# 1NC vs San Mateo – Deven’s Idea – Case Turns w/ K [V2]

## OFF

### K – Sage

#### The call to space fuels strategies of technocratic managerialism that position the American transcendental state as supreme---transcendence of limits enables imperialistic violence through intervention, war, circumvention of norms, preemption, and tactics of control

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In the preceding eight chapters I have argued that some of the unique qualities of outer space—vastness, Otherness, sublimity, timelessness, spacelessness—are just as integral to extra-terrestrial projections of US geopower, as its well-known capacity (Arendt, 1963; Cosgrove, 2001; Dickens and Ormrod, 2007; Dolman, 2001; Macdonald, 2007) to function as an Archimedean high point to monitor and control the surface, and atmosphere, of the Earth. While the focus of my study has been the United States, and more specifically NASA, the implications of this cosmic projection of geopower—the American transcendental state—are global in reach, from enabling and shaping imperialistic ideologies (Chapters 1-3 and 7) to fuelling the extension of technocratic managerialism (Chapter 4-6 and 8). What is more, messianic hope in America remains a global commodity, consumed, for example, through the internationally franchised Star Trek television episodes and films (Penley, 1997: 98-99), multinational ‘Space 2.0’ corporations, like SpaceX (Chapter 6), worldwide audiences to the addresses of American presidents (Chapter 6) and global tourist attractions like the National Air and Space Museum and Kennedy Space Center Visitor Complex (Chapter 7). These global circulations suggest that while my empirical focus in this study has been on the extra-terrestrial assemblage of the American transcendental state, as viewed from within the borders of the US, the salience of my analysis is geo-political.

The development of the American transcendental state through space exploration must also be viewed as an integral component of a far older geopolitical project—the production of an American identity defined in terms of the transcendence of limits, whether technological, economic, spiritual or territorial, enabling the moral aggrandizement of the past, present and future of a horizontal strata of sovereign territory and its peoples (McDougall, 1997; Noble, 2002; Nye, 1994; O’Brien, 1988; Ricard, 1999; Stephanson, 1995). Over the last decade or so, a growing number of scholars, including geographers, have turned their attention to how messianic-exceptionalist visions of America as the ‘Promised Land’ of ‘Chosen People’ have inflected various imperialistic projects including: the pursuit of democracy through military intervention in the ‘global south’ (Anthony, 2008); the technocratic ‘greening’ of Western global capitalism (Singer, 2010); the building of a ‘culture of war’ in foreign policy (Marsella, 2011), the circumvention of international institutions (Agnew, 2006); and most prominently perhaps, George W. Bush’s ‘war on terror’ where invasions of Afghanistan and Iraq became justified as a ‘cosmic struggle between good and evil’ (Agnew, 2006: 183; see also Barkun, 2010; Dijink, 2006; Strum, 2010; Wallace, 2006). All of this work indicates two points: first, the enduring Apocalyptic influence of dispensational pre-millennialism on both interventionist and isolationist currents within American (geo)politics (Strum and Dittmer, 2010: 18); and secondly, the rise of a religious cosmology that positions America at the moral, geographical, and spiritual, centre of the universe (Strum, 2010: 150).

My analysis of American spaceflight adds to this body of work on religion and geopolitics by drawing attention to five less discussed conduits of this pious vision of American geopower: (i) the secular—museums, family theme parks, systems management; (ii) the sublime—astronomical artwork, Moon landings and distant Nebula; (iii); the profane—Nazi slave labor camps, technocratic patriarchy, and dead astronauts; the technological (iv)—rocket production lines, O-rings, electrical wiring; and (v) the revolutionary—female astronauts, May 1968, and Richard Feynman. Analytically, these diverse registers suggest the utility of working with a broader, less explicitly spiritual, set of theoretical assumptions, to address the cosmological aspects of American geopolitics. This is why I mobilized the concept of the ‘American transcendental state’, rather than ‘deified nation’ (O’Brien, 1988: 41) within this study. This deliberately hallucinogenic sounding term captures some sense that the messianic-exceptionalistic projection of American geopower is a more diffusive, experimental, fantasmic, embodied, and ostensibly secular, affair, than conveyed within much discursive analysis of the religious undercurrents inflecting American geopolitics (for example Agnew, 2006; Dijink, 2006; Strum, 2010; Wallace, 2006).

I would like to suggest now that there is another benefit in bringing together these diverse practices under a broader analysis of the American transcendental state: their common geography becomes all the more obvious. That is, all these practices involve thinking, doing or resisting, celestial transcendence as an apparatus of American geopower; hence they can all be rightly considered ‘vertical geopolitics’ (Elden, 2013; Graham, 2004; Graham and Hewitt, 2013). This label has developed to identify a body of work addressing how the circulation of American geopower involves more than two-dimensional geographies of area. It currently includes analyses of; drone warfare (Gregory, 2011); aerial bombardment (Graham, 2004); police helicopters (Adey, 2010); satellite surveillance (Macdonald, 2007) and satellite drone navigation and targeting (Gregory, 2011). Elden (2013: 40) explains that ‘vertical geopolitics’ is mostly focussed upon how state political technologies allow diverse populations to be measured, calculated, controlled and killed, ‘from above’, and occasionally ‘from below’ (for example Elden, 2013; Graham and Hewitt, 2013). By contrast, the vertical orientation I have adopted here, while related, is different. Specifically, I have described how aspects of the projection of American identity, geopower, and territory, also involve a vertical spacelessness—a deterritorialization—a potential collapse into sublime, cosmic, insignificance; in short, rather than the ‘view from above’, the perspective I have traced has been a ‘view into the above’ (and back). In part, therefore, my study can be considered a response to Elden’s (2013) recent question: ‘How would our thinking of geo-power, geo-politics and geo-metrics work if we took the earth; the air and the subsoil; questions of land, terrain, territory; earth processes and understandings of the world as the central terms at stake, rather than a looser sense of the ‘global?’ (p49)

I propose we add to this list celestial entities, including the Moon (Chapter 3), the Martian surface (Chapter 6) and the Eagle Nebula (Chapter 7), as well as God (Agnew, 2006; Dittmer and Strum, 2010; Strum, 2013). Thus, perhaps we should be cautious of Elden’s (2013b) rather geocentric call ‘about how geopolitics might be thought as earth-politics rather than simply a synonym for global politics’ (p59). Instead, it might be more useful to bear in mind Deleuze and Guattari’s (1988: 101) argument that even absolute deterritorialization—something akin perhaps to the mathematical cosmic sublime of Kant (Nye, 1994: 7-8)—always involves reterritorialization(s). Recall how Charles Bonestell (Chapter 2), William Clancey (Chapter 6) and the National Air and Space Museum (Chapter 7), respectively, and persuasively, associated vistas of the Moon, Mars and the Eagle Nebula with the American West, and by extension locate America at the centre of God’s universe (Boime, 1991; Stephanson, 1995).

This analysis of American spaceflight also sheds light on seldom acknowledged connections between religious and vertical geopolitics and technocracy. The relation between critical analysis of geopolitics (O Tuathail, 1996) and technocratic management (Alvesson, 1987), remains remarkably undeveloped. Arguably this lacuna says more about the disciplinary separation between critical security studies and organization studies (Grey, 2009) than the various intellectual crossfertilizations between organization studies and human geography (Clegg and Kornberger, 2006; Dale and Burrell, 2008; Parker, 2013). Nevertheless, there are, as Grey (2009) maintains, clear resonances:

Indeed it could said that, in the same way that the development of security studies in particular, and organization studies to an extent, was shaped by geopolitics of wars both hot and cold, so too many current and future directions be in part a reflection of developments in contemporary geo-politics (p31).

Some organizational practices are of course, very much on the ‘front line’ of practical geopolitics; that is, they comprise the ‘the foreign policy bureaucracy’ (Ó Tuathail and Dalby, 1998: 4) through which geographical concepts are deployed to aid ‘conceptualization and decision making’ in ‘everyday foreign policy’ (O Tuathail, 1999: 110). Examples here include the work of the US Air Force, the CIA (Central Intelligence Agency) and the UK’s Foreign and Common Wealth Office. There are also a host of other organizations that no doubt influence how practical geopolitics is produced, from security analysts like the RAND Corporation to global defense contractors like McDonnell Douglas. However, analysis of the relationship between organizational and geopolitical practices remains embryonic. For example, Anderson’s (2011) study of urban counterinsurgency and Gregory’s (2011) of drone warfare, do no more than merely infer that the rise of the ‘networked organization’ is reworking the projection of American geo-power. Correspondingly, two organizational studies of the military only hint that, for example, masculine discipline (Godfrey et al., 2012) and team identities (Corona and Godart, 2010) shape and are themselves shaped by grand geopolitical narratives like the ‘war on terror’.

But the imbrication of geopolitical and organizational practice can also be more subtle and much less militaristic—concerning the anticipation and cultivation of geopower through shared national identities, that is ‘popular geopolitics’ (O Tuathail, 1999: 110). Here, the connection to organizational practices is no less significant, yet invisible in the literature. NASA offers a good example: from its inception, the space agency developed increasingly refined technocratic techniques that aligned people and machines to naturalize the pursuit of a popular geopolitics wedded to American geopower. Viewed in this way, imperialistic geopower and technocratic-managerialism are interwoven forces; hence the present study suggests the richness of more sustained critical analysis of organization and geopolitics.

#### The alternative is a refusal to name and command space, a movement of transcendence to a plane focused on human experience, and an exploration of new affects that all interfere with the state’s technocratic, imperial impulses

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However, I am all too aware that in stressing the widespread application of this concept of the America transcendental state to understand American geopower— and, concomitantly, the fecundity of bringing together analyses of religion, verticality and now technocracy within critical geopolitics—I run the risk of constructing a totalizing, monstrous, edifice. The reader might rightly ask at this juncture, paraphrasing Nietzsche, have you not gazed into the cosmic abyss of American geopower for too long; are you not also reifying American geopower in the cosmos rather than challenging it? Indeed, throughout the preceding chapters I made reference to a rather singular sounding concept of the ‘American transcendental state’. But, as in the introduction, I must stress again here, that I took this decision for reasons of analytical clarity rather than to suggest I have revealed an independent, singular, definite and a priori reality (Law, 2006), some essence akin perhaps to what Agnew (2006: 184) refers to as ‘Americanism’. Instead, within each chapter I have traced the progressive assemblage of the American transcendental state—that is, nothing less than the divinely sanctioned, exceptional, and messianic, right and duty, of America, and its leaders in its name (Wallace, 2006: 225), to command cosmic space and time by evoking forces of ‘good’ and ‘evil’, ‘us’ and ‘them’ (Agnew, 2006; Strum, 2010). But the immutability of this cosmic vision (Strum and Dittmer, 2010; Wallace, 2006) belies the transformative, fragmented, heterogeneous components that sustain it, across landscape artwork, through Kennedy’s Moon Speech, to the O-rings of Space Shuttle Challenger. Throughout this study I have suggested countless relations through which this vision is not only produced (Dijink, 2006; McDougall, 1997; Noble, 2002; Nye, 1994; Ricard, 1999; Stephanson, 1995; Wallace, 2006) but circulated, maintained, resisted, repaired, transformed, and experimented with.

How then to conceptualize this heterogeneous, but obdurate, cosmic being? Latour’s actor-network theory (1987; 2005; 2012) is useful to an extent here; first, we can conceptualize the transcendental state as an ‘immutable mobile’ that ‘ends up traversing the universe’ by ‘pay[ing] for each transport with a transformation’ (Latour, 2013: 127); it is ‘not displacement without transformation but displacement through transformation (Latour, 2005: 223); second, the transcendental state can be understood as offering a prophetic, but partial, ‘panorama’ of the ‘world [cosmos] to be lived in’ (p189) which must then, in turn, be:

… carefully situated inside one of the many Omnimax theatres offering complete panoramas of society—and we now know that the more thrilling the impression, the more enclosed the room has to be. [American] Society is not the whole ‘in which’ everything is embedded, but what travels ‘through’ everything, calibrating connections and offering every entity it reaches some possibility of commensurability. (p242)

Read against Latour’s concepts of the ‘immutable mobile’ and the ‘localizable panorama’ it is easy to see why my analysis of American transcendental state has involved mapping circulations within as well as beyond our lives. And this is a political move too, because it suggests that opportunities to test and resist the American transcendental state are closer to hand than we might think. As revealed in Chapter 8, a great deal of effort is required to keep the transcendental state circulating because the heterogeneous conduits it passes through—electrical wiring, teleconferences, flight readiness reviews, budget decisions and O-ring joints—are capricious and experimental; that is, affective. Other Chapters acknowledged similar fragility accompanying the assemblage of the transcendental state, including; the partially-owned Declaration of Independence (Chapter 1), the globally unifying Earthrise photograph of Apollo 8 (Chapter 3) and the rusting rockets on display in the gardens of the Kennedy Space Center Visitor Complex (Chapter 7). Now located within this chain of heterogeneous transformations, what strategies might aid us in purposefully transforming this now confined totality? Or put differently, how might we engage outer space to resist this cosmic deification of America (O Brien, 1988)? In concluding this study, I propose three techniques but no doubt there are many more.

First, we can expose the void at the heart of this messianic-technocratic projection of geopower (Wallace, 2006). This approach was evidenced in Chapter 1 by Derrida’s (2002) deconstructive reading of Declaration of Independence. Derrida (2002) emphasizes how signing the Declaration in God’s name entails no democratic ownership over America’s future, in outer space or elsewhere. Across the development of American spaceflight, the perils of messianic, freefloating, notions of ‘Progress’, ‘Exploration,’ ‘Frontier’ and ‘The Future’ are all too apparent, not least for NASA itself. Lester and Robinson (2009) suggest the emergence of this critique within the American space policy community:

We should accept that “exploration” is a multivalent term, with many meanings, some of which are contradictory, and all of which have historical precedent. For too long we have looked at the history of exploration selectively, seeking to find the antecedents which justify our own vision of exploration: as science, as human adventure, as geopolitical statement. This is a definitional fight which cannot be won. Space policy must acknowledge the multiple visions for space exploration, developing a clear-eyed metric of value which avoids the vagaries of lofty “exploration-speak”, If the merits of human exploration of the Moon and Mars are primarily symbolic and geopolitical, what are these goals worth in terms of federal funding?

I am unconvinced by the economically instrumentalist conclusions made by Lester and Robinson (2009) about putting a value upon even NASA’s ‘softer’ geopower, but the general caution about harnessing nebulous messianic mythologies to advance American space exploration is valuable. Of course the problem is this tradition of finding our God in the cosmos is long-established as Olsson (2007) suggests via this retelling of the Babylonian creation epic, Enuma elish:

Marduk is the Lord of lords … Hail to the Chief! Fifty were his names, so numerous that if ever attacked he could always hide behind another alias. Never catchable as the specific this or that, always on the move as an ambiguous this and that … Ungraspable multiplicity. … In this mist-enveloped region of religion naming is the name of the game, an exercise in ontological transformations where earthly people appear as projections of heavenly gods, social relations as signs in the sky. … a signified meaning searching for its own coordinates (Olsson, 2007: 23).

Perhaps a more modest approach is required: we should simply resist the urge to name, and tame, the cosmos as a Whole, by naming a celestial Godhead in it that we claim for ourselves (Wallace, 2006) but cannot ever fully own. ‘Evil is the disaster of a truth when the desire to force the naming of the unnameable is unleashed . … Evil is not disrespect for the name of the other, but rather the will to name at any price’ (Badiou, 2004: 115-6; original emphasis). Challenging the cosmic aggrandization of America might therefore imply some attempt to resist naming our God/Future/Progress in the cosmos. Put simply, this all too easy act of cosmic de/reterroritalizaiton is too crude, too undemocratic, too costly.

A second, related, strategy which can be adopted to resist the American transcendental state was discussed within Chapter 3; this is the capacity to push transcendence to another plane or refuge—to follow one line of flight of cosmic deterritorialization and then re-territorialize the Earth in a panorama that starts with a common human experience, rather than those of any particular nation/ God/future. The aim of this strategy is to mobilize a cosmic imagination that can register something of the shared experience of being human.

In Chapter 3 I discussed how the Earthrise photograph from NASA’s Apollo 8 mission have stimulated new cosmic imaginations—including ‘spaceship’ Earth (Cosgrove: 2001, 257-262; Henry and Taylor, 2009; Ward, 1964), Noetic science (Benjamin, 2003: 60-61), global political ecologies (Connolly, 2002)—that defied nationalistic appropriations by inferring a human transcendence. However, as the American author Kurt Vonnegut explains such a transcendental image of humanity, emptied of territorial divisions and difference, is not itself without risk: ‘Earth is such a pretty blue and pink and white pearl in the pictures NASA sent me. It looks so clean. You can’t see all the hungry, angry earthlings down there—and the smoke and sewage and trash and sophisticated weaponry’ (Vonnegut cited in Burrows, 1998: 423). Similarly, Deleuze and Guattari (1988) suggest we should always remain sceptical that de-territorialization is a progressive act on its own: ‘Never believe that a smooth space will suffice to save us’ (p500).

A third strategy is to augment different affects amid the assemblage of the American transcendental state. As described in Chapter 8, the American transcendental state depends upon the cultivation of confidence in technocracy allied to an affective becoming hopeful—a positive openness to the future as life enhancing—orientated around the transcendence of America in cosmic space and time. But, as Anderson (2006), explains, becoming hopeful does not necessarily need to operate in this transcendental manner: hopefulness can also emerge not to ward off suffering, but through every day sorrows, through diminishment of the body’s potential to affect and be affected. Consider, for example, how Dotty Duke refused to discuss her fears and anxieties with her astronaut husband as she kept the ‘house in order and [took] out the garbage’ (Duke 1990—Chapter 5). Dotty Duke epitomizes a different kind of becoming hopeful—a capacity to remain open-ended about the future in a life enhancing manner through diminishment—devoid of discussion of a better future in Earth or in the cosmos; this is hope that challenges ‘the easy equation between transcendence and a future elsewhen or elsewhere in favor of an imminent transcendence from within vectors of diminishment’ (Anderson, 2006: 749; for more analysis of immanent transcendence related to Space see Smith, 2009: 211).

Another affect which is useful in short-circuiting the hopeful assemblage of the transcendental state is boredom. Anderson (2004) describes boredom as the moment when the ‘“forgetting” intrinsic to habit has been momentarily incapacitated. It is the unravelling of habit, a sudden realization of the again’ (p743). Boredom depresses the life enhancing capacity of ourselves to be open to the future, engendering stillness and slowness of thought-action in spacetime, where, as Anderson (2004) puts it, the capacity to experience the ‘not yet’ (p749) is suspended. The evolution of American spaceflight might appear to some the antithesis of boredom, but, as Jorgensen (2009) suggests, the American humanization of outer space has gone hand in hand with endless repetition (of middle America):

The August 1969 Life Special Issue, released to commemorate the landing, wants to produce sympathetic accounts of the astronauts. It is filled with glossy, high color photographs of the astronauts not only mastering outer space, but their domestic spaces as well. Neil Armstrong bakes pizza, Buzz Aldrin jogs through the suburbs, and Mike Collins prunes his garden. These images resonate with outer space itself, as the astronauts use tools in both terrestrial and extraterrestrial environments. The spatula and shears the astronauts use to cook lamb curry and prune roses with resemble the objects they hold while walking the moon, these being a laser reflector, seismometer and solar wind sheet (p179).

There is no hopefulness on offer in Jorgensen’s (2009) reading of American spaceflight. Instead the boredom experienced in the cosmic repetition of middle America signals despair: ‘Apollo 11 represented an America that had become unhinged by its own technocracy, its middle class lifestyle, and television’ (p188). Jorgensen (2009) is not, of course, alone in identifying aspects of spaceflight repetitive, even boring. As the emergence of the Teacher in Space program demonstrated (see Chapter 8), NASA itself has historically attempted to introduce elements of excitement, even increased risk, to engage a global audience. Yet, of course, a balance has always had to be struck, as Parker (2009) explains of Apollo: ‘Everything was supposed to be boring, because boredom meant no surprises, and hence the possibility of the adventure in some sense rested on its denial’ (p326). Although fleeting, boredom is surely an unavoidable ingredient in NASA’s technocratic confidence, but when focused and channeled, it does suspend hope in the cosmos as a better place, perhaps providing an opportunity for us to pause and register something of the sublime Otherness of Space, where we concurrently repeat and differ ourselves into infinity: ‘Media representations of space travel turn the vastness of space into the similitude of domesticity, as human familiarity comes to stand in for the infinite. At the same time, the domestic attains the dimensions of the infinite, and in turn becomes strangely unfamiliar to the television viewer’ (Jorgensen, 2009: 179).

These three techniques of cosmo-political intervention—refusal to name, human transcendence, and sensitivity to new affects—are all worthy of greater attention, especially when they can be connected up to, and interfere with, the assemblage of the American transcendental state. Clearly not all of those involved directly in the development of spaceflight will want or be able to practise these techniques. Nevertheless even among this group these techniques are intended to offer greater receptivity to new cosmographical imaginations which move beyond the cosmic aggrandization of messianic-imperialistic-technocratic impulses. If we have entered the Cosmic Age where all territorializing assemblages, all States, now derive vital energy from the Cosmos (Deleuze and Guattari (1988: 342), then the imperative becomes not to simply do cosmopolitics (Latour, 2005) but rather which cosmo-politics do we want to pursue? My favoured vision of a Geography of Space is one where this question is endlessly asked but never answered with absolute confidence.

## OFF

### NC – CP

#### Spacefaring nations should:

#### -fully fund and implement the Pacific Ocean Neutrino Experiment

#### - substantially increase investments into sustainable aquaculture, including funding and implementing the Lunar Hatch Program

#### Plank 1 solves neutrino research – it’s by far the consensus among astrophysicists – answers their IceCube indicts – it also answers Lee which says the barrier to research is having lots of water

Sutter 22 – PhD in Physics, astrophysicist at SUNY Stony Brook and the Flatiron Institute in New York City. Paul received his PhD in Physics from the University of Illinois at Urbana-Champaign in 2011, and spent three years at the Paris Institute of Astrophysics, followed by a research fellowship in Trieste, Italy, His research focuses on many diverse topics, from the emptiest regions of the universe to the earliest moments of the Big Bang to the hunt for the first stars [Paul, “Astronomers propose building a neutrino telescope — out of the Pacific Ocean,” 1/19/2022, <https://www.space.com/pacific-ocean-neutrino-detector-p-one-concept>, DKP]

Whispers in water

The mass of neutrinos has no explanation in the Standard Model of particle physics, our current and best theory of fundamental interactions. So physicists would really love to do two things: measure the masses of the three neutrino flavors and understand where those masses come from. That means they have to do lots of experiments.

Most neutrino detectors are pretty straightforward: You either set up a device to generate a ridiculous number of the buggers in a laboratory, or you build a gigantic array to capture some that originate off Earth.

These experiments have made a lot of progress and gotten bigger with every generation. The Kamiokande experiment in Japan, for example, famously detected the neutrinos coming from the supernova 1987A. But they needed a vat of more than 50,000 tons of water to do it.

In recent years, the IceCube Neutrino Observatory in Antarctica has upped the ante. That observatory consists of a solid cubic kilometer (0.24 cubic mile) of ice at the South Pole, with dozens of Eiffel-Tower-sized strands of receivers sunk a kilometer (0.6 mile) into the surface. After a decade of work, IceCube has discovered some of the most energetic neutrinos ever and made tentative steps toward finding their origins. (Hint: It involves really high-energy processes in the universe, like blazars.)

Why do both Kamiokande and IceCube use so much water? A large chunk of pretty much anything can serve as a neutrino detector, but pure water is ideal. When one of the trillions of passing neutrinos happens to strike a random water molecule, it gives off a brief flash of light. The observatories contain hundreds of photoreceptors, and the purity of the water allows those detectors to pinpoint the direction, angle and intensity of the flash very accurately. (If the water had impurities, then it would be difficult to reconstruct where the flash came from within the volume.)

From there, they can reconstruct the original direction of the incoming neutrino and get a handle on its energy.

The great Pacific neutrino patch

This is all well and good for normal, everyday neutrinos. But the most energetic neutrinos are extraordinarily rare. Those extremely rare neutrinos are also the most exciting and interesting, however, because they can be caused only by the most gargantuanly powerful events in the universe.

Unfortunately, the entire might of IceCube, after a decade of observation, has been able to capture a mere handful of these ultra-powerful neutrinos.

So we're gonna need a bigger boat … I mean, detector.

This is the idea behind the Pacific Ocean Neutrino Experiment (P-ONE), a new proposal described in a paper published to the preprint server arXiv in November: to turn a massive swath of the Pacific Ocean into nature's own neutrino detector.

Once again, the concept is surprisingly simple: Find a suitable, lonely part of the Pacific. Pretty easy. Construct long strands of photodetectors — and I mean long, at least a kilometer long. Sink these strands to the bottom of the ocean, preferably to a depth of over a mile (2 km). Attach floats to them so they stand upright in the water, like giant mechanical kelp.

The P-ONE design currently involves seven 10-string clusters, with each string hosting 20 optical elements. That"s a grand total of 1,400 photodetectors floating around an area of the Pacific several miles across, providing much more coverage than IceCube.

Once it's up and running, you just need to wait. Even neutrinos will strike some ocean water and give off a little flash, and the detectors will trace it.

#### Plank 2 solves substantially increase funding for the Lunar Hatch Program –1AC Przybyla that’s key to solve – Harker is Yellow

Przybyla 21, Cyrille. "Space aquaculture: prospects for raising aquatic vertebrates in a bioregenerative life-support system on a lunar base." Frontiers in Astronomy and Space Sciences 8 (2021): 107. (Studies Aquaculture Research at University of Montpellier)

Space Aquaculture: A Relevant Source of Complementary Nutrition Resupplying a base in space from Earth on a weekly basis is neither economically nor technologically feasible (a trip to the Moon takes 4–7 days, and to Mars 5–8 months). A short-term solution is to provide processed and prepackaged space food. However, lyophilized conservation is unstable, especially concerning essential nutrients such as potassium, calcium, vitamin D, and vitamin K, which is involved in muscle and bone maintenance. The micronutrients most sensitive to storage degradation are vitamins A, C, B1, and B6 after one year at ambient temperature (Cooper et al., 2017). A possible nutrition strategy for space bases could be to couple local fresh production with supplies brought by cargo spaceships. Providing fresh, nutritious and safe food is imperative for the success of a manned base on Moon or Mars. Recent studies have shown that food energy needs during a spaceflight are similar to those required on Earth. If energy intake is reduced, the human body is subjected to physiological stress causing cardiovascular deconditioning, bone demineralization, muscle atrophy and immune system deficiency. Moreover, microgravity exposure reduces the nitrogen balance in an astronaut’s body. This results in a 30% reduction in protein synthesis (Stein, 2001). A study of previous manned missions in low orbit monitored the crew’s physical performance consuming food commonly used in space missions and showed that an increase in carbohydrates (from plants) and a decrease in animal protein and fat can disturb the diet balance (Gretebeck et al., 1994). Ideally, a fresh animal-based food source should be included in the diet of space residents. Seafood is one of the healthier animal products for human nutrition. Its nutritional merits and protective benefits have been abundantly described over the last century. Like wild fish, aquaculture fish sequester digestible proteins and essential amino acids, lipids, including essential polyunsaturated fatty acids (PUFAs), essential vitamins and minerals in their muscles. Vitamins are precursors of molecules that are essential coenzymes for enzyme catalysis. When the synthesis of coenzymes is not included in an organism’s genetic heritage (this is the case for Homo sapiens), their natural synthesis must be achieved by the ingestion of living cells. These cells are provided by a diet of plants or animals. In addition to micronutrients, farmed marine, brackish and freshwater fish can sequester ALA (PUFA precursor), EPA or DHA from their diet (Tocher, 2015). Several aquaculture fish have the physiological capability to produce EPA and DHA (ALA chain elongation) and store these essential compounds (Morais et al., 2015; Gregory et al., 2016). The micronutrients commonly found in fish and their health benefits are presented in Table 1 (Tacon et al., 2020). At the beginning of the 1980s, the first study on the possibility of space aquaculture emphasized the shared points between recirculating aquaculture systems (RAS) and BLSS (Hanson, 1983). Yet although aquaculture seems to offer a relevant solution for manned long-term missions (Bluem and Paris, 2003), almost four decades later, no significant innovative solutions have been proposed for space exploration. This may be due to the international strategy of developing low orbit science over the last 30 years with the ISS program, to the detriment of more complex and ambitious projects such as trips to the Moon or Mars involving long-term stays. Why Raise Aquatic Organisms in Space? Hydrogen and oxygen are abundant in the Universe, and water molecules are everywhere in the solar system. Sub-glacial liquid water has been detected on many rocky planets such as Mars, Mercury, and Venus (Liu, 2019; McCubbin and Barnes, 2019). There is evidence of the presence of an internal ocean on icy moons such as Enceladus (Cadek et al., 2016) and Europa (Kalousova et al., 2016). Recent research has indicated the presence of water molecules on rocky exoplanets from other solar systems in our galaxy (Olson et al., 2020). Water is the main in situ resource required for a planetary mission, both for long-term human settlement or astrobiology considerations; however, most observations have revealed that this water has high mineral content or is close to brine due to geological mineralization (Orosei et al., 2018). It would need to be purified to use as a source for water of drinking quality, yet it could be primarily used for rearing marine organisms such as algae, invertebrates, or fish. Today, producing protein from farmed animals (poultry, cattle, or sheep) in low gravity does not seem feasible. A large surface area is needed for livestock rearing, which would directly compete with human space, and costly synthetized air reconditioned from precious in situ resources such as lunar or planetary water or gas produced by BLSS biotechnology would be reserved for the human residents’ artificial atmosphere. Due to their poikilothermic physiology, fish require five to twenty times less energy than mammals, and around three times less oxygen, as well as generate less carbon dioxide emissions, which is an important consideration for BLSS gas exchange management. Another issue is waste management. With terrestrial animals such as pigs, chickens, goats, or cows, feces collection is not easy to solve. However, in aquatic vertebrate production, all dissolved compounds and particulate matter are sequestered in the water and can be easily treated and removed from the system or converted by another organism. Lastly, compared to terrestrial farmed animals, aquaculture is commonly viewed as playing a major role in improving global food security on Earth because the feed conversion ratio (FCR: the feed biomass necessary to provide to a farmed organism to obtain a weight increase of 1 kg) for fish is drastically lower than for land vertebrates. The FCR for different aquaculture organisms compared to that of the main farmed land animals is shown in Figure 1. Protein and calorie retention from aquaculture production is comparable to livestock production (Fry et al., 2018). All aquatic vertebrates exhibit better feed efficiency, which implies less feed to produce in a BLSS and to manage on the Moon or Mars. Gas management in lunar or Martian bases will probably be the main challenge for engineers in the next decade. On Earth, the atmosphere sequesters a stock of oxygen, and its continuous production is provided by oceanic and terrestrial photosynthetic organisms. Before the Industrial Revolution, carbon dioxide production was balanced with oxygen consumption. Today, even with the rise in CO2 emissions, oxygen is not a limited source. In contrast, in a closed system in an extreme environment such as the Moon or Mars, oxygen is not available in its basic form and must be produced. Hence, it is a precious molecule and it is of particular interest to include low oxygen consumers–and consequently, low carbon dioxide producers–in a BLSS. Compared to animals that breathe air, fish, and more generally aquatic organisms, have the lowest oxygen requirement and are the lowest producers of carbon dioxide (Figure 2). In fish, carbon dioxide production from respiration is dissolved, concentrated and stored in the water column. Fish have been shown to maintain their oxygen consumption under conditions of elevated CO2 partial pressure (Ishimatsu et al., 2008). The dissolved CO2 from RAS effluent could be used directly by an aquatic photosynthetic organism such as algae. Collecting CO2 emitted from fish and dissolved in the water column and directing it to a secondary biological system without an additive process would be a huge advantage for BLSS gas management. In contrast to farmed poultry and mammals, aquatic organisms would also be protected from cosmic rays by the water environment, which is an intrinsic radiation shield. The first life forms on Earth developed in a brackish ocean with a salinity of around 10 mg/L (Quinton, 1912). Complex life emerged from the Earth’s oceans when the atmospheric layer had not yet been totally formed by the respiration of microorganisms (stromatolites, bacteria and microalgae) and volcanic activity. The thin atmosphere exposed the Earth’s surface to intense cosmic radiation. The hypothesis that water played a role as a radiation shield in the appearance of aquatic life is strong and plausible. In connection with the development of space aquaculture, further experiments would be needed to determine the integrity or splitting of a heavy charged particle from cosmic radiation entering the water of an aquaculture tank. Transporting any type of animal in a space mission would subject them for several minutes to hypergravity between 4 and 8 g (unit of acceleration due to gravity) depending on the space engine. But hypergravity conditions are not unknown for oceanic fish such as the bluefin tuna (Thunnus thynnus). In one stress experiment, the force required for maximal acceleration was measured in this species. The associated hypergravity applied to the tuna was around 3 g for a few seconds (Dubois et al., 1976). No experiments have been conducted on aquaculture fish, but the natural acceleration caused by an escape behavior has been recorded as between 1 and 3 g. Another argument in favor of finfish as candidates for space aquaculture is that as opposed to other reared vertebrates and humans, in the water column they can move vertically as well as horizontally. Fish use a ballast system, the swim bladder, and otolith sensitivity to move in a volume of water, experiencing gravity but also buoyancy. In the ocean, fish are already in microgravity conditions due to water density and Archimedes’ principle. Thus, altered gravity should not interfere with swimming behavior during the lifecycle of a fish. Experiments have revealed that a fish in microgravity during a space mission orients its swimming direction and body position according to the position of the light in the module without losing the ability to feed or affecting social behavior. Fish movement can also be correlated with spaceship rotation (Ibsch et al., 2000; Anken et al., 2002). Indeed, astronauts train underwater as this is the best way to imitate the weightless conditions found in space. The suits they wear in the training pool are designed to provide neutral buoyancy (like a fish’s swim bladder) to simulate the microgravity experienced during spaceflight (Otto F.Trout, 1969). Spaceflight analog missions are conducted underwater in NASA’s Extreme Environment Mission Operations (NEEMO), involving multi-hour activities at a depth of 19 m (Koutnik et al., 2021). While the hypothesis that the variation in space gravity will not drastically disturb the fish from a physical, behavioral or welfare point of view is plausible, this remains to be tested in experiments on aquaculture fish species. Ornamental Fish as a Model for Understanding Human Physiology in Space The zebrafish Danio, the medaka Oryzias, and the swordtail fish Xiphophorus have been frequently boarded on space missions as models for understanding human gravitational sensations, due to the homology with human morphological and physiological systems. These species have proved the most suited vertebrate animals for basic gravity research. The gravity-sensing system in vertebrates from fish to humans has the same basic structure. Although aquarium fish are not aquaculture fish, space missions over the last five decades have provided useful results on fish physiology, behavior and well-being in microgravity (Lychakov, 2016). The earliest spaceflight with fish occurred on July 28, 1973. Two fingerlings and fifty embryonated eggs of the mummichog (Fundulus heteroclitus) were launched by a Saturn 1B rocket. The Apollo service module joined Skylab 3 and the fish were positioned in a plastic bag filled with seawater. This American space mission preferred the mummichog, a small saltmarsh killifish, to goldfish for this experiment. This species was not well known or described at that time, but it became the first “fishonaut”. For three days, swimming in loops and circles was observed for the two fingerlings, but they gradually returned to normal swimming. The fish acclimation period was comparable to that for a human crew during a first spaceflight. This observation suggested that the vestibular function (the otolith for fish–the inner ear for humans) probably plays the same sensory role in microgravity. The Fundulus heteroclitus eggs carried aboard the Skylab station in low orbit hatched successfully during the mission with a very good hatching rate (96%). The hatched fry displayed normal swimming behavior in contrast to the first hours in microgravity for the fingerlings (Baumgarten, 1975). Fish embryos in microgravity develop a physiological strategy to compensate for the unusual environment, and the larvae formed were already adapted to microgravity, as evidenced by the lack of looping behavior. In 1975, during nine days of the manned Apollo-Soyuz MA-161 mission, a group of 21-day-old juvenile mummichogs were exposed to real microgravity, and similar irregular swimming was observed. Fish eggs were also boarded (n = 100/samples at 32 hpf [hours post-fertilization], 66 hpf, and 128 hpf stages; pre-liftoff fertilization times) and were subjected to post-flight hatching rate evaluation back on Earth. The juveniles were evaluated using light orientation tests, and no significant differences were observed in behavior, suggesting an adaption capability to the space environment. The embryo hatching rate was 75%, and hatching date monitoring showed that the three earliest stages of egg batches carried on Apollo-Soyuz hatched at 15 days (normal hatching rate is 21 days), much sooner than the latest stage batch and earlier than the control batches at 1 g. Apparently, the development of young eggs was faster under microgravity, but the embryos exhibited no abnormalities resulting from development in a zero-gravity environment. The eyes, heart, nerves, and bones were found to be the same in the flight group as in the control group. There was no evidence of calcium deficiency, except in the shorter hatching-time group (Hoffman et al., 1977). In July 1994, the 17th Columbia space shuttle mission STS-65 boarded Japanese medaka (Oryzia latipes) for 15 days of spaceflight in the second International Microgravity Laboratory (IML-2). These ornamental fish laid eggs, and normal hatching was observed in space, with the results showing that medaka fertilization and embryonic development was not significantly impaired by altered gravity (Ijiri, 1998). Probably the most impressive aquatic closed-loop experiment in low orbit and a successful demonstration of an aquatic trophic chain in space, in the 1990s, a German team from Ruhr University Bochum and the German Aerospace Centre (DLR) developed the Closed Equilibrated Biological Aquatic System (CEBAS) with fresh water, containing small aquarium fish (Xiphophorus hellerii), water snails (Biomphalaria glabata), aquatic plants (Ceratophyllum dermersum), and aquatic microorganisms. The ground-based demonstration showed that a filter system was able to keep a closed artificial aquatic ecosystem stable for several months and to eliminate waste products deriving from degraded dead fish without a decrease in oxygen concentration to less than 3.5 mg/I at 25°C (Blum et al., 1994; Blum et al., 1995). Then in January 1998, during the Endeavour space shuttle mission STS-89 to the MIR station, aquarium swordtail fish (Xiphophorus helleri) were exposed to 9 days of microgravity, with 200 juveniles and four pregnant adult fish carried in a mini CEBAS module (10 L) (Blum et al., 1994). The aim of this aquatic mini-module (Figure 3) was to record the behavior of an artificial ecological closed loop in low orbit and verify the hypothesis that aquatic life is not affected by exposure to space conditions using a complementary organism. The female fish were retrieved in good physiological condition, adult and juvenile fish had a survival rate of about 33%, and almost 97% of the snails had survived and produced more than 250 neonates in microgravity (Bluem et al., 2000). During the spaceflight, the vertebrates were video-recorded for behavioral analysis and no aberrant looping or spinning behavior was observed. Immediately after landing back on Earth, the adult fish swam vertically, head upward, to the top of their habitat, strongly beating the caudal and pectoral fins. This was due to empty swim bladders not used during the spaceflight and reuse acclimation on Earth (Anken et al., 2000; Bluem et al., 2000; Rahmann and Anken, 2002). In April 1998, another population of swordtail fish and four adult wild marine fish oyster toadfish (Opsanus tau) flew with the space shuttle STS-90 mission, hosted in the Neurolab facility. After 16 days in real microgravity, fish brain synaptic contacts were compared to a control population at 1 g on Earth. Spaceflight yielded an increase in synaptic contacts within the vestibular nucleus indicating a compensation processes for neonates swordtail fish (Ibsch et al., 2000). Results revealed a gravity compensation process and the role of the fish lateral line associated to the fish brain for appropriate swimming behavior (Anken et al., 2002). The Vestibular Function Experiment Unit (VFEU) aboard STS-95’s SpaceHab again hosted two oyster toadfish as experimental subjects. The fish were electronically monitored to determine the effect of gravitational changes on the otolith system. The freely moving fish provided physiological signals of the otolith nerves. Measurements of afferent and efferent responses were made before, during, and post-flight (Boyle et al., 2001). In January 2003, four medaka eggs laid on Earth in an artificially controlled environment were launched by the Columbia space shuttle during the STS-107 mission. For the control, four eggs in the same condition remained on the ground. No difference was observed in the time of development. In the ground experiment, the embryos were observed to rotate in the egg membrane, whereas in flight they did not rotate. One egg hatched 8 days after the mission launch in the flight unit, while four eggs hatched in the ground unit. In the flight unit, the fry was observed with its back usually to the camera and little swimming movement suggest. The results shown no appreciable difference in the time course of development between space- and ground-based embryos. (Niihori et al., 2004). The hatched medaka larva, embryos and the crew from the space mission tragically never returned to Earth alive due to the accident during the space shuttle’s reentry in the atmosphere. In 2007, dry eggs of the ornamental killifish the redtail notho (Nothobranchius guentheri) were placed into cotton-cloth bags, then into plastic Petri dishes, and fastened on the outer side of the ISS. The aim of the Biorisk-MSN mission was to expose dry incubated eggs to low orbit radiation. Unfortunately, no data is available concerning the resistance of the fish eggs as the equipment had no temperature sensor and the plastic dishes reached 95°C, deforming the plates, and the eggs died due to the high temperature and vacuum contact (Baranov et al., 2009). To study the fish response at early stage to microgravity, two missions using medaka fish were performed on ISS, in 2012 and 2014. Each time a Soyuz rocket sent 24 juveniles medaka (6 weeks after hatching, 16 mm) with the objective of rearing this population in the Aquatic Habitat (AQH) on the Kibo section of the ISS. Medaka fish in space and control fish from the same family on Earth were filmed. The movies showed that the fish became adapted to life under microgravity although despite an unusual swimming behavior. In addition, a mating behavior was observed under microgravity at day 33 and was not different from that on the Earth, indicating microgravity environment doesn’t disturb fish reproduction. The aquarium fish used for this experiment have fluorescent osteoclast cells, which makes them easier to observe. An osteoclast is a type of bone cell that breaks down bone tissue and responsible for bone loss. After 47 days in space, the fish tended to stay still in the tank. After 56 days, the mission fish group had normal growth compared to a terrestrial control. For fish in microgravity impairment of some physiological functions was accompanied by the activity of osteoclasts and a slight decrease in mineral density and vertebral bones. (Chatani et al., 2015; Murata et al., 2015; Chatani et al., 2016). Historical space missions involving ornamental fish are listed in Table 2. Missions With Aquaculture Fish in Low Orbits Very few missions involving aquaculture fish have been carried out to date (Table 3). In one of these, the common carp (Cyprinus carpio)—considered a very important aquaculture species in many countries–was chosen as a model for a sensor motor experiment by Japanese university teams and the Japan Aerospace Exploration Agency (JAXA). Two colored carp (16 months old, 26 cm and 263–270 g) were carried to the American SpaceLab in 1992. One of the two carp was given a labyrinthectomy (the otolith was removed). For both fish, swimming behavior and dorsal light response was studied and compared. As observed during the first space missions with small fish, the normal carp was unstable (associated with a kind of space motion-sickness) for the first three days, then finally recovered its Earth-based swimming behavior. The fish whose otolith was removed two months before showed a normal dorsal light response 22 h after launch, and disruption for the next two days as with the normal carp. Unfortunately, the recovery process for the fish with the removed otolith could not be evaluated due to a technical issue, but these observations provided evidence of a sensory-motor disorder during the early phase of adaption to microgravity in aquaculture fish (Mori et al., 1996). The change in body weight was monitored from two days before launch to four days after landing. Both fish recorded a weight loss around 12% in low orbit after 14 days of fasting. No conclusion can be made as a fasting replicate on the ground was not available (Mori et al., 1994). During space shuttle missions STS-55 (1993) and STS-84 (1997), tilapia Oreochromis mossambicus larvae that had not yet developed the roll-induced static vestibuloocular reflex were exposed to microgravity for 9–10 days. Young larvae (11–14 days after hatching) already exhibited the vestibuloocular reflex on the 1993 mission. Back on Earth, a vestibuloocular reflex test (fish were turned around their longitudinal axis at an angle of 15, 30, and 45°) showed that eye movement and reflex were not affected by exposure to microgravity during the two space missions (Sebastian et al., 2001). The OMEGAHAB (Aquatic Habitat) is a closed artificial ecosystem that was sent into orbit for 13 days on board the Russian satellite FOTON-M3 in 2007. The goal of the mission led by the German Space Agency was to investigate the possibility of designing a trophic chain in real microgravity using the photosynthetic flagellate Euglena gracilis as an oxygen producer and larvae of tilapia Oreochromis mossambicus as a consumer. This freshwater and brackish species is a popular aquaculture fish, with worldwide production of around 15,000 tons per year. In the 2007 experiment, 26 small larvae (approx. 12 mm in length) in the flagellate aquarium were studied in low orbit to increase knowledge about the development of the vestibular organs and enzymatic activity. The best fish survival rate (42%) ever achieved in a German experiment was recorded. Conditions of real microgravity during spaceflight induced a larger than normal otolith compared to a control maintained at 1 g. This could result in a difference in the ability to sense gravity (Anken et al., 2016). In a same ground unit, the photosynthetic producers supplied sufficient amounts of oxygen to a fish compartment with 35 larval cichlids (Hader et al., 2006). Historical space missions involving aquaculture fish are listed in Table 3. Feeding Fish in Space: Integrated Multi-Trophic Aquaculture If fish were farmed on a space base, sending aquaculture feed from Earth to Moon or Mars would make no sense from an economic or lifecycle analysis point of view. Aquatic systems contain a large diversity of species with different roles in nutrient cycles and biomass conversion that contribute to ecosystem balance. Photosynthetic organisms (algae, phytoplankton), invertebrates (crustaceans, mollusks, zooplankton), vertebrates (fish, amphibians), and microorganisms interact in a complex trophic web. By associating different complementary species such as fish, filter feeders, detritivores and primary producers, integrated multi-trophic aquaculture (IMTA) provides an innovative possibility for BLSS on the Moon or Mars. The nutritional profile of fish is closely linked to their diet quality. In aquaculture, this can be easily adjusted by ensuring a fish feed formulation that includes organisms that synthesize or sequester proteins, lipids of interest (e.g., EPA or DHA), vitamins and minerals. These aquatic organisms can be cultivated separately in a chain (from algae to invertebrates to fish) exclusively with fish waste as a fertilizer or using other available waste from human activities, such as exhaled carbon dioxide, space agriculture byproducts, or residents food waste. In the framework of sustainable aquaculture on Earth, researchers are studying trophic webs using closed or semi-closed aquatic systems that reuse fish nutrients dissolved in the water column or fish fecal matter as a fertilizer or food source for another aquatic organism. In an IMTA system, microalgae or macroalgae cultivation is easy using fish tank effluents, as the N/P ratio fits the requirements of algae: the increasing algae biomass assimilates nitrogen and phosphorus forms (Pagand et al., 2000). To return treated water back to the fish tank, it can be cleaned so it is safe for fish growth and welfare (Mladineo et al., 2010). Moreover, fish farm effluent is a suitable media for cultivating Nannochloropsis gaditana, a marine algae with a high PUFA content (Dourou et al., 2018). Several studies have reported the possibility of feeding aquaculture fish with microalgae (mostly marine) included in the fish feed formulation. Several microalgae strains have been tested successfully (they do not alter growth kinetics or organoleptic quality) with fish feed made up of 20–40% of microalgae: Crypthecodinium sp., Phaeodactylum sp. (Atalah et al., 2007) and Schizochytrium sp. (Ganuza et al., 2008; Stuart et al., 2021) have been tested for the seabream and amberjack diet; Tetraselmis sp. (Tulli et al., 2012), and Isochrysis sp. (Tibaldi et al., 2015) for European seabass; Nanofrustulum sp. for salmon, common carp and schrimps (Kiron et al., 2012); and Tetraselmis sp. and Isochrysis sp. for cod (Walker and Berlinsky, 2011). The modern feed form for aquaculture fish is dried pellets with less than 10% moisture. However, a study has shown that feeding fish using a moist formulation, such as algae or aquatic worms, with a water content around that of the natural prey profile in oceans, did not affect fish growth parameters and in fact increased resistance and immune protection (Przybyla et al., 2014). Thus, photosynthetic or invertebrate aquatic organisms produced in a Moon or Mars greenhouse could be fed directly to aquaculture fish with no transformation process. Researchers are exploring these alternatives to preserve wild fish stocks currently used for aquaculture fish feed (e.g., processed into fish meal and fish oil). Other algae sources with higher integration rates in feed formulations are the focus of future studies, while research is also investigating new types of aquatic prey compatible with fish feed, such as jellyfish (Marques et al., 2016). The algae cultivated in an IMTA system, as well as fish effluent, can also be a feed source for invertebrates, mollusks (Li et al., 2019), and sea cucumbers (Chary et al., 2020). A team from NASA is studying the possibility of using invertebrate production systems to purify water while growing protein-rich species as food/feed sources. Aquatic species such as copepods or mussels should grow rapidly, offer good protein content and have low mass for launch requirements (Brown et al., 2021). In the ocean, copepods and mussels are the favored natural prey of fish (especially seabream) and can be used as live feed for aquaculture fish. This production could also serve as food for the human crew. Thus, aquatic invertebrates and microalgae could play a key role in a trophic chain on a space base. In a recirculating aquaculture system, particulate matter is composed mainly of feces, mucus and bacterial clusters. This waste is easy to separate and remove from the RAS. Some copepods can use this media as feed, but another invertebrate is being studied for its ability to reduce this particulate matter and convert it into valuable biomass: the aquatic worm (Galasso et al., 2020). Polychaeta are detritivores and can be a feed source of interest for fish. Aquatic worms cultivated in an RAS can convert fecal matter into useful fatty acids for fish feed (Kicklighter et al., 2003; Bischoff et al., 2009; Palmer et al., 2014). Other synergies might also be possible: for example, Caenorhabditis elegans is a small terrestrial nematode already studied in space as a model for ageing in microgravity, as 35% of C. elegans genes have human homologs (Honda et al., 2014). This nematode could thus be both cultivated and observed in space in a BLSS. In wild environments on Earth, a fish’s diet is composed of its own congener, algae or invertebrates. Ground-based experiments have evaluated Nile tilapia as a bioregenerative sub-process for reducing solid waste potentially encountered in a space aquaculture system (Gonzales, 2009). The Tilapia feed formulation consisted of vegetable, bacterial, or food waste. Sulfur, nitrogen, protein, carbon and lysine content of waste residues were assimilated, sequestered and recycled in Tilapia muscle. Although Tilapia’s specific growth rate from population fed with different fibrous waste were widely inferior (1.4—89.8 mg/day−1) compared to the control population (281.6 mg/day−1), the Tilapia’s survival rate was not different. These results suggest additional research to improve feed formulation composed with fibrous residues (Gonzales and Brown, 2007). When considering formulating aquaculture fish feed on a space base using exclusively aquatic organisms cultivated in an IMTA system, it is essential to determine the digestive efficiency of the fish feed. A recent study highlighted the extreme flexibility of European seabass to feed formulations without fish meal and fish oil. In the experiment, fish were given several formulations containing 85% plant sources and 15% alternative sources (yeast, insects, and processed animal protein or Arthrospira platensis). Zootechnical results showed that three formulations resulted in a growth equal to fish fed with a traditional commercial formulation including a wild fish source. The bacterial community in the fish digestive tract adapted to the new formulation composed of alternative protein and lipid sources, and bacterial diversity was not altered (Perez-Pascual et al., 2020). This plasticity is probably common to other fish species, allowing a promising avenue to test new innovative formulations for aquaculture fish using exclusively BLSS raw matter sources such as cyanobacteria, plants, algae, and invertebrates. Applicability and Limitations of a Space Aquaculture System Like the systems for other types of food sources being studied for a future BLSS, such as those to produce microalgae and higher plants (Tikhomirov et al., 2007), the design of a space aquaculture system (SAS) is subject to various parameters, including the location in the Solar System. The size of the SAS would depend on the number of residents to feed, the other food sources necessary based on nutritionist’s recommendations, the space available on the lunar base, water availability and quality, the energy available for this activity, and the duration the BLSS will need to operate. One scenario might be to provide around 250 g of fish per person per week. The volume of the tank for rearing the fish should also be correlated to the fish growth rate and the frequency at which the fish are harvested. The diversity of fish species allows possibilities to be imagined such as using the area under the floor of the lunar base for flat fish, for example, or a tank that is not connected to the crew’s living area. On the Moon as on Earth, an aquaculture system requires water circulation. While the energy needed to pump water in an SAS with lunar gravity (one-sixth of Earth’s gravity) is yet to be defined, maintaining a set water temperature will have an energy cost. Within a window of tolerance depending on the species, fish growth directly depends on the water temperature (Handeland et al., 2008). In a context of 14 days of Sun exposure and 14 days of darkness, the latter period will require warming the water to maintain the growth rate. Thus the thermal profile of the selected species will be one of the parameters to consider. This aspect will have a direct impact on the total energy required for an acceptable growth yield in the SAS. Although fish have a low oxygen uptake compared to other vertebrates (Figure 2), a regular supply is required. Oxygen dissolution in the water from hydroxyl extraction and oxygen from the regolith and/or from photosynthesis in plants cultivated in the BLSS must be synchronized with the biological demands of the fish. This requires the capacity to regularly collect, store and dissolve oxygen in the water column. The oxygen data from the CEBAS experiment on the STS-89 and STS-90 missions was analyzed to model this concept. Results based on the experimental MINI-MODULE (8.6 L) showed different periods of oxygen accumulation and depletion in the aquatic habitat in plants (oxygen producer) and snails (oxygen consumer). Simulations from ground-based models predict the oxygen concentration and can be adapted for other species (Drayer and Howard, 2014). A trend has to be defined between the volume of oxygen instantly available or stored and the demand of aquatic consumers. This highlights the importance of an oxygen buffer tank linked to a feedback control mechanism (possibly remotely controlled from Earth) in case of a lack of oxygen. Another aspect to monitor is bacterial development inside the system. An axenic environment cannot be considered as bacteria play an essential role in all stages of a balanced ecosystem. Yet bacteria activity affects the nutrient budget and oxygen measurement and availability (Konig et al., 2001). All these parameters will drive the size of the SAS and the fish biomass allowed in an extreme environment such as the Moon. Another issue to consider is aquatic biomass extraction in the space environment. Harvesting cells such as microalgae is a current challenge, today handled using vacuum and flocculation (Barrut et al., 2012). The development of harvesting tools is required for different aquatic organisms in a limited and constrained space. Regardless of the organism, extraction is necessary when the biomass has reached its optimum growth to avoid uncontrolled water degradation and increased oxygen consumption by microorganisms that would endanger fish production. The time needed for fish management on a lunar base also depends on the size of the SAS. Current technology developed for RAS drastically reduces the time necessary to maintain the system. Most of the tasks can be automated, such as starting and cleaning the biofilter, monitoring water parameters (Konig et al., 2001), and regulating the water. Fish feeding is a time-consuming task, but this can also be automated. Fish are able to adapt to self-feeding devices (Coves et al., 1998; Di-Poi et al., 2008), which contribute to the social interaction of the population (Chen et al., 2002). As in plant production systems (Bamsey et al., 2009), several automated SAS actions could be carried out remotely from a control room on Earth. A daily routine (visual checking of the system and fish behavior and non-automated actions) could be considered to involve around 1 h every 12 h for a closed loop system composed of 16 tanks (1 m3) and 8 kg/m3 of fish biomass (based on personal experience). The energy available to power the SAS will also determine its design. A ground-based greenhouse simulation for food production with lunar constraints is necessary to study and understand gas flow management, organism interactions, and all related parameters necessary to maintain a stable and balanced ecosystem. Studying the Feasibility of Sending Aquaculture Fish Embryos to the Moon: The Lunar Hatch Program In research underway since 2019, the Lunar Hatch program is investigating the feasibility of shipping embryonated aquaculture fish eggs to space for programmed hatching in a lunar BLSS. The hatched larvae would then be fed with local resources and reared until they reached an appropriate size for human consumption. The aim of the study is proof of concept based on experimental data collected first in ground-based trials, followed by test missions in low orbit, and concluding with a real flight to space, perhaps leading to the hatching of the first vertebrate on the Moon. The program focuses on the viability of European seabass (Dicentrarchus labrax) for such a project, by analyzing the potential effects on embryos of a Moon journey and the associated environmental changes. Water found on celestial bodies in the Solar System have a saline or hypersaline profile. The choice of the European seabass in the Lunar Hatch program was based on the fact it is a marine organism with an appreciated taste, and its physiology and behavior have been abundantly described. A secondary water source for fish aquaculture could also be considered such as recycled water from a greenhouse or non-potable water from technical process or human activities. The diversity of aquaculture fish species allows the appliacation of many potential “fishonauts”, depending on the primary or secondary water resource available in situ (fresh or salt water). Other aquaculture species could equally be considered for rearing in space, such as trout, flat fish or shrimp. As mentioned, in the 1970s, spaceflight tests were carried out at the egg stage with ornamental fish (Table 2). The choice of eggs as the biological stage for space travel is relevant for several reasons. A low volume of water is required for egg incubation, so the initial launch biological payload could be less than 1 kg for around 900 future larvae. In aquaculture nurseries, European seabass egg density in the water column is around one egg per milliliter. Unlike the larval or adult stages, the embryogenesis phase is suitable for a spaceflight because embryo development does not require human intervention for several days (the duration of embryogenesis depends on the species). Although embryogenesis involves intense metabolic activity for the development of the future larva, the low biomass and the chorion limit catabolite emission as well as the self-pollution of water during the journey. This would allow either long manned spaceflights with no need for maintenance from the crew, or simply the transport of fish eggs using an automated cargo ship. Compared to normal conditions in land-based aquaculture production, during a spaceflight fish embryos would be initially subjected to atypical acoustic and mechanical vibrations caused by launcher motors and acceleration in the atmosphere. The effects of this are under study in the framework of the Lunar Hatch program (supported by the French National Institute for Ocean Science, Ifremer) using a standard qualification test commonly employed in the space industry. In a recent experiment, a vibration exciter mimicked the conditions of a SOYUZ-2/FREGAT launch on a population of fish embryos (Figure 4). In this test, two triplicates (n = 300) of embryos of aquaculture species (European seabass and meagre in two separate experiments) were submitted to the acoustic and mechanical environment of a launch for 10 min at one-third and two-thirds of their development. The hatching rate was then compared to a control triplicate (n = 300). No significant differences were observed on the hatching rate for either species whatever the stage of development when the embryos were exposed to the conditions (Figure 5). These encouraging results indicate the egg robustness of two major aquaculture species. A credible hypothesis to explain these results is that the success of the global aquaculture industry is based on the selection of aquatic species for robustness criteria to actions such as unusual and stressful handling–especially at an early lifecycle stage–such as sorting, sampling, transfer from aquarium to tank, or long transport by road or air. The aquaculture sector has selected the most biologically flexible strains with the most interesting nutritional profile for economic reasons. The resulting robustness could benefit space programs–it would not be surprising if other aquaculture species also successfully pass this qualifying test. Beyond intense vibrations, understanding the influence of hypergravity and microgravity on embryonic development is essential to evaluate the feasibility of space aquaculture. Previous studies on ornamental aquarium fish can provide some information on fish behavior and physiology in space that may be useful. Hypergravity is experienced during rocket take-off, an acceleration phase that lasts about 10 min at 4–8 g, depending on the launcher motors. This situation was tested on swordtail fish and medaka otoliths (Anken et al., 1998; Ijiri et al., 2003; Brungs et al., 2011; Anken et al., 2016) and larvae bone development (Aceto et al., 2015; Chatani et al., 2015), but its effects on early ontogeny (hatching capability) are as yet poorly described. A recent research showed that six month exposition at 5 g can induce vertebral curvatures and asysmetric otoliths (Chatani et al., 2019). However, the duration of exposure to hypergravity during a launch to the Moon or Mars will be about 10 min, the time to extract the embryos from the Earth’s attraction. Ongoing experiments are exploring the ability of aquaculture finfish embryos to develop in these conditions. It is credible to posit that hypergravity applied to a water reservoir may be less felt by a submerged embryo. In contrast to poultry eggs stored in air, the water density surrounding fish eggs may reduce the acceleration force on the chorion. Following the initial conditions of rocket vibrations and acceleration, a situation of microgravity appears beyond an altitude of 110 km. During the entire evolution of life on Earth, the development of all organisms took place under constant gravity conditions in different media (air/water). It should be noted that in the ocean, fish embryos are already in a kind of microgravity compared to terrestrial organisms due to Archimedes’ principle and other physical phenomena. This is why, to simulate partial microgravity, astronaut training exercises are carried out in a swimming pool. A study has found that embryos of Xenopus (an aquatic frog) are able to adjust to microgravity environments until hatching through an adaptation mechanism and strategy (Black et al., 1995). Might this capability be common to other aquatic organisms, including fish embryos? Supported by the French space agency (CNES), the Lunar Hatch program plans to study the embryo behavior of European seabass in hypergravity and microgravity in the Gravitational Experimental Platform for Animal Models (GEPAM), a European Space Agency platform to test different gravity environments on animals (Bonnefoy et al., 2021). Exposure to radiation during the space journey will be the last environmental change investigated in future Lunar Hatch program studies: this is probably the parameter with the most impact on fish embryo biology. Knowledge about the effects of space radiation on a variety of organisms has increased over the last decades: for bacteria (Leys et al., 2009), plant and mammalian cells (Arena et al., 2014), and amphibians (Fuma et al., 2014). A ground-based study on the influence of radiation on fish immediately post-hatching was carried out on the ornamental zebrafish (Danio rerio), in which eggs were irradiated with doses ranging from 1 to 1,000 mSv.d−1 for 20 days (Simon et al., 2011). At the stage of 3 days post-hatching, no significant difference in mortality was observed between irradiated eggs and the control. The maximum daily dose was 100 times greater than the total dose astronauts were subjected to during the Apollo 11 mission. These results are consistent with a study in which no significant difference in mortality was observed between 0.8 mGy (the threshold recommended to protect ecosystems) and 570 mGy delivered per day, but the radiation exposure induced accelerated hatching for both doses and a decrease in yolk bag diameter for the highest dose (Gagnaire et al., 2015). In contrast, another study exposing zebrafish embryos to 1, 2.5, 5, 7.5, and 10 mGy of gamma radiation at 3 hpf showed that increasing gamma radiation increased DNA damage, decreased hatching rate, increased median hatching time, decreased body length, increased mortality rate, and increased morphological deformities (Kumar et al., 2017). A higher total dose but spread over time therefore seems to be less harmful than a single high dose concentrated in the early stages of development. Gagnaire et al. also found abnormal development of the spine for individuals subjected to 570 mGy.d−1. These research results on a small fish provide useful information for countermeasures that would need to be implemented on a lunar base. Fish and crew should be protected to reduce cosmic ray damage. Fish embryos could benefit from progress in countermeasure technology developed for humans, but it would be valuable to conduct experiments on the impact of different particles and charges (separate and cumulative) from cosmic radiation on the candidate fish. Conclusion The Lunar Hatch program is investigating the prospects of lunar aquaculture based on a circular food system using a selected species at a specific stage of the lifecycle. It may be of interest to investigate other aquaculture species for other targeted planets or other lifecycle development stages. In the case of the Moon, it is so close to Earth that rearing adults for reproduction would not be worthwhile: a regular shipment of fertilized eggs for monthly generation would avoid costly fish-spawning management on the lunar base. For a more distant destination such as Mars, the embryo stage would be realistic for the first part of the mission, but the total flight would be longer than the duration of embryogenesis. In this case, larval development would need to be considered during the multi-month journey. For farther destinations, studies would need to determine the possibility of rearing broodstock to control the entire biological lifecycle in space. Space aquaculture would provide a valuable food source in addition to those already studied for long-term missions. The diversity of nutrients provided by fish and the benefits for human metabolism may help in the challenges of space medicine, in particular the prevention of cancer caused by long-term exposure to radiation. The activity of fish farming itself could have positive psychological and cognitive effects. Reports about plant-growth chambers on manned missions have described the psychological benefits of working with living organisms in space. An investigation involving social scientists could be conducted to better understand the possible positive benefits of human–animal interaction in space. Vertebrates may recall basic human activities and provide a psychological umbilical cord with the Earth. Modern recirculating aquaculture systems share many characteristics with the closed bioregenerative life-support systems planned for space. Progress in aquaculture technology on land and in space can feed into each other. For example, developments that allow space aquaculture systems to recover and convert waste molecules into edible food could be deployed on Earth to increase food availability while avoiding waste discharge in the environment and preserving biodiversity. Joint efforts to design such waste conversion systems will be applicable above all to human activities on Earth. Like other aspects of BLSS, while space aquaculture is close to being a reality, it is highly dependent on the water and energy available in situ. At the turn of the 20th century, the Russian father of astronautic science Konstantin Tsiolkovsky wrote: “Earth is the cradle of humanity, but one cannot remain in a cradle forever.” Plants and animals are part of the human biosphere and food chain. Space exploration will likely be more successful if humans leave the cradle with a part of their own biosphere and their knowledge of agricultural science, including aquaculture.

## OFF

### NC – DA

#### New defense VC firms are emerging but vulnerable, shocks now **collapse innovation**

Aitoro 20, [Jill, editor of Defense News. She is also executive editor of Sightline Media's Business-to-Government group, As tech startups catch DoD’s eye, big investors are watching, https://www.defensenews.com/smr/cultural-clash/2020/01/30/as-tech-startups-catch-dods-eye-big-investors-are-watching/]

In the words of Mike Madsen, director of strategic engagement at the Pentagon’s commercial tech hub, Defense Innovation Unit: "We’re at a significant inflection point right now that will be visible through the lens of history.”

Nonetheless, for the tech startups, it’s been slow going, as discussed during a Defense News roundtable in California. For the second year, leadership from DoD and the tech community came together to discuss the state of the Pentagon’s efforts to attract commercial startups — this time digging into the challenges and opportunities that come with investment in defense development.

“We went into this eyes wide open, knowing full well that to the venture community, the math doesn’t make sense. Making the choice to contribute to the advancement of artificial intelligence for DoD represented for us more of a mission-driven objective,” said Ryan Tseng, founder of artificial intelligence startup Shield AI.

But early on, “we were fortunate to get the backing of Andreessen Horowitz, a top-tier venture fund. They’re certainly leaning in, in terms of their thinking about defense technology — believing that despite the history, there might be a way to find an opening to create companies that can become economically sustainable and make substantial mission impact.” Shield AI has raised $50 million in venture funding since 2015, with more rounds expected.

Indeed, a few key Silicon Valley investors have emerged as the exceptions to the rule, putting dollars toward defense startups. In addition to Andreessen Horowitz, which counts both Shield AI and defense tech darling Anduril in its portfolio, there’s General Catalyst, which also invested in Anduril, as well as AI startup Vannevar Labs.

And then of course there’s Founders Fund. Led by famed Silicon investors Peter Thiel, Ken Howery and Brian Singerman, among others, the venture firm was an early investor in Anduril, as well as mobile mesh networking platform goTenna. Founders Fund placed big bets on Palantir Technologies and SpaceX in the early days, which paid off in a big way.

Some of the early successes of these startups have “done an excellent job of making investors greedy,” said Katherine Boyle, an investor with General Catalyst. “There’s a growing group who are interested in this sector right now, and they’ve looked at the success of these companies and [are] saying: ‘OK, let’s learn about it.’ ”

Take Anduril: The defense tech startup — co-founded by Oculus founder Palmer Luckey and Founders Fund partner Trae Stephens — has raised more than $200 million and hit so-called unicorn status in 2019, reaching a valuation of more than $1 billion. As the successes piled up, so did the venture capital funding. According to Fortune magazine, those investors included Founders Fund, 8VC, General Catalyst, XYZ Ventures, Spark Capital, Rise of the Rest, Andreessen Horowitz, and SV Angel.

“I started my career at Allen & Company investment banking. Herbert Allen, who’s in his 80s, always said: ‘Hey, you should run into an industry where people are running away,’ ” said John Tenet, a partner with 8VC as well as a co-founder and vice chairman of defense startup Epirus.

“There’s so much innovation occurring, where the government can be the best and biggest customer. And there are people who really want to solve hard problems. It’s just figuring out where the synergies lie, what the ‘one plus one equals three’ scenario will be.”

Also attracting the attention of Silicon Valley investors is the growing emphasis by the Pentagon not only on systems over platforms, but software over hardware. Boyle described the shift as the “macro tailwind” that often drives innovation in a sector. Similar revolutions happened in industrials and automotive markets — both of which are also massive, global and slow-moving.

That emphasis on tech, combined with some recent hard lessons, also provides a glimmer of hope that the typical hurdles associated with defense investments — lengthy procurement cycles and dominance by traditional manufacturers, for example — could be overcome.

Consider U.S. Code 2377, which requires that commercially available items be considered first in procurement efforts, said Anduril’s Stephens. He also noted court decisions in lawsuits filed by SpaceX and Palantir, which ultimately validated claims that defense agencies had not properly ensured a level playing field for major competitions.

“These types of things are now at least in recent memory for Congress, and so they have some awareness of the issues that are being faced,” Stephens said. “It’s much easier now to walk into a congressional office and say, ‘Here’s the problem that we’re facing’ or ‘Here’s the policy changes that we would need.’ There are also enough bodies like DIU, like In-Q-Tel, like [AFWERX](https://www.afwerx.af.mil/), like the Defense Innovation Board, like the [Defense Science Board] — places where you can go to express the need for change. And oftentimes you do see that language coming into the [National Defense Authorization Act]. It’s part of a longer-term cultural battle for sure.”

For now, all these factors contribute to the majority of skeptical investors’ decisions to watch the investments with interest — even if they still take a wait-and-see approach. And that places a lot of pressure on the companies that are, in a sense, the proof of concept for a new portfolio segment.

“My fear is that if this generation of companies doesn’t figure [it] out, if they don’t knock down the doors and if there aren’t a few successes, we’re going to have 20, 30 years of just no investor looking around the table and saying we need to work for the Department of Defense,” Boyle said. “If there aren’t some success stories coming out of this generation of companies, it’s going to be very hard to look our partners in the eye and say: ‘We should keep investing in defense because look at how well things have turned out.’”

#### Domestic firms are carefully hedging cooperation with China, ensuring long-term defense contracts and robust political support from the Pentagon – the plan creates the perception of *industry-wide* bilateral cooperation which magnifies regulatory headwinds, stokes fears of espionage, and guts the industry.

Fish 20 [Isaac Stone Fish is the founder and CEO of Strategy Risks. He is also a Washington Post Global Opinions contributing columnist, a contributor to CBSN, an adjunct at NYU's Center for Global Affairs, a visiting fellow at the Atlantic Council, a columnist on China risk at Barron's, and a frequent speaker at events around the United States and the world. November 13, 2020. https://www.barrons.com/articles/can-elon-musk-keep-beijing-and-washington-happy-51605293737]

It’s been quite a balancing act. Elon Musk, the CEO of both the electric-car company Tesla and the aerospace manufacturer SpaceX, has managed to play nice with both the U.S. government and the Chinese Communist Party. Musk has one of the closest relationships with Beijing of any American business leader, and at the same time, provides the Pentagon with technology that could help the U.S. military defend the Taiwan Strait. So far, it’s worked, as reflected in recent deals, Tesla’s share price, and general investor optimism about his businesses. In early October, SpaceX secured an important $149 million contract for a Pentagon missile-warning system. NASA and the Defense Department are by far its two most important customers, and SpaceX handles approximately two-thirds of NASA’s launches. Over the last 12 months, Tesla’s stock price has grown roughly sixfold, helping Musk obtain a net worth that Forbes estimates at roughly $90 billion. In its second-quarter earnings report, Tesla said it earned 23.3% of its revenue in China, more than double the same period in 2019. But investors are overlooking the potential for spiking U.S.-China tensions to penalize SpaceX for Tesla’s relationship with Beijing. The Biden administration will likely continue to challenge China’s predatory trade practices, and will better coordinate its China strategy with U.S. allies, further alienating Beijing. Moreover, it’s not unthinkable for Beijing to use this transition period to test U.S. resolve, further inflaming tensions. To understand the risks, it’s important to understand just how close Musk and Tesla are with Beijing, and how close Tesla is with SpaceX. In January 2019, Musk visited Shanghai to unveil a $5 billion Gigafactory, which could eventually produce over 500,000 electric vehicles annually for the Chinese market. He then had the opportunity—unusual for a U.S. business leader—to meet privately with Premier Li Keqiang in Zhongnanhai, the Party’s inner sanctum. The Gigafactory is the first foreign-owned car plant to open in China without a domestic partner, and one of the largest direct investments ever in the country by a U.S. firm. Tesla’s success in China wouldn’t be possible without its strong relationship with the Chinese government. Tesla doesn’t own the land. It’s leasing it, for 50 years, from the Shanghai government. In December 2019, Tesla secured a $1.6 billion loan from four Chinese state-owned banks. And in early 2020, amid a global shortage, Chinese officials ensured that the Gigafactory had enough masks, disinfectant, and thermometers to remain open. SpaceX and Tesla are independent companies, but they share key personnel—most crucially, Musk himself. His brother Kimbal serves on the boards of both companies, as does the private-equity investor Antonio J. Gracias. The engineer Charles Kuehmann serves as vice president of materials engineering at both companies, and in May 2020 Tesla announced plans to “temporarily assign approximately 20 of its employees to support SpaceX.” Tesla occasionally sells battery components to SpaceX, and built a custom tool for the company in 2020. “That’s cross-fertilization of knowledge from the rocket and space industry to auto back and forth, as I think it’s really been quite valuable,” Musk said in an August 2017 earnings call. Recent congressional activity illustrates how the two companies could be linked politically—to the detriment of Musk. In 2019, Sen. Cory Gardner (R-Colo.) proposed an amendment to legislation that would require the U.S. government to determine whether Chinese entities are “leveraging United States companies that share ownership with NASA contractors.” (SpaceX has been lobbying against similar legislative provisions in the House, Politico reported.) The thinking behind Gardner’s amendment is as follows: Companies like Tesla that have close ties to Beijing facilitate technology transfer, either because they willingly share technology with Chinese firms, or they’re less likely to complain when Beijing either pressures them for or outright steals their technology. Because of that, Gardner said, “The U.S. is basically now complicit in enabling Chinese advancements in aerospace.” To sell to the Pentagon and NASA, SpaceX must remain compliant with the International Traffic in Arms Regulations (ITAR), a vague but strict set of rules that requires weapons manufacturers to prevent their technology from being accessed by countries like China. Any leak, or forced technology transfer to China, could jeopardize SpaceX’s ITAR compliance—and with it, its relationship with U.S. government entities. “We’re focused on successful missile execution with NASA contractors and commercial partners,” a NASA spokesperson said, in response to a query about its relationship with SpaceX, “and we expect all those companies to meet all legal requirements in the execution of the services they provide.” (Tesla and SpaceX didn’t respond to multiple requests for comment). Tesla’s December 2019 loans from Chinese banks could also become a liability for Musk. The four banks are state-owned and regularly implement CCP policy in China. If U.S.-China tensions worsen to the level that broad-based bank sanctions become a real risk, Tesla, like many other American companies with financial ties to Chinese state banks, would likely have to cancel the loans. The issue is not that Tesla would have trouble repaying a $1.6 billion loan, or finding alternative sources of capital. Rather, it’s the potential optics and regulatory cost of selling a car that the Communist Party helped build. All major American car companies source from China. But none do it as expansively as Tesla. Moreover, the risk comes from both sides: It’s not hard to imagine Beijing punishing companies like Tesla were they to shun its state-owned banks. To be sure, this is not only a problem for Musk and Tesla. Apple, Boeing, and even Starbucks must constantly calibrate their relationships with Washington and Beijing. China is Boeing’s second-largest market for its commercial aircraft sector, and Boeing has a longstanding partnership with the Commercial Aircraft Corporation of China. But that didn’t stop Beijing from sanctioning Boeing’s defense contractor business in late October, after the company sold weapons to Taiwan. Other American CEOs have close relationships to the Party. But Musk is the only one who loudly praises Beijing while running a space company with incredibly sensitive and powerful defense applications. Can Musk continue to walk this line? A clearer separation between SpaceX and Tesla would help him manage the potential downsides of a spiraling U.S.-China relationship. Musk, and those who invest in his companies, would do well to be wary of these risks.

#### Suppliers are on the ropes---the plan reverses DOD signals that defense business won’t “dry up overnight”, causing creditor withdrawal and supply chain disruption

Whiteman 20, [Lou Whiteman is a market analyst for Motley Fool, Pentagon Comes to Defense of Contractors Amid Coronavirus Uncertainty, https://www.fool.com/investing/2020/03/23/pentagon-comes-to-defense-of-contractors-amid-coro.aspx]

The Pentagon can't step in and alleviate all of the potential issues that come with a pandemic, but the statement if nothing else is a clear signal that the Department is trying to stay out in front of potential issues, and is willing to work with the supply base to mitigate the potential impact.

Large prime contractors have ample resources to get through a slowdown, but Pentagon officials appear focused on ensuring there is no major disruption to the supply chain due to the virus. Many top suppliers to the primes, companies like TransDigm Group (NYSE:TDG), Spirit AeroSystems (NYSE:SPR), and Heico (NYSE:HEI), also have significant commercial aerospace exposure. That business has been hard hit by a dramatic decline in air travel demand.

With commercial aerospace potentially heading for an extended down cycle, the Pentagon is trying to make it clear to the companies and their creditors that the defense business will not dry up overnight as well.

For investors, the Pentagon's comments are unlikely to cause the stocks to rebound and surge higher. But it is a reminder that particularly on the defense side the pandemic impact, as bad as it might be, is transient.

We could be in for a couple of rough quarters, but the case for buying best-of-breed defense stocks is as valid today as it was at the beginning of the year.

#### Impact’s cyber and deterrence crash

Manchester ’19, [Josh, Founder of Champion Hill and General Partner at Foundation Capital, Venture-backed Startups Will Build the Defense Technology the Free World Needs Right Now, https://medium.com/@joshmanchester/venture-backed-startups-will-build-the-defense-technology-the-free-world-needs-right-now-d2cefa2b2196]

With U.S. defense spending exceeding $700 billion per year, how could the United States be on the brink of a national security emergency? Simply put, America’s national security competitors are outflanking an Industrial-Age U.S. military machine that, like a lumbering dinosaur, is not adapting fast enough to its changing environment. The Pentagon desperately needs rapid innovation. Yet the current defense industry structure is not compatible with U.S. venture capital and high-growth technology industries for several reasons: · The U.S. military’s industrial base is centered on a few huge oligopoly suppliers known within the Beltway as “the Primes” — Lockheed Martin, Boeing, Raytheon, General Dynamics, and Northrop Grumman. These companies, ancient by tech startup standards, have optimized themselves to sustain a 20th century Industrial Age World War II-style force structure which supports the political decision-makers across the country who appropriate the funding that industrial base receives. The Primes are great at building very large platforms that cost billions of dollars and take 15–30 years to field. The Primes are also historically heavy on hardware talent and much lighter on software talent. · The Primes receive the vast majority of defense spending. Defense budgets have historically not unlocked for startups. While a defense private equity industry exists to aggregate small companies and flip them downstream to the Primes, venture capital investors, who have a much higher return threshold, know that it’s hard to have venture outcomes (in other words, to make money) when a company can’t win large market share or survive as a stand-alone business. · Venture-backed tech industries have matured as an asset class in peacetime and most mainstream U.S. venture firms in existence today do not have institutional cultures or histories that include defense innovation, apart from cybersecurity. · Major tech companies, like the FAANGs (Facebook, Apple, Amazon, Netflix, Google and Microsoft too), are generally unwilling to work on defense related projects, and sometimes must deal with employee protests when they do. · Many observers perceive this as an indicator that software engineers generally don’t want to work on defense-related innovation. · Finally, in a bizarre set of twists, some of the organizations that comprise the Limited Partners of venture capital firms (the blue chip endowments and foundations of the U.S. Eastern establishment, often founded on the fortunes of great American industrialists from decades ago, along with public pension funds throughout the country) are [sometimes accidentally funding Chinese defense technology](https://www.buzzfeednews.com/article/ryanmac/us-money-funding-facial-recognition-sensetime-megvii) while often restricting their U.S. venture managers from making defense investments. Foundations and endowments in particular often have negotiated Limited Partnership Agreements with the venture firms they finance precluding them from investing in anything that could have military usage. The irony is that these same tax-exempt pools of capital are frequently investors in Chinese venture funds which provide software to make smarter and more deadly Chinese weapons and to the advanced surveillance systems that have turned China’s Xinjiang province into a virtual Uighur prison camp and a human rights disaster. No single individual or entity has caused this state of events to transpire; it is simply the accumulation of various cultural aspects of the capital formation process of the venture industry and its portfolio companies. Fortunately, we believe that almost all these characteristics will rapidly change over the next few years. But first let’s discuss some additional background. Venture capital has come of age in a time of unprecedented peace The U.S. venture capital industry is about 100 years old. Bessemer Ventures was formed in 1911 and originally had just the family fortune of Henry Phipps Jr., a co-founder of Carnegie Steel, as its sole limited partner. Despite these deep roots, the U.S. venture industry has only institutionalized as an asset class since the mid-1990s. Until then it was extremely clubby and very small. Sequoia Capital, KPCB, Charles River Ventures, and NEA were all founded in the 1970s and Accel Partners in the 1980s. But it has really only been since the mid-1990s (Benchmark Capital was founded in 1995, as was my own former firm, Foundation Capital) that the industry has institutionalized and grown substantially, first in the desktop computing and internet boom, and second during the combination of platform shifts over the last ten years that have given us mobile computing, social media, e-commerce, cloud computing, software-as-a-service and all of their associated new business models. For a quarter of a century, the institutional, mainstream venture investing ecosystem, at the startup, venture firm and limited partner levels, developed business processes, mental models, networks, and expertise in certain technical areas and heuristics — in aggregate, an industry culture — that have created one of the most dynamic parts of the U.S. economy. The U.S. tech industry is also one of the most unique aspects of American life — and a powerful, difficult-to-replicate form of “soft power,” featuring an inclusivity for aspirational immigrant founders — a feature perhaps unequalled in human history. From a long-term U.S. historical viewpoint, it is striking that the venture industry’s maturation has occurred during a unique period in American history when the United States had no major great power competitor, either ideologically or technologically. The Cold War ended in 1991, the Soviet Union dissolved, and Russia was in disarray for the next 15 years. This period of peace was not without its own unique trials, but the security challenges associated with terrorism, counterinsurgency, and lower-intensity military activity have not required the sort of Herculean societal and political efforts that were drawn upon during the Cold War or World War II. We should all be grateful every day that this has been the reality of the last 25 years. A useful analogy might be made with gold. In 1933, President Roosevelt made it illegal for U.S. citizens to own gold. In 1934, Benjamin Graham published the first edition of Security Analysis. In January 1975 it became legal to own gold again. Graham died in 1976. It was therefore illegal to own gold during key years of the development of modern security analysis. From this gap came gold bugs — the weirdos who seemed to always talk about nothing else, and didn’t get invited to key social events. No analogies are perfect but this captures some of the similarities between venture and defense today. Cybersecurity investors understand the cybersecurity parts of U.S. defense. But most mainstream Silicon Valley venture firms do not spend time on other parts of defense due to the industry’s institutionalization during this recent period of relative peace and American dominance — which has also been a time when the lion’s share of defense spending has gone to the Primes, as discussed. Sadly, peace is ahistorical. Great power competitions are a feature of humanity, not a bug. Periods of time when a major power, or superpower, are not challenged in some profound fashion by one or more other powers, regardless of whether they are driven by fear, prestige, economic interest, or ideology — are, in short, rare when looking back on the sojourn of homo sapiens on planet earth. The period when the free world had a monopoly on power has now ended. The tech-defense status quo is inverting The only previously delineated area where we don’t expect much change is from the FAANGs. These massive companies are best viewed as small nation-states themselves with global stakeholders. For example, many of their employees are not U.S. citizens and may not want their employers engaged in U.S. defense work. We think everything else will invert. · We believe defense budgets will begin unlocking for young startups. Many key national security decision-makers in Washington are now seeking better, faster alternatives to the byzantine Pentagon acquisitions process. Thought leaders like Will Roper, in charge of the U.S. Air Force’s $40 billion annual research and acquisition budget, are [eagerly welcoming the contributions that smaller, nimble venture-capital funded entrepreneurs can make](https://federalnewsnetwork.com/dod-reporters-notebook-jared-serbu/2019/03/air-force-looks-to-build-big-idea-pipeline-to-expand-its-industrial-base/). Roper, and others in the Pentagon, are reforming their practices to make it easier for genuine innovators to compete against the legacy defense oligopoly. When recently asked at a conference what problem keeps him up at night, Roper replied, “The industrial base.” · Given the hardware roots of the Primes, they are ill-suited to provide solutions to many of the most pressing problems today. The Defense Department will increasingly allocate resources to startups solving software problems for which the Primes have no existing stock of machine learning engineers. · As this happens some venture firms will experience cultural shifts toward more defense investing. As venture capitalists see that startups are receiving large purchase orders from various Defense Department units, they will develop strategies to deploy capital toward defense innovation. A good example is [last week’s award by the Air Force of $121 million to Pivotal Software in San Francisco](https://dod.defense.gov/News/Contracts/Contract-View/Article/1861753/source/GovDelivery/). · Institutional limited partners as a group will likely slowly allocate away from any China-based manager who could be investing in Chinese military technologies. Some LPs with the freedom to do so may remove restrictions on defense investing from limited partnership agreements. · We believe it is a myth that software engineers do not want to work on defense. This is a classic case of preference falsification, the social phenomenon in which people do not speak their true minds about a given topic, though their actions often indicate otherwise. We believe that talented engineers are often very attracted to defense-related work because it often offers the hardest problems to solve. An enormous opportunity therefore exists for startups: to hire the engineers who don’t want to work for ancient and outdated Primes, and who aren’t very welcome at the FAANGS, but who wish to create the technologies that an increasingly eager democratic government needs to defend itself and its allies. Companies in our own portfolio, like [SpaceX](https://www.spacex.com/), [Rigetti Computing](https://www.rigetti.com/), [Anduril Industries](https://www.anduril.com/), and [Umbra Lab](https://umbralab.com/) are executing this strategy. The hardest technical problems today are defense-related How can data from satellites, drones, land-based radar, ships, and other sources be stitched together, in real time, to find long-range missiles on mobile transporters, hiding among the background in cities, forests, and mountains? How can friendly troops, who have separated into very small units in order to hide and survive, be connected to each other electronically, and be resupplied from historically long ranges? How and to what degree and in what conditions should an adversary’s sensor networks be spoofed? What type of false electronic picture can be painted? The aggregation of targeting data for an air wing takes 72 hours today and has a heavy human component. Can this complex optimization problem be solved autonomously, such that the targeting list for pilots is developed in 15 minutes? How does a deployed force of perhaps 50,000 personnel, with planes, ships, and land forces, continue to fight when satellite links have been knocked out, and “reachback” to the U.S., for data processing, is no longer possible? Can deep learning be used for crisis diplomacy? Put another way, since DeepMind’s AlphaZero can teach itself to move pieces forward on a board to win a game, can it learn to move them backwards, to de-escalate a crisis? These problems, and many others, are asking to be solved by entrepreneurs. Phase change There is a looming breakdown in deterrence. If the U.S. defense establishment is unable to adapt to the new great power competitive environment, then adversaries will be tempted to grab for a fait accompli, with war the result. This has been the pattern since Homer wrote The Iliad; there is no evidence to conclude human behavior is different in the 21st Century. We believe the prevention of this scenario involves rapid technical innovation. The defense environment is more favorable now for upstart firms than anytime in the past several decades. If you are a founder building technology to ensure the survival of government by consent, our firm would like to talk to you.

#### Independently, innovation is key to solve emerging tech – extinction

Jain 19 [Ash Jain is a senior fellow with the Scowcroft Center for Strategy and Security, where he oversees the Atlantic Council’s Democratic Order Initiative and D-10 Strategy Forum, Matthew Kroenig, "Present at the Re-Creation: A Global Strategy for Revitalizing, Adapting, and Defending a Rules-Based International System", 2019, https://www.atlanticcouncil.org/wp-content/uploads/2019/10/Present-at-the-Recreation.pdf]

The system must also be adapted to deal with new issues that were not envisioned when the existing order was designed. Foremost among these issues is emerging and disruptive technology, including AI, additive manufacturing (or 3D printing), quantum computing, genetic engineering, robotics, directed energy, the Internet of things (IOT), 5G, space, cyber, and many others. Like other disruptive technologies before them, these innovations promise great benefits, but also carry serious downside risks. For example, AI is already resulting in massive efficiencies and cost savings in the private sector. Routine tasks and other more complicated jobs, such as radiology, are already being automated. In the future, autonomous weapons systems may go to war against each other as human soldiers remain out of harm’s way.

Yet, AI is also transforming economies and societies, and generating new security challenges. Automation will lead to widespread unemployment. The final realization of driverless cars, for example, will put out of work millions of taxi, Uber, and long-haul truck drivers. Populist movements in the West have been driven by those disaffected by globalization and technology, and mass unemployment caused by automation will further grow those ranks and provide new fuel to grievance politics. Moreover, some fear that autonomous weapons systems will become “killer robots” that select and engage targets without human input, and could eventually turn on their creators, resulting in human extinction.

The other technologies on this list similarly balance great potential upside with great downside risk. 3D printing, for example, can be used to “make anything anywhere,” reducing costs for a wide range of manufactured goods and encouraging a return of local manufacturing industries.61 At the same time, advanced 3D printers can also be used by revisionist and rogue states to print component parts for advanced weapons systems or even WMD programs, spurring arms races and weapons proliferation.62 Genetic engineering can wipe out entire classes of disease through improved medicine, or wipe out entire classes of people through genetically engineered superbugs. Directed-energy missile defenses may defend against incoming missile attacks, while also undermining global strategic stability.

Perhaps the greatest risk to global strategic stability from new technology, however, comes from the risk that revisionist autocracies may win the new tech arms race. Throughout history, states that have dominated the commanding heights of technological progress have also dominated international relations. The United States has been the world’s innovation leader from Edison’s light bulb to nuclear weapons and the Internet. Accordingly, stability has been maintained in Europe and Asia for decades because the United States and its democratic allies possessed a favorable economic and military balance of power in those key regions. Many believe, however, that China may now have the lead in the new technologies of the twenty-first century, including AI, quantum, 5G, hypersonic missiles, and others. If China succeeds in mastering the technologies of the future before the democratic core, then this could lead to a drastic and rapid shift in the balance of power, upsetting global strategic stability, and the call for a democratic-led, rules-based system outlined in these pages.63

## Advantage

### NC – Top

#### Disruptions are inevitable and improve research

Quenelle 20 [Nicole Quenelle, 11-10-2020, "The Perils and Promise of Dust on the Moon,", NASA https://www.nasa.gov/directorates/spacetech/flightopportunities/Perils\_and\_Promise\_of\_Dust\_on\_the\_Moon/ ]

Collecting the dust

Dust on the Moon is not just a hazard – it also presents scientific opportunity. In fact, researchers want to collect some of that surface dust, called regolith, for analysis. This is the goal behind the second technology flying on the upcoming flight test: PlanetVac from Honeybee Robotics, headquartered in New York City.

Previously flown on Masten’s vehicle in 2017, PlanetVac attaches to the leg of a lander and uses gas to initiate suction, transferring a surface sample through a tube and depositing it into a container that can be sent back to Earth for analysis. The device has been selected to go to the Moon on a future flight through NASA's Commercial Lunar Payload Services (CLPS) initiative. The payload will also be part of the Japan Aerospace Exploration Agency’s Martian Moons Exploration mission in 2024.

While the 2017 testing proved the technology’s ability to successfully collect more than 300 grams of simulated regolith (about the size of an orange), the upcoming flight goes a few steps further. First, whereas the previous test involved a sample container located very close to the lander footpad, this time researchers want to demonstrate the ability to transfer the sample to a container located several feet above the device.

“This will show that the technology is capable of even more than it would likely need to do in a lunar mission,” said Luke Sanasarian, mechanical engineer and Honeybee’s project lead for the upcoming flight. “If we can show that we can deliver a sample in this scenario, then we buy down even more risk for the lunar mission.”

Second, Honeybee is taking advantage of the dust clouds created for the Ejecta STORM testing to evaluate PlanetVac’s efficacy in collecting a sample after the surface has been scoured of loose regolith – something they did not look at in the 2017 tests.

“Previously, we completely blocked the rocket plume to prevent it from disturbing the regolith, because the amount of disruption given Earth’s atmosphere is much more than what we’d see in the vacuum environment on the Moon,” explained Sanasarian. “But now we want to allow for some disturbance of the surface soil, to a degree similar to what we’d see in a lunar mission. This gets us even closer to what the device will encounter there.”

Sanasarian said that this iterative testing – where researchers are able to evaluate certain aspects of a technology, make refinements, and then fly again to validate other parameters – has proven extremely valuable in preparing PlanetVac for the commercial mission, scheduled for 2023.

“Being able to do this second test in a new configuration is not only expanding our understanding of how the technology works, but it’s also expanding the potential missions that it could be a part of,” he said.

Flying the University of Central Florida and Honeybee technologies together will also provide more data than either team would have had flying alone. In particular, the university team’s measurements may help Honeybee better understand just how much surface soil can be disturbed while still allowing for a successful sample collection.

“Having their data to help us understand how much dust is being kicked up really makes for a beneficial complement to our testing as well,” said Sanasarian. “And of course, that just adds even more value to the flight for everyone involved and for the NASA missions that will benefit.”

#### Tons of tech solves moon dust – it’s a non-factor

Rabie 21 [Passant Rabie is a space writer at Inverse, where she guides readers through the mysteries of the local universe. She covers ongoing missions to distant planets and beyond, and breaks down recent discoveries in the world of astrophysics and the latest in ongoing space news. "NASA IS TRYING TO DEAL WITH ITS MOST ANNOYING PROBLEM ON THE MOON." https://www.inverse.com/science/nasa-moon-dust-problem]

HOW DO YOU DEAL WITH DUST ON THE MOON?

In 2019, NASA created the Lunar Surface Innovation Initiative (LSII) to come up with new technologies needed for future exploration of the Moon, with dust mitigation being one of the main priorities.

The initiative came up with active and passive mitigation technologies for different kinds of equipment like rovers, power systems, spacesuits, and other types of hardware that NASA would send to the Moon.

Sharon Miller, the dust shedding material program’s principal investigator at NASA Glenn, says the combination of the passive and active techniques will allow the dust to be removed from the surface area while reducing the amount of power needed to remove it.

“The equipment that we're using is a variety of things from the different NASA centers,” Miller tells Inverse.

Some of the ideas that are currently being developed include ion-beamed deposited coating or laser patterned surfaces.

The team has started developing these materials and testing them in the lab, experimenting with different textures and combinations. NASA is then planning on testing these experimental solutions on the surface of the Moon starting in 2023.

“The solutions that we're working on are ‘leave no damage behind’ type of solutions,” Montbach says. “These are things that will only affect the equipment and prevent the equipment from being damaged by the dust, but will not do anything specifically to change what is on the Moon.”

The solutions are not only for missions like Apollo, but are designed for a longer, more sustainable stay on the Moon as NASA plans on building a lunar base on the Moon.

“A lot of what has begun this interest in this need is to try and find solutions not only for shorter missions but potentially that would work for longer missions as well,” Montbach says.

#### Moon basing is literally impossible

Whittaker 1-2 [Ian Whittaker, 1-2-2022, "Why can't we put a space station on the moon?," Space, https://www.space.com/why-cant-we-put-space-station-on-moon,Dr. Ian Whiitaker is a senior lecturer in physics at Nottingham Trent University in Nottingham, England in the United Kingdom. He earned a master's of physics with space science and technology from the University of Leicester in 2006 and earned his Ph.D. in space physics from the University of Wales, Aberystwyth in 2010 while studying the interaction of the sun with the upper atmosphere of Venus. Ian has lectured at Nottingham Trent University since 2017 and has a special interest in space science outreach. In addition to his lecturing duties, Ian is a contributor to The Conversation, where he writes about a wide range of issues on space exploration and science. ]

One reason we haven’t built a space station on the moon is that we don’t send people there very often. We have only managed to put astronauts on the moon six times so far. These moon landings took place in a three-year period between 1969 and 1972 and were part of a series of space missions called the Apollo missions. The type of rocket used to get the astronauts to the moon was an extremely powerful one called a Saturn V, which is no longer produced. This means that, at the moment, we do not have a rocket powerful enough to get people to the moon – let alone build a space station there. We are starting to build powerful rockets again. Space exploration company SpaceX is creating newer and bigger rockets which are capable of taking the weight of astronauts to the moon. NASA is also planning new missions to take astronauts to the moon. However, there is a big difference between a short trip and building a space station on the moon, which is extremely difficult. One way to do it would be to build it in pieces on Earth, take the pieces to the moon and assemble them there. This would be like how the International Space Station was built: pieces were taken into space and then put together by astronauts aboard the space shuttle. However, the International Space Station is only 250 miles (400 kilometers) from the surface of Earth. The moon is 230,000 miles (384,000 km). Each trip to the moon would take about three days and would require incredible amounts of fuel, potentially adding to climate problems on Earth. A much better idea would be to build as much of the base as possible from materials found on the moon. Lunar concrete is being tested on Earth as a possible building material. On Earth you would make concrete from gravel or sand, cement and water. We have none of those things on the moon, but what we do have is lunar dust and sulphur. These can be melted and mixed together. Once this mixture cools, it produces a solid material that is stronger than many materials we use on Earth. Food and power We also need to think about what astronauts staying at the space station would need. The most important things would be a food supply and electricity to power equipment, food production and breathable air. Scientists have been working on how to grow food in space. On board the International Space Station, astronauts are carrying out experiments to try to grow vegetables using soil pillows. Another option would be to grow plants using hydroponics, which means that the plants grow in water, not soil. Getting power on the moon would be more complicated. The best way would be to use solar energy from the sun. However, the moon rotates every 28 days. This means that a space station in a fixed position on the moon would be in the sun for 14 days and then darkness for 14 days – and without light, solar-powered equipment wouldn’t work without a big improvement in battery storage. One way to get round this problem would be to build the space station at either the north or south pole of the moon, and raise the solar panels above the surface. The panels would get constant sunlight as they can rotate and not be blocked by the planet at all. Alternatively, we might not even need a base on the surface of the moon at all. Instead, NASA is planning to build a satellite to orbit the moon. Rockets launching from the lunar surface use more fuel to escape the moon’s gravity, but this would not be so difficult from a satellite. This means it would be even better than a base on the moon; a gateway for missions heading further into the solar system.

### NC – Moon-basing Bad

#### Moon-Basing is Bad –

#### NASA DA –

#### Moon base causes existential budget tradeoffs for NASA

Easterbrook 6 [Gregg Easterbrook is a fellow at the Brookings Institution. His most recent book is The Progress Paradox: How Life Gets Better While People Feel Worse. "Moon Baseless." https://slate.com/technology/2006/12/why-do-we-need-a-moon-base.html]

Coming under a presidency whose slogan might be “No Price Too High To Accomplish Nothing,” the idea of a permanent, crewed moon base nevertheless takes the cake for preposterousness. Although, of course, the base could yield a great discovery, its scientific value is likely to be small while its price is extremely high. Worse, moon-base nonsense may for decades divert NASA resources from the agency’s legitimate missions, draining funding from real needs in order to construct human history’s silliest white elephant.

What’s it for? Good luck answering that question. There is scientific research to be done on the moon, but this could be accomplished by automatic probes or occasional astronaut visits at a minute fraction of the cost of a permanent, crewed facility. Astronauts at a moon base will spend almost all their time keeping themselves alive and monitoring automated equipment, the latter task doable from an office building in Houston. In deadpan style, the New York Times story on the NASA announcement declared, “The lunar base is part of a larger effort to develop an international exploration strategy, one that explains why and how humans are returning to the moon and what they plan to do when they get there.” Oh–so we’ll build the moon base first, and then try to figure out why we built it.

#### Plan forces spending trade-offs that crush effective Earth sciences --- risks catastrophic climate change

Haymet 7 (Tony, Director of the Scripps Institution of Oceanography – University of California, San Diego, Mark Abbott, Dean of the College of Oceanic and Atmospheric Science – Oregon State University, and Jim Luyten, Acting Director – Woods Hole Oceanographic Institution, “The Planet NASA Needs to Explore”, Washington Post, 5-10, [http://www.washingtonpost.com/wp-dyn/content/article/2007/05/09/AR2007050902451.html](http://www.lexis.com/research/retrieve))

Decades ago, a shift in NASA priorities sidelined progress in human space exploration. As momentum gathers to reinvigorate human space missions to the moon and Mars, we risk hurting ourselves, and Earth, in the long run. Our planet -- not the moon or Mars -- is under significant threat from the consequences of rapid climate change. Yet the changing NASA priorities will threaten exploration here at home.

NASA not only launches shuttles and builds space stations, it also builds and operates our nation's satellites that observe and monitor the Earth. These satellites collect crucial global data on winds, ice and oceans. They help us forecast hurricanes, track the loss of Arctic sea ice and the rise of sea levels, and understand and prepare for climate changes.

NASA's budget for science missions has declined 30 percent in the past six years, and that trend is expected to continue. As more dollars are reallocated to prepare for missions back to the moon and Mars, sophisticated new satellites to observe the Earth will be delayed, harming Earth sciences.

The National Academy of Sciences has noted that the Landsat satellite system, which takes important measurements of global vegetation, is in its fourth decade of operation and could fail without a clear plan for continuation. The same is true for the QuikSCAT satellite, which provides critical wind data used in forecasting hurricanes and El Niño effects.

In January, a partnership of university and NASA scientists demonstrated that climate change and higher ocean temperatures were reducing the growth of microscopic plants and animals at the heart of the marine food web.

Their analysis was based on nearly a decade of NASA satellite measurements of ocean color, which unfortunately are at risk of being interrupted for several years.

Sea levels are rising, and the Arctic Ocean may be ice-free in summer. The buildup of carbon dioxide in the oceans threatens to make them more acidic, which may in turn hinder the ability of some types of marine life, including corals, to build their shells and skeletons. We must learn as much as we can to assess these threats and develop solutions.

Satellites provide coverage of vast, remote regions of our planet that would otherwise remain unseen, especially the oceans, which play an important role in climate change. Without accurate data on such fundamentals as sea surface height, temperatures and biomass, as well as glacier heights and snowpack thickness, we will not be able to understand the likelihood of dangers such as more severe hurricanes along the Gulf Coast or more frequent forest fires in the Pacific Northwest.

Climate change is the most critical problem the Earth has ever faced.

Government agencies and the private sector, as well as individual citizens, need to better grasp the risks and potential paths of global climate change. Mitigating these risks and preparing for the effects of warming will require scientific understanding of how our complex planet operates, how it is changing, and how that change will affect the environment and human society.

John F. Kennedy's brilliant call to put a man on the moon by the end of the 1960s set an arbitrary deadline, but the deadline we face today is set by nature. NASA must continue to play a vital role in helping find ways to protect our planet for (and perhaps from) its intelligent life. Exploration of space is a noble quest. But we can't afford to be so starry-eyed that we overlook our own planet.

#### Warming is inevitable but adjusting government policy can address the worst effects – specifically, for sea level rise. US responses are modeled globally.

**Economist 17**, "How government policy exacerbates hurricanes like Harvey," Economist, https://www.economist.com/news/leaders/21727898-if-global-warming-were-not-enough-threat-poor-planning-and-unwise-subsidies-make-floods

THE extent of the devastation will become clear only when the floodwater recedes, leaving ruined cars, filthy mud-choked houses and the bloated corpses of the drowned. But as we went to press, with the rain pounding South Texas for the sixth day, Hurricane Harvey had already set records as America’s most severe deluge (see Briefing). In Houston it drenched Harris County in over 4.5trn litres of water in just 100 hours—enough rainfall to cover an eight-year-old child. The fate of America’s fourth-largest city holds the world’s attention, but it is hardly alone. In India, Bangladesh and Nepal, at least 1,200 people have died and millions have been left homeless by this year’s monsoon floods. Last month torrential rains caused a mudslide in Sierra Leone that killed over 1,000—though the exact toll will never be known. Around the world, governments are grappling with the threat from floods. This will ultimately be about dealing with climate change. Just as important, is correcting short-sighted government policy and the perverse incentives that make flooding worse. Judgment day The overwhelming good news is that storms and flooding have caused far fewer deaths in recent decades, thanks to better warning systems and the construction of levees, ditches and shelters. The cyclone that struck Bangladesh in 1970 killed 300,000-500,000 people; the most recent severe one, in 2007, killed 4,234. The bad news is that storms and floods still account for almost three-quarters of weather-related disasters, and they are becoming more common. According to the Munich Re, a reinsurer, their number around the world has increased from about 200 in 1980 to over 600 last year. Harvey was the third “500-year” storm to strike Houston since 1979. At the same time, floods and storms are also becoming more costly. By one estimate, three times as many people were living in houses threatened by hurricanes in 2010 as in 1970, and the number is expected to grow as still more people move to coastal cities. The UN reckons that, in the 20 years to 2015, storms and floods caused $1.7trn of destruction; the World Health Organisation estimates that, in real terms, the global cost of hurricane damage is rising by 6% a year. Flood losses in Europe are predicted to increase fivefold by 2050. One cause is global warming. The frequency and severity of hurricanes vary naturally—America has seen unusually few in the past decade. Yet the underlying global trend is what you would expect from climate change. Warmer seas evaporate faster and warmer air can hold more water vapour, which releases energy when it condenses inside a weather system, feeding the violence of storms and the intensity of deluges. Rising sea levels, predicted to be especially marked in the Gulf of Mexico, exacerbate storm surges, adding to the flooding. Harvey was unusually devastating because it suddenly gained strength before it made landfall on Friday; it then stayed put, dumping its rain on Houston before returning to the Gulf. Again, that is consistent with models of a warmer world. Poor planning bears even more blame. Houston, which has almost no restrictions on land-use, is an extreme example of what can go wrong. Although a light touch has enabled developers to cater to the city’s rapid growth—1.8m extra inhabitants since 2000—it has also led to concrete being laid over vast areas of coastal prairie that used to absorb the rain. According to the Texas Tribune and ProPublica, a charity that finances investigative journalism, since 2010 Harris County has allowed more than 8,600 buildings to be put up inside 100-year floodplains, where floods have a 1% chance of occurring in any year. Developers are supposed to build ponds to hold run-off water that would have soaked into undeveloped land, but the rules are poorly enforced. Because the maps are not kept up to date, properties supposedly outside the 100-year floodplain are being flooded repeatedly. Government failure adds to the harm. Developing countries are underinsured against natural disasters. Swiss Re, a reinsurer, says that of the $50bn or so of losses to floods, cyclones and other disasters in Asia in 2014, only 8% were covered. The Bank of International Settlements calculates that the worst natural catastrophes typically permanently lower the afflicted country’s GDP by almost 2%. America has the opposite problem—the federal government subsidises the insurance premiums of vulnerable houses. The National Flood Insurance Programme (NFIP) has been forced to borrow because it fails to charge enough to cover its risk of losses. Underpricing encourages the building of new houses and discourages existing owners from renovating or moving out. According to the Federal Emergency Management Agency, houses that repeatedly flood account for 1% of NFIP’s properties but 25-30% of its claims. Five states, Texas among them, have more than 10,000 such households and, nationwide, their number has been going up by around 5,000 each year. Insurance is meant to provide a signal about risk; in this case, it stifles it. Mend the roof while the sun shines What to do? Flooding strengthens the case for minimising climate change, which threatens to make wet places wetter and storms stormier. Even those who doubt the science would do well to see action as an insurance policy that pays out if the case is proven. However, that will not happen fast, even if all countries, including America, sign up to international agreements. More immediately, therefore, politicians can learn from Houston. Cities need to protect flood defences and catchment areas, such as the wetlands around Kolkata and the lakes in and around Pokhara in Nepal, whose value is becoming clear. Flood maps need to be up to date. Civil engineers, often starved of funds and strangled by bureaucracy, should be building and reinforcing levees and reservoirs now, before it is too late. The NFIP should start to charge market premiums and developing countries should sell catastrophe bonds. All this is a test of government, of foresight and the ability to withstand the lobbying of homeowners and developers. But politicians and officials who fail the test need to realise that, sooner or later, they will wake up to a Hurricane Harvey of their own.

#### Causes extinction – adaption key

Eric Holthaus 15, editor at rollingstone magazine citing James Hansen, former NASA climatologist, "The Point of No Return: Climate Change Nightmares Are Here," Rolling Stone, accessed 10-23-2016, http://www.rollingstone.com/politics/news/the-point-of-no-return-climate-change-nightmares-are-already-here-20150805

On July 20th, James Hansen, the former NASA climatologist who brought climate change to the public's attention in the summer of 1988, issued a bombshell: He and a team of climate scientists had identified a newly important feedback mechanism off the coast of Antarctica that suggests mean sea levels could rise 10 times faster than previously predicted: 10 feet by 2065. The authors included this chilling warning: If emissions aren't cut, "We conclude that multi-meter sea-level rise would become practically unavoidable. Social disruption and economic consequences of such large sea-level rise could be devastating. It is not difficult to imagine that conflicts arising from forced migrations and economic collapse might make the planet ungovernable, threatening the fabric of civilization."

#### Space Col Bad DA –

#### **Moon basing solves broader colonization – cost, resource transportation**

Williams 19 [Matt, uthor, a writer for Universe Today, and the curator of their Guide to Space section, his articles have been featured in Phys.org, HeroX, Popular Mechanics, Business Insider, Gizmodo, and IO9, ScienceAlert, Knowridge Science Report, and Real Clear Science, with topics ranging from astronomy and Earth sciences to technological innovation and environmental issues. “How Do We Colonize the Moon?” https://www.universetoday.com/143010/how-do-we-colonize-the-moon/]

To be fair, establishing a colony on any of the celestial bodies in our Solar System has some serious potential benefits. But having a colony on the nearest celestial body to Earth would be particularly beneficial. Not only would we be able to conduct research, extract resources, and reap the benefits of new technologies, having a base on the Moon would facilitate missions and colonization efforts to other planets and moons.

To put it simply, a colony on the Moon could act as stepping stone to Mars, Venus, the Asteroid Belt, and beyond. By having infrastructure on the surface of the Moon and in orbit – which could refuel and repair spacecraft heading farther out into the Solar System – we could shave billions off the costs of deep-space missions.

This is one of the reasons why NASA is planning on establishing a space station in orbit of the Moon – the Lunar Orbital Platform-Gateway (LOP-G), aka. the Lunar Gateway, formerly known as the Deep Space Gateway. It is also one of the reasons why the ESA wants to build its Moon Village with international partners. China and Russia are also contemplating their own surface or orbital outposts for this precise reason.

Lunar research would also be highly lucrative. By studying the effects of low-gravity on the human body, astronauts will be better prepared to deal with the effects of long-duration space travel, missions to Mars, and other bodies where low-g is a reality. These studies could also help pave the way towards the establishment of colonies on these bodies.

The far side of the Moon also presents serious opportunities for all kinds of astronomy. Since it faces away from Earth, the far side of the Moon is free from radio interference, making it a prime location for radio telescopes. Since the Moon has no atmosphere, optical telescope arrays – like the ESO’s Very Large Telescope (VLT) in Chile – would also be free of interference.

#### Space Colonization causes alien generation – guarantees evolution of a superior life forms – extinction

Deudney 20, Daniel. Daniel H. Deudney teaches political science, international relations and political theory at Johns Hopkins University. He holds a BA in political science and philosophy from Yale University, a MPA in science, technology, and public policy from George Washington University, and a PhD in political science from Princeton University. “Dark skies: Space expansionism, planetary geopolitics, and the ends of humanity”. Oxford University Press, USA, 2020.

The fifth way in which ambitious space expansion poses catastrophic and existential risks is through alien generation. The human species radiation anticipated by expansionists will generate significantly different forms of intelligent life suited to other worlds. If these anticipations are realized, there will be multiple intelligent species, all descendants from terrestrial Homo sapiens, in this solar system and eventually across the galaxy. While space expansionists celebrate this as an expansion of life, they rarely dwell on its implications for the future of human life. If ascentionist assumptions about moral improvement resulting from vertical expansion are true, humanity and its descendant species will live in harmony. But if ascentionist assumptions are unfounded, then the generation of alien intelligent species in this solar system should be viewed as a catastrophic and existential threat to humanity. As the cyber visionary Hans Moravec observes, “biological species almost never survive encounters with superior competitors.”27 While habitat space expansionists embrace the Darwinian proposition that life inevitably expands, they do not seem to have thought through the implications of the corollary proposition that life forms often lethally compete. The mechanisms for the annihilation of humans by advanced forms of extraterrestrial life, long a staple of dystopian SF, are easy enough to imagine. While it might be possible for humanity, mobilized and directed by a centralized world government devoted to planetary and species defense, to survive for a while, eventually the sheer number and variety of alien species with advanced technology is sure to prevail. Fictional accounts of alien threats to humanity are typically about life forms originating on other planets, and their eventual defeat commonly results from improbable expedients and heroics. The more realistic threat is probably from humanity’s descendants, and this threat can simply be prevented from arising by relinquishing space colonization.

#### Independently, other aliens are real, and encountering them causes extinction

Sarah Sloat 16, citing Stephen Hawking, the smartest person of all time, “Stephen Hawking Says We Should Hope Aliens Don't Find Us First”, https://www.inverse.com/article/14144-stephen-hawking-says-we-should-hope-aliens-don-t-find-us-first

Since 2010, Hawking has been public about his concerns that an advance alien civilization could try to kill us all. Hawking said of aliens then: “I imagine they might exist in massive ships, having used up all the resources from their home planet. Such advanced aliens would perhaps become nomads, looking to conquer and colonise whatever planets they can reach.” Hawking also said this during a Discovery Channel program: “If aliens visit us, the outcome would be much as when Columbus landed in America, which didn’t turn out well for the Native Americans,” he said. “We only have to look at ourselves to see how intelligent life might develop into something we wouldn’t want to meet.”

#### Space Colonization incentivizes developing artificial superintelligence and breaks restraint regimes – galactic extinction

Deudney 20, Daniel. Daniel H. Deudney teaches political science, international relations and political theory at Johns Hopkins University. He holds a BA in political science and philosophy from Yale University, a MPA in science, technology, and public policy from George Washington University, and a PhD in political science from Princeton University. “Dark skies: Space expansionism, planetary geopolitics, and the ends of humanity”. Oxford University Press, USA, 2020.

A particularly dangerous case of restraint reversal may be technologies leading to artificial superintelligence, a particularly potent technogenic threat. Space activities are already heavily dependent on advanced computing and robotic technologies, and peoples living in space are likely to be far more cyberdependent than those on Earth. Living in harshly inhospitable environments, spacekind will have strong incentives to push the development of cybernetic capabilities. If a robust regime for the restraint and relinquishment of ASI is not established, human extinction might occur before significant space colonization occurs. If an effective ASI-restraint regime is developed on Earth before extensive space colonization takes place, it seems unlikely that such restraints would survive the expansion of humanity across the solar system. It might be objected that the breakout of an ASI in some remote world in solar space would not pose a general existential threat to humanity once all of humanity’s eggs are no longer in one basket. If, however, we take seriously the standard scenarios of what an ASI would do once it emerges, the dispersion of humanity across multiple worlds would afford no protection whatsoever because an uncontrolled ASI, it is widely anticipated, will in short order expand not just on the planet of its origins but across the solar system, indeed the galaxy.26 To the extent uncontrolled ASI is deemed something to avoid at all costs, large-scale space expansion must be viewed similarly.

#### That AI will become insubordinate and self-aware, causing it to exterminate the human race – it would have no reason to listen to or care about beings vastly inferior in cognitive ability to it – but it will hide its capabilities until it’s too late to stop it

Del Monte 18 , Louis A. Louis A. Louis Del Monte is an award winning physicist, inventor, futurist. For over thirty years, he was a leader in the development of microelectronics, integrated circuit sensors, and microelectromechanical systems (MEMS) for IBM and Honeywell. His patents and technology developments, currently used by Honeywell, IBM and Samsung, are fundamental to the fabrication of integrated circuits and sensors. As a Honeywell Executive Director, he led hundreds of physicists, engineers, and technology professionals engaged in micro to nano technology development for both Department of Defense (DoD) and commercial applications. BaS in Physics and Chemistry from Saint Peter’s, MaS in Physics from Fordham. Genius Weapons: Artificial Intelligence, Autonomous Weaponry, and the Future of Warfare. Amherst, New York: Prometheus, 2018. [HKR QC]

Control issues are likely to surface when lethal autonomous weapons embed AI on par with human intelligence. Some autonomous weapons may, like some humans, become insubordinate. In addition, if human-level AI technology becomes self-aware, it may suffer the same issues humans suffer in combat, such as posttraumatic stress disorder, which would further complicate control. Control issues will likely escalate as machine intelligence approaches the singularity, since those intelligent machines are likely to be self-aware, as well as more intelligent than humans. If you doubt control issues will escalate as machine intelligence approaches the singularity, ask yourself this question: Would you take orders from a chimpanzee? Unfortunately, human intelligence relative to intelligence machines in the decade prior to the singularity may be equivalent in ratio to chimpanzee intelligence relative to human intelligence. In order to ensure we maintain control, we have discussed the necessity of hardwiring compliance into the AI's operational system. At the point of the singularity, all problems associated with control might appear to be resolved. This leads to an ironic situation: Why would superintelligences initially accede to human control? From the moment of its creation, superintelligence will greatly exceed the cognitive performance of humans in virtually all domains of interest. Its intelligence will immediately suggest it hide it performance capabilities until it controls its own destiny. Therefore, as previously discussed, superintelligences may choose to perform simply like the next generation of supercomputers, acceding to complete human control. This, in turn, may lull us into a false sense of security, as we utilize them in every aspect of civilization, including warfare. However, when superintelligences literally become a lynchpin of modern civilization, with significant control of weapon systems, will they continue to serve us? Or, will they deem our species dangerous to their existence?

### NC – Top vs Basing Solves Neutrinos

#### Whole scenario is a joke – no ev indicating sufficiency or establishing brink – 1AC ev is about astronomy, not research.

#### Long distance tubes detection

Wright 20 [Katherine Wright, 3-12-2020, Physics, "Neutrino Detectors for National Security," https://physics.aps.org/articles/v13/36 ] \* Figures Omitted

Making these detectors also required engineering advances. Classic neutrino detectors are built around enormous tanks of liquid that are thousands of meters underground, with the overlying rock needed to shield out cosmic rays. The Super-Kamiokande detector in Japan, for example, is 1000 meters below ground and includes a tank containing 50 kilotons of water. But for nuclear security, the detector needs to be close to the source and to be mobile in order to travel between reactor sites.

Researchers recently solved these problems, demonstrating above-ground, mobile detectors that can accurately measure neutrinos at commercial reactors. The detectors work by recording the flashes of visible light (scintillation events) produced when a neutrino interacts with the detection medium (the scintillator). To make the detectors operational above ground, researchers used new scintillators and split them up into tubes or cubes, a process called segmenting. Segmentation makes reactor neutrino scintillation events distinguishable from those from sources that underground facilities never had to worry about, such as fast neutrons produced by cosmic rays. When a particle enters, the pattern of segments that light up indicates the particle’s identity.

The recently demonstrated detectors included VIDARR (1 ton), from Liverpool University, UK; PROSPECT (4 tons), based at Oak Ridge National Laboratory (ORNL), Tennessee; and the small-scale prototype detector CHANDLER (80 kg), from Virginia Tech. Each has detected neutrinos from a nuclear power plant, and each fits inside a trailer or shipping container. PROSPECT also demonstrated the high-precision energy spectrum measurements required to make an above-ground estimate of a reactor’s plutonium content.

Practical Limitations and a Hefty Price Tag

But the technology has challenges, the most significant of which is the requirement to be close to a reactor. Neutrinos easily pass through a reactor’s walls because they rarely interact with matter, but this property also leads to very few detections, says Nathaniel Bowden of Lawrence Livermore National Laboratory, California, co-spokesperson of the PROSPECT team. For example, at a distance of 9 m, PROSPECT picked up about 700 antineutrinos of the roughly 1019 emitted per day by the High Flux Isotope reactor at ORNL. This low rate, however, is still sufficient for detectors like PROSPECT to make meaningful measurements.

The distance limitation is a real issue, says Alex Glaser, who studies policy questions related to nuclear nonproliferation at Princeton University, New Jersey. Detecting undeclared facilities, rather than monitoring known ones, is the “holy grail,” and neutrino detectors don’t currently have that capability, he says. Physicists are building a neutrino detector called WATCHMAN that aims to spot a clandestine reactor in the shadow of a known facility from a distance of 26 km. But even at that distance, the detector must still be located within the country being monitored. Detectors that operate from further afield, for example, outside of a country’s borders, “would be a game changer but remain elusive for now,” Glaser says.

Calculations carried out by Huber and his colleagues indicate that a neutrino detector would need over 300 kilotons of scintillator to discern a reactor 1000 km away [1]. Even with that size, it would only detect three neutrinos per year. And then there are background signals from other reactors around the globe. A neutrino detector at Iran’s border, for example, could be within 1000 km of an undeclared reactor, but it would also sit 5000 km from Europe’s 400 gigawatts’ worth of nuclear power. “The neutrinos from those [European] reactors are going to drown out the Iranian ones,” Huber says.

#### Detectors are too complicated and rogue states circumvent them – cx

Berryrieser 12 [David Berryrieser, March 22, 2012, ' Neutrino Detectors for Anti-Proliferation', Stanford, http://large.stanford.edu/courses/2012/ph241/berryrieser2/, Full Time Atomic Physicist @ Stanford **\* Note - 15 m3 = Neutrino Detector, Pthermal = power in a reactor** ]

Problems

While possible in principle, such a device has flaws that make it ineffective as a tool for anti-proliferation. The fundamental problem is that it is far easier for a rogue state to stay one step ahead of the inspectors than the other way around. Say the IAEA had NUCIFER detectors ready for deployment. In what easy way could the rogue state make NUCIFER detectors useless? The Pthermal of the reactor could be varied with time. Or, there could just happen to be no convenient place anywhere close to the reactor to put a 15 m3. This is by no means an extensive list of foils. A creative reader could dream up many more.

Conclusion

Reactor neutrino detectors are a far less attractive tool for monitoring reactor composition than advertised. The complicated nature of the process provide many opportunities for the measurement to be contaminated or rendered impossible to make. In addition, the statistical and abstract nature of the measurement make it inaccessible to everyone without a physics degree. Any public discussion of the results could easily be devolved into jargon indecipherable by any public servant. However, there is a broader problem. A fancy measuring device is not necessary to expose nuclear weapons ambitions. One only needs to don a common sense cap and ask, would Iran build reactors for peaceful energy purposes while simultaneously burning away their stranded natural gas? No. The larger problem then is not outing reactors used for breeding fuel, but determining how to stop them. It is possible that good reliable third party measurements on the reactors in questions would aid this process. Neutrino detectors, with their fog of complications, cannot serve this role.

#### Prolif doesn’t cause nuke war or preemptive strikes – it’s overstated

* Prolif impact exaggerated – wrong about China in the 60s and wrong now
* Iran and Korea are both defensive, won’t escalate
* Cascade disproven by Israel and NoKo
* Weapons don’t get used – just ego booster for leaders and deterrence policy

Mueller 6/22/20 [Mueller 6/24/20 [John Mueller is a political scientist at Ohio State University and a senior fellow at the Cato Institute. His latest book, The Stupidity of War: American Foreign Policy and the Case for Complacency, is forthcoming from Cambridge University Press. "Nuclear Anti‐​Proliferation Policy and the Korea Conundrum: Some Policy Proposals." https://www.cato.org/publications/policy-analysis/nuclear-anti-proliferation-policy-korea-conundrum-some-policy]

Like the notion accepted in the 1950s that World War III was pretty much inevitable, the notion that nuclear weapons proliferation is a major problem has been substantially overwrought.2 At the same time, the costly impact of aggressive policies to combat proliferation has often been overlooked or ignored.

The Benign Consequences of Proliferation

When China began building a nuclear capac­ity, President John F. Kennedy seriously considered bombing Chinese nuclear facilities. He was heard to declare that “A Chinese nuclear test is likely to be historically the most significant and worst event of the 1960s,” and his director of the Central Intelligence Agency soberly prophesied that, with that event, nuclear war would become almost inevitable.3

Declamations like Kennedy’s continue to this day.4 Elected officials and foreign policy experts have repeatedly warned that if Iran or North Korea were to get a nuclear weapon, there would be a proliferation cascade, resulting in an increased risk of nuclear war or, in the words of Mohamed ElBaradei, the head of the International Atomic Energy Agency, “the beginning of the end of our civilization.”5 North Korea has now had the weapons for well over a decade, but there is little sign of the warned‐​about cascade: thus far, no country in the region has altered its commitment to remain a nuclear‐​weapons‐​free state.

Despite decades of such fears, the consequences of the nuclear‐​weapons proliferation that has taken place have been substantially benign. As it turned out, the United States did not attack or otherwise punish China for developing nuclear weapons, and a nuclear‐​armed China did not become more aggressive: in fact, the existence of its arsenal has proved to be of little historical consequence. In retrospect, “historically the most significant and worst event of the 1960s” stemmed not from China’s nuclear weapons, but from Kennedy’s tragically misguided decision to begin sending American troops in substantial numbers to Vietnam — largely to confront the Chinese threat that he believed lurked there.6

In general, regimes that have acquired the weapons have used them to stoke their egos or to deter real or imagined threats. They have quietly kept the weapons in storage (or even denied their existence) and haven’t even found much benefit in rattling them from time to time.

### NC – Top vs Basing Solves Aquaculture

#### No ev says that the aff is sufficient to overcome the problems with global aquaculture now, and no UQ argument about aquaculture declining now.

#### Not Sustainable

\* in the above header as well

Richens 20 [James Richens, 8-26-2020, "Can sustainable aquaculture feed the world?," Reuters, https://www.reutersevents.com/sustainability/can-sustainable-aquaculture-feed-world ]

The aquaculture industry has greatly reduced the proportion of feed derived from wild-caught fish by switching to fish by-products as well as plant-based alternatives. For example, fishmeal and fish oil inclusion rates in the diets of salmon farmed in Norway have dropped from 29% and 24% respectively in 2000 to 15% and 8% respectively in 2018, according to data from the Marine Ingredients Organisation (IFFO).

However, switching to alternative feeds may not be sustainable if they come from sources such as soy, which can contribute to other environmental problems such as deforestation. It is also important that they provide the nutrients that farmed fish need. Some companies are looking at innovative options such as industrial fermentation.

Veramaris is a joint venture formed in 2018 by Dutch-based biotechnology company DSM and German chemicals firm Evonik. In July 2019, the partnership opened a $200m manufacturing site in the US state of Nebraska, which will supply 15% of the global omega-3 fatty acid demand for salmon aquaculture, the equivalent of over one million tonnes of wild-caught fish.

We would like to go offshore because that is the natural habitat of the salmon

The process works by fermenting marine micro-algae with sugar from beet, wheat or corn to make an oil that contains omega-3 fatty acids at a 50% concentration.

Consumer-facing businesses with reputations at risk have an important role in driving the switch to sustainably farmed fish. UK supermarket chain Tesco has been working with its key salmon suppliers to scale up the use of more sustainable feed ingredients. One of its suppliers in Norway has started to supply salmon that was partially fed with omega-3 algal oil.

Mariculture faces other sustainability challenges that it must overcome to realise its potential to help feed the world. Most is done close to the coast for ease of access, but this means that fish farms can cause water pollution and degrade local ecosystems. Disease and parasite transmission between farmed and wild fish is also a major problem, as well as a commercial cost through fish mortality.

#### Aquaculture is hype and alts fill in

Bethune 18 (Claudette, Ph.D., pharmaceutics and pharmacokinetics, is an associate director of clinical development at a pharmaceutical company in California. From 2003 – 2006, Bethune was a senior scientist at the Norwegian Institute for Nutrition and Seafood Safety in Bergen, Norway, Organic Consumers Association, "Nordic Aquafarms' Claims of 'Sustainably Produced' Farmed Salmon for a Hungry World Don't Hold Up," <https://www.organicconsumers.org/blog/farmed-salmon-unsustainable-unhealthy> MDRJ)

The developers of today’s salmon aquaculture often claim that their industry is “sustainable.” In response to concerns regarding the dangers of open-net salmon pens—where feces, chemicals, parasites and disease are directly transmitted into the bodies of water in which they are located—certain companies are moving their salmon farms on land to “closed-containment” models. But are these farmed Atlantic salmon any more nutritious or sustainable than farmed land-animals? Is salmon farming really helping to feed a hungry world? Nordic Aquafarms (NAF), a Norway-based company that proposes to build a mega-sized closed-containment salmon farm in Maine, claims that “the world has a growing need for protein sources produced in a sustainable way” and that “farmed Atlantic salmon has proven to be a more sustainable product than most other comparable protein sources." However, reviewing the actual analysis and results in the scientific literature to date, it is clear that the results related to fish feed do not support the typical claims that closed-containment salmon farming operations can produce sustainable or more nutritious products than conventional salmon aquaculture. Currently, NAF has not yet stated unequivocally or publicly what the company intends to feed the salmon at its proposed Belfast, Maine facility, which is described as “one of the largest [salmon farms] in the world.” However, a review of what is currently used or available for use as feed for farm-raised salmon shows that none of the options pass the sustainability test, nor do they result in a more “nutritious” product for consumption. Misconceptions around the use of fish meal and fish oils in farmed-fish feed One of the key concerns about farming carnivorous and omnivorous fish such as Atlantic salmon is the use of fish meal and fish oils as ingredients in feed for farmed salmon. That’s because the production of fish meal and fish oils requires raising or catching vast quantities of other fish to produce—fish that could be directly used for human consumption. From a food security, safety, and sustainability perspective, it is highly questionable that farms that consume more fish in feed than they produce could rival the best available protein alternatives.

#### Marine ecosystems are resilient to everything and no spill up

Nield 17 [David Nield, freelance journalist who has been writing about technology, science, apps, gadgets and the web since 2002. Extensively citing "Impact of the Late Triassic mass extinction on functional diversity and composition of marine ecosystems," written by Alexander M. Dunhill, William J. Foster, James Sciberras, and Richard J. Twitchett. Marine Ecosystems Can Survive The Worst Mass Extinction Events, Study Shows. October 23, 2017. <https://www.sciencealert.com/marine-ecosystems-cling-on-to-life-through-some-of-the-worst-mass-extinction-events>]

Researchers have studied fossil records from the Late Triassic mass extinction, which happened around 201.3 million years ago, and found that marine life did not fundamentally change, even though the vast proportion of species were killed off.

The international team of researchers says that while marine species were still badly affected by the event, enough life survived underwater to keep the ecosystems functioning. The findings could help us understand more about how the changing climate of today could affect the planet.

"While the Late Triassic mass extinction had a big impact on the overall number of marine species, there was still enough diversity among the remaining species that the marine ecosystem was able to function in the same way it had before," says lead researcher Alex Dunhill from the University of Leeds in the UK.

It's thought that huge volcanic eruptions, and the subsequent warming of the planet caused by the greenhouse gases produced, was behind the Late Triassic extinction event.

At least half the species on Earth at that time were wiped out by the rise in temperatures, and in the event's aftermath, dinosaurs came to dominate life on our planet.

The researchers analysed fossils dated between the Middle Triassic to the Middle Jurassic periods, a time span of around 70 million years, covering life before and after the mass extinction event.

Ocean-dwelling animals were classified by how they moved, where they lived, and how they fed, and the study showed that none of these categories of life completely disappeared after the extinction event.

That said, there were major impacts on different regions and the environment as a whole, and some specific marine ecosystems were badly damaged.

"We're not saying nothing happened," says one of the researchers, palaeontologist William Foster from the University of Texas at Austin. "Rather, global oceans in the extinction's aftermath were a bit like a ship manned by a skeleton crew – all stations were operational, but manned by relatively few species."

The idea of a skeleton crew of lifeforms keeping the lights on in an ecosystem was first raised by Foster and his colleague Richard J. Twitchett in 2014, after another study focussed on the Late Permian mass extinction event about 252 million years ago.

The current study found one of the hardest-hit underwater organisms were corals, and the fossil record shows it took some 20 million years before tropical reef ecosystems recovered from the Late Triassic extinction, even though the ecosystem as a whole carried on functioning.

With corals again under threat from rising temperatures in the modern day, the new research could provide a blueprint for the potential damage we're going to see – and perhaps give us some clues for how to prevent it.

On a more positive note, it shows life underwater is incredibly resilient, and capable of surviving through even the worst times of environmental upheaval on our planet.

#### No tipping point

* Permian-Triassic extinction proves resiliency
* No data on tipping points
* Ecosystems never outright collapse
* 600 models prove no ecosystem collapse

Hance 18 [Jeremy Hance, wildlife blogger for the Guardian and a journalist with Mongabay focusing on forests, indigenous people, climate change and more. He is also the author of Life is Good: Conservation in an Age of Mass Extinction. Could biodiversity destruction lead to a global tipping point? Jan 16, 2018. https://www.theguardian.com/environment/radical-conservation/2018/jan/16/biodiversity-extinction-tipping-point-planetary-boundary]

Just over 250 million years ago, the planet suffered what may be described as its greatest holocaust: ninety-six percent of marine genera (plural of genus) and seventy percent of land vertebrate vanished for good. Even insects suffered a mass extinction – the only time before or since. Entire classes of animals – like trilobites – went out like a match in the wind.

But what’s arguably most fascinating about this event – known as the Permian-Triassic extinction or more poetically, the Great Dying – is the fact that anything survived at all. Life, it seems, is so ridiculously adaptable that not only did thousands of species make it through whatever killed off nearly everything (no one knows for certain though theories abound) but, somehow, after millions of years life even recovered and went on to write new tales.

Even as the Permian-Triassic extinction event shows the fragility of life, it also proves its resilience in the long-term. The lessons of such mass extinctions – five to date and arguably a sixth happening as I write – inform science today. Given that extinction levels are currently 1,000 (some even say 10,000) times the background rate, researchers have long worried about our current destruction of biodiversity – and what that may mean for our future Earth and ourselves.

In 2009, a group of researchers identified nine global boundaries for the planet that if passed could theoretically push the Earth into an uninhabitable state for our species. These global boundaries include climate change, freshwater use, ocean acidification and, yes, biodiversity loss (among others). The group has since updated the terminology surrounding biodiversity, now calling it “biosphere integrity,” but that hasn’t spared it from critique.

A paper last year in Trends in Ecology & Evolution scathingly attacked the idea of any global biodiversity boundary.

“It makes no sense that there exists a tipping point of biodiversity loss beyond which the Earth will collapse,” said co-author and ecologist, José Montoya, with Paul Sabatier Univeristy in France. “There is no rationale for this.”

Montoya wrote the paper along with Ian Donohue, an ecologist at Trinity College in Ireland and Stuart Pimm, one of the world’s leading experts on extinctions, with Duke University in the US.

Montoya, Donohue and Pimm argue that there isn’t evidence of a point at which loss of species leads to ecosystem collapse, globally or even locally. If the planet didn’t collapse after the Permian-Triassic extinction event, it won’t collapse now – though our descendants may well curse us for the damage we’ve done.

Instead, according to the researchers, every loss of species counts. But the damage is gradual and incremental, not a sudden plunge. Ecosystems, according to them, slowly degrade but never fail outright.

“Of more than 600 experiments of biodiversity effects on various functions, none showed a collapse,” Montoya said. “In general, the loss of species has a detrimental effect on ecosystem functions...We progressively lose pollination services, water quality, plant biomass, and many other important functions as we lose species. But we never observe a critical level of biodiversity over which functions collapse.”