A National Parks System for the Moon?

A Proposal to Fellow Members of The American Lunar Society

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Forward to the Discussion

Most people have not thought seriously about the establishment of a human frontier on the Moon. They see the Moon as a dead body worth exploring, perhaps; but who in their right mind would want to live there? Early humans in the forests and plains of Africa, had they been shown a glimpse of the Arctic coast lands, would have thought the same thing. But now we have Eskimos, Inuit, and Samoyeds who feel perfectly at home in such a "hostile and unforgiving" environment. We are a pioneering species that has always been able to make itself "at home" wherever we settled.

There are many space enthusiasts who look forward to Antarctic-style outposts on the Moon, but would side with those early Africans when it comes to talk of settlement. Then there are those who look on the humanity as a cancer infecting our home planet, something to prevent from spreading. Butt there is yet another view, that intelligent technology-enabled climax species are the only way nature has to spread life to worlds that could be made to support it, once imported, but which could never give rise to native life on their own. In as much as we are talking not only about humans on the Moon, but extensive vegetation to support our mini-biospheres, settlements on the Moon would be not just human exclaves, but also viable pockets of Earth-life in general.

When it comes to talk of lunar settlement, there are those who feel we will only "trash the Moon as we have the Earth." There are two responses here. First, on Earth, where the biosphere is so vast, we can get away with our environmental sins and leave it to our grandchildren to handle the mess. Not a nice thing to do, we agree, I like to point out that since the Moon has no biosphere, and we must live in mini-biospheres of our own creation and careful maintenance, our pioneers will be "living downwind and downstream of themselves" and will have to live clean because there will be no option. Under the gun, they will learn ways to live in harmony with nature, lessons too easily postponed here on Earth. The green technologies and lifestyles they create will be one of the most significant exports back to the home world.

Human presence on the Moon will not be easily obvious.

Pertinent to this discussion are some facts about the Moon that will naturally work to moderate the "in our face" visibility of human presence and activities on the Moon.

The Moon is "virgin territory," -- well, almost virgin. Intact artifacts left behind by the Apollo manned Moon landings and various US and Soviet robotic missions are destined either to be part of future Frontier Historic Monuments, or to be relocated in Lunar settlement museums.

Once we return to the Moon "to stay," while some paraphernalia such as warehousing of items that can handle extreme hot-cold cycles, and equipment such as solar panels will be out on the surface, human habitats and activity spaces will need to be shielded by a moondust blanket, meaning that unless you are "flying" or "coming in" just overhead, they will blend into the landscape in coloration. Night lighting is another issue that will be brought up below.

While early settlements will likely be on the surface under a few yards of moondust, it is possible that the direction of expansion, at least in mare areas, will be in subsurface lava tubes. These voluminous features are certainly ideal for industrial parks, warehousing operations, and archiving. But they are found only in the maria; surface-visible installations are likely to be more common in highland regions that cover most of the Moon.

Given that land-hungry agriculture out in the open is not supportable, and that skimming the regolith blanket for common minerals need not be disruptive, we could perhaps protect as much as 90% or more of the Moon's surface and still leave plenty of room for pressurized settlements. Indeed, the ideal space for land-intensive operations that require shielding and/or pressurization such as industrial parks, agriculture, warehousing, etc. will be in mare lava tubes, out of sight, below the surface.

Most of the chemical elements we will want to produce are well represented in this same moondust blanket, no open-pit mining needed. Machinery that harvests these elements can lay the "tailings" back behind them. These machines will pretty well destroy craters of a meter or so in size or smaller, but steer around anything hard to drive over. Again, except from up close, the alteration of the moonscapes by mining activity will be difficult to see. And, of course, there are no forests to cut down. Non-pulverized, purer basalt may be of value and this could be quarried after removing the regolith blanket in advance of placement of modules, and then replacing the moondust on top of the module complex. We could also quarry basalt in road cuts through mare lave flow fronts, or within lavatubes. If any crater central peaks are shown to consist of upthrust mantle material, as has been suggested, it is possible that there may be some economic advantage to mine them. Platinum group metals would be a prize, but we do not know if we would find them there.

The nature of the frontier economy will strongly motivate recycling and reuse, greatly minimizing the "landfill problem" here on Earth of our own making. That said, we will build roads, some bridges, some tunnels, along with railroads, spaceports, etc. And extensive solar arrays are likely. Each industry will bring with it issues that need to be addressed. But here, to get things started, we are concerned with general guidelines.

Lurking in the background is the most worrisome problem of all. Pioneers often cannot imagine what their small beginnings will someday lead to in generations ahead. They will have more immediate concerns. This attitude is closely related to the phenomenon commonly called "The Tragedy of the Commons."

http://en.wikipedia.org/wiki/Tragedy_of_the_commons

> **"**multiple individuals (or individual companies or individual nations), acting independently, and solely and rationally consulting their own self-interest, will ultimately deplete a shared limited resource even when it is clear that it is not in anyone's long-term interest for this to happen."

Space Debris as an example of the Tragedy of the Commons

Unfortunately, we already have seen the first consequence of this in the space age: The growing problem of Space Debris is a clear example of the "it is not necessary to do anything" approach. For decades, individuals have been sounding the alarm, only to be dismissed as fear-mongers who think "the sky is falling." Low Earth Orbit *is a Commons*, and we should have known the certain result. The problem is now orders of magnitude worse than it was when attention was first called to it more than two decades ago, and all national space agencies, including NASA, have for too long just shrugged their shoulders. Preventive action has costs of its own and so it is tempting to defray costs by postponing action until it is the next generation's problem.

Now belatedly NASA and other agencies are indeed trying to establish protocols to *slow the growth* of the problem and are *soliciting idea*s for debris cleanup. Yet we are years away from doing anything and by then the problem will only have gotten worse. But gee whiz, guys! Hadn't you heard that "a stitch in time saves nine?" or that "an ounce of prevention is worth a pound of cure"? Inaction motivated by thrift is false economy, false to the point of being criminal. Perhaps it would help to hold mock trials of those warned but who sat on their hands. Note that if this runaway problem gets to the point where humans may be prevented from traveling into space for centuries or more, whom will we put in prison, or hang? That's the *Tragedy* of The Commons. What is happening to our oceans is yet another example.

The Moon is a Commons. No one has authority or responsibility. That we are not yet technologically ready to establish a permanent and growing presence on the Moon gives us lead time to replace the Lunar Commons with a Lunar National Parks Treaty to provide a framework of protections well before the era of economic and industrial development of the Moon begins.

The Antarctic Treaty is a flawed example

It would be almost as tragic to simply adopt the Antarctic Treaty as that document avoids the problem by forbidding commercial or industrial development of any kind. Yet it allows individual bases to contaminate their perimeters by a lack of planned housekeeping. It is only because of the unwelcome and embarrassing spotlight of Greenpeace intervention that McMurdo has cleaned up its act. Again, we can't leave it to the pioneers themselves, as they will be "too close to the trees to see the forest" and will have more immediate priorities. It is clearly time for action now.

Lunar National Parks and Other Preserves

> **World Book:** [a] **National park** is an area set aside by a nation's government to protect natural beauty, wildlife, or ... places of cultural, historical, or scientific interest. ... Governments create national parks to guard their natural treasures from the harmful effects of farming, hunting, logging, mining, and other economic development.
>
> The world's first national park, Yellowstone National Park, was established in the United States in 1872. National Park systems have now spread throughout the world. Today, about 1,500 national parks ... [exist] in more than 120 countries.

Now is clearly the time to think and act ahead about preserving and protecting some areas of the Moon of especial geological interest or uncommon scenic beauty by setting them aside as Lunar National Parks (to be transferred to a Lunar Frontier Authority if and when the latter emerges as the acting civil authority.)

Differences of opinion on the merits of individual areas to be protected

We do not have to have agreement on a comprehensive list of features to be treated with care by the pioneers. At this stage, we are only trying to get acceptance for the general concept. It should be possible to find broad agreement on a short starter list, and on initial compromise positions on the protocols governing activities in or near these sites. Once we have done this homework, we can invite others to the table with the goal being a more mature and widely acceptable product.

For this incipient stage, a poll of those who participate in this exercise would put at the top those features picked by the largest number of participants, and including at the bottom, those picked by at least one participant. We might devise some form of weighting system. The more people participate in this effort, the more respectable will be the results.

The great risk in delay is that development will suddenly start, and proceed without restriction, with no guiding protocols or safeguards in place. Only a rational middle ground between total preservation and total development has a chance of acceptance. Those who stand by and do nothing do more total damage than those who set out to do damage on purpose.

A two-phase endeavor:
1) Establish site classifications and protection protocols
2) Identify and list places to be protected second

While the goal of this exercise is the adoption of an International Treaty, we are at the homework stage in developing a widely supportable proposal. As the US National Park system has grown and developed, we have national parks, national monuments, national forests, national historic sites etc., and a set of protocols appropriate for each to protect

from unfettered economic and industrial development. These protocols govern access roads and commercial and/or industrial and/or tourist concessions.

Of course, once jurisdiction passes to the local frontier authority (a stepped process which should be milestone-driven and established beforehand by treaty to remove it as a political and power-play issue,) that "Lunar authority" would have the right, limited and defined in its own constitution, to review and reset any such protocols.

This list, to be an "attachment" to the original treaty establishing a Lunar National Park System, could always grow or be amended as time goes on. *Our job* (American Lunar Society members and friends who participate) would be to recommend a representative set of better-known features for inclusion. We must realize, however, that the pioneers, seeing things from a ground-level perspective, will choose to add more sites, and possibly de-list some sites that look special from above through our telescopes, but not from the surface where they will live and work.

For example, from in the air *directly* above, Rainbow Bridge does not reveal its special beauty. For that you have to be in front of it, under it, and/or behind it (I cherish the experience of all three.) But telescopic observation is all we can go by for now, along with angle shots taken by various lunar orbiters. So we can expect the pioneers to add or otherwise amend our list. Each settlement will be more motivated to protect special areas in its hinterland, even if they pick sites, which from a lunar global area are "mediocre." The point is we should not try to be "complete" but to be sufficiently "representative" to get this project started.

A Stage Two Review Team

The second step is the nomination of specific features or regions to be so protected by an international committee of self-selected geologists and other scientists, tourist industry panels, commerce and industry representatives, and of interested/concerned individuals.

The best result will come from a well-rounded team with diverse representation but excluding, those on the one extreme who would put the Moon totally off limits to non-scientific activity, and also excluding those on the other extreme, who would reject any guidelines or protocols whatsoever. Everyone else should have the right to suggest what seems proper to him or her.

For both of these steps, setting protocols and starting a list, there will be considerable disagreement:

√ Some will want to guarantee the treasured sites on the original list from any and all human encroachment, while

√ Others will seek more pragmatic provisions.

√ A reasonable compromise would be to create classes with graduated levels of protection according to the rank of "specialness" that we give them:

Class A containing the most protected,

Class B those with intermediate protection

Class C those only minimally protected, probably by a baseline set of protocols that will apply to the entire lunar surface and maybe even to subsurface lavatubes.

√ Some will favor only a few original parks,

√ Others will want to preserve half the Moon or more.

Certainly those of us who enjoy observing the Moon in greater detail than the naked eye allows through our various telescopes should have an important say both when it comes to identifying special sites, and in suggesting protocols which will protect appearance from well above. In this regard we will be representing Earth-bound populations for whom the sight of the Moon is something of great beauty, and to be respected and preserved. However, as most activities on the Moon will not be visible to the naked eye from Earth, the really important protocols will be those that protect the beauty and awesomeness of features to residents and travelers on the lunar surface. We need to remain on the team, in a host/chair position.

That said we should include in the group, lunar scientists, environmentalists with a geological bent, tourist industry representatives, road and railroad-building engineers, mining and industry representatives who are up to speed on lunar resources, topography, and conditions, etc.

Beyond the Nearside

But how much are we fixated on the Moon's nearside? Should we not undertake to provide the same protection for the 2/3rds of farside visible from L4 and L5? And what about the 1/6th of the Moon in "deep farside" invisible from L4 and L5 and out side of the radio noise footprint of those locations. We must remember that most lunar tourists, either on approach and/or departure, will fly over the farside, some or all of it sunlit at the time.

Nighttime city lights?

Also as telescope-using observers, we have to realize that the portion of the Moon not sunlit could become lit with settlement and roadside lights. As astronomers, we are already acutely aware of nighttime light pollution. Earth's city lights look beautiful form several miles up in an airplane, but we have to keep in mind that all light seen from above is wasted light, a sign not of progress but of inefficiency and wastefulness. As producing extra power during dayspan for use during nightspan will be a significant expense for the settlers, the pioneers are likely to want to be frugal with light beamed wastefully spaceward. They might welcome protocols for nighttime lighting of lunar settlements and other installations.

Actually, only a significant cluster of lights could possibly be seen from Earth. Even spaceport beacons might not be visible to us. In the interests of economy only road intersections may be lit along highways. But even here, at least in the early era when both surface and space traffic will be on the light side, lights could be proximity controlled by approaching vehicles of whatever kind, instead of lit all the time. We could also use non-

visible wavelengths, and let the sensors turn that into visible signs on the view screen. It will be a long time before any settlement is large enough to show up from hundreds of thousands of kilometers away, and even more unlikely, given the need to use nightspan energy as efficiently as possible, that they would make an effort to be noticed, except on holiday occasions to celebrate their existence, survival and progress!

Presenting our results to others for further input

Our original suggestions and lists should be presented to others for input:

- √ Environmentalists focused on geological treasures rather than biological ones.
- √ Civil engineers (road and railroad construction, bridge, tunnels, cable systems, power transmission systems, etc.) After all, if we are to have any scattering of settlements simply because all the needed mineral resources are not to be found in any one place in economical percentages. The easiest placement of transportation routes will have a lot to say when it comes to choosing between equally endowed locations.
- √ Tourist industry people who can be brought up to speed with the lunar globe and topography, craters, inter-crater plains, crater central peaks, maria, mare-highland coasts, lavatubes, rilles, lava sheet flow-fronts and other features of interest.
- √ We want to include mining and processing people brought up to speed on lunar conditions and the geographic location of minerals, etc., to suggest mining/industrial settlement clusters, etc.

Mining & Processing Industry Protocols

As we have pointed out, "Moon mining" is unlikely to be a "scarring" operation. The elements we need are to be found in the already "premined" impact-pulverized debris blanket of rock and powder, meters-thick, that covers the entire lunar surface: the "regolith." That said, we can split mining operations into:

- Those aimed at "producing" elements found just about everywhere or, at least rather widely: oxygen, silicon, iron, aluminum, calcium, titanium, magnesium - all in parts per hundred;
- Others found in parts per ten thousand] and
- Those concentrated only in a few atypical areas.

Clearly, any mining activity seeking elements in this first classification, since it can be done most anywhere, can, without inconvenience, be completely forbidden within the selected park areas and their approaches.

Any rare and strategically needed elements which are especially concentrated in an area nominated for inclusion in the Lunar National Park System, could be mined within the area in question, in a tightly regulated "clean" operation, and then processed elsewhere. What we have in mind is the possibility that we would discover that a protected impact crater area is of the Sudbury (Ontario) type, rich in metals otherwise absent on the Moon in economically producible abundances, such as copper, zinc, gold, silver, platinum. At Sudbury, Ontario, north of Lake Huron, this treasure is an *indirect* gift of the impactor,

which did not itself bring them, but which shattered the crust below so thoroughly that these elements present in the magma ocean below found there way up into the fractured bedrock of the crater rim above. All of these elements are industrially strategic and finding them in an otherwise protected site would "overrule" any reasons to sustain that protection. Lunar geologists have yet to identify any such area, it is possible one or more may be identified in the future.

Tourist Industry Protocols

Some areas, chosen for inclusion on the original list for their especial *noteworthy geological features, might also be identified as having especial scenic value*.
Others areas of no unique geological interest, may be nominated for inclusion on the merits of *outstanding scenic appeal alone, and vice versa*.

Types of Access restriction

1) Guided eco-tours in self-contained sleep-aboard vehicles**,** or
2) Opened up to do-it-yourself self-guiding tours for individuals in private "camping" vehicles. The limited access provisions would apply to especially fragile sites and may include "pack it in, pack it out" regulations to guarantee that human detritus would not accumulate.
3) An option, if growth in traffic merits, might be excursions via suspended monorails, or cableways, hugging the high ground where possible.

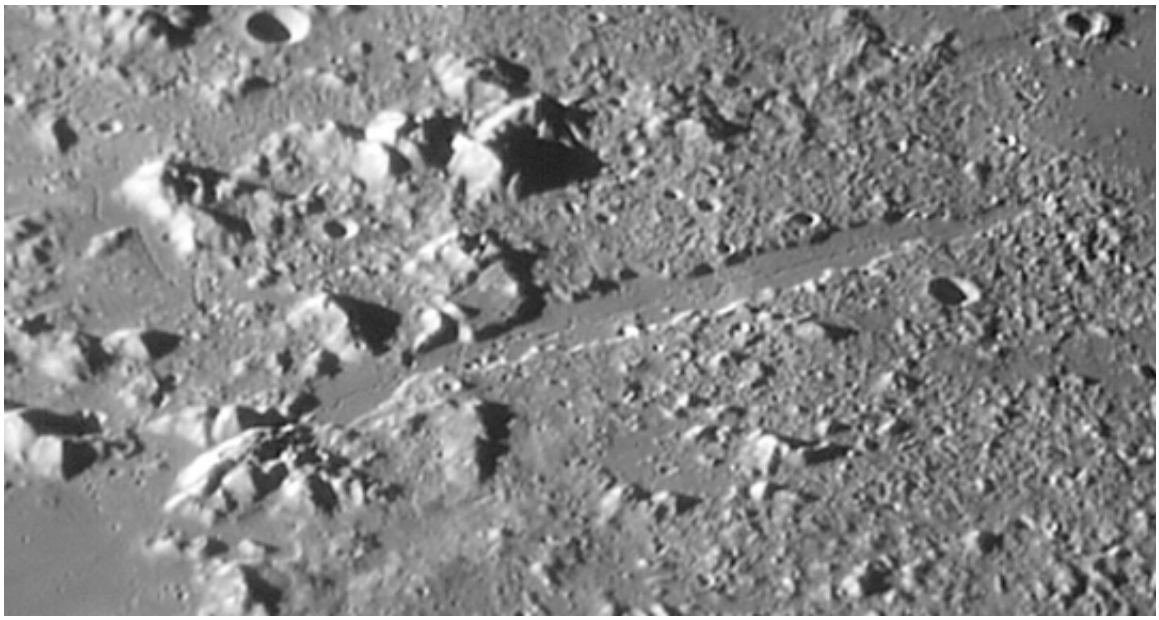
Once tourist traffic and volume grew to the point where it made sense, the "park authorities" could allow and provide for *carefully regulated tourist-serving "concessions" within the park area - hotels, restaurants, "general stores," even RV camping grounds*. If these operations could be conveniently placed at, or just outside, the park boundaries, that would be preferable.

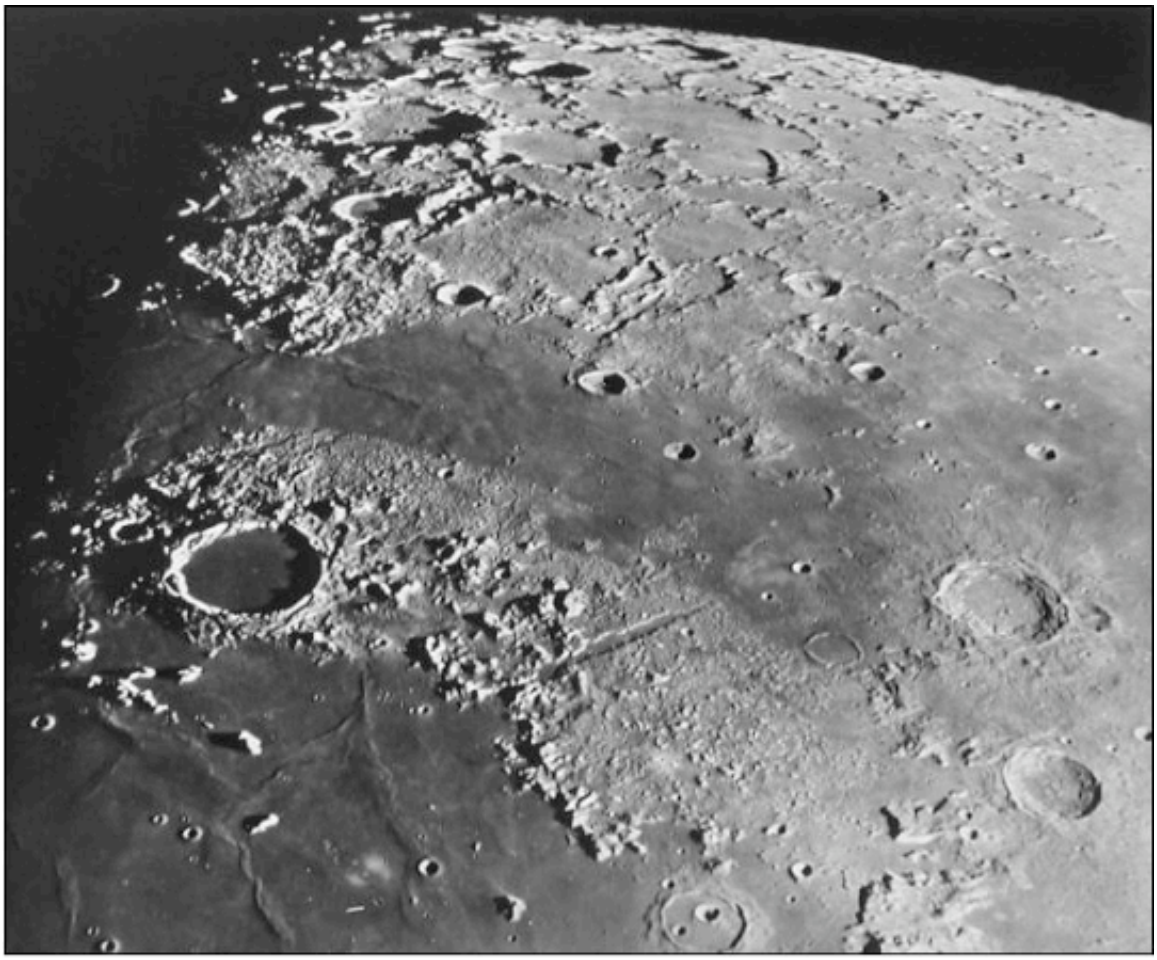
Transport Corridor Protocols

Roads and Trails: In some especially delicate areas, we may want to allow only a bare minimum of overland access, keeping the route as "rustic" as possible. For especially scenic craters, riles, escarpments and other high vantage points, we may want to provide only scenic "rim roads" or scenic overlooks, with no access to the floor or area below other than by specially equipped go-anywhere, off-road vehicles that do not require intrusively bulldozer-graded routes, such as by legged walkers rather than wheeled vehicles.
ILLUSTRATION: Cableway -
http://www.moonsociety.org/images/changing/cable_susp.gif
Illustration: Spider walker
http://www.moonsociety.org/images/changing/spider_text.gif

The Alpine Valley Test

In a few cases, we will want to provide for a major highway but with a minimum of traveler-serving concessions, and tightly regulated signage. The prime example of a need for compromise is the unique **Alpine Valley** providing access between northern Mare Imbrium and Mare Frigoris. An attempt to close this route to travel would never succeed. So we must do the next best thing, design a road that blends in respectfully and has the bare minimum of conveniences.





The merit of transportation access is obvious. How else are we to enjoy these treasures set-aside for us? By browsing through a book or watching a DVD documentary? We could provide both, of course, for tourist wannabes and those selecting their itineraries. But for the future Lunans themselves, if not for Earthworms like us, access is clearly in order -- access with thoughtful restrictions.

Some Park-worthy nominations “from the wrong end of a telescope”

I no longer have a telescope but I do remember revisiting my favorite sites on the Moon. There are, of course, noteworthy areas, features of special scenic interest -- at least form our wrong-end-of-a-telescope vantage point -- in all areas of the Moon’s surface: in the nearside highlands and maria; on the farside. As we do not know (although many are prematurely “sure”) where the first outpost will be sited, and where early and subsequent industrial settlements will spring up, it will be important to identify candidate sites all around the globe for protection. With my 12” globe of the Moon in hand, I’d like to start the list off with the following short starter-list nominations of features I visited time and time again with a telescope in earlier years:

• **Nearside craters:** Aristarchus, Plato, Copernicus, Tycho, Theophilus, Proclus - there are *equally outstanding craters elsewhere on nearside*, that should be added to the list if settlement, transportation, or mining activities were to be considered nearby.

• **Other nearside features:** I have been fascinated by those isolated and well defined areas such as the Aristrachus Plateau and the irregular highland strip between Sinus Roris and Mare Frigoris on the North and Sinus Iridium, Mare Imbrium, and Mare Serenitatis on the South and including the prominent mare-filled crater Plato and the Alpine Valley. Perhaps being a lifetime resident on the east shore of Lake Michigan and of the Great Lakes basin in general, such choices are to be expected. And perhaps because it is the single most identifiable feature on the early Moon, I have also always had a special place for Mare Crisium and know it shores and ramparts by heart. But each observer will have favorite locations to add to the list.

• **Nearside historical sites:** the Apollo Moon landing sites, the Lunakhod sites, any intact landers.

While I have explored the farside only by globe and photos, I have some favorites there as well.
• Farside Craters: Tsiolkovsky, possibly the single most identifiable crater from a deep space perscpective (other than the much larger Mare Orientalis!) is at the top of my list, and certainly Van de Graaf. And Mare Ingenii, the antipodes of the Imbrium impact event. *We should identify many more*. We need not worry about being complete. It will be enough for us to start the process.

Once the site of the initial international outpost is agreed open, worthy sites within reach should be identified and protected appropriately. *One may argue, of course, that most places on the Moon are already protected by their very remoteness and inaccessibility*. But the day may come, when many noteworthy places will no longer be remote and inaccessible.

Conclusion:

Establishing a Lunar National Park System infrastructure, even without a short list of first inclusions, would be a wise move for these reasons:
• It is easier to establish such a system now, when the threat seems remote, than later, when economic counter-interests may have arisen.
• Early establishment of a Lunar National Park System will be a media coup, thrusting the Moon and its beauty into the public consciousness.
• It will whet the appetite for lunar tourism, thus helping create the justification for development of the vehicles and systems needed for on-location tours.

The very act of establishment of a Lunar National Park System by treaty, along with a starter list of included areas, will lay the economic grounds for private enterprise to land robotic “tour guides” on location, to photograph and explore the especially scenic features with maximum “ooh and aah” appeal, to be included in edited tourist

documentaries on video and DVD or in National Geographic, along with promotions of sponsor tourist companies, of course. Tourism "pump-primers." A next step would be actual live tours, rehearsed or unrehearsed, exploring especially mysterious areas such as the first lavatube to be entered.

Fast forward a century or so: Flora & Fauna Preserves

When *we* think of "National Parks," places of great geological and biological beauty come to mind: Yellowstone, Banff, Great Smokies, etc. Yet we too have preserved areas in which life is sparse, if not all but invisible: the Grand Canyon, Arches, and Haleakala National Parks for example. Biological preserves would seem to be out of consideration on the barren and lifeless Moon, but we may see them within the pressurized confines of larger settlements.

On a larger scale, heavily-traveled inter-settlement routes between neighboring population clusters may one day be relocated into pressurized tubes or canopied rilles with broad fringe areas that can also be planted with a mix of crops and purely ornamental plants – creating **lunar national parkways**. And there may be small scale "national forests" created in pressurized structures by private enterprise seeking tourist dollars.

A Lunar National Park System will have a profound impact of the way lunar settlement develops, and even on its pace. The time is ripe. Let's get started! PK

NOTE: This would have to be revised for inclusion in M3IQ and also as an **MMM Paper,** but perhaps not. **Redo in html and post.**