A failure of imagination
Dr. Philip B. Duffy
President & Executive Director

On a long plane flight recently I watched The Big Short, a dramatized documentary about the 2008 financial crisis and subsequent recession. WHRC’s newest Senior Fellow, economist Spencer Glendon, has suggested this as a useful analogy for climate change. That 2008 catastrophe was precipitated by the collapse of financial instruments called mortgage-backed securities. A major contributing cause was a spike in mortgage defaults resulting from the expiration of “teaser” interest rates on ill-advised mortgage loans.

Those responsible for making policies about the housing market did not anticipate this series of events, although the evidence was there for anyone who cared to look for it. Among the people directly involved in the events leading up to the crisis, some looked no farther than the money they were raking in. It seemed not to occur to them to ask if the music would stop someday, and what would happen if it did. More interesting are the leaders who should have known better. Even when confronted with evidence that a lot of very risky mortgages had been securitized, they simply could not believe that the housing market was in danger of collapse.

As Spencer Glendon points out, this was a failure as much of imagination as of intellect. It is difficult for humans to accept the possibility of calamitous events if we’ve never experienced them. Those of us who are old enough remember survivors of the Great Depression (or remember the Depression itself) know that those who experienced it were forever changed by that event. Reading about it has nothing like the same impact.

Imagination continued on next page

Primary Forest Symposium connects science, policy experts
by Miles Grant

Ahead of key United Nations talks, WHRC hosted the 2019 Tropical and Boreal-Temperate Primary Forest Research Symposium from March 18 to 20. Organized in conjunction with Australia’s Griffith University Climate Change Response Program, the symposium brought scientists together to share insights, collaborate on projects, and gain a deeper understanding of the values, benefits, threats, and opportunities for the conservation of these undisturbed ecosystems. Attendees traveled to WHRC’s Massachusetts campus from all over the world, including Australia, Canada, and Germany.

Around 32 percent of the world’s forests are primary forests - ancient woodlands undisturbed by roads, logging, mining, and agriculture. These forests are still dominated by natural processes and ecosystems. About half of the world’s remaining primary forests are located in the tropics and are often home to indigenous groups who have lived for centuries in ways that maintained the forest’s ecological integrity.

Creating effective international protections for primary forests remains a challenge. The symposium was a chance to combine WHRC’s science expertise with top policymaking specialists from around the world.

Symposium continued on next page
Lack of imagination has a lot to do with our failure as a society to respond effectively to climate change. Evidence of terrible outcomes is here, and growing every day, but we’re not reacting with sufficient vigor or vision. Twenty-five years ago climate scientists spoke about “low probability/high consequence events.” These included changes in the large scale ocean circulation, greenhouse gas emissions from thawing permafrost, massive ecosystem responses, and decay of large land ice sheets. Today, every one of these “low probability” outcomes is observed to be happening, yet our societal response is incremental at best.

So how does this end? A tipping point in the politics of climate change will come, probably before long. It is important when that happens that the response be constructive—not panic and isolationism. We can influence that, partly by pushing to make change happen sooner rather than later, and partly by offering good, science-based solutions. WHRC’s research, our work with governments, faith leaders, with the Niskanen Center, and now with the private sector, all push things in the direction of more immediate and more evidence-based responses to climate change. The need has never been greater, but neither has the opportunity.

“Primary forests are so valuable yet enormously underappreciated. This gathering is one step toward the collaboration we need to make that value better known around the world, and to close loopholes in international policy,” said WHRC Assistant Scientist Dr. Glenn Bush.

WHRC and partners will continue working to make sure policymakers have the best science available, much of it being produced by WHRC’s ongoing research in places like the Tanguro research station in Brazil and Projet Equateur in the heart of the Congo Basin’s forest. The United Nations Framework Convention on Climate Change and the UN’s Sustainable Development Goals will be updated in the next two years, giving a short window to influence policy.

“Wood extraction in primary forests is incompatible with confronting climate change. Just a tiny proportion, around 1 percent, of individual trees in primary forests can hold half of its carbon. That means even low impact, selective logging, just a few mature trees per hectare (about the size of a soccer field) can reduce most of the forest carbon stock,” Bush said.

WHRC also invited the public to a forum featuring Griffith Climate Change Response Program Director Brendan Mackey, WILD Foundation Senior Policy Adviser Cyril Kormos, Australian Rainforest Conservation Society Forests and Climate Director Virginia Young, and ICFC Tropical Ecologist Barbara Zimmerman. After the completion of the symposium, WHRC hosted a meeting of the steering committee of International Action for Primary Forests (IntAct).

New study investigates how different agricultural management practices affect overall N$_2$O emissions

by Emily Marshall

Grasslands that are managed intensively with inputs from manure and fertilizer release much more nitrous oxide (N$_2$O) than grasslands that are in a natural state or minimally managed condition, according to a new paper released by WHRC Postdoctoral Fellow Dr. Shree Dangal.

N$_2$O is a powerful greenhouse gas with a global warming potential roughly 265-298 times greater than carbon dioxide (over a hundred year reference period). Land management practices such as mineral nitrogen fertilizer and manure application play a significant role in N$_2$O emission growth. In grassland ecosystems, nitrogen inputs in the form of manure and mineral nitrogen, and livestock excreta nitrogen deposition (i.e. feces), have the potential to release a lot more N$_2$O to the atmosphere. But, until now, the effect and contribution of different management practices to global N$_2$O emission remained unclear.

Using a terrestrial ecosystem model, the study found that N$_2$O fluxes are highly variable across time and space, driven by climate, management intensity, and soil conditions. N$_2$O emissions, however, generally increased with management intensity. In particular, large N$_2$O emissions from intensively managed pasturelands were associated with warmer and wetter climatic conditions, together with high nitrogen input in the form of excreta and manure/fertilizer application.

Dangal also found animal excreta is the biggest contributor to N$_2$O emissions as compared to manure and synthetic fertilizer. This is because animal excreta nitrogen deposition in grassland ecosystems are significantly higher due to an increase in livestock numbers since 1961.

The study also attributed net N$_2$O emission to different sources and found that excreta deposition was the largest source of N$_2$O emission in pasturelands and rangelands, contributing to 54% of the mean N$_2$O emissions followed by manure application (13%) and fertilizer application (7%), during 1961–2014.

“Decreasing nitrogen input through sustainable grazing management practices could go a long way in climate change mitigation,” Dangal said.
Fund for Climate Solutions concludes first year of internal grant awards

In February, WHRC issued a round of grants from the Fund for Climate Solutions, a new internal funding instrument created by the Board of Directors. Projects awarded over the past year include establishing multiple permanent monitoring structures at observation sites in Alaska’s Yukon-Kuskokwim Delta, remote sensing research to help scientists and policy makers understand the global carbon cycle, and an on-the-ground project that will experiment with restored New England wetlands to improve coastal resiliency. The seven projects awarded during this fiscal year, which was also the pilot phase for the Fund, totaled $610,000 in grants.

The Fund for Climate Solutions aims to advance climate solutions by extending or augmenting crucial research initiatives, seeding new projects that offer breakthrough policy or scientific impact, and allowing startup projects to get off the ground to show proof of concept work for outside funding opportunities.

“At a time when the climate threat is more clear than ever, we need to encourage cutting edge research. The Fund for Climate Solutions shows WHRC’s leadership in driving scientific innovation,” said Connie Roosevelt, a member of WHRC’s Board of Directors and co-chair for the Fund for Climate Solutions fundraising campaign, with Joseph Mueller.

The new projects being supported by the Fund:

**Wetland Restoration as a Climate Adaptation Strategy for Massachusetts**
*Project Lead: Chris Neill*

The retirement of coastal cranberry bogs in Massachusetts is an opportunity to return these bogs to coastal wetlands. Among other benefits, this would provide protection against storms and sea level rise, as well as carbon storage. Work led by Neill will continue WHRC's involvement in wetlands restoration in Massachusetts, by working with the state’s Division of Ecological Restoration.

**Can old forests and large trees sustain or enhance the terrestrial carbon sink?**
*Project Lead: Rich Birdsey*

New measurements have shown that old trees not only hold more carbon than younger ones, but also remove carbon from the atmosphere at a faster rate. Work led by Birdsey will use this new understanding to estimate the potential climate benefits of preserving older “intact” forests throughout the United States. This has urgent policy relevance as interest builds in burning wood to produce electricity.

**Arctic Climate Change Observatory**
*Project Lead: Dr. Sue Natali*

This project will establish permanent, unmanned monitoring structures at research sites in Alaska’s Yukon-Kuskokwim Delta. The Yukon-Kuskokwim Delta has been identified as a “hotspot” for methane emissions – a greenhouse gas and major contributor to global warming. The observatory will be the first ground-based system in the region for monitoring levels of methane and carbon dioxide emissions. It will also enable WHRC scientists to learn more about permafrost thaw and related climate impacts.

**Forest Research Targets High-Emissions Fires**
*Project Lead: Dr. Brendan Rogers*

Wildfires in Alaska release large amounts of greenhouse gases as the area’s carbon-rich vegetation is burned. Through new research, Rogers hopes to give land managers in Alaska the information needed to fight fires. Picking the right battles could be the key for land managers, who can cut carbon emissions by targeting the highest CO₂-producing fires. To achieve net-zero emissions, we need to know when, where, and how fire management can and should be deployed as a mitigation tool.

**Burning Arctic Soil**
*Project Lead: Dr. Jonathan Sanderman*

Arctic wildfires – which are becoming more frequent – convert plant and animal remains into charcoal that is stored in Arctic soil. The charcoal, called pyrogenic carbon, accumulates over time, storing more carbon underground as fires light and spread. Pyrogenic soil emits carbon at a slower rate than non-pyrogenic soil because of its slower decomposition rate. However, that differing rate of decomposition is not considered when calculating Arctic emissions of greenhouse gases. Sanderman hopes the pyrogenic carbon study will be an important building block as researchers work to understand emissions from the Arctic.

**Gas Push-Pull Technique: A novel approach to in situ quantification of soil CH₄ oxidation rates**
*Project Lead: Marcia Macedo*

Through thawing permafrost, agriculture, and other means, greenhouse gas emissions from soils are an important contributor to climate change, but one that is impossible now to measure accurately. Work led by Macedo will develop and test a novel technique for measuring emissions from soils, which is applicable from the Arctic to the tropics. This should allow those emissions to be better understood and managed.

**Advancing the State-of-the-Art in Peer-Reviewed Science on Global Aboveground Carbon Stocks and Change**
*Project Lead: Wayne Walker*

Scientists believe that land absorbs about 25 percent of human greenhouse gas emissions, but despite many attempts, it has never been possible to determine where that absorption occurs. By using WHRC’s unique forest-carbon monitoring capabilities to map how much carbon is going into forests globally, work led by Walker will shed light on the long-long-standing scientific mystery known as the “missing sink” of carbon.
WHRC study shows tapirs can help restore Amazon forests
by Miles Grant

A new study conducted at WHRC’s research facility at Tanguro Ranch in Brazil shows lowland tapirs can restore degraded Amazonian forests, eating the fruit of healthy trees, then depositing their seeds in areas that had been previously burned. This service provided by tapirs may be among the cheapest and easiest solutions for large-scale forest restoration.

The team collected and studied almost 130,000 seeds representing 24 different species from tapir dung in degraded forests in Mato Grosso Brazil. The study, published in the journal Biotropica, shows that tapirs disperse three times more seeds in degraded forests than in primary ones, probably because they prefer spending time where resprouts are available.

Two factors contribute to the tapir’s unique role: Size and distance. The last representative of megafauna in South America, tapirs can reach up to 8 feet in length and up to 700 pounds, therefore they eat a lot. This study shows that contrary to previous belief, tapirs pass many large seeds intact and undamaged through their digestive system, with their large waste protecting the seeds from beetles. And while other large mammal dispersers like monkeys prefer to stay in healthy and intact forests, tapirs can cross open areas and thus bring seeds to a disturbed or degraded forest – ultimately increasing its plant diversity and abundance.

“When we think of climate and forest solutions, tapirs aren’t the first thing that comes to mind, but our study shows they play a critical role in forest recovery by dispersing the large-seeded species that eventually become large trees, meaning they contribute indirectly to maintaining forest carbon stocks,” said Woods Hole Research Center Assistant Scientist Paulo Brando.

The lowland tapir (also known as the South American or Brazilian tapir) is considered endangered by the U.S. Fish and Wildlife Service and vulnerable by the IUCN. Their population is dwindling in the face of deforestation and hunting.

The Amazon has already lost 800,000 square kilometers of forest, an area equivalent to 1/10th of the lower 48 United States, much of it to intentional burning to clear land for agriculture. The ability of forest residents like tapirs, birds and many other animals to spread seeds into degraded areas shows natural regeneration can help tropical countries to achieve their goals to maintain and restore forest carbon stocks, biodiversity and forest ecosystem services.

New partnership connects faith leaders and scientists
by Dave McGlinchey

More than 80 people gathered in Chestnut Hill, Massachusetts, in early February to kick off a new era for the fledgling Massachusetts-based religion and science coalition—newly minted as the Faith Science Alliance for Climate Leadership (FSA).

The initiative that grew into the FSA was launched early last year, when WHRC President Phil Duffy and Archbishop of Boston Cardinal Sean Patrick O’Malley held a two-day meeting to focus on the shared value of climate action. Scientists and faith leaders discussed the urgency of the climate crisis and opportunities for legislative action and education in Massachusetts. The group took shape throughout 2018, and held its 2019 kickoff meeting at Boston College’s School of Theology and Ministry.

“It is no small accomplishment that religion and science come together,” said Father Bryan Hehir, of the Harvard Kennedy School and the Archdiocese of Boston. But, he argued, such a partnership was necessary for a climate crisis “that is global, national, local, and intergenerational.”

The FSA is now led by a steering committee of nine members. Rabbi Alison Adler of Temple B’nai Abraham in Beverly, MA, Rev. Jeff Barz-Snell of the Unitarian Universalist First Parish Church in Weston, MA, Dr. Gaurab Basu of the Cambridge Health Alliance and Harvard Medical School, Dr. Dorothy Boorse of Gordon College, James Driscoll of the Massachusetts Catholic Conference, Peter Dunbeck of the Environmental Stewardship Diocese of Worcester, Episcopal priest and author Rev. Dr. Robert K. Massie, Rev. Fred Small of the Unitarian Universalist Arlington Street Church in Boston, Rev. Leslie K. Sterling of St. Bartholomew’s Episcopal Church in Cambridge, and WHRC’s Dr. Marcia Macedo.

“Because we have the Woods Hole Research Center with us from the beginning of this coalition,” Hehir said, “we are operating with the gold standard of science.”
Earlier this year, Woods Hole Research Center scientists and colleagues used LiDAR (light detection and ranging) at the Tanguro ranch research facility in Brazil for a study that showed fire-damaged trees are especially vulnerable to windstorms for several years or even decades—especially the largest, and most carbon-rich trees.

LiDAR is a decades-old technology but continues delivering critical new science, and WHRC scientists are using it in innovative ways to monitor forest carbon. LiDAR measures distance to a target using pulses of laser light and measuring differences in laser return times and wavelengths to make three-dimensional digital representations. It can be ground-based, plane- or drone-based, or even space-based. It can measure the lay of the land across a large area - with or without natural features like trees or man-made features like buildings.

When used in forests, LiDAR can measure tree height and size, capturing the canopy in incredible detail and converting it to data that can be analyzed. Plane-based LiDAR provides the most detailed and most useful imaging over a large area, but cost is an issue as chartering and fueling planes comes with a high price tag. WHRC scientists Wayne Walker and Alessandro Baccini used LiDAR extensively in their landmark 2017 study showing human-driven degradation is causing tropical forests to lose more carbon than they are sequestering.

“LiDAR fills the gap between field data and planetary knowledge,” says WHRC Associate Scientist Dr. Wayne Walker, who’s been using LiDAR in his work for 20 years. "Without it, we’d never have been able to extend our work from assessing individual forest canopies to monitoring and verifying global carbon storage.”

NASA recently launched and installed the Global Ecosystem Dynamics Investigation (GEDI) LiDAR system and installed it on the International Space Station, aiming to measure how deforestation has contributed to atmospheric carbon pollution. GEDI is expected to produce about 10 billion cloud-free observations during its planned 24-month mission. Former WHRC Deputy Director Scott Goetz serves as Deputy Principal Investigator of the GEDI team. GEDI joins ICESat-2 (Ice, Cloud, and land Elevation Satellite) as part of NASA’s Earth Observing System.

In the news

Satellite images show the nightmare bomb cyclone whirling across the US and Nebraska flooding shows (again) how extreme weather can threaten national security. WHRC Senior Scientist Jennifer Francis is quoted in articles on the most recent climate change-related storms and the threat these types of weather events pose in The Verge. March 14, March 18

The True Climate Corridor – and the Risks of Severing an Ecological Artery. WHRC Founder George Woodwell and Senior Scientist Richard Houghton and quoted on the damaging effects of forest fragmentation that could be caused by a transmission line from Quebec to Massachusetts in Maine Center for Public Interest Reporting’s PineTreeWatch.org. March 14

Combined effects of fire, fragmentation, and windstorms leave Amazonian trees particularly vulnerable. Assistant Scientist Paulo Brando is quoted and his study of the effects of forest fragmentation is referenced in Mongabay. March 11

Why Has The 2018-19 Wisconsin Winter Been So Bad? Senior Science Jennifer Francis is interviewed on the extreme weather created by the recent polar vortex incidents in Wisconsin in the Mount Pleasant-Sturtevant Patch. March 7

EU sued to stop burning trees for energy, it’s not carbon neutral: plaintiffs. WHRC’s publication on discrediting the assumption new tree plantings immediately and fully offset carbon emissions from wood burning is cited in Mongabay. March 6

Wallace Smith Broecker, the ‘grandfather’ of climate science, leaves a final warning for Earth. Senior Arctic Policy Fellow Rafe Pomerance is quoted in the commemorative article on NBC News. March 3

Heavy snow on Maui. Historic floods on Kauai. Hawaii weather is getting weird. Here’s why. WHRC Senior Scientist Jennifer Francis is quoted in an article in Hawaii News Now (KGMB-TV & KHNL-TV). March 1

The Amazon on Red Alert. Assistant Scientist Dr. Paulo Brando is quoted on the Brazil news magazine Veja. March 1

Tapir feces can regenerate degraded forests in the Amazon, reveals a study. The results of Assistant Scientist Dr. Paulo Brando’s recently published paper are discussed in the 4th largest paper of Brazil, Estadão. February 28

Etsy Crafts a Plan for Carbon-Neutral Online Shopping. President and Executive Director Dr. Phil Duffy was quoted in a Wired Magazine article on Etsy implementing carbon offset measures. February 27

Congress just proved there is hope for honest discussion on climate. Senior Scientist Dr. Jennifer Francis and Niskanen Center’s Joseph Majkut, both of whom testified before the House Science, Space, and Technology Committee in February, wrote an op-ed piece for The Hill. February 26

When Climate Justice and Religion Mix. Rev. Mariama White-Hammond’s recent talk at WHRC on addressing climate change through action in faith was discussed on WCAI’s program Living Lab Radio. February 24

Map of Mangrove Height Reveals Carbon-rich Coastal Forests. Associate Scientist Dr. Jonathan Sanderman was quoted in an Inside Science article on global mapping of mangrove height and above-ground carbon. February 22
This image shows the dense, humid primary forest around the Congo River. Darker greens indicate seasonally inundated forests while lighter colors are higher, dryer areas. After the Amazon, the Congo Basin comprises the second largest tropical forest on Earth. It contains one of the largest terrestrial storehouses of carbon and is home to a vast rural population and diverse species, including bonobos, forest elephants and leopards. This image was built by WHRC’s Greg Fiske using a combination of MODIS satellite optical imagery as well as predicted biomass and elevation data.