

Policy Briefing: The Growing Impact of Satellite Constellations on Astrophotography and Celestial Heritage



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1. Introduction: A shared sky under threat

The night sky represents a shared global commons—a source of scientific data, cultural orientation, and universal inspiration that constitutes the celestial heritage of all humanity. For millennia, it has connected us to the cosmos and our place within it. Today, this irreplaceable resource is under an unprecedented and accelerating threat from the rapid proliferation of satellite mega-constellations. While these technologies promise global connectivity, their deployment is fundamentally altering the night sky for observers on the ground. This briefing synthesizes new data from a 2025 global survey of the astrophotography community to quantify the escalating impacts of this orbital industrialization. The findings present a clear, evidence-based foundation for urgent and decisive policy and regulatory action to protect our shared celestial heritage for future generations.

2. A global consensus on a worsening problem

To understand the scope of the satellite interference issue, it is crucial to establish its global scale and the strong consensus within the affected community. The challenges documented in this briefing are not isolated incidents but a shared and worsening experience for a dedicated international community of astrophotographers.

A 2025 global survey of 203 astrophotographers from 31 countries confirms the universal nature of this problem. The respondents represent a highly experienced and dedicated community, with a combined **34%** identifying as professional, semi-professional, citizen scientists, or academics. The data reveal a clear and alarming consensus: **90% of respondents now report moderate or worse interference** from satellites in their work. This breaks down into 47% experiencing "moderate" impacts, 37% "significant," and 3% "severe" impacts that inhibit their work entirely. Furthermore, there is near-unanimous agreement that the problem is rapidly escalating, with a staggering **198 out of 203 respondents stating that impacts have worsened over the past five years.**

"It is a new type of pollution, 'satellite pollution,' which is affecting both the capture of celestial images to show the sky and natural nature, as well as scientific observations."

— Survey Respondent, Spain

This overwhelming consensus demonstrates that satellite trails are no longer a minor nuisance but a pervasive environmental challenge. The scale of this impact imposes specific, measurable burdens on photographers worldwide.

3. The quantifiable burden: Measuring the hidden costs

The interference from satellite constellations imposes tangible, quantifiable costs on the astrophotography community. These are not mere inconveniences but represent a significant expenditure of time, the loss of valuable data, and a drain on resources for the astrophotography community globally. These "hidden costs" are a direct consequence of orbital activity and constitute a substantial burden.

Key metrics from the global survey quantify this burden:

- **Additional post-processing time:** On average, photographers spend an extra **27 minutes per image** manually editing out satellite trails and other artifacts. This time quickly adds up. Editing satellites out of star trail images can mean thousands of images that need to be manually edited. This represents a significant and uncompensated time commitment required to restore the integrity of their work.
- **Lost data and wasted resources:** An average of **16 photographic frames are lost per imaging session** due to satellite contamination. Each lost frame represents wasted time, energy, and equipment use, often in remote, dark-sky locations that require considerable effort to reach.

While photographers have developed mitigation techniques, these tools are struggling to keep pace with the growing number of satellites. Stacking images with rejection algorithms is rated as the most effective current technique. However, a significant portion of the community—**41% of respondents—believes that current mitigation tools are not keeping pace** with the increasing number of satellites, compared to only 20% who believe they are. AI-based removal tools were noted as promising but are inconsistently adopted, indicating that while innovation is occurring, it is not yet a systemic solution.

This data demonstrates that post-processing is a form of uncompensated labor imposed upon the public by the satellite industry.

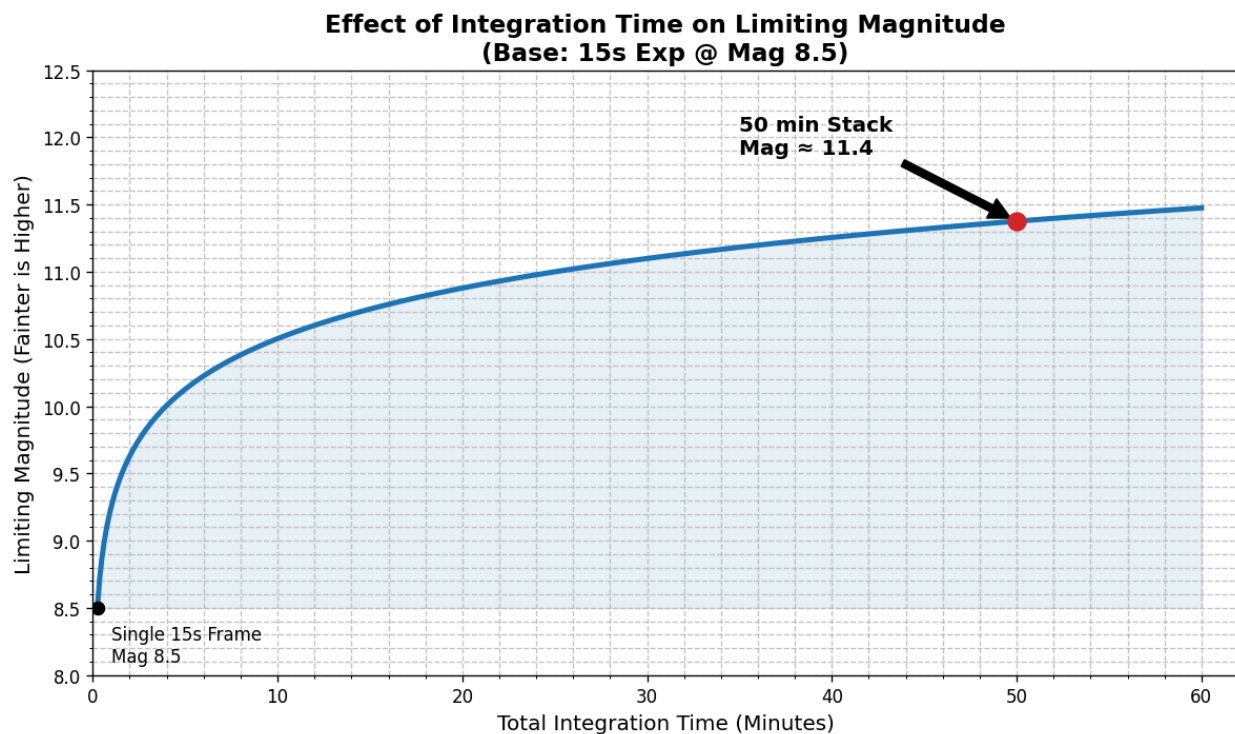
4. The technical reality: Why "invisible to the naked eye" is not a viable standard

DarkSky has advocated that, for the general public's enjoyment of the night sky, maintained satellite brightness should be invisible to the unaided eye (approximately Magnitude 7). This is a good initial target, but it is insufficient for astrophotography and is based on a misunderstanding of modern sensor technology. This section deconstructs this misconception to establish the clear need for a more stringent and scientifically grounded regulatory standard.

The astronomical magnitude scale is logarithmic, meaning small numerical differences represent large changes in brightness. Modern cameras are vastly more sensitive than the human eye, creating a significant "sensitivity gap." Based on standard professional-amateur equipment (e.g., fast wide-angle lenses and small telescopes) under dark-sky conditions, the sensitivity gap is stark:

- **The human eye:** Under the darkest skies, the human eye can see stars down to Magnitude 6 or 7.
- **Tracked wide-field astrophotography:** A standard setup for capturing the Milky Way can routinely detect objects down to Magnitude 11-12. This is approximately **100 times more sensitive** than the human eye.
- **Telescopic deep-sky imaging:** An amateur telescope setup for imaging faint galaxies and nebulae can detect objects down to Magnitude 18-20. This is approximately **100,000 times more sensitive** than the human eye.

The following chart illustrates how the limiting magnitude changes with total integration time for a 24 mm lens shooting at ISO around 1600–6400 on a tracking mount.



The policy implication of this technical reality is profound and unambiguous: **a satellite dimmed to Magnitude 7 remains exceptionally bright to astrophotography equipment.** From the perspective of a sensitive deep-sky camera, a satellite that is "invisible" to the naked eye can still be tens of thousands of times brighter than the faint galaxies and nebulae that are the artistic and scientific subjects of the image. Setting regulatory standards based on the limitations of human vision ignores the primary tools

used for both amateur and professional astronomy, rendering such standards ineffective for protecting the night sky.

This technical challenge is not just a matter of data; it has profound cultural and personal consequences for those who seek to connect with the night sky.

5. The cultural cost: Erosion of a shared celestial heritage

The impacts of satellite pollution extend far beyond technical data loss, inflicting a significant cultural and emotional toll on a global community. Qualitative feedback reveals deep-seated frustration and a sense that the fundamental experience of the night sky is being polluted and stolen. Respondents described how the constant intrusion of satellites "sucks the joy" out of their work and "breaks my heart," turning a source of awe into an exercise in mitigation. One respondent shared a poignant story of having to explain to their young nieces that the streaks they were wishing upon were not shooting stars, but satellites.

The community perceives a clear "break point" on the horizon. A strong majority—**78% of respondents—believe a threshold exists** at which the sheer number of satellites will irreparably harm astrophotography. The median estimate for this break point is approximately **25,000 active satellites**. This figure is alarming when contrasted with the roughly 4,000 satellites in orbit before 2019 and the projected total of up to 100,000 in the coming years. This community-defined 'break point' offers a clear, quantifiable target for regulators, representing the threshold at which a shared cultural resource is perceived to be lost.

This sense of loss is accompanied by a call for accountability and the protection of the sky as a cultural resource for all of humanity, not just a commercial space for a few.

"Regulation by an independent international organisation that not only has the commercial benefit in mind, but also the cultural impact from spoiling our night skies."

— Survey Respondent, Switzerland

This cultural erosion demands that the problem be addressed not just as a technical nuisance, but as a threat to a fundamental aspect of the human experience. Actionable policy is required to secure a sustainable future.

6. Recommendations for a sustainable orbital future

The survey data and technical analysis point to a clear and urgent need for proactive, evidence-based policy. A sustainable future in orbit requires a collaborative framework where industry, the scientific and amateur astronomy communities, and regulatory bodies work together to protect the night sky as a shared, finite resource. Based on the evidence presented, we recommend the following actions:

1. **Establish international brightness standards for satellites.** While regulations should use a baseline of magnitude 6-7 as the *minimum* acceptable brightness limit, this naked-eye standard cannot be the endpoint. Regulations must be based on the significantly greater sensitivity of modern digital sensors, not solely on the limitations of human vision. A scientifically meaningful standard should be developed in consultation with the astronomical community to minimize interference with both professional and amateur observation, ensuring that satellites are faint enough to avoid detection in typical long-exposure images.
2. **Mandate accountability and mitigation in licensing.** Regulatory bodies must treat orbital brightness as a form of environmental pollution. As such, licensing and spectrum allocation must be contingent upon operators submitting binding impact assessments and mitigation plans that are subject to independent review. As expressed by survey respondents, the responsibility for mitigating satellite trails should fall on the companies creating them, making it a prerequisite for launch approval.
3. **Foster collaborative development of mitigation tools.** The community has an urgent need for more effective, automated software to manage satellite trails. Policy should create frameworks or incentives for satellite operators to collaborate directly with software developers and the astronomy community. This could include funding open-source projects or providing precise orbital data to facilitate the creation of effective, publicly available mitigation solutions.
4. **Promote public awareness and education.** The scale of the threat to the night sky is not yet widely understood by the general public. We recommend supporting educational initiatives to raise public awareness of the value of dark skies and the growing problem of satellite pollution. As one respondent noted with a sense of urgency, "*it won't stop, and it will get worse because the general public is unaware of the problem,*" making widespread education a critical component of any long-term solution.

7. Acknowledgment:

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