

Chair Castor, Ranking Member Graves, Distinguished Members of the Committee:

Thank you for the honor and the invitation to represent the innovation and conservation communities, which are increasingly convergent on our shared mission to enable community resilience, and to ensure the continuity of economic prosperity. It is increasingly clear that the essential pathway to these objectives involves understanding and applying the value of natural capital for the sustainable modernization of our market economy.

This year, we have been confronted with repeated reminders of the destructive violence and senseless damage climate change inflicts on our communities and ecosystems. These range from the raging wildfires in the Amazon and California to the intensified hurricanes relentlessly pounding our nation's southern and eastern coastal communities. Recurring heatwaves were the deadliest climate hazard from 2015-2019, affecting all continents and setting temperature records around the world. Even as Japan deploys resources and technology to fortify its physical resilience to natural disasters, many expressed in the wake of Typhoon Hagibis that the "best recovery strategy" is simply to persevere in the face of pain, suffering, and loss.¹ We are inching toward tipping points that threaten irreplaceable ecosystems such as tropical peatlands, mangroves, prairies, and seagrasses - all of which have a vital role in sequestering carbon and maintaining the Earth's delicate planetary equilibrium.

There is growing recognition that these human and ecosystem tolls will also likely induce a cascade of irreversible and poorly predicted economic consequences. The insurance industry and other stakeholders recognize that current flood risk assessment tools are too crude and outdated to accurately predict flood risk and assess the impact of mitigation investments, and that financial institutions and property owners have no accurate, standardized way to measure asset risk. This is also true of wildfires; Munich Re, the world's largest reinsurance firm, indicated that climate change was responsible for \$24 billion in losses due to the 2018 California wildfires.² Last week, the CEO of already-bankrupt Pacific Gas & Electric (PG&E) warned of safety blackouts for another ten years to update equipment prone to sparking wildfires, which are becoming increasingly likely in California due to rising temperatures. All of this points to the urgent necessity to prepare and proactively transition our public policies and institutional management by thoughtful design.

A few days ago, the Federal Reserve Bank of San Francisco published a dire warning of the dangers climate change poses to America's businesses and communities, calling upon lenders and businesses to act swiftly. This is especially imperative since municipalities, counties, parishes, and local and state governments are unlikely to have the capacity or balance sheets to fully prepare through conventional mitigation and adaptation efforts. It is therefore urgent that

¹ The Independent, "Everything is gone': Japan left reeling from worst storm in decades, October 19, 2019, <https://www.independent.co.uk/news/world/asia/japan-typhoon-hagibis-storm-destruction-fukushima-a9163101.html>

² Neslen, Arthur. "Climate Change Could Make Insurance Too Expensive for Most People Report." *The Guardian*, 21 Mar. 2019.

this Committee prioritize recommendations for community resilience and maximize the value of local ecosystems in attenuating these known and rising risks to lives, property, safety, and security.

Economic effects have already been set in motion. These are not future, hypothetical risks to our collective prosperity. Rather, the market has already begun to take account of climate change, noting the insufficiency of policy guardrails, and has started discounting and devaluing real estate - our homes, schools, small businesses, factories, and infrastructure - accordingly. Properties which are likely to be underwater if sea levels rise by one foot now sell for approximately 15 percent less than comparable properties without this exposure to flood risk.³ As this decline in property values sends signals to the rest of the financial system, banks may avoid lending to flood-prone areas in a practice called “bluelining”, which will imperil the health and resilience of the often poor communities that are already vulnerable to these disasters. This is another form of regressive taxation imposed by neglect.

Credit rating agencies are deeply attuned as well. In 2017, Moody’s warned that climate change would increasingly negatively affect the creditworthiness of U.S. state and local issuers, the cost of which flows through to American pocketbooks and livelihoods. Recently, both Moody’s and S&P acquired significant stakes in leading providers of data, intelligence, and analysis on physical climate risk, indicating clearly that climate data and computational science will be key drivers in determining the cost of funds and credit for all of us.

Moreover, there are significant indicators that capital markets are both considering and executing dramatic shifts in how accounting is managed, information is exchanged, and disclosure is verified. The private sector is assessing contingent liabilities and incorporating unmitigated climate change risk into their reporting, planning, and strategic investing. Earlier this month, for example, eleven leading environmental and sustainable business organizations published an open letter in the New York Times urging corporate CEOs to increase their climate policy engagement. Over 160 companies overseeing \$86 trillion in assets support the G20’s Task Force for Climate Disclosures (TCFD), which has called for companies to disclose their exposure to climate risk. The Climate Action 100+ initiative includes 360 investors with over \$34 trillion in assets under management, and aims to hold accountable the world’s largest corporate emitters. Recently, 34 central banks - including the Bank of England and Banque de France - joined the Network for Greening the Financial System, which aims to ensure a smooth transition to a low-carbon economy. This network represents approximately half of global emissions and recommended that central banks act quickly to avoid a climate-driven abrupt collapse in asset prices.⁴

Various blueprints have been carefully laid out to map the path toward the net zero emissions future needed to avert the worst and least predictable climate impacts. Last year’s IPCC Special Report on Global Warming of 1.5 °C concluded that to limit global warming to this level, global

³ Asaf Bernstein, Matthew Gustafson, and Ryan Lewis, *Real Estate as a Tool for Adaptive Banking*, Community Development Innovation Review, Volume 14, Issue 1, 2019.

⁴ Exponential Roadmap 1.5: Scaling 36 Solutions to Halve Emissions by 2030, September 19, 2019.

GHG emissions must decline by approximately 45 percent below 2010 levels by 2030. This would require rapid acceleration of solutions across sectors - energy, transport, buildings, and industry - with falling costs and rapid uptake of sustainable solutions.

Importantly, large-scale removal of atmospheric CO₂ will be absolutely necessary to avoid key tipping points and irreversible climate thresholds. Restoring degraded areas of land will likely be the only cost-effective way to remove atmospheric carbon at scale. Reforestation, biochar, and improved agricultural practices can prospectively store up to 9.1 billion tons of CO₂e annually, eventually storing 225 billion tons by the end of the century.⁵

Underpinning and cross-cutting these approaches is an exponential wave of American innovation and technologies that can far more effectively and sustainably strengthen our natural resilience, conservation strategies, and intelligent interaction with natural resources. We must modernize and design policies commensurate with the abundance of innovation that is revolutionizing our agriculture, food, forestry, aquaculture, and oceanic ecosystems, along with the global supply chains that connect them to the modern economy. This is the surest way to maintain American economic competitiveness, standards of living, and prospects for long-term prosperity as we adapt to new climate realities. With the right policy guidance, these technologies are poised to be game-changers for adaptive, agile, creative strategies to turn today's climate risks into problem-solving opportunities.

The fastest way to scale all of these changes is to address the core of the problem: the misalignment between markets and nature. Humanity's industrial-age relationship with nature is premised on the idea that natural resources are inexhaustible and can be consumed without limit. When embedded in markets, this assumption has led to the exponential scaling of behavior and outcomes that are detached from the true cost of irrationally depleting the asset value of healthy habitats. We are only beginning to understand with precision mispriced risk resulting from an inability to ascertain or quantify the gaps between asset prices and their underlying value. The net effect is mounting uncertainty, and the rising probability that the future does not resemble empirical models of the past. Financial regulators, banks, businesses, and to a lesser degree policymakers have begun sounding the alarm that a financial crisis of unknown proportions (exceeding the 2009 mortgage crisis) may be looming on the horizon.

It's worth remembering that virtually all of human civilization, including our moral beliefs and values, our social norms, and the democratic, free-market system that has produced unrivaled wealth and prosperity evolved in a relatively tranquil period on Earth, an interregnum between the end of the Paleolithic Ice Age, about 12 thousand years ago, and today. Our beliefs about the world, and our place within it, evolved in this nursery of stability and abundance, and it left its mark in our minds and in the systems we've built. The ideologies that won out in this period, rooted in the *conquest* of nature, in the possibility of limitless growth, and in our inherent separateness and superiority to other living things, require continued abundance and stability to underwrite and sustain them.

⁵ Exponential Roadmap 1.5: Scaling 36 Solutions to Halve Emissions by 2030, September 19, 2019.

Today, the erroneous presumption, built upon prior generations' thinking, that the world provides unending resources is why we tend to measure and fully account for certain things (like the processed and manufactured goods we consume) and not others (the natural resources required to produce these material comforts). Yet this system will not survive unchallenged in an era of profound ecosystem volatility, disruption, and the loss of nature. Capitalism and our personal freedoms are cornerstones of modern society, but they are incomplete without a companion sensibility: the understanding that we are symbiotically enmeshed with the systems that make life possible, and that we must preserve them.

Without making these invisible relationships visible, the invisible hand of the market cannot work effectively. It will systematically discount those things that are vital and common, and advantage those things that are privately profitable but harmful to all. In other words, we are fortifying - with existing policy, or lack thereof, "tragedies of the commons" that undermine classic principles of free enterprise, such as personal responsibility and transparent accountability.

While Greta Thunberg has brought focus to a generation's attention and priorities, with moral clarity as to the present urgency, Congress and this Committee in particular have an enormous opportunity to galvanize all Americans to apply our nation's strengths to the magnitude of the challenge we collectively face. Principal amongst these is our unparalleled capacity to induce innovation and scale technological progress through market penetration at incredible speeds.

Rather than being burdened by guilt and despair, we can remain pragmatic and optimistic, realistic and resolute, to maximize Nature's capacity to act as our ally and innovate the tools and technologies that enable us to thrive in the rapid transition to a new era of deep decarbonization.

The inexorable and exponential evolution from an industrial and natural resource-intensive economy to a data information economy has afforded us an unprecedented opportunity to account with precision the true value of ecosystem services. It is possible now to integrate that value into the modern economy with price discovery and evolved accounting standards. We call this market-based methodology of unleashing the value of natural capital "Natural Currency". Natural capital is a well-known and respected tenet of conservation, and ensures that nature is inventoried and valued for its ecosystem services beyond its extractive value. Natural Currency goes one step further and seeks to enable efficient markets for price discovery and exchange of ecosystem services that align the interest of people with the health of their natural habitats. For example, the rate at which a southern pine forest in Florida absorbs carbon or a mangrove wetland in Louisiana or South Carolina buffers communities against sea level rise has an absolute and unequivocal economic value. It has previously been challenging to capture that value and integrate it into our markets and risk management decision-making, because of the lack of precision in measuring, managing, and monitoring the natural capital in such a way that it could be readily priced and monetized. These are two particularly powerful and intertwined levers: the creation of Natural Currency (i.e. integrating nature's true value into market-based solutions), and Nature's ability to increasingly provide and scale ecosystem services and nature-

based solutions to climate change. To be absolutely clear, having had three decades of experience in energy technology research, development, commercialization, and financing, there is no pathway to successfully mitigate GHG emissions at the scale and within the timeframe needed, without designing systems to maximize the contribution of nature-based solutions.

The Need for Natural Currency

A technological revolution is well under way in digitalization, robotics, synthetic biology, artificial intelligence, cloud computing, and the Internet of Things (IoT). These have been described as the biggest “wildcard” in navigating the economic transition ahead. The exponential growth of these technologies, if designed and deployed efficiently, should spread across all sectors to maximize clean energy and material efficiency, support health and environmental restoration, facilitate the spread of creative disruption and proliferate the growth of new enterprise, and usher in an era of decentralized, democratized, localized infrastructure.

Specific applications might include the digitalization of the grid to enable its electrification and decentralization (including through new trading mechanisms such as blockchain); sharing models for energy usage in buildings; and improvements of delivery by optimizing shipments, routes, and traffic systems. Importantly, in the context of today’s hearing, the same breakthrough tools and technologies available for our man-made logistics and trading systems are available for drawing upon our nature-based solutions, and can deliver such solutions to society and markets - often at lower prices with far more sustainable and effective outcomes.

We have the technologies to enable supply and demand prediction for food systems that track and trace what we eat and drink from farm or field to fork. We can track accurately and in real time the performance and prediction of not only deforestation, but also restoration and regeneration - with the precision of counting biomass tree by tree, and plant by plant. There are sensors and artificial intelligence that can locally ensure our oceans and waterways, including our largest source of seafood, aquaculture, remains healthy, cost-effective, free of toxins, and managed sustainably in concert with global climate challenges.

Such technologies can help make the invisible visible. For example, Planet, a global Earth observation organization based in San Francisco, has deployed the largest constellation of Earth-observing satellites in history. Together these satellites image the entire planet every day in high resolution - capturing every act of deforestation, every illegal fishing vessel, every crop growing in every field, everywhere, every day. In so doing, Planet's satellites - and other observation technologies - can help us “measure the treasure” of Earth’s natural systems, in exquisite detail, in both time and space, and inform the kinds of “big indicators” that can inform our policies, our choices, our markets, and our social norms. Similarly, advances in optical and portable measurement tools, drones to detect and monitor leaks, and the Environmental Defense Fund’s MethaneSAT program have made it possible to capture global, real-time data on methane leaks, which can be translated into actionable information for resource

management via advances in machine learning. Better tools and better technologies for natural systems support both stronger ecosystems and stronger corporate balance sheets.

A critical role of policy will be to support and shape the digital revolution to align with the well-being of humanity and nature. This is not merely an imperative for sustainability and environmental health. Rather, this is an essential precursor for the United States to maintain technology leadership and accelerate its economic performance.

Perhaps most importantly, these technologies are enabling us to design, dynamically develop, implement, and account for credible, verifiable natural capital metrics. Through these metrics, it is possible to establish a globally recognized set of reliable criteria to support environmental sustainability, social responsibility, and stronger communities that thrive with greater economic opportunity.

Tying verification and measurement to objective, quantifiable, real-time monitoring will unlock possibilities for value creation and accountability enforcement across all industries and sectors. We now have the ability to harvest data from countless sources, embedded on land and in the air, in the ocean, from satellites, sensors, and citizen scientist networks, to create complete, real-time visibility of land and oceans. What we need first are indicators that tell us about the health and welfare of the essential and fragile systems on which life depends. Today, we don't have a "NASDAQ for Nature" or a "Dow Jones for Deforestation" - but in the future, we must. I urge the Committee to seriously account for America's present technological leadership and the overwhelming abundance of innovation that is bursting from our country's entrepreneurs and laboratories, that can be applied with immediacy and impact, enabling our economy to prosper through unprecedented problem-solving at scale.

Innovation abounds in financing instruments that catalyze capital toward climate resilience. This is largely due to the recognition by the financial sector and business at large that climate change risks are real, and strategies incorporating financial opportunities that identify and monetize the value of ecosystem services may be economically advantageous. This value has previously been difficult to capture with any precision, let alone monetize. Historically, market design either discounted or disallowed any quantified value for natural capital beyond its physical extraction and consumption, instead relegating a science-based approximation to the domain of non-market actors such as governments, academics, and nonprofits.

New financing mechanisms are being driven by the recognition that we have access to measurement and evaluation tools to correct our markets. Technologies that meaningfully measure the progress of ecosystem performance are critical enablers of contractual and business model innovation. The data needed to underpin these decisions is often already available and being collected, but has been insufficiently indexed and categorized according to common frameworks to be of maximum value to investors and other stakeholders. This *information* must be sifted and processed to illuminate the underlying *insights*, and make them organized, scalable, maintainable, and easily accessed through open APIs. This would underpin leading *indicators* that can predict financial and economic climate-related outcomes, developed

with the scientific community. Such verifiable, objective, third-party indicators would reverse the longstanding assumption that the market clearing price of natural capital is zero, and set the stage for an era of natural monetization, and perpetual innovation and evolution of financial *instruments* to redirect capital and redistribute risks.

These standardized, verified metrics enable more concrete and meaningful environmental and social governance (ESG) reporting. Embedding climate risk into asset prices also drives large-scale mainstream investors toward decisions beyond traditional “impact” investing, also unlocking significant arbitrage opportunities for those who effectively integrate climate risk. Alongside their recognition of the threat posed by climate change and mispriced assets, the investment community has begun to recognize the opportunities for those who access the right information and analytics to equip more accurate price discovery. For example, Blackrock, one of the largest holders of U.S. securities, released a report this year drawing on granular climate modeling and big data techniques to show variation in physical climate risk by region. Although slower-moving changes such as sea level rise may seem distant and difficult to model, their granular assessment of local climate risks shed light on implications for the U.S. municipal bond market, real estate, and the vulnerabilities of the U.S. electricity sector due to aging and vulnerable infrastructure.

The scale of the climate change challenge we are seeking to address is asymmetrical to the solutions, whether man-made or natural, we have thus far deployed. There is no possibility whatsoever that this country, or any country, can tithe or tax its way to a solution in the relevant timeframe. It is essential that we address market imperfections and harness market forces to enable the scaled benefits of nature-based solutions. No other source of deep decarbonization is more readily available, nor more measurably attainable, than the power of nature itself. Therefore I encourage the Committee, in its final report, to prioritize and recommend on a bipartisan basis, that the value of natural conservation, assessed and delivered through technological innovation, be paramount.

Ecological Prosperity IS Economic Prosperity

The power of Natural Currency to unlock opportunities for economic growth and new abundance should not be underestimated, and would address the single greatest cause of misalignment between markets and nature. Once natural capital and ecosystem services are properly valued and market priced, the flow of capital to realign markets and nature will inevitably be reflected in market-based, cost-benefit decisions by municipalities, engineers, architects, building materials manufacturers, investors, insurers, consumers, and others across the economy.

For example, the innovations in spatial assessment and measuring capabilities described above can help identify degrees of ecosystem degradation, anticipated trends in biodiversity and other climate patterns, and the ecosystem services that restoration techniques could re-introduce to these landscapes. These advances in predictive power lessen the need for risk management and reduce investment risk from the public and private sectors. They enable greater inclusion of private sector participants, especially including small businesses and everyday citizens, in

investment opportunities designed to capture the value of nature-based benefits while strengthening our local communities' resilience and adaptation.

Abundant application of innovation to accelerate nature-based solutions already exist. In one example, intelligent risk management services focus on quantification and valuation of blue carbon (as discussed by my expert colleague from Conservation International) in coastal and marine systems. The carbon mitigation benefits of mangroves are immense; they store up to ten times the carbon of terrestrial forests on a per area basis, while protecting more than ten million people globally from flooding, and reducing flood damage to coastal assets by more than \$82 billion each year. The market is already producing a new wave of entrepreneurs to create revenue streams for mangrove conservation and restoration by incorporating their risk reduction value into insurance products, and monetizing the climate mitigation value of mangroves through "blue carbon credits".

By managing sites where mangroves provide verifiably high flood reduction benefits, linking these to site-specific calculation of flood risk benefits, and securing annual payment from insurance companies for continued, verified mangrove conservation and restoration, new jobs are created, new enterprise thrives, and communities are protected with greater resilience and the benefits of their stocks of natural capital. This assessment and monetization of coastal asset risk reduction value, and the natural benefits of mangroves, is enabled by unprecedented technological advances for precision quantification and calculation methodologies that support credible, verifiable third-party standards for voluntary carbon markets. As infrastructure turnover accelerates toward more sustainable assets, there will also be opportunities for project developers to support green infrastructure and access the value created by nature-based solutions.

Conclusion: design a just transition that accelerates innovation, "measures the treasure", values and prices nature-based solutions, and strengthens community resilience, adaptation, and prospects for prosperity

To support economic development and community adaptation and resilience in the face of inexorable climate change, it is essential for policy design to integrate the intrinsic benefits of American innovation, which is advancing technological solutions that interface with natural systems as never before. As has been the case throughout our history, America's investment in creating a technology push through research and development has been facilitated by "demand pull" in the marketplace, shaped by policy priorities for the public good. This is as true for the revolution in renewable energy as it has been for GPS, the Internet, and many other innovations that have emerged from effective policy and governance. This is particularly true in developing standards of measurement and management (such as those at NIST), especially in the early stages of a technology's emergence in the marketplace. Examples might include:

- A "Natural Capital Innovation Prize" investing in the most effective means for American citizens (and/or institutions, such as small businesses, secondary schools, universities,

and civic organizations) to directly participate, protect, and restore carbon-rich natural ecosystems at home and abroad, with higher funding to scale winning solutions.

- Ensuring that insurance commissioners have no impediment to innovation in regulation that allows products to integrate climate risk reduction and mitigation measures, including nature-based solutions. Additionally, aligning market-based incentives with preventative preparation and resilient adaptation to respond to the evolving frequency and severity of catastrophic weather events.
- Policies to encourage true cost accounting, informed by transparency and disclosure, with precision measures and metrics where governmental institutions take account for the power of tools and technologies to deliver the next generation of accounting performance
- Natural capital “opportunity zones” corresponding to measurable, vital ecosystems

These examples illustrate the range of ways in which policymakers can create demand for, and directly benefit from the measurement and management of natural capital, and subsequent market realignment. Such measures can create the regulatory environment needed to guide the application of these exponential technologies to their highest value.

While there are many bold and often controversial ideas for costing up carbon, there are too few policy proposals circulating that directly incentivize decarbonization. Last year, Congress passed into law a provision known as 45Q, that provided tax credits for man-made forms of carbon sequestration, discriminating and discounting conservation and ecosystem services with superior scalability, volumetric availability, immediacy, and permanency. In other words, the most effective, efficient, sustainable, and immediately available solution for decarbonization was disincentivized relative to more speculative future technological bets. While I am a strong supporter of funding multiple innovation pathways for rapid and deep decarbonization, the highest priority legislative fix to unleash natural capital innovation would simply be to allow such solutions to access the 45Q sequestration tax credits - or, alternatively, to design a tax credit for that purpose.

Despite the daunting nature of the climate crisis, as with any risk, there is also veiled opportunity - for human ingenuity, for optimism, and for entrepreneurial solutions to achieve what may be possible. Climate risk represents inordinate scale - in fact, planetary scale. And yet this grand challenge we face together, across nations and our common humanity, compels us to unleash American innovation in technologies, policies, and market design. In doing so, we heighten the probability that we will successfully address this mounting challenge, with a resilient strategy to adapt and thrive in concert with the natural systems that sustain us. These systems will continue to give life to our communities and posterity, defining our collective legacy at this pivotal inflection point in the history of our nation and our global commons.