"Handbook of Climate Change and Biodiversity"
Implications for Biodiversity of Potentially Committed Global Climate Change (from Science and Policy)

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Abstract Vital policy-relevant information regarding global climate change and biodiversity includes the sources of increased future global warming commitment, which stem from both climate change policy and climate science. Full, long-term (over many 100s of years) equilibrium global warming commitment calculated by the constant atmospheric GHG composition, is put it at 'about 2° C.' by the IPCC 2014 assessment. Significant further committed warming at 2° C is expected due to weakened terrestrial carbon sinks and large planetary sources of carbon feedback emissions. Committed climate change due to policy is calculated from national emissions targets. Together these policy targets lead to over 3° C global warming by 2100, which will increase much more after 2100. These commitments constitute a planetary emergency for biodiversity loss, especially considering, for catastrophic risk, higher than median climate change projections.

Keywords Committed global climate change • Global warming • Biodiversity • Extinction • Forest dieback • Ocean acidification

That the world is in a very large extinction event has been publicized over a period of years, so it should be well known. It was in 1996 that Richard Leakey published *The Sixth Extinction: Patterns of Life and the Future of Humankind* (Leakey 1996). In 2017, Ceballos, Ehrlich and Dirzo were published under the shocking title *Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines*. What is less well known is that already committed global climate change will make the extinction rate far worse than projected (Urban 2015).

In its 2007 assessment, the IPCC said:

> In the medium term (i.e., decades), climate change will increasingly exacerbate human-induced pressures, causing a progressive decline in biodiversity. Projected future climate change and other human-induced pressures are virtually certain to be unprecedented compared with the past several hundred millennia.' (IPCC 2007 WG2 4.1.2.)

Climate change impacts further increasing today's accelerating biodiversity loss (Ceballos et al. 2015) would be a truly catastrophic case of abrupt climate change, as explained by the National Research Council (NRC) (2013): 'The abrupt changes that are already underway … include increases in extinction rates of marine and terrestrial species.’ The NRC (2013) states that unchecked habitat destruction, fragmentation, and over-exploitation combined with the ongoing pressures of climate change could result in a mass extinction equivalent in magnitude to the one that wiped out the dinosaurs, and that it conceivably could occur before the year 2100. The predicted “velocity” of climate change – that is, how fast populations of a species would have to shift in order to keep pace with the local climate envelope shift – is unprecedented.

Moreover, the overall temperature of the planet is rapidly rising to levels higher than most living species have experienced. Research (NRC 2013) suggests that up to 41% of bird species, 66% of amphibian species, and 61-100% percent of corals that are not now considered threatened with extinction will become threatened due to climate change this century. Africa’s 10-40% of mammal species now considered not to be at risk of extinction will move into the critically endangered or extinct categories possibly as early as 2050.
All sources project large increases in species extinctions from global climate change. Even the best-case emissions scenario with immediate global emissions decline increases the risk of extinctions (IPCC 2014 WG2 SPM). In view of the fact that the world is in or is entering a catastrophic sixth major extinction event already, the effect of global climate change would appear to be potentially cataclysmic to biodiversity, which is addressed in this chapter. Both global climate change due to greenhouse gas emissions and the increased extinction of species by climate change have great inertia, each taking decades (or more for extinction).

The challenge of preserving enough habitat for biodiversity to recover in the future is enormous. Pimm et al. (2014) (in arguably the most up to date and most comprehensive research paper on future biodiversity loss under global climate change) say that conservation is key, backed up by the point that the rate at which mammals, birds, and amphibians have slid toward extinction over the past four decades would have been 20% higher were it not for conservation efforts. Although the paper says that data and research lag far behind what is needed, we nevertheless do know the two big solutions that would have enormous benefit. These are conservation through the termination of deforestation and termination of industrial age fossil fuel emissions. Both are in theory achievable, with large countervailing benefits to human populations and the future of humanity. No more research is required to know that these must happen. The success of conservation is a strong argument for the huge conservation upgrade in the proposed plan of E. O. Wilson (2016) to protect half of the Earth's land and oceans, in addition to zero deforestation. These are well known solutions, but now they really do have to happen now, because committed global change gives us – and all species – no more time to act.

This chapter treats biodiversity loss and ecosystem loss as one and the same. Climate change increases biodiversity loss, and biodiversity/ecosystem loss increases climate change by reducing land carbon sinks, e.g., forests. The greatly increased future biodiversity loss by future global climate change is assessed here by looking at today’s already committed degrees of global climate change. Commitment clearly shows the climate, oceans and biodiversity global emergency, requiring the immediate emergency decline of emissions with supporting responses that are well known and universally recommended. These commitments stem from both climate

policy and climate system science. If policies are improved, the policy commitment might lessen. Climate system commitment is actually much more than is published and is irreversible (locked in). Commitment further reinforces a cataclysmic outcome for global biodiversity.
The data on commitment paints a terrible picture for the future of biodiversity and the natural world, so at the outset let us be reminded that we have all the solutions. They are well known (see Sutter 2016: How to stop the sixth mass extinction), they are developed, and they are readily applicable. In addition is the protection of half of the Earth's land and oceans, a proposal by E. O. Wilson (2016) as the 'global solution to extinction.'

Biodiversity loss is already extreme and accelerating. According to the NRC (2013), the extreme rate of acceleration in biodiversity loss is probably unprecedented in 65 million years; today's sixth mass extinction event reveals it as an abrupt planetary catastrophe that will be further greatly accelerated by a committed, unavoidable increase in global climate change. Data sets show that all climate change indicators from 1900 are accelerating, particularly atmospheric CO2, atmospheric CO2 equivalent, global surface warming, northern hemisphere and Arctic warming, ocean heating, ocean acidification, and ocean deoxygenation. In terms of policy, this is an Earth (or biodiversity) emergency requiring immediate measures for concerted and energetic mitigation, adaption and conservation.

Assessing the projected impacts on ecosystems and biodiversity in global climate change models is essential for urgently planning both biodiversity conservation measures and climate change mitigation measures, and to plan strategies for adaptation. Because species extinction is irreversible (also because global emissions are close to the worst-case scenario), the worst-case projections of global climate change losses are used. Climate change drivers and impacts must be projected far beyond 2100 (the horizon used by the IPCC). Because of climate system inertia with respect to committed extra climate change, observed ecosystem damage and loss at the time will be practically irreversible. In doing such an assessment, it is necessary to address today's already committed degree of global climate change and the several sources that cause committed future global climate change. There is locked-in commitment due to climate change science and there is climate change policy (emissions) commitment, which both lead to a far greater degree of global climate change than today's, which is already having severe disastrous to catastrophic local and regional impacts on all continents.

On policy commitment, current government policy, recorded by the national government emissions targets filed with the United Nations as intended nationally determined commitments (INDCs), will lead to a substantial increase in global emissions by 2030, according to an update from the UN Climate Change Secretariat (2016), and can only be expected to lead to a collapse of global and regional ecosystem biodiversity. These combined emissions targets lead to a global warming of over 3°C by 2100 (which would be much higher after 2100), according to Climate Action Tracker (2017). This warming by 2100 is triple today's warming of just over 1°C. Because of ocean thermal inertia, added feedback emissions and carbon sink failure, warming long after 2100 would be up to at least 6°C. The ocean heat lag commits warming by 2100 to

double long after 2100, which is best explained by the NRC Climate Stabilization Targets (2011).
Also on policy commitment, the 1992 Framework Convention on Climate Change (UN Climate Change Secretariat 1992), to which all governments are bound, requires the stabilization of greenhouse gas concentrations in the atmosphere at a level sufficient to allow ecosystems to adapt naturally to climate change. Stabilization of atmospheric greenhouse gas concentrations is the right metric to use because, unlike the global average surface warming alone, the atmospheric greenhouse gas concentrations account for additional future committed warming. However, atmospheric greenhouse gas concentrations are already above a safe level for ecosystems, on land and in oceans, and CO2 increase is accelerating.

Climate system science commitment is 2° C (very long-term equilibrium warming), based on constant atmospheric GHG concentrations. Atmospheric CO2 was 392 ppm at 2012. Based on a 2012 global warming of 0.85° C, the fifth IPCC assessment (IPCC 2014) estimated that this commitment would be an extra 0.6° C by 2100 and a full equilibrium warming commitment of 'about 2° C' long after 2100 (Chapter 12). Today's global warming is 1.1°C and atmospheric CO2 is 408 ppm (March 2018 seasonally adjusted mean CO2). That would put today's committed warming at 2.08° C. Atmospheric CO2 is increasing faster than ever. Both committed global temperature increases (policy and science) last for a thousand or more years (Solomon et al. 2009), over which time more species will be driven to extinction.

The first estimate for a climate change danger limit was in 1990 and was based on safety for ecosystems. 'A maximum sea level rise of between 0.2 and 0.5 m above the 1990 global sea level' and 'a maximum rate of rise of between 20 and 50 mm per decade were recommended to 'permit the vast majority of vulnerable ecosystems, such as natural wetlands and coral reefs, to adapt' because 'beyond this rate of rise, damage to ecosystems will rise rapidly' (Rijsberman and Swart 1990).

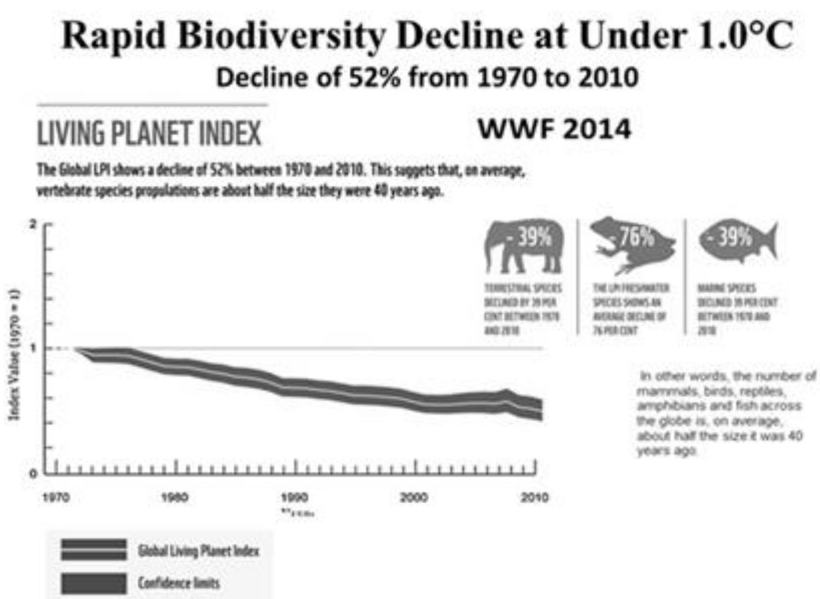
A mean global temperature rise limited to a maximum rate of change in temperature of 0.1° C per decade was recommended based on an understanding of the vulnerability of ecosystems. 'Temperature increases beyond 1° C may elicit rapid, unpredictable, and non-linear responses that could lead to extensive ecosystem damage' (Rijsberman and Swart 1990).
Rijsberman and Swart (1990) also recommended a maximum CO2 equivalent concentration of 330 to 400 ppm in the atmosphere. Today global temperature change is just above 1.0° C and atmospheric CO2 equivalent in 2016 was 489 ppm (NOAA 2017), far above ecosystem safety. Since the 2012 UN Paris Climate Agreement, the science has treated 1.5° C, rather than 2° C, as the danger limit. Although not so defined in the Paris Agreement, since 2009 the standing equilibrium warming target has been reduced to a target only by 2100. Climate system commitment means that this will be double long after 2100.

The IPCC assessments, the main source of data and information for this chapter, let us know how much and how long we have known about the global climate change impacts to biodiversity.

With each succeeding assessment since 1990, the climate change situation for biodiversity has been found, with more research, to be worse, not better. Furthermore, the uncertainties make the predictable impacts on biodiversity considerably worse than published.

The committed species extinction rate at increasing degrees of climate change was used in the IPCC’s 4th assessment (2007). Population abundance is a major indicator of biodiversity decline.

The last World Wide Fund for Nature Living Planet Report (2016) on species population abundance shows a sustained rapid decline since 1970.



In this time of accelerating global warming (Haustein et al. 2017),ecosystems matter a lot to global, as well as regional,biodiversity and the future survival of most of the world’s species. Some ecosystems hold enormous sources of potential carbon feedback emissions that are vulnerable to release by global warming acting upon these ecosystems (recognized by IPCC 1990). As recognized and mapped in 2006, these large vulnerable carbon pools include permafrost, high latitude peatlands, tropical peatlands and vegetation subject to fire and/or deforestation (Canadell et al. 2006). Risk of acceleration of global warming due to global induced warming induced Amazon die back is well known and was recognized years ago (Cox et al. 2000).

The worst possible effect of global surface warming on all of life is an ecosystem change effect of the Arctic releasing wetland and permafrost carbon. Global warming will last for over 1000 years (Solomon et al. 2009), which means we can expect multiple carbon feedback emissions from the several enormous planetary pools of carbon. The risk of planetary catastrophic ‘runaway carbon dynamic’ was first recognized by the IPCC in the third assessment (IPCC 2001).

Another great concern, with respect to global climate change and biodiversity, is the potential amplifying negative interaction between biodiversity loss and global climate change, where each makes the other worse in a negative synergistic manner for both. Brook et al. (2008) point out that species loss can occur directly and abruptly if habitat destruction or overexploitation of populations is severe. 'Yet the final descent to extinction is often driven by synergistic processes (amplifying feedbacks) that can be disconnected from the original cause of decline.' They reviewed 'recent observational, experimental and meta-analytic work which together show that owing to interacting and self-reinforcing processes, estimates of extinction risk for most species are more severe than previously recognized. As such, conservation actions which only target single-threat drivers risk being inadequate because of the cascading effects caused by unmanaged synergies.' Their paper anticipated that climate change would interact with and accelerate ongoing threats to biodiversity, such as habitat degradation, overexploitation and invasive species.

This synergistic interaction, taken further by Segan et al. (2016), has to be taken into account in a general and region-specific manner to plan priorities in conservation, mitigation and adaptation. Adaptation is urgent today but cannot be expected to be successful for long without concomitant mitigation; a long-held global climate change principle is that adaptation must accompany mitigation. For mitigation, this means a biodiversity and climate emergency immediate, rapid decline in global emissions. This will have a multiplier effect on estimates of future biodiversity loss by projections of already committed global climate change, hence the extreme urgency of mitigating for both.

The IPCC 4th assessment (2007) said that global extinction is a crucial key issue 'because of a very likely link between biodiversity and ecosystem functioning in the maintenance of ecosystem services' and 'extinctions are critical for ecosystem functioning.' Grace et al. (2016) found that communities rich in species are substantially healthier and more productive than those depleted of species. Here we take the health of ecosystems and biodiversity as one entity called 'ecosystem biodiversity.'

As it is, the current accelerating rate of species extinction is 1,000 times the background rate (Pimm et al. 2014). With committed climate change, this is likely to become the highest rate of any extinction event on Earth with accelerating losses for every degree rise in global temperatures (Urban 2015). Today's emissions targets, which substantially increase (rather than decrease) global emissions by 2030, are bound to make this extinction qualify as the fastest ever. This policy commitment is, to a large extent, avoidable and would be greatly reduced if governments followed the recommendations of the climate and ocean change scientists, which is to immediately and rapidly reduce global emissions.

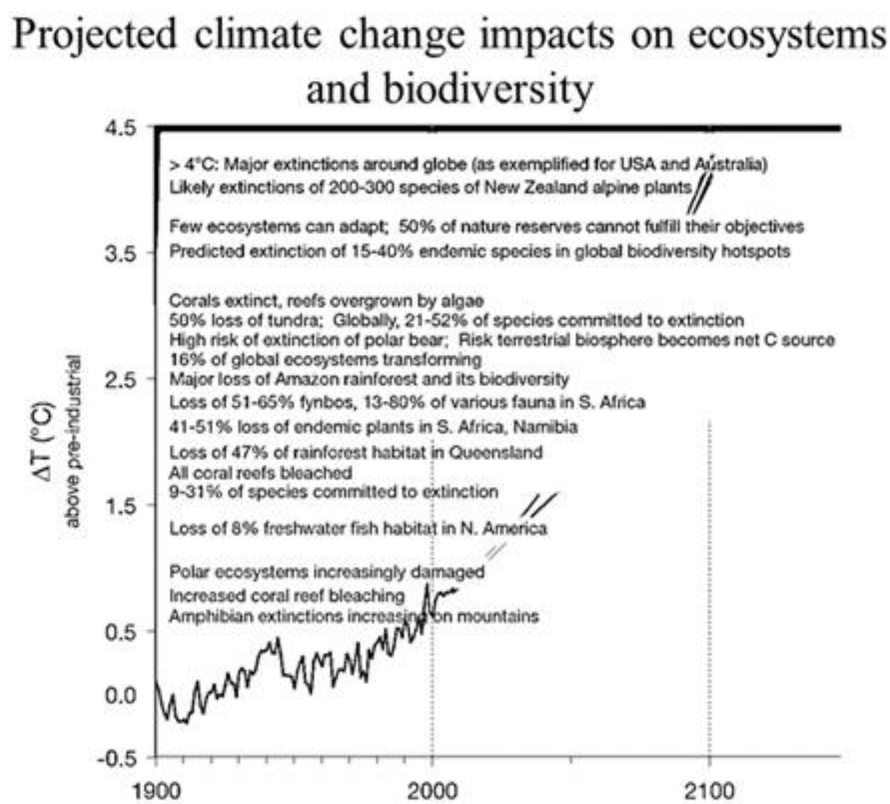
Climate system inertia results in an unavoidable global climate change commitment, which is substantially higher than today's degree of climate change. Based on a 2012 global warming of 0.85°C, the IPCC's 5th assessment (2014) estimated that this commitment would be an extra

0.6C 0.6C by 2100 and a full equilibrium warming commitment of 'about 2° C' long after 2100. Today, global warming has reached just over 1° C since industrialization.

The IPCC's 3rd assessment (2001) Summary for Policy Makers (SPM) (which is approved by all world governments) reported emergent findings that regional changes in climate, particularly increases in temperature, had already affected a diverse set of physical and biological systems in many parts of the world, with associations between changes in regional temperatures and observed changes in physical and biological systems documented in many aquatic, terrestrial, and marine environments.

The IPCC (2007)SPM reported with high confidence that recent warming was strongly affecting terrestrial biological systems and changes in freshwater and marine biological systems, with declining oxygen levels and circulation. Approximately 20-30% of plant and animal species assessed at additional increased risk of extinction above 1.5-2.5° C. For increases in global average temperature exceeding 1.5-2.5° C and in concomitant atmospheric carbon dioxide concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions, and species' geographical ranges, with predominantly negative consequences for biodiversity. The progressive acidification of oceans due to increasing atmospheric carbon dioxide is expected to have negative impacts on marine shell-forming organisms (e.g., corals) and their dependent species.

The species extinction projections attracted much publicity. The IPCC 4th assessment provided a graph of more specific ecosystem and species impacts (IPCC (2014) WG2 Fig. 4.4).



IPCC 2007, Figure 4.4. Compendium of projected risks due to critical climate change impacts on ecosystems for different levels of global mean annual temperature rise, ΔT, relative to pre-industrial climate

For an in depth projection of ecosystem impacts, see IPCC (2007) Working Group 2 Table 4.1. Their extinction projections relied largely on Thomas et al (2004), a short paper that remains very important as it is rich with information on global climate change and biodiversity. The topic has been revisited and the Thomas projections mainly confirmed. The Thomas et al. projections include a high emissions climate change scenario, the latter being the closest to that which the world is tracking. The paper draws several crucial conclusions:

These estimates show the importance of rapid implementation of technologies to decrease greenhouse gas emissions and strategies for carbon sequestration. […] Minimum expected (that is, inevitable) climate-change scenarios for 2050 produce fewer projected “committed extinctions” by about half of those predicted under maximum expected climate change. These scenarios would diverge even more by 2100. In other words, minimizing greenhouse gas emissions and sequestering carbon to realize minimum, rather than mid-range or maximum, expected climate warming could save a substantial percentage of terrestrial species from extinction. Returning to near pre-industrial global temperatures as quickly as possible could prevent much of the projected, but slower acting, climate-related extinction from being realized. (Thomas et al. 2004)

This is a call for the immediate global decline of emissions, as in the IPCC (2014) best-case scenario.

A big point of the paper was that by 2050, global climate change could take over from direct habitat change as the main cause of special extinctions and biodiversity loss. The worst case was a committed 58% of all species by 2050 by climate change alone. The paper estimated that an additional 34% of all original species would be committed to extinction due to habitat destruction from 2000 to 2050. The paper adds that extinction risks might be even higher taking other factors into account. (Thomas et al. 2004)

One of the worst possible outcomes for biodiversity is synergy between global climate change and the other non-global climate change impacts, where the combined effects of multiple stressors are greater than the sum of individual effects. Assessments have assumed that multiple stressors lead to cumulative linear effects, with little interaction among threats considered. Findings serve as a reminder that these assessments should seriously consider the potential synergy and compounding threat interactions, especially with stressors that are as complex as climate change. Fortini and Dye (2017) indicate the seriousness of ‘potential synergisms and compounding threat interactions, especially with stressors that are as complex as climate change.’

It is important to realize, due to commitment, that to prevent an impact projected to occur at, for example, 3° C, the global warming must be limited to 1.5° due to total climate system inertia. The IPCC (2014) climate change assessment is grim for the future of biodiversity and species:‘A large fraction of both terrestrial and freshwater species faces increased extinction risk under projected climate change during and beyond the 21st century, especially as climate change interacts with other stressors, such as habitat modification, over-exploitation, pollution, and invasive species (*high confidence*).’ Extinction risk is increased under all RCP (representative carbon pathway) scenarios, with risk increasing with both magnitude and rate of climate change. Many species will be unable to track suitable climates under all scenarios except the best case (RCP2.6) this century. Those that cannot adapt sufficiently fast will decrease in abundance or go extinct in some or all of their ranges, with large losses of biodiversity.

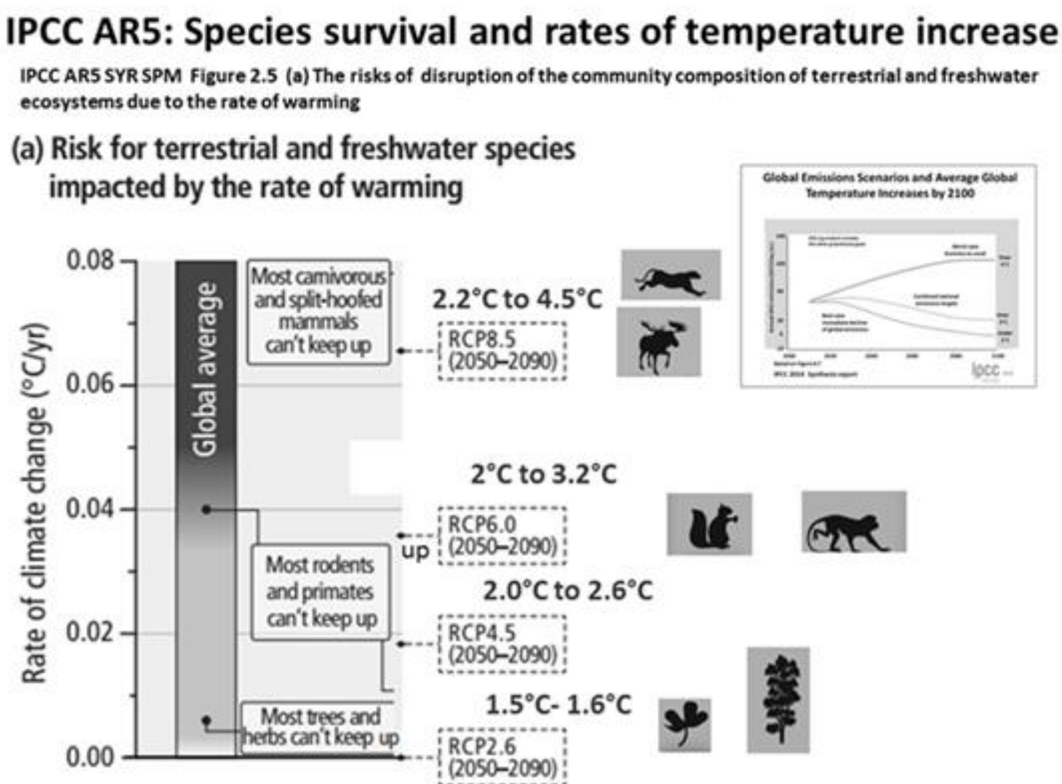
The IPCC (2014[RIB1])SPM Synthesis report provided Figure 2.5, showing the velocity capacity of species compared to the rate of climate change. Under the best-case emissions scenario (RCP2.60, which causes the slowest rate of climate change, trees and herbaceous plants cannot keep up, leading to an extremely high risk of extinctions in general. At the highest emissions scenario, which the world is rodents and jungle primates will be unable to keep up. The same applies to freshwater mollusks

[RIB1]Intergovernmental Panel on Climate Change (2014) Climate change 2014: mitigation of climate change. Cambridge University Press

‘Continued emission of greenhouse gases’ increases ‘the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. [⋯] Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. [⋯] The risks of abrupt or irreversible changes increase as the magnitude of the warming increases’ (IPCC 2014 SYR).

Within this century, magnitudes and rates of climate change associated with all but the ~~best case~~best-case emissions scenario (immediate global decline) pose high risk of abrupt and irreversible impacts on terrestrial and freshwater ecosystems, including wetlands. These include the potential of ecosystems to become a source of feedback carbon emissions. Examples that could lead to substantial impact on climate are the boreal-tundra Arctic system and the Amazon forest. Carbon stored in the terrestrial biosphere (e.g., in peatlands, permafrost, and forests) is susceptible to loss to the atmosphere. Increased tree mortality and associated forest dieback is projected to occur in many regions this century, due to increased temperatures and drought. Forest die back poses risks to carbon storage and biodiversity. In fact, forest die back has already started, with the IPCC (2014) reporting ‘extensive tree mortality and widespread forest die back linked to drought and temperature stress have been documented on all vegetated continents.’ This includes the great Amazon and Boreal forests (IPCC 2014 Box 4-1).

The IPCC (2014) assessment of species extinctions is only up to 2100, which is not in fact total committed extinctions as warming is committed to substantially increase after 2100.



The fact that trees and herbaceous plants are unable to keep up with the rate of climate change equivalent to a global warming of 1.5° C by 2100 is of enormous concern because of the very many species that depend on trees and plants for survival. With extensive tree mortality and widespread forest die back on all vegetated continents (IPCC 2014), the impact of this on biodiversity in general is clear. For example, the Wildlife Tree Committee of British Columbia, Canada (n.d.) has determined that about 80 species, or 15% of the province's birds, mammals and amphibians, depend on trees for their survival.

This is yet another reason for making the immediate global decline of emissions an imperative for the survival of the natural world.

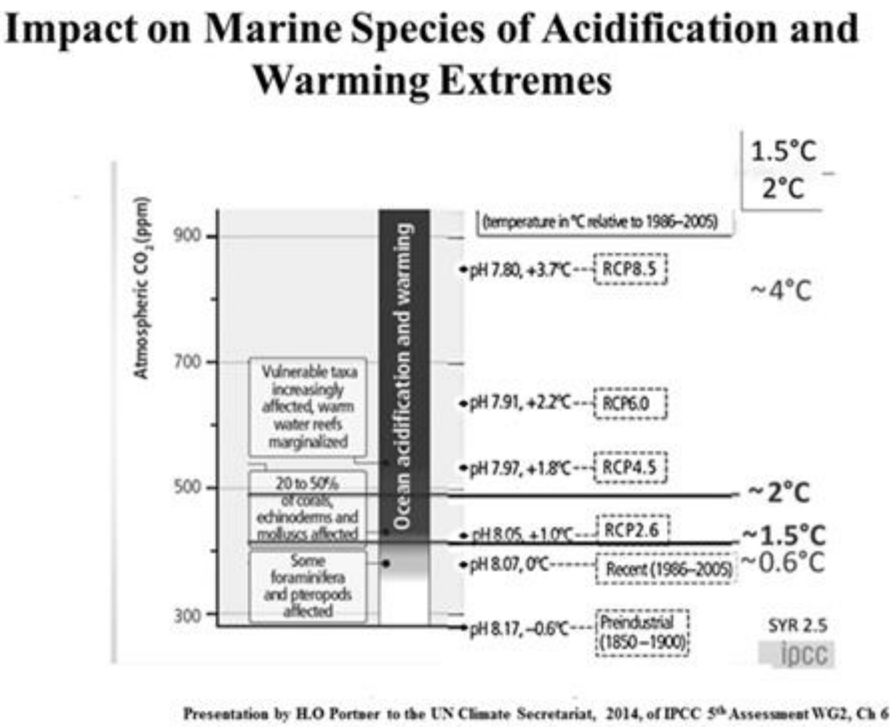
The IPCC (2014)Chapter 4 provides for detail. Forests have greened up,but recent evidence suggests that the stimulatory effects of rising CO2 concentrations on tree growth may have already peaked, and that warming and changes in precipitation are increasing tree mortality in a wide range of forest systems. Recent and longer-term assessments indicate with high confidence that many areas of boreal forest have started to experience productivity declines mainly due to drying and drought**.** The forests of the Amazon Basin are being altered through severe droughts, land use (deforestation, logging), and increased frequencies of forest fire. Some of these processes are self-reinforcing through positive feedbacks, and create the potential for a large-scale tipping point. Climate change contributes to this tipping point by increasing drought severity, reducing rainfall, and raising air temperatures (IPCC 2014 WG2 Fig 4.8).

Kew's State of the World's Plants 2016 (2016) estimated that 1 in 5 plants are threatened with extinction. In 2017, Botanic Gardens Conservation International published the first-ever global database of trees (Beech et al. 2017), which revealed that out of 60,065 total, 9,600 tree species are threatened with extinction. This number includes over 300 species that are critically endangered with fewer than 50 individuals remaining in the wild.

The effective measures for ecosystem adaptations are essentially the same as for mitigation, that is, large expansion of protected areas and termination of deforestation. Coastal afforestation, watershed management, and maintaining wetlands and urban green space (IPCC 2014WG2 Table SPM 1) will only be successful if they accompany the most aggressive global climate change mitigation measures possible. There are no known effective adaptation measures for Arctic ecosystems (IPCC 2014 SPM Box 2 table 1).

According to the IPCC fifth assessment (2014), coastal biodiversity is threatened by eutrophication-driven deoxygenation and sea level rise. Ocean biodiversity is severely threatened by the combination of deep open ocean heating, deoxygenation and acidification. These are all accelerating – with ocean heating going deeper, faster – and the IPCC (2014) says they are predicted to combine synergistically, a situation that has the potential for ocean biodiversity collapse, which alone would be a calamity for life on land. In the Pörtner projections (IPCC 2014), keep in mind that climate system commitment is 2° C equilibrium warming and policy commitment is over 3° C by 2100, which is a full equilibrium commitment of over 6° C after 2100.

The graph on marine species impacted by ocean acidification and warming extremes, provided by the IPCC (2014)SYR Fig. 2.5. shows a risk to marine species from ocean acidification and warming. This shows that today, some foraminifera and pteropods are already being affected. At an acidification with a global surface warming of 1.6° C, 20-50% of corals, echinoderms and molluscs are affected. At a global warming of 2.4° C, vulnerable taxa are increasingly affected and warm water coral reefs are marginalized



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From 1910 to 2010, there is a recorded 70% decline in ocean biomass and fish stocks (IPCC 2014 Chapter 6). 'The progressive expansion of oxygen minimum zones and anoxic "dead zones" is projected to further constrain fish habitat. Open-ocean net primary production is projected to redistribute and to fall this century globally under all RCP scenarios. Climate change adds to the threats of over-fishing and other non-climatic stressors' (IPCC 2014 WG2 SPM). There is little to no effective adaptation available for ocean ecosystems and species (IPCC 2014 SPM Box 2 Table 1).

Far ahead of the modelling projections, 2018 research has the ocean meridional overturning circulation leading to an abrupt cooling of 2-3° C in a decade. At today's climate system committed global warming, land ecosystems neighbouring the North Atlantic could be plunged into a devastating abrupt cooling (Sgubin et al. 2017). The IPCC (2007)had projected ecosystem impacts due to weakening of the meridional overturning circulation from a global warming of 2.5° C.

For all emissions scenarios except the best-case immediate global emissions reduction scenario, ocean acidification poses substantial risks to marine ecosystems, associated with impacts on the physiology, behaviour, and population dynamics of individual species from phytoplankton to animals. Ocean acidification acts together with other global changes (e.g., warming, decreasing oxygen levels) and with local changes (e.g., pollution, eutrophication). Simultaneous drivers, such as warming and ocean acidification, can lead to interactive, complex, and amplified impacts for species and ecosystems (IPCC 2014 WG2 SPM).

Coral reefs worldwide would seem committed to extinction at a 2° C global warming plus acidification. To protect at least 50% of the coral reef cells, global mean temperature change would have to be limited to 1.2° C (1.1-1.4° C), not taking ocean acidification effects into account (Frieler et al. 2013). The phenomenon of interspecies mismatching / mistiming is a huge climate change concern that is now happening ([RIB1] Kharouba[RIB2] et al. 2018), adding another devastating layer to climate change impacts on biodiversity. (Read more at: https://phys.org/news/2018-04-global-nature-dinner.html.)

Conclusions

The global aggregate of national emissions policies commits (indeed, condemns) the world to a future global biodiversity collapse. The now recommended limit to global warming of 1.5° C, on top of the 6th extinction, is still deadly for global biodiversity. The imperative now is mitigating catastrophic global climate change to ecosystems and biodiversity. From multiple lines of evidence, this requires the immediate and rapid decline in global emissions, reaching near zero within decades. Due to climate system commitment, preventing the future collapse of global biodiversity depends on achieving safe removal and sequestration of atmospheric CO2, which, for biodiversity, is definitely not biomass energy with carbon capture and sequestration (BECCS). Geo-engineered global cooling is not an option for biodiversity.

Due to climate system commitment, preventing the future collapse of global biodiversity will depend on industrial greenhouse gas emissions being put into immediate rapid decline (achieving near zero emissions by mid-century); ending fossil fuel subsidies; ending deforestation, and deforestation-driving government subsidies; charging central fossil fuel producers the full environmental and social costs of their pollution; and protecting huge swathes of the world's land and oceans.

Clearly, the imperative is also for a massive global upgrade of conservation and ecosystem adaptation prioritized on global biodiversity hotspots. This will require massive upgrading in funding for the research, the conservation, and the adaptation.

[RIB1]**More information:** Heather M. Kharouba el al., "Global shifts in the phenological synchrony of species interactions over recent decades," *PNAS*(2018). www.pnas.org/cgi/doi/10.1073/pnas.1714511115

Read more at: https://phys.org/news/2018-04-global-nature-dinner.html#jCp

[RIB2]Kharouba HM, Ehrlén J, Gelman A, Bolmgren K, Allen JM, Travers SE, Wolkovich EM (2018) Global shifts in the phenological synchrony of species interactions over recent decades. Proceedings of the National Academy of Sciences 11:201714511

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