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Burning the Midnight Oil

Comet Hyakutake, a frozen flare of dust and ice hurtling towards the inner Solar System for the first time in 17,000 years, passed very near to Earth in the spring of 1996. It was close enough that it was reportedly a marvel to see, even with the naked eye, because its tail was bright and distinct. Soon it reached perihelion (the point of its orbit that is nearest to the Sun) and continued on its elliptic path back into the cold, far-flung recesses of space. Due to the gravity from the gas giant planets plucking at and stretching its orbit, Hyakutake won't revisit the Sun for another approximate 70,000 years. Its proximity was a reminder that humanity and its entire history is dependent upon how slim the odds are of a large celestial object colliding with Earth.

Certainly Hyakutake was a close approach, but still, it was nothing special. Other comets have come nearer to us, even within the span of the same century. However, what interests me most is not the doomsday *what-if* scenario if Hyakutake had dared to come closer to us, but the elegance of its mechanics. The 70,000 year prediction is just a ballpark estimate, but astronomers' ability to roughly know how prolonged its journey will be is astounding. Even more staggering is the accuracy with which other astronomical events are mapped out. Solar eclipses that will occur thousands of years from now, for instance, are listed out with their precise date, time, and even duration. The abstract splattering of stars across the night sky is actually mathematical, to an unimaginably formulaic degree. Knowing this, it's easy to think of

the sky as eternally calculable, and unwavering, no matter how much the surface of our planet may alter.

This is why I was so stunned to see the moon reverse the direction it was facing, in the span of only a day. It was a semicircle with its right side hollowed out when I left my home state of Maine in August of 2022, and by the time I arrived in Patagonia, it was backwards — as though someone had reflected its image across the *y* axis of a graph.

My mom, brother, and I had the opportunity to travel to Chile because my mom had been granted a sabbatical after nearly thirty years working for the same company. As the de facto travel agent of the family, I had the privilege of ironing out every last detail, and so the itinerary was jam-packed: Patagonia was the first destination, and from there we would return to Santiago and roadtrip northwards.

The trip was deliberately booked so that we would be in the southern Atacama Desert, a world-renowned location for stargazing, during the new moon. Moonless nights are crucial for optimal viewing, because even a thin crescent can interfere with visibility. Even though I had repeatedly checked the lunar cycle, as we left Maine, I was glad to see the distant waning moon, curved in the shape of a *C* due to its clockwise rotation.

And then, six thousand miles south of home, was an incomprehensible sight: a reversed moon*,* like if the DreamWorks logo that a boy casts his fishing rod from was mirrored. I remember how baffling that feeling of cognitive dissonance was; how could the moon, at the end of its cycle two nights before, now be nearing a full moon instead? The morning itself was exquisite. We were in pajamas, isolated in thousands of miles of wilderness, and shivering (August is mid-winter for southern Chile). The moon rose in the lavender backdrop of Cerro Paine Grande, a rugged mountain crowned in snow that watches over Lago Grey, and beside it,

El Glaciar Grey, a pale aqua protuberance at the back of the lake. Westward, where it was darker, stars peppered the heavens. Swathing the landscape were hues like a Crayola crayon I remember loving as a child, *purple mountains' majesty*; the air, unspoilt and icy, was hushed with dawn, and still I could only think about the seemingly ludicrous illusion of the moon.

Moonrise above Cerro Paine Grande

Hundreds of early morning stars visible above the western horizon (both these images are unedited; the sky was vividly purple)

Only moments later it occurred to me that we were standing in the southern hemisphere, and therefore looking at the moon upside-down, in a sense, relative to how we usually saw it in Maine. It was an *aha* moment, because I had temporarily doubted that I had planned the trip properly, and thought we'd have to stargaze amidst a full moon. The conviction that the sky had somehow flip-flopped in a matter of days had defied all logic — it isn't supposed to change, it's meant to be a constant in our lives. It's the only landscape in the world that *everyone* shares.

The moon didn't shift 180 degrees while we were in Patagonia. But now, I fear the gradual changes to our sky that *will* come — the veil of light pollution that inches along in its opacity so that we don't notice a few stars are missing until we tilt our heads back and can only see five or six. It's a problem ubiquitous to us all, extending beyond the aesthetic objections into

questions of health, the economy, energy consumption, and wildlife, yet is often excluded by environmental action.

I've only just begun thinking about this issue, but there are Mainers who have led night sky organizations for years. Recently I had the privilege of asking Rob Burgess and Paul Howell questions about their group that they founded twenty years ago, Southern Maine Astronomers. Rob and Paul are avid stargazers, and the creeping haziness blotting out the skies is something they're deeply concerned about.

"Dark is a vanishing resource," Rob said. "It's so intangible and ephemeral that it's just not an obvious thing that people recognize is happening until it's gone. Right now it's estimated that better than 99% of Ameicans and Western Europeans live under skies that are light polluted to some extent." It's a scary statistic that makes me think about how desensitized we are to light pollution. How does each subsequent generation know that they're living under a sky with less stars than the sky their grandparents grew up underneath?

Stargazing is far from a modern phenomenon — in fact, astronomy predates all other sciences. From megaliths to cave paintings to clay tablets, it has graced the milieu of every civilization, and today underlines the cosmological theories and axioms of the universe itself. Preserving the night sky is not merely a question of whether we care enough about identifying constellations or witnessing a meteor shower; so much of human history is fringed with the stars. Early navigators were led by the stars, from the Minoans to the ancient Chinese to the Renaissance Europeans who would commence a period of more than the words *cultural diffusion* suggest — the Transatlantic slave trade, colonialism, genocide. The stars have always been stimuli for philosophical thought — central names like Copernicus and Ptolemy have grappled at the question of our place in the universe. Religion blooms in the stars, inspiring figures and

myths, beliefs and cultural truths, memorializing godlike explanations of Apollo, Huitzilopochtli, Surya, and Ra in our very own star that staunchly rises in the east and sets in the west each day. Light pollution is thus an urgent crisis of scientific, cultural, and historical heritage, because the planetarium above our heads is an archive of human progress.

Yet with every passing year, the night sky gets a little less black. Globe at Night, a program that synthesizes tens of thousands of naked-eye appraisals from stargazers across the world, reported that global light pollution increases by approximately 9.6% each year. This is a low estimate — regions with high-economic growth, where light pollution is worsening most rapidly, tend to be under-sampled. Satellite data, transferred into glowing red and yellow threads that indicate the brightest regions on a map, reveals just how visual artificial lighting is, but anyone in or near an urban space can testify to this themselves, just by looking up. Cities endure a bronze luminescence called “skyglow,” a haunting sight I discovered only when I moved to Chicago for college. There’s a notable demarcation between the city and Lake Michigan; sallow haze rapidly lapses into pitchy darkness over the water. In places like this, according to Paul, “tens of thousands of years of cultural heritage is gone.”

The nighttime color gradient over Chicago’s skyline; no stars are visible

It was also in Chicago that I developed an interest in astronomy. Prior to college, I had a vague appreciation for the stars, but I neither cared nor knew about the physics behind astronomical phenomena. Reluctantly I enrolled in a course called Earth as a Planet to satisfy a physical science requirement as painlessly as possible. *I am not a STEM-type person*, I always told myself. It wasn't that I had a vendetta against the sciences, but rather I felt more comfortable in the humanities, and was unwilling to engage in anything that would subvert the pre-defined "right-brained" category I had carved out for myself.

The decision to take that course shattered whatever expectations I had for my college experience. Our first assignment was to track the moon — its phases, location, shape, rising and setting times. I settled into a habit of scanning the sky every time I crossed the Midway, and it didn't take long to notice patterns. On my way to breakfast, I might expect a waning gibbous moon rising a few degrees over the dining hall, and lo and behold, there it would be. Crackling underneath the amusement of predicting where and when I would see the moon was a newfound, electric awe of how unwavering the lunar cycle is. This assignment was supplemented by lectures on the gravitational interactions between Earth and the moon, and I was floored by how simple formulas could explain something so profound as a celestial object steadfastly orbiting us, every day and night, for billions of years without fail.

From there, my fascination with astrophysics snowballed into a minor. I've looked through physical and remote telescopes, listened to presentations on stupefying theories of cosmology, struggled through mathematical calculations of exoplanet detection, studied dark matter, and forayed into computer programming for astrophysics (which, though very interesting, I am frankly terrible at).

A view of the moon on an observation night with the Ryerson Astronomical Society at UChicago

Yet most revolutionary of all, since I began the minor, is stargazing itself. There's an intimacy to it that didn't exist when I was younger; a kinship now between us, in that I almost feel as though we know one another in a reciprocal way. They are the only witnesses to the entirety of Earth's history, and now I have some inkling of *their* history, too — how they knit themselves from the dust and grit of space, and like someone who is cold rubbing their hands together, generate their own light through nuclear fusion. This is, broadly speaking, the origin story for every speckle in the night sky — a majority of which we can no longer see, thanks to our own light that *we* create.

I had the opportunity to speak with Nancy Hathaway, the president of Dark Sky Maine (DSM), a nonprofit organization that combats light pollution through advocacy and an enthusiasm for celebrating the stars. She described the conversation she had with an astronomer that would eventually give rise to DSM: "One morning in [Gardiner, Maine] we had breakfast at the A1 Diner." (The A1 diner is a charming and popular breakfast locale with a classic 1940s atmosphere right beside the Cobbosseecontee Stream.) "We decided instead of having a

[DarkSky International] chapter, we would start our own nonprofit, because we would have more freedom. So, we started Dark Sky Maine."

The organization intends to help others achieve what Nancy has done — establish reserves formally recognized by DarkSky International (essentially, the global version of DSM), implement town ordinances more friendly to a dark night, and commemorate the beauty of the sky with "star parties," nighttime gatherings throughout the year that might include observations, art displays, presentations, and telescopes. I've never been to a star party — in fact, I hadn't heard of them until I began researching light pollution — and it's something I'm looking forward to participating in. How many other people haven't heard of star parties, either, who would join if they knew? It's a question with a much broader implication: *How many people, like me only a few years ago, haven't had the chance to appreciate the night skies, and what it would mean to lose them?*

"I want the night sky, the stars over my head," Nancy said, a sober truth when I asked her why she has devoted herself to this advocacy. "It gives me my place in the universe. That's why."

It's not just humans that have a place in the universe because of the stars, though. There is a myth that light pollution is an aesthetic complaint, one that, worst case scenario, affects stargazing only. Unfortunately, this is far from the truth. At the forefront of unwitting victims of our steady lamps and streetlights, blinding stadiums and light shows, steady headlights and floodlights, are the flora and fauna.

There is a creek that cascades through my backyard. Burbling with cold water, it enters under the stone wall my dad built along the border of the property, weaves downhill, draping over rocks and arching around curves, and collects in a large pool that we call "the frog pond." During the spring, while in bed at night, I can hear the frogs peeping, a symphony of squeaks and

croaks as they prepare to mate. But if we turn on the floodlights from the back deck, it's noticeably quieter.

This isn't a coincidence. Reproduction is only one dimension impacted by artificial lighting. The brightness of cities not only disrupts the timing of migratory birds but their route as well. Often the glare of lights further entraps them within cities; in an attempt to escape, the birds fatally collide with infrastructure. Sea turtles can mistake a gleaming sign for the moon and head towards a busy street instead of the ocean. Studies discuss a number of effects on amphibians, beginning with the general patterns of diurnal and nocturnal wildlife, the former of whom are more likely to hunt in artificially-lit night — which does not bode well for their prey — and the latter, like the salamander, accordingly decline in foraging activity, which can lead to population loss. Toads, attracted to the insect buffet underneath streetlights, are more frequently killed by bicycles and cars. And for the frogs in my creek at home, lighting does more than silence their peeping. Exposure to light delays metamorphosis in tadpoles and thus leads to increased rates of mortality.

Less research has been devoted to moths than their well-admired relative, butterflies, and so we aren't told what is happening to these insects, because it simply isn't talked about much, even in discussions of light pollution. But unlike bees, who often pollinate a specific plant, moths aren't fussy. They flutter from plant to plant, and therefore are integral to pollination. As a consequence of light pollution, however, pollination rates in bright nightscapes can lower by as much as sixty percent.

On the biological level, light at night corrupts millennia of genetic programming. Simply put, hormonal cycles depend on the sun to function properly, and have been calibrated with this natural clock for thousands of years for both humans and wildlife. Light pollution as a concept

didn't really materialize until the 1980s, so we have absolutely no precedent or evidence, outside of hypotheses produced by controlled studies and theory, for what the long-term consequences will be. It goes without saying that electricity is a beautiful, integral facet of modern life, but how can we harness its benefits without allowing it to sabotage something so innate as our biorhythm?

But this is far from a singular problem, and the biological question is not the only one we need to ask. Only two months ago, I was in the car with my mom, driving north from Portland. Less than five minutes from our home, a beaded necklace of stars, arching upwards from the horizon, caught my eye. We pulled over on the side of a large field, next to the Piscataqua River, though by the time we got out of the car the lights were already beginning to vanish into the depths of the sky. It was not very dissimilar from the feeling of bafflement I'd experienced in Chile, upon seeing the backwards moon. The stars aligned perfectly, shooting upwards into the blacker zenith above, akin to the dotted parabolas my high school math teacher used to dash on the whiteboard. I could only think, absurdly, that we were witnessing something extraterrestrial.

A quick Google search informed us that this was the telltale sighting of the Starlink satellites launching into orbit. Pioneered by SpaceX, this "megaconstellation" has already placed about 4,000 satellites in orbit around Earth with permission to launch 12,000 from the U.S. Federal Communications Commission, and they recently filed a request to dispatch another 30,000. For context, as of September 2023, there are currently around ten thousand satellites in space.

The Starlink satellites climbing upwards

It might be asked whether this matters. Surely one man-made pinprick of light, faraway from a ground observer, has no material difference from its neighboring natural pinprick of light. But satellites aren't light-years away like stars are. They're low in Earth's orbit, and smear astronomical data that is sensitive to faint objects because of their reflective surface. While they don't produce skyglow, this is a variant of light pollution, one that poses more of a threat to research because even in the most rural location, telescopes are at the mercy of a clear-enough orbit. Observations damaged by satellite streaks often render them useless, and so more low-altitude satellites polluting the sky means more tossed data.

Of course, just like electricity, Starlink is far from an antagonist. After the war in Ukraine began, it proved to be an invaluable asset for Ukrainian technology that would have otherwise been compromised by Russian attacks, and in general it provides Internet connection to remote locations across the world. This is perhaps what makes light pollution so difficult to address despite its seemingly easy solution of responsible lighting: the perpetrators and victims are not

split into a binary of good and evil. Adjusting policies to rectify the issue will necessitate a calculated decision of pros, cons, and gray unknowns hiding in between.

That's not including the challenge of garnering enough political interest to warrant any action in the first place. Interested in policy concerning light regulation (or lack thereof), I corresponded this summer with the town council for my hometown, New Gloucester. Admittedly, it's a small town, so I didn't expect an exuberant reaction to my proposal of designating New Gloucester a Dark Sky Community (a process that takes much citizen engagement, ordinance revisions, and eventual implementation of responsible lighting). However, only a few days after I first emailed the Environmental Resources Committee (ERC), I received a response. They, too, sympathized with the idea of preserving the rural skies. I was thrilled. The project is still in a very early phase, but I'm psyched by the idea of helping to bring a Dark Sky title to my hometown. Currently the project is bouncing around as the ERC hasn't designated a person to take the reins, but even if it takes years, it's still progress.

Still, designating a town as a Dark Sky Community isn't a breezy decision to make. Policy and lighting changes hinge on a massive expense of time and money, and this is why there has been no widespread action sweeping the nation. However, there is less reason to understand why cities, with their large presence of Dark Sky advocates, astronomers, and light pollution researchers have not more frequently heeded calls for action. They have the means, the support, and the research; why not follow through? It's especially strange because reducing bright lights is in the interest of any city that wishes to save money on their electric bill.

Portland, the largest city in Maine, is an exemplar for the positive correlation between light usage and expenditures. In 2018 the city began replacing its old streetlights with new DarkSky-endorsed fixtures and light-emitting diode (LED) lights. On the financial side, the

project saves taxpayers one million dollars in electricity bills every year; on the environmental side, less energy is used in the lights' output, and their color temperature is 3000K. This doesn't result in visibility diminishing, either, because temperature is unrelated to intensity.

It's a step in the right direction for Portland, even if the color temperature could have been lower. Supine on the patio in the backyard of my mom's house, most of the domed sky above is dark enough to see the Milky Way. It's only towards the south, where Portland gleams just twenty minutes away, that the charcoal color is washed out by copper. No matter the hour, it's an eerie lump of luminescence on the horizon, like a permanent dusk half an hour after the sun has descended below the trees. Despite this, I don't want to complain, because we're fortunate to have such a panoramic celestial view. My favorite time to stargaze here is in August, when the annual Perseid meteor shower blazes through the sky as Earth orbits through the debris that Comet Swift-Tuttle left in its wake over thirty years ago.

Stargazing at home with my mom and step-dad in Falmouth, a town less than twenty minutes from Portland and a testament to the relatively dark skies in Maine's most urban region

However, even with the success of Portland's project, LEDs in general can be good or bad for light pollution, depending on their implementation. I asked Rob and Paul about Portland's installation, and learned that it all boils down to color temperature. Lights that are higher, such as 5000K, are sterile white and scatter more widely due to increased blue in their spectrum. In contrast, low temperature lights, usually at 3000K or lower, are a warmer, more buttery yellow, which is more pleasing and less disruptive. Rob explained the urgency of choosing a warmer color temperature when LEDs are installed, because "without adequate ordinances or advocacy by people, those conversions might happen without any input as to the color temperature of the replacement fixtures."

The longevity of LEDs means that they can't be replaced for a long time after they're installed — so if a town spends all of its money to put up 6,000K lights, then they're stuck with their bad choice for a long time. The low cost of LEDs also tend to dupe town officials into purchasing more than necessary, and the result is often a night that masquerades as day.

For instance, Cook's Corner, a shopping center in Brunswick, Maine, recently transitioned their parking lot lights to 5,700K. "You could almost do surgery in the parking lot with the whiteness of that lighting," Rob said. "No one had any say in that because there wasn't a requirement in the ordinance to get approval from the town. We're [SMA] trying to prevent those things from happening elsewhere."

"But, peel the onion. The biggest [factor] could be municipal lighting anyway," Paul added. "Incrementalism eventually will win." In other words, the very reason for light pollution is also the solution, because the more towns that adopt responsible ordinances, the more we tiptoe towards a darker night. This is why the public outreach from advocates like himself, Rob, and Nancy are so important, because it's not well-understood that better lighting isn't always

dimmer lighting. In a world where cheap products and money-hungry industries force us to associate *going green* with *going broke*, Portland's project is evidence that economically-friendly can be closely tied to ecologically-friendly.

Our wallets are far from the only consideration when we stop to think about our use of energy. Roughly approximated, one pound of coal yields one kilowatt hour of electricity (the energy of one kilowatt given in one hour). If we dim our lights, we dial down our rate of fossil fuel exhaustion. Lighting is estimated to account for a fifth of electricity consumption worldwide and six percent of carbon emissions, but if left unaddressed, the UN Environment Programme predicts that "global energy consumption for lighting will grow by 60% by the year 2030." As pleasant as it would be to consider light pollution an isolated problem, this is far from the truth. It is intrinsically and irrevocably entwined with climate change as a direct byproduct of our flagrant energy waste.

A popular refrain, however, is that we need *more* light. Light makes us feel safe; it allows us, after dark, to drive down the road and walk down the street. My mom has instilled in me to fear crime in parking garages, so even with their radiant white lights, I can't help but walk (or hurry) to my car and lock my doors immediately if I'm alone. *Dim the lights*, dark sky advocates say, and it's easy to counter, *But safety comes first*.

Yet the idea that dimmer lighting increases safety hazards is a misconception. In fact, our cities are so corpulent with brightness that it can obstruct our safety. Gleaming lights produce glare that hinders drivers' ability to see and creates a contrast so that the human eye cannot perceive the darkness behind it. This is certainly not to argue for *no* lights, but rather to discard the surplus and maintain only what we need to have optimal safety. Adopting this method has shown "little evidence for any associations between street light adaptation strategies and

day-adjusted night-time collision rates" in studies of vehicular safety, and as for crime, "no evidence that these lighting strategies are associated with an increase [...] at an area level."

Imagine the main street of a small town, shining like a beacon, light spilling on the pavement, the brick buildings, the maples along the road, and of course the sky above, from white streetlights that march down the sidewalk. This can be changed instantly, without abetting crime: Enough spacing between streetlights, so that the periphery of one reaches the next, without an overlapping flood of light. Shielded fixtures acting as top hats on the lights, so that they go where they are intended: downwards. Yellow color temperatures like those of Portland's new lamps. And if the town can afford it, motion-activated sensors.

"Sending photons into the atmosphere is not making anybody any safer," Rob said. "It's all about how the fixtures are designed and where the light is going."

I joined DarkSky International as an advocate a year ago, and while I've heard from so many astounding people who are passionate for the starry skies, I've also realized there just aren't enough people involved in the movement. It raises the question of *why*. True, no one is dying. There are no photos of dead baby animals to pull at the heartstrings of Facebook users, no earnest documentary from David Attenborough devoted to the problem. No one is scared for their life and their future as a consequence of light pollution. But is that what our conception of environmental action has come to? That we should only act when lives are at stake? How devastating that we have collectively decided to turn a blind eye to environmental threats unless those threats are holding a knife at our throats. It's only when the Earth retaliates — with drought, or rising seawater, or forest fires — that we leap up to say, *This is an issue we must address*. Statistics about energy consumption can be thrown left and right to convince politicians, institutions, and even citizens that this is worth taking a look at. But is it not enough to argue that

we will lose our celestial heritage? The sky is almost a perfectly preserved museum over our heads. Whereas Galileo's telescopes, Kepler's notes, and Annie Jump Cannon's catalogs are barred in glass exhibits, their muse — the night sky — is available for anyone, anywhere, to witness at absolutely no cost.

When I was fourteen, there were reports that the aurora borealis would be active above Acadia National Park around midnight. We were camping there, as we do every summer for one week in July, just outside of Bar Harbor. I went aurora hunting at Jordan Pond with my cousin, and we walked through the woods to the stone dam bridge overlooking the Bubble Mountains. He is a photographer and busied himself with setting up his tripod, while I gamboled on the rocks that sat in the shallow water like lily pads. I don't remember how long we waited, but I do recall being bored; at that age I was easily stressed by being awake "past my bedtime" and didn't expect the spectacle to be much more than a few colors in the sky, if the aurora even deigned to show up.

But it did. Its radiance was not particularly strong, and at first I wasn't sure if I was simply seeing a fast-moving cloud wisp through the sky, but the shadows increased in saturation until there were breezy, faint green paint strokes rippling directly above us. Though the electromagnetic storm never increased in fury, and the colors remained gossamer-thin, I was so relieved that I wasn't back at the campground asleep in the tent like my brother, who I couldn't believe had missed the show.

Kayaking with my dad on Jordan Pond (sadly, I have no photos of my midnight excursion here to see the northern lights)

The awe I felt that night isn't something that can be substituted by a video of the northern lights. Experiencing the sky, away from the classroom, away from a screen, is the only way to get that resonating, inexplicable sense of smallness that the universe above gives me. It can't be replicated by a book, or even a mathematical operation, no matter how much the math of astronomy has its own separate sense of awe that I feel when looking at the faraway future dates of eclipses and comet perihelions. There's a Walt Whitman poem that reflects on this niche understanding of the two different wonders of astronomy, and how one can't be replaced by the other:

When I heard the learn'd astronomer,

When the proofs, the figures, were ranged in columns before me,

When I was shown the charts and diagrams, to add, divide, and measure them,

When I heard the astronomer where he lectured with much applause in the lecture-room,

How soon unaccountable I became tired and sick,

Till rising and gliding out I wander'd off by myself,

In the mystical moist night-air, and from time to time,

Look'd up in perfect silence at the stars.

While I would disagree with Whitman about becoming tired and sick of the equations, because I think they've got their own special genre of beauty, he perfectly encapsulates the unique knowledge of seeing the sky in all its glory. If more people could see the northern lights, and feel for themselves that unadulterated awe, I really believe light pollution could be solved easily. It wouldn't even be an option to widely use harsh, extraneous lighting; no one would want it.

The northern lights that I saw lasted no more than fifteen minutes before the flares dissipated, but the memory of its grandeur remained, notwithstanding my ignorance of the physics for how and why the sky was dancing with thin jade drapery. It's exactly this prickling feeling of wonder that I want everyone on the planet to savor, no matter what inch of the sky they live beneath.

But the trouble is that not all skies are created equal. At least, not anymore.

A whopping eighty percent of United States citizens are unable to see the Milky Way at night. Enshrined in the night sky is more than history and science; there is also culture. The Wabanaki, an indigenous confederation of First Nations in the New England and surrounding Canadian area, esteem the stars as part of the afterlife and ancestral significance. Countless

works of poetry and literature ruminate on the beauty of a starry sky. Maritime navigation is an art itself, considering the complexity of reading the stars like a map. In other words, more than astronomy is lost when we allow our lights to erase the heavens — skyglow is actively depriving people of an inherent right they have to experience the beauty of our universe.

If that is not enough of an injustice, then there are also the health factors that accompany light pollution to take into account. The circadian rhythm is not to be trifled with: where the biological clock is tampered with, mental and physical consequences can follow, such as an increase in hormone-dependent cancers. The impact is disproportionate, because communities with less access to shades or blinds are much more subjected to outdoor light. Bright conditions at night remodel daily behaviors by making daytime activities such as eating or socializing possible at any hour. In the United States, the percentage of people who report poor sleep — sixteen percent — rises to twenty-nine percent in brightly-lit regions, and insomnia such as this is recognized as a risk for obesity, depression, and diabetes, amongst other conditions. Sleep affected by artificial light pollution may snowball into other repercussions, too. Paul explained that the eyes have a photoreceptor that is sensitive to blue and involved in the production of melatonin. “This has to be true of many mammals, if not all,” he noted, emphasizing that the sleep cycle isn’t disturbed only in humans.

I took notes while researching these consequences, but eventually realized there was simply too much to write down, if I were to jot every ominous causality. The reality is that the relationship between light pollution and health is tenuous, and reports on light pollution are forthright in admitting to this in their abstracts or conclusions. This is not to denigrate the possible negative effects of light pollution, which are very serious to consider, but rather to underscore the lack of research, and the open-ended terminology we’re forced to unravel for

ourselves. *May cause. Potential correlation. Might result in. Can, in some cases. Some studies show.* It's a circus of terrifying health threats, when it's very likely that only a portion of preliminary research is something consequential we should be wary of. How can we ultimately know what's actually going to hurt us?

Although we are in desperate need of more studies to truly understand the nature of light pollution and its effect on our lives, I can say with certainty that we will be unequivocally hurt if we lose our skies. On the trip I took to Chile with my mom and brother, we stargazed in El Valle del Elqui, and still this is the moment I cherish most, that can never be forgotten for any of us. Packed into our little rental car, the three of us drove out of town, to truly escape all artificial lighting. The road was dusty and wound about bulbous, cactus-pimpled hills. Eventually we passed a small, dirt road — I don't know where it led to — and parked, so that we would be off the main road. It's remarkable to me in retrospect, because it was pitch black, and none of us knew what sort of creatures might be scurrying around in the southern Atacama night (upon a quick Google search later, apparently scorpions do), but we plunked down and lay on our backs in the dirt, nothing beneath us and infinity above us. I wish I could recall what we talked about, because I know it was a long conversation of life and death and everything in between. What has not faded, however, is the sparkling array of lights that shone above us, and the silver flush of the Milky Way. It was unfathomably beautiful.

The skies above El Valle del Elqui

Maine or Chile, the night sky itself has a right to protection. Though billions of times more distant than the Appalachian mountains, buoy-dotted harbors, or dense woods, the nightscape is equally part of a larger environmental construct that we need to conserve — our natural planet and all its vistas. The municipal factor is obviously the tallest hurdle, but even residential efforts have a visible impact. Neighborhoods that elect to regulate lighting can carve out pockets of darkness amidst urban areas, for both better stargazing and darker sleeping conditions.

At my mom's house, I've got shades that block out most of the lighting across the street, but I have a neighbor who turns on their LED porch lights (bright white, unshielded) without fail every evening, and leaves them on through the entire night, three hundred sixty-five days a year.

It shouldn't bother me that much, because I know that it's only a couple of bulbs — merely nothing compared to the cavalry of LEDs in the Walmart parking lot in town. Still, I can't help but agonize over the waste of energy and unnecessary light pollution of the neighborhood. If my town were to adopt an ordinance for responsible lighting, however, it's highly unlikely that my neighbor's porch lights would be subject to any requirements.

"If there's a third rail in this, so to speak, it is trying to control people's residential lighting," Rob told me. As irritated as I am by the porch lights, I know he's right. Home lighting is a personal choice, and it would be extremely inappropriate for anyone, miffed neighbor or government, to encroach upon it. "The best way to handle that," Rob continued, "is through public education about light pollution, and the options people have to minimize it in their own home."

DarkSky is the most informative site for this, and they outline the five principles of responsible outdoor lighting at home. It's a concise and illustrative guide to independent activism. That being said, providing a how-to site isn't a surefire way to convince people of the stars' importance. For a lot of Mainers, that webpage is nothing but an expensive solution to a problem that they can't afford to be concerned about (currently, Maine's poverty line is around eleven percent). Asking a single working parent, for example, to exchange their floodlights with warmer, lower lighting alongside their grocery, gas, and electricity bills is nothing short of delusional and disrespectful.

That's why it's so crucial that action against light pollution is voluntary. A concerted effort is necessary, and people shouldn't be forced to love the stars; it should come naturally, through an intrinsic value that we place upon the sky as a society. Plus, for those who are convinced and able to participate in the movement, there are financial benefits.

"In Maine, we've got some of the highest electric rates in the country. If you reduce your consumption, you're going to lower your bill," Rob said. "There may be an initial cost of converting your outside fixtures, but if it results in using less electricity, you're going to benefit in the long run." For anyone who can afford that initial cost, then why not do it?

Whereas my mom's neighborhood is in a meadow, so the light carries far, my dad's is heavily wooded and much more insulated, so I grew up in this area of New Gloucester with a dazzling sky every clear night. Faintly I can remember stargazing for the first time, at the bottom of our road. My dad used to take my brother and me (and our old collie shepherd, Kobe) on "nighttime walks," an exhilarating adventure purely because it meant we'd get to take out our flashlights in the heavy dark of night. I remember the agency of illuminating the dark with a beam of light was magical, like wielding a lightsaber or wand, and we relished the power of it. One night — or maybe we did this multiple times, I can't be sure — we shut off our flashlights and laid at the base of our road, facing the stars. Kobe waited beside us while we were immobile on the pavement, and my dad must have been listening for any incoming cars that might have made us roadkill, but I only remember staring upwards and thinking, *We need to do this every nighttime walk we have*.

Incredibly, light pollution can be solved instantly. Skyglow does not linger like air pollution; it is not runaway like global warming or a forever chemical. Light moves at 186,000 miles *per second* — we can reverse its effects instantly. While solving some environmental problems can feel like trying to divide by zero, this is simply not the case for light pollution. That may be what we need most of all, in a world riddled with climate change: proof that we can make a difference.

I finished my conversation with Rob and Paul with a broad question about why they initiated SMA. How should we regard light pollution? What is at stake if we lose sight, physically and figuratively, of the stars? What does the privilege of the sky mean to them?

Paul's response: "The answer is in your question. It is a privilege." This lingered with me. He's right; it is a privilege. Do we deserve to keep this privilege if we tarnish the historical mural above us so carelessly?

"To me, I think that the most valuable thing is… to see the night sky, and to allow my mind to put my existence in a larger context," Rob said. "I think that the world needs a lot more humility [in order to] put our petty human squabbles in a bigger perspective."

What we can reap from a clean sky is invaluable, far beyond the scope of astronomy. It's entrancing how something so faraway, that is neither living nor tangible, can be so humbling; the universe mirrors and humanizes us, in a cosmic sense. Celia Thaxter, a Maine poet, perhaps captures this most poignantly of all: "And yet, what fire divine makes hope to glow / Through the pale ashes of our earthly fate? / Immortal hope, above all joy, below / All depths of pain wherein we strive and wait!"

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