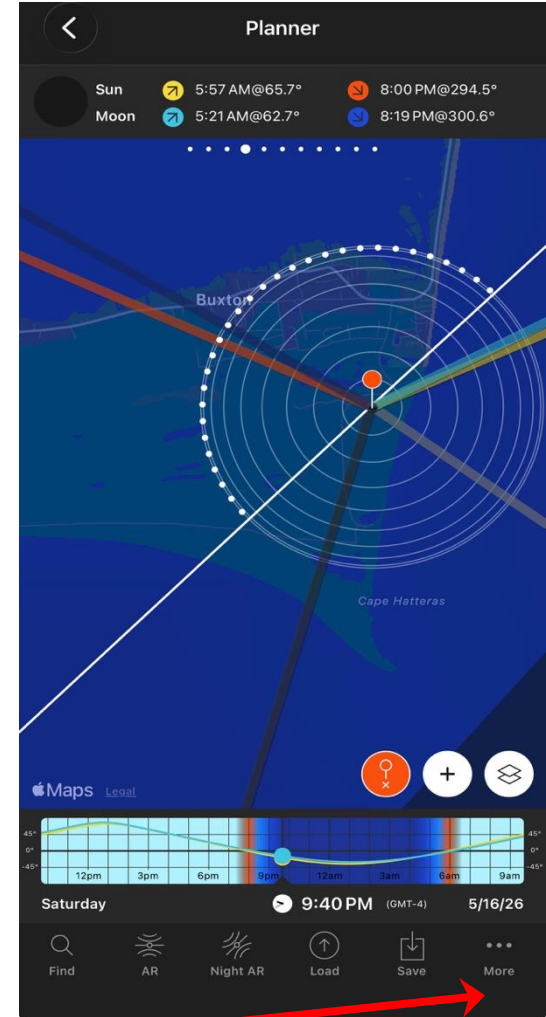
- The "core season" is from March to September, with June and July the best combination of high visibility, long viewing hours, and warmer weather. The photogenic galactic core is visible for nearly the entire night by mid-summer.
- Allow for Sunset more than 90 minutes prior.
- Moon: if either New or  $<10\%$  you're good. If  $>10\%$  allow for Moonset at least 90 minutes prior.
- Wait until the Milky Way's Galactic Core has risen.
- There are a lot of bad days where these things don't happen – you need to check.

# PhotoPills (Apple App for iOS or Google Play for Android – best on iPad) or [The Photographers' Ephemeris](#)



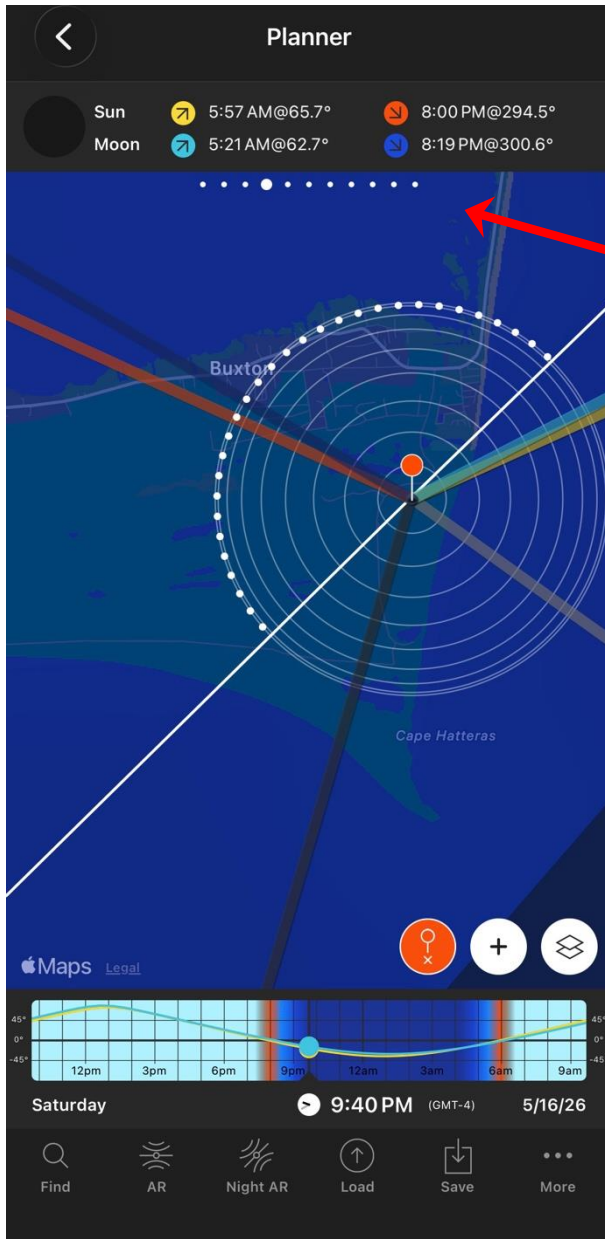
Use your thumb and index finger to expand or compress the scale of the map and finger to move it.

PhotoPills Planner – unpin last location, move map to new location, drop pin.



Put in a date and rough time – Time bar has day, golden hour, blue hour, night: you can slide it back and forth to evaluate.

# PhotoPills

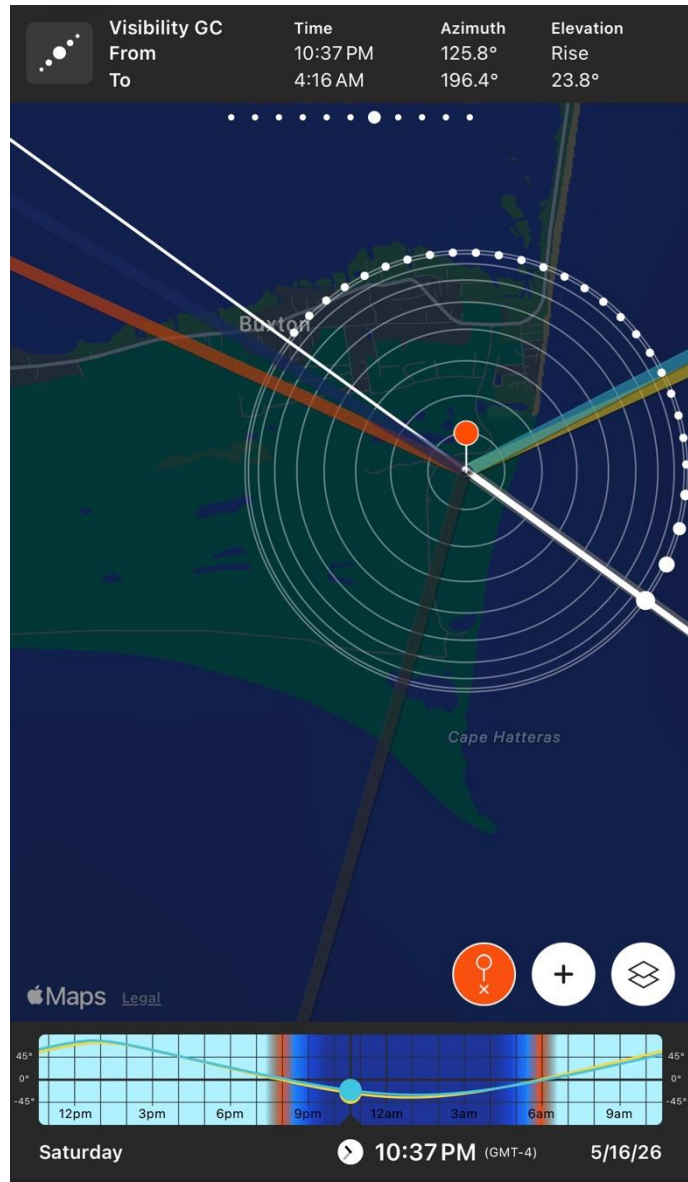


Up top you can scroll the data panels right and left to see the:

- Sun rise and set times and directions,
- Moon rise and set times and directions
- Moon phase (“New Moon”) and % of full
- When Astronomical twilight ends (Full dark)
- Rise and set times, and azimuth and elevation, of Milky Way GC (Galactic Core)

Under the layers you can turn on Sun, Moon, and Milky Way if they aren't on by default.

# PhotoPills



Seeing that the GC rises at 10:37 p.m., we scroll the time bar at the bottom to 10:37 p.m. The graphic moves as you change the time.

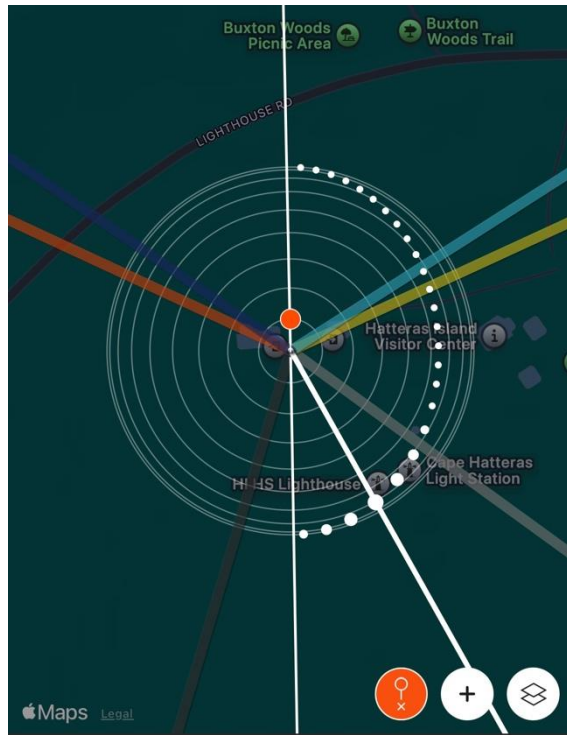
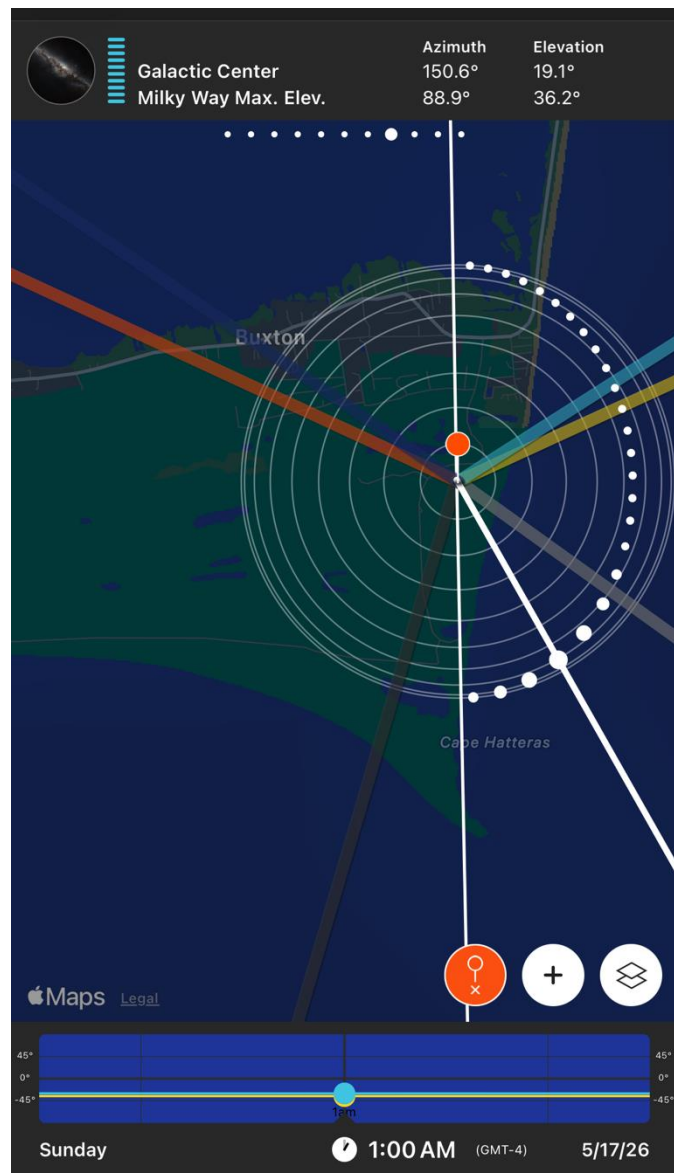
The fattest white circle with the white line running through it is the location of the GC, and is on the horizon at 10:37 p.m.

# PhotoPills

We can scroll the top panel to the right to see the GC azimuth and elevation at the time below.

Scroll time bar to see how the GC climbs up in the sky and rotates to the south. At 1:00 a.m. the GC is  $19.1^\circ$  above the horizon at an azimuth of  $150.6^\circ$  (SE)

You can move your location pin to line up the GC against your foreground subject:



Here the GC is lined up with the lighthouse from my new location.

(I used Satellite View in Google Maps to pick the area in front of the Museum)

# Gear

- Camera
  - Full-frame or crop sensor mirrorless/DSLR - good high-ISO performance is better
- Lenses
  - Wide-angle lens (14–24mm range) with a fast aperture (e.g.  $f/1.4$  -  $f/2.8$ )
  - Here is a bargain: Rokinon/Samyang 14mm,  $f/2.8$
- Support
  - Sturdy tripod (consider weighted bag) — for long (e.g. 25 seconds) exposures
  - Ball head for precise framing
- Power & Storage
  - Extra camera batteries (~ 3-4 total)
  - Extra memory cards (UHS-II recommended)
  - Portable power bank and camera power cord (w/ Velcro) - optional
- Accessories
  - Remote shutter release or intervalometer to avoid camera shake – Velcro to attach it to tripod leg. (or camera self-timer/intervalometer)
  - Red light headlamp (preserves night vision and images)
  - Tape to secure manual focus setting on lens.
  - Optional white flashlight for light-painting, walking on beach in dark
  - Lens heater strap — inexpensive USB-powered - to prevent the likely condensation on lens
  - Microfiber cloth for cleaning lens
  - Camera cover for wind-blown sand

# Gear – Part 2

- Accessories
  - For Milky Way photography on Assateague Island on May 16, we expect chilly overnight temperatures (averaging 55°F) and biting flies. Since you will be standing still for long periods, you will feel the cold more than usual.
  - Weather appropriate clothing, e.g. for Assateague:
    - Layers, including windbreaker or waterproof jacket,
    - Hat and/or beanie
    - Gloves (liner gloves allow you to operate camera buttons)
    - Hiking boots (or other shoes for walking in deep sand),
    - Full coverage: long sleeve shirt and pants (mosquitoes & biting flies)
  - Mosquito repellent.
    - 20% Picaridin lotion or spray (e.g. Sawyer). Will not destroy your plastic camera parts or synthetic coatings like DEET can.
  - Head net (optional)
  - Small stool/chair
- Day/Evening use Lenses
  - Your walk-around lens (e.g. 24-70mm)
  - A longer telephoto might get you a wild pony at Assateague

# Lens Focal Length Comparison

15mm Full-Frame  
10mm crop frame

24mm Full-Frame  
16mm crop frame

50mm Full-Frame  
33mm crop frame



# Focal Length vs Shutter Speed

- Stars move across your sensor at a rate of  $15^\circ$  per hour due to Earth's rotation
- The star trails are longer and more distracting at longer focal lengths due to the smaller fields of view. Field of view of FF lenses:

- 15mm:  $110^\circ$
- 24mm:  $84^\circ$
- 35mm:  $63^\circ$
- 50mm:  $46^\circ$



# Focal Length vs Max Shutter Speed

## Rule of 500:

Max Shutter Speed =  $500 / \text{Focal Length (mm)}$

Old-Timey Rule-of-Thumb developed for *35mm film cameras* to estimate how long you can keep the shutter open without streaking the stars.



- Focal Length vs. Max Shutter Speed (Full-Frame – Rule of 500):
  - 14mm–16mm: 31-35 seconds
  - 20mm–24mm: 21–25 seconds
  - 35mm: 14 seconds
  - 50mm+: Requires a star tracker for long enough exposures.
- For smaller sensor cameras, e.g. 1.5x crop, **Rule of 333**:
  - 14mm–16mm: 21–24 seconds
  - 20mm–24mm: 14–17 seconds
  - 35mm: 10 seconds

# The NPF Rule for Shutter Speed

The **500 Rule** was developed for 35 mm film cameras, but the star steaking it allows is more obvious on densely pixeled digital cameras.

The **NPF Rule** accounts for high density digital sensors but works for all digital cameras, including both Full Frame and Crop Sensors.

**The NPF Rule (simplified) is:**

- Max Shutter speed =  $(35 \times \mathbf{N} + 30 \times \mathbf{P}) \div \mathbf{F}$

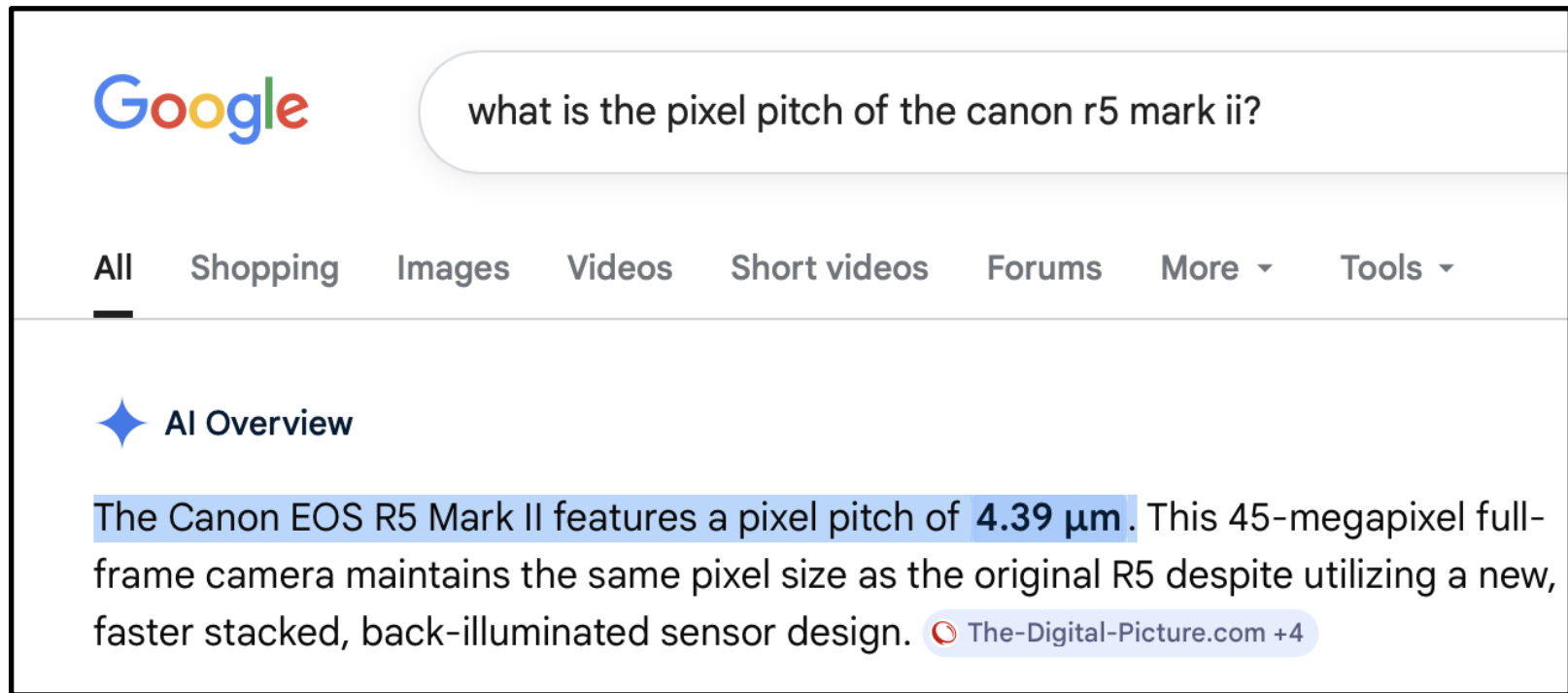
where:

- N = aperture (F-**N**umber)
- P = Pixel **P**itch (pixel size in micrometers -  $\mu\text{m}$ )
- F = **F**ocal length (mm)

It's a more accurate alternative to the simpler 500 rule, especially on high-resolution sensors.

# Look up your camera's pixel pitch:

e.g. Google:



The screenshot shows a Google search interface. The search bar contains the text "what is the pixel pitch of the canon r5 mark ii?". Below the search bar, there are navigation tabs for "All", "Shopping", "Images", "Videos", "Short videos", "Forums", "More", and "Tools". The "All" tab is selected. Below the tabs, there is an "AI Overview" section. The AI Overview snippet states: "The Canon EOS R5 Mark II features a pixel pitch of 4.39 μm. This 45-megapixel full-frame camera maintains the same pixel size as the original R5 despite utilizing a new, faster stacked, back-illuminated sensor design." The source is cited as "The-Digital-Picture.com +4".

Say we have a **f/2.8** aperture, and a focal length of **18 mm**:

$$P = 4.39, N = 2.8, \text{ and } F = 18 \dots$$

# Compare NPF Rule to 500 Rule

## The NPF Rule:

- Max Shutter speed =  $(35 \times \mathbf{N} + 30 \times \mathbf{P}) \div \mathbf{F}$
- Max Shutter speed =  $(35 \times 2.8 + 30 \times 4.39) \div 18 = 12.9$  seconds

## Compare: The 500 Rule

- Max Shutter speed =  $500 \div \text{Focal length}$
- Max Shutter speed =  $500 \div 18 = 27.8$  seconds – twice as long!

In practice, if you used the 27.8-second exposure suggested by the 500 rule, you would capture much more light, but your stars would likely appear elongated if you zoomed in on the photo. [ you CAN try more than one shutter speed!]

# Lens Aperture

- The wider the aperture of a lens, the more light that can be gathered for your exposure. A wider aperture lens means that you can get away with
  - shorter shutter speeds and
  - lower ISO settings than with other comparable lenses.
- For example, say you shoot a 24mm focal length:
  - f/2.8: ISO 6400 for 20 seconds is same exposure as
  - f/1.4: ISO 3200 for 10 seconds (less noise, better dynamic range, sharper stars)
- The downside to wider aperture lenses is the greater cost, size, and weight.
- You get the most light with your largest aperture, but the stars may be soft at this selection. You can evaluate this during focusing on a bright star (or read a review of your lens performance). You may want to reduce your aperture size a bit.

# Condensation on Lenses

- Warm humid conditions (e.g. like Assateague in mid-May) may favor condensation buildup on your lens. This will mess up your photos. You will need to keep the lens warm.
- A lens will fog when the temperature of the front glass of the lens (or the filter you have on it) dips a few degrees below the dew point.



# “Lens Heater” Lens Strap to Prevent Condensation

- A USB-powered Lens Heater strap is ideal, as it allows for a secure wrap around the lens body (or hood) and connects to a standard portable power bank.

## Key Considerations:

- **Power Supply:** A 5V USB design is generally used, and compatible with 5V power banks. There are some 12V designs as well.
- **Controller:** Select a heater with a built-in controller to avoid overheating your lens in moderate conditions.
- **Installation:** Wrap the strap around the lens hood or the lens barrel just behind the front element for the best result.

# Top Recommended Lens Heaters



Power Bank  
w/ USB-A port

Attach to  
tripod leg

e.g. Anker 313 Power Bank  
(PowerCore 10K) – 5V USB-A and C

Note: if using power bank for  
camera, this is a 2<sup>nd</sup> one!



Temperature  
controller

Velcro strap

USB-A  
connector

- **COOWOO USB Lens Heater:** A highly rated, versatile USB-powered strap with a temperature regulator, often recommended for astrophotography. 5V USB-A power
- **Svbony SV172 Dew Heater Strap (320mm):** Features 3-gear temperature control, effective for keeping the lens above the dew point. 5V USB-A power.
- **KIWIFOTOS Lens Heater (DHS-1):** A cost-effective USB option with multiple heating modes. 5V USB-A power

# Camera Settings (starting point)

- **Mode:** Manual (M)
- **Shoot in RAW** for best post-processing performance
- **Aperture:** Widest possible (e.g., f/1.4, f/1.8, f/2.8).
- **Shutter Speed:** ~10–30 seconds
  - (use the NPF Rule:  $\text{Shutter Speed} = (35 \times N + 30 \times P) \div F$ )
    - Lean towards shorter times if stacking
- **ISO:** 1600–6400 (adjust based on camera noise performance and shutter speed and aperture).
- **Focus:** Manual, set lens to infinity, and perfect using Live View on a bright star: zoomed in all the way.
- **White Balance:** 3,800K-4,000K for a balanced look. Not Auto.
- **Turn off Lens IS** (Image Stabilization), a.k.a. O.I.S., VC, VR, IBIS

# White Balance Recommendations

- **Neutral Starting Point:** 3800K to 4000K is widely considered the "sweet spot" for balancing the deep blue of the sky with the warm tones of the Milky Way.
- **Cool/Blue Aesthetic:** 3200K (Tungsten/Incandescent) creates a punchy, moody blue look that can help the Milky Way stand out.
- **Scientifically Accurate:** 5000K to 5500K (Daylight) is technically the most accurate for star colors, though it often looks overly yellow or "muddy" due to light pollution.
- **Light Polluted Areas:** If you are near a city, lower your Kelvin to 3400K–3900K to neutralize the orange glow from streetlights.
- **Key Tips for the Field**
  - **Shoot in RAW:** RAW files are not affected by white balance settings, allowing you to change it completely during editing without losing image quality.
  - **Avoid Auto White Balance (AWB):** AWB often struggles in the dark and can vary between shots, making it difficult to maintain consistency.

# Composition and Composition Tips

- **Foreground:** Include interesting foreground elements (can use a flashlight for light painting to illuminate them. (watch out for other photographers))
- Include both the horizon and the sky within the composition.
- **Composition:** Position the Milky Way core towards a corner of the frame, allowing the Milky Way arc to lead the eye through the scene.




# Foreground Settings (Focus Stacking)

- For the foreground, you want maximum sharpness and depth of field.
- Aperture: Use a smaller aperture like f/8 to f/11. This increases the depth of field, making each frame in your focus stack cover more area.
- ISO: Keep this as low as possible, ideally ISO 100 to 400, to ensure a clean, noise-free foreground image.
- Shutter Speed: Since you're on a tripod and the foreground isn't moving, use a long shutter speed (often 30 seconds to several minutes in bulb mode) to get a bright, detailed exposure.
- Focusing: following ...

# The Settings Gist

## Setting Changes Comparison

Feature 	Foreground Stack	Milky Way Background
Aperture	Narrow (f/8 – f/11)	Wide (f/1.4 – f/2.8)
ISO	Low (100 – 400)	High (3200 – 12,800)
Shutter Speed	Long (30s – several mins)	Short (10 – 20s)
Focus	Multi-point (front to back) (if needed)	Infinity (on stars)

# Do the foreground first

- If you have a foreground object in your shot, you want both the foreground and the stars to be in perfect focus. Since you will be shooting stars with a wide open aperture, focused at infinity, how do you achieve that?
- Use a technique called “focus stacking”, except you are probably going to take only two images, with one focused on the sky and the other focused on your foreground. If the middle distance is visible and out of focus, you’ll need to include a shot focused on the middle distance too. Don’t move camera!
- Then you can use Photoshop to merge the shots into a single composite, with perfect focus on everything.
- Shoot your foreground before focusing the stars because you will lock down your focus then.

# Focusing the Stars

- Set your lens to Manual Focus and turn Live View on.
- Point your camera at a very bright star or some distant light, centered in Live View.
- Some Live Views in cameras are very good and will boost the night sky and reveal the stars. You may have to turn on an Exposure Simulation option in your menu or increase the ISO temporarily.
- Zoom in on your star to 10x. Focus to best sharpness. Back off your exposure with smaller apertures if you see optical distortion effects (can happen at widest aperture settings). Focus back and forth through sharpest focus to find the best focus.
- If nothing works out, you can try using the infinity mark on top of the lens and take sample shots to see if focus is properly acquired or not. If you see blurry stars when zoomed in to 100%, then you know that you need to rotate the focus ring a tad to get better focus.
- When sharp CAREFULLY tape down your focus ring so that it won't move.

# Distorted Stars?



'Coma' distortion – lens effect  
Try stopping aperture down a little



Star Trail elongation – long shutter speed  
Try shorter shutter speed

# Image Stacking for Dramatic Results

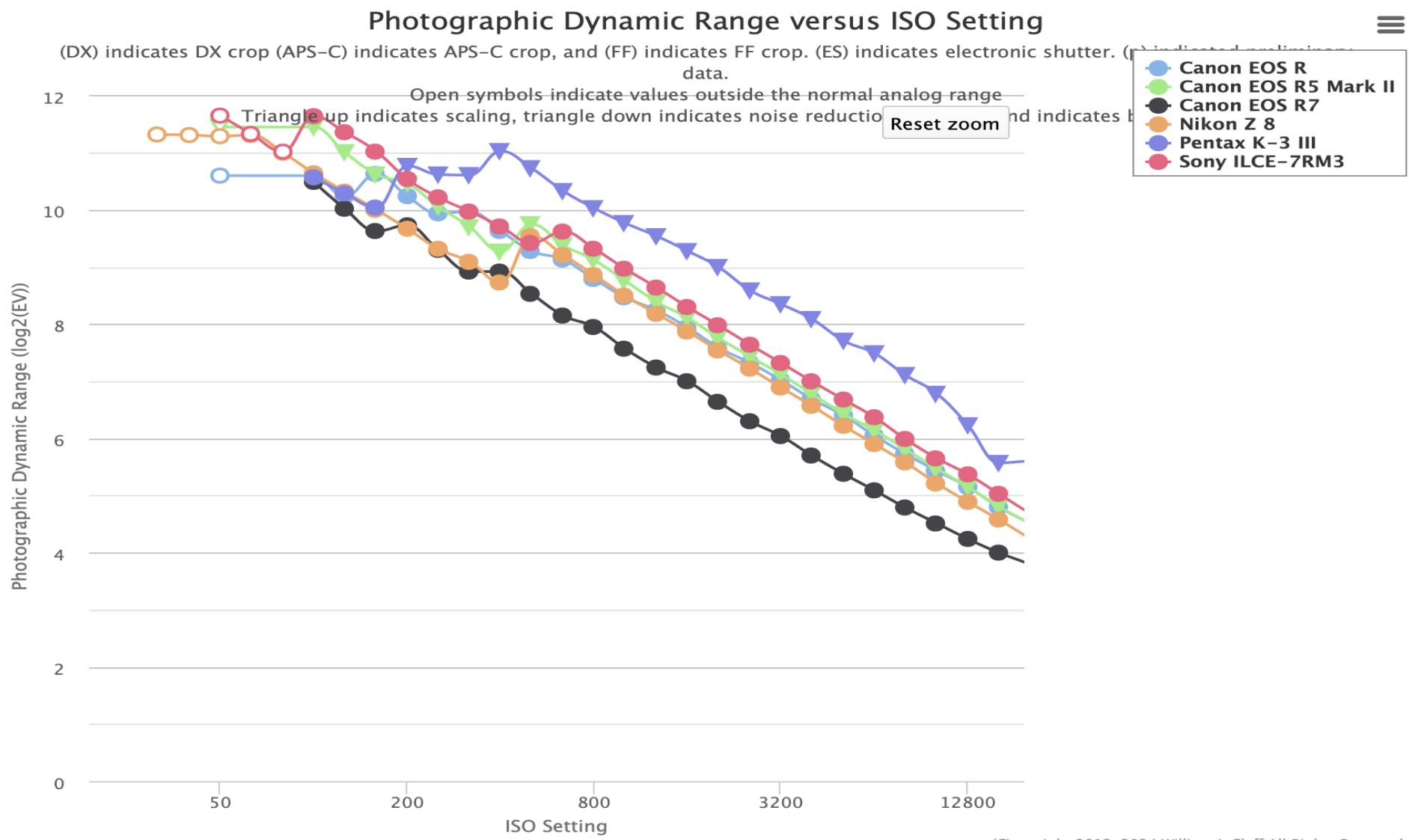
- Similar to “Focus Stacking” we can shoot multiple images of the Milky Way and combine them in post-processing for better dynamic range, lower noise, and more dramatic results.
- Just shoot 10-20 identical images back-to-back, allow a 1 sec delay between shots.
  - E.g. if using a built-in intervalometer, you may need to set an “Interval” that includes the shutter time.
  - A 15 sec exposure plus a 1 sec delay = 16 sec Interval.
- Avoid any star trails by shortening your shutter speed (< 20 sec). You can increase your ISO to compensate.
- Combine in Postprocessing:
  - For Windows: **Sequator** is a powerful, free tool that is highly effective at freezing the landscape while stacking the stars.
  - For Mac: **Starry Landscape Stacker** is an industry standard for creating clean, artifact-free sky masks. \$39.99, but free trial offered.

# Backup

# Camera Performance

- Full Frame is better than Crop Sensor or Micro Four Thirds for high ISO noise performance
- ISO Invariant Sensors: Some sensors (common in Nikon, Sony, and Fuji) produce the same amount of noise whether you use a high ISO in-camera or brighten a low-ISO shot later in software. For these, you might use a lower ISO (e.g., 800 or 1600) to protect highlights while maintaining similar noise performance.
- ISO Variant Sensors: Older or different sensor types (often seen in Canon DSLRs) may produce more noise if you shoot at a low ISO and try to brighten it later. With these, it is often better to use a higher ISO (3200+) at the time of capture
- Read Noise Reduction: In many modern cameras, increasing the ISO actually decreases read noise up to a certain point! This helps faint starlight "stand out" from the sensor's own electronic noise.
- Here is the RAW data: [Photons to Photos](#)

# Dynamic Range vs ISO



# Shadow Improvement with ISO

Photographic Dynamic Range Shadow Improvement versus ISO Setting

(DX) indicates DX crop (APS-C) indicates APS-C crop, and (FF) indicates FF crop. (ES) indicates electronic shutter  
 Open symbols indicate values outside the normal analog range  
 Triangle up indicates scaling, triangle down indicates noise reduction, and diamond indicates

- Canon EOS R
- Canon EOS R5 Mark II
- Canon EOS R7
- Nikon Z 8
- Pentax K-3 III
- Sony ILCE-7M3

