Rialtas na hÉireann
Government of Ireland

Ireland's Biodiversity Sectoral Climate Change Adaptation Plan

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Green Shieldbug (*Palomena prasina*) was confined to south of Dublin and Galway but has moved north in last few decades and now is found as far north as Belfast and Lough Neagh (Photographer: Brian Nelson)

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Executive Summary

Climate change is now affecting every country on every continent. It is disrupting national economies, affecting lives, and is a major and growing driver of biodiversity loss. Headline results from the 2018 Living Planet Report, published by the World Wildlife Fund, reveal that Earth is currently losing biodiversity at a rate seen only during mass extinctions. We are the first generation that has a clear picture of the value of nature and its integral link with human well-being. We are also the last generation that has the opportunity to prevent the collapse of our planet's biodiversity in the face of habitat destruction and climate change.

Irish biodiversity is highly vulnerable to the impacts of climate change and has a low adaptive capacity compared to other vulnerable sectors. Climate change has major indirect impacts on Irish biodiversity through its interaction with other stressors, in particular habitat fragmentation and loss; over-exploitation; pollution of air, water and soil; and spread of invasive species. This Biodiversity Sectoral Adaptation Plan considers terrestrial, freshwater and marine biodiversity and ecosystem services. The purpose is to identify adaptation options that will help to protect biodiversity and ecosystem services from the impacts of changing climate.

The goal of this Plan is to protect biodiversity from the impacts of climate change and to conserve and manage ecosystems so that they deliver services that increase the adaptive capacity of people and biodiversity. This will contribute towards commitments made under the 2015 Climate Paris Agreement.

The objectives set out in this plan are to:

1. Protect and restore biodiversity to increase the resilience of natural and human systems to climate change;
2. Improve understanding of the impacts of climate change on biodiversity;
3. Improve landscape connectivity to facilitate mobility in a changing climate;
4. Engage society to protect biodiversity to enhance resilience; and
5. Ensure sufficient financing is available to implement the Biodiversity Climate Change Adaptation Plan

It is imperative that all sectors recognise their role in reducing the pressures on biodiversity, protecting and restoring ecosystem services and contributing to adaptation measures to increase resilience to climate change. For example, the permeability of the landscape and potential avenues for the spread of invasive species should be considered by the transport sector; Local and national

planning authorities should incorporate green infrastructure into future development plans; and Agriculture, forestry and fisheries should evaluate measures undertaken in government programmes to ensure no further degradation of biodiversity occurs. Due to this cross-cutting nature of biodiversity it is vital that ALL sectoral and local adaptation plans take ownership over this plan. This responsibility is shared with the citizens of Ireland, state agencies, local authorities and all government departments.

Introduction

"We are the first generation that has a clear picture of the value of nature and its integral link with human well-being. We are also the last generation that has the opportunity to prevent the collapse of our planet's biodiversity in the face of habitat destruction and climate change" (WWF, 2018).

The scientific evidence indicates that the Earth's climate is changing (IPCC, 2014a) and, without taking appropriate and early action, climate change will have severe impacts on many of the planet's species and habitats and their capacity to provide adaptation and other benefits to people (COM, 2009; Scheffers et al., 2016). Furthermore, a recent special report by the Intergovernmental Panel on Climate Change (IPCC) indicates significant impacts to biodiversity and other sectors are set to occur even if we keep climate change to 1.5^{O}C over preindustrial levels, which are below business-as-usual global average temperature increases by mid-century (IPCC, 2018).

Biodiversity is at the forefront of climate change impacts globally. Headline results from the 2018 Living Planet Report, published by the World Wildlife Fund (WWF, 2018), reveal that Earth is losing biodiversity at a rate seen only during mass extinctions. The report finds that global losses in vertebrate species - mammals, fish, birds, amphibians and reptiles – have averaged 60% between 1970 and 2014. Overexploitation of species, agriculture, land conversion, and climate change are the main drivers of biodiversity decline, with climate change becoming a growing threat. The 2018 Conference of the Parties to the Convention on Biodiversity also echoes the findings of the WWF Living Planet report in highlighting the critical role of biodiversity and ecosystems functions and services for human well-being (CBD, 2018). The Conference also recognised that climate change is a major and growing driver of biodiversity loss, and that biodiversity and ecosystem functions and services, significantly contribute to climate change adaptation, mitigation and disaster risk reduction.

Ireland's national policy in response to climate change is the Climate Action and Low Carbon Development Act 2015. This Act provides for preparation and approval of plans by Government covering climate change mitigation and adaptation with the purpose of pursuing the transition to a low carbon, climate resilient and environmentally sustainable economy by 2050 (DECLG, 2016). This includes the submission of iterative National Adaptation Frameworks (NAFs). Under the statutory National Adaptation Framework (NAF) Government Departments have to prepare Sectoral Adaptation Plans (DCCAE, 2018a). Twelve sectors including Biodiversity have been selected for consideration. While biodiversity is included as a sector (along with health, water quality, transport infrastructure and electricity and gas networks) it is clearly a special case as it does not fit neatly into sectoral bounds. Biodiversity is a cross-cutting issue with implications for all sectors and all levels of decision making.

The science is clear that climate change will exacerbate the threat facing biodiversity. Furthermore, biodiversity is highly vulnerable to the impacts of climate change and also has the lowest adaptive capacity (ability) to recover from damages of all sectors currently considered (Coll and Sweeney, 2013). It is also well documented that degraded habitats are less resilient to the impact of climate change and are less able to provide the ecosystem services humans need to survive. Ireland is committed to safeguarding biodiversity – under the Convention on Biological Diversity (CBD) and the Sustainable Development Goals (SDGs) – as well as by European and national law. Climate change thus creates another imperative to safeguard biodiversity and in turn biodiversity will protect and increase the resilience of human beings to the impacts of climate change (e.g. healthy dune systems give protection from increased storminess and well vegetated uplands reduce the risk of soil erosion and landslides in intense rainfall).

Due to the cross-cutting nature of biodiversity it is vital that ALL sectoral and local adaptation plans:

1) Emphasise the importance of natural capital, including biodiversity, to resilience building in all sectors;
2) Systematically evaluate and implement (where viable) nature-based adaptation actions.

As such ownership for this plan is shared with the citizens of Ireland, state agencies, local authorities and all government departments.

Box 1: Definitions

"Biological diversity" or biodiversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD Secretariat, 1992).

Biodiversity plays a key role in the functioning of *ecosystems*, their resilience and their continuing ability capacity to provide *"ecosystem services"* (Seddon et al., 2016; Oliver et al., 2015; Isbell et al., 2015). Biodiversity provides us with, for example, clean air, water, food, materials, medicines, health benefits, and recreation. It supports pollination and soil fertility, regulates climate and protects us from extreme weather and other effects of climate change. It is these benefits that underpin our economy, health and wellbeing (MEA 2005).

Natural capital is the world's stock of natural resources, which includes geology, soils, air, water and all living organisms. Some natural capital assets provide people with free goods and services, often called ecosystem services. These underpin our economy and society and make human life possible[1].

Nature-based or ecosystem based adaptation actions are actions that restore and protect natural habitats to help people adapt to the effects of climate change. There is an increasing awareness that nature can often provide the most cost-effective way of adapting to climate change whilst also protecting the ecosystem services on which we depend[2].

[1] Natural Capital Coalition www.naturalcapitalcoalition.org

[2] IUCN https://www.iucn.org/resources/issues-briefs/ecosystem-based-adaptation

The purpose of this document is to identify adaptation options that will help to protect biodiversity and ecosystem services from the impacts of a changing climate and secure the flow of ecosystem services, including adaptation benefits, to people (Box 2). The issue of climate change cannot be addressed by the Government alone. Therefore, this document is aimed at a wide range of actors, including public bodies, land managers, businesses and communities, who will be supporting the implementation of biodiversity-related actions, set out in this adaptation plan.

Development of this sectoral plan follows the stepwise methodology proposed by the former Department of the Environment, Community and Local Government (through a National Adaptation Steering Committee) who are responsible for developing the new framework (DCCAE, 2018a; Climate Change Advisory Council, 2018). See the Sectoral Planning Guidelines for Climate Change Adaptation for further detail (DCCAE, 2018b). Five steps have been identified in the Guidelines:

1. Building the adaptation team
2. Assessing the adaptation baseline
3. Assessing future climate risk
4. Identifying, assessing and prioritising adaptation options
5. Monitoring and Review

Biodiversity provides a wide range of ecosystem services that are essential for human well-being and sustainable development. Biodiversity, through the ecosystem services it supports, can make an important contribution to reducing the negative effects of climate change (CBD Secretariat, 2016). For example, conserved or restored habitats, such as forests and wetlands, can help to both mitigate the effects of climate

Box 2: Definition of adaptation and mitigation

To address the challenges and opportunities of climate change and the protection of biodiversity and ecosystem services two types of action are required: adaptation and mitigation. The Intergovernmental Panel on Climate Change (IPCC) define adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014a). The IPCC define mitigation as "a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs)", which is likely to be the dominant cause of the observed warming since the mid-20th century (IPCC, 2014a). Mitigation is not the focus of this plan but it is recognised that there are many synergies between mitigation and adaptation actions. For example, important land management decisions may exacerbate or reduce GHGs and some actions suggested here may contribute to mitigation. Meanwhile, efforts to protect ecosystems from the effects of climate change may enhance the capacity of the land to provide adaptation benefits to people (SWD, 2013)

change by removing carbon dioxide from the atmosphere and reduce the impacts of climate change by stabilizing slopes or slowing flood waters in catchments. Indeed, natural environments provide a wide range of ecosystem services (MEA, 2005), many of which effectively buffer communities from the adverse effects of climate change at low cost. These so-called 'adaptation services' can be provided directly (e.g. coastal ecosystems protecting local communities against erosion, wave damage and salt water intrusion) or indirectly (e.g. agroforestry techniques helping maintain crop yield under drier or more variable climates) (Jones et al., 2012). In recognition of these benefits, ecosystem-based adaptation is becoming increasingly recognised as an effective low-cost solution to both the causes and consequences of climate change.

The IPCC (2014b) recognise two main groups of options to reduce the vulnerability of biodiversity to the negative impacts of climate change (Box 3).

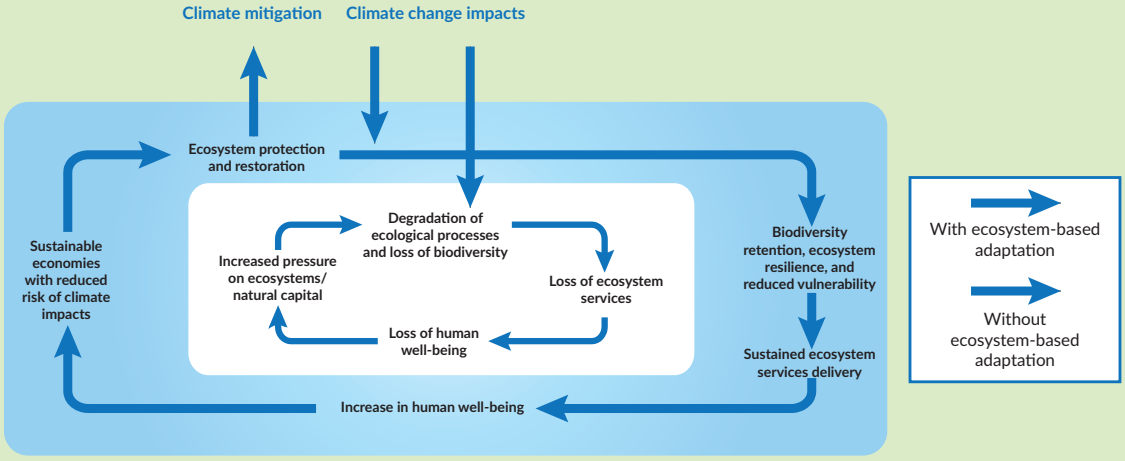
Many upland habitats regulate the flow of water and sequester carbon (Photographer: Jenni Roche)

Box 3: Adapting to climate change

Options to reduce the vulnerability of biodiversity to the adverse impacts of climate change can be grouped as:

1. Actions to help species and ecosystems adapt to specific climate change impacts, such as reducing habitat fragmentation, maintaining genetic diversity, assisting migration (translocation) and manipulating disturbance regimes; and
2. Ecosystem-based approaches (EbA) to adaptation, which refer to the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Such approaches include: management and establishment of protected areas and conservation agreements, coastal and wetland maintenance and restoration, adaptive forest management, the use of agro-ecosystems in farming systems, ecotourism activities and direct species management (CBD Secretariat, 2016).

The Figure below illustrates how EbA uses the capacity of nature to buffer human systems from the negative impacts of climate change (IPCC, 2014b). Maintaining ecosystem resilience helps to reduce the vulnerability of ecosystems by increasing their ability to adapt to changes. Integrated approaches to ecosystem management are a key feature of many EbA projects. They can contribute to the ability of EbA to deliver additional social and environmental benefits while reducing the change of maladaptation. Further, where the value of ecosystem services have been recognized, EbA is often a cost effective response to many climate change challenges (CBD Secretariat, 2016).



Ecosystem-based adaptation uses the capacity of nature to buffer human systems from the adverse impacts of climate change. Source: IPCC, 2014b.

Ecosystem conservation, restoration and management can contribute to climate change mitigation in addition to adaptation, biodiversity conservation and sustainable development. For example, increasing carbon storage through the restoration of degraded peatlands and grasslands, which also helps control flood waters (Dadson et al., 2017). Further, as mitigation reduces the rate and magnitude of warming, it increases the time available for climate change adaptation (CBD Secretariat, 2016).

The next section in this SAP provides a background to Irish biodiversity, including biodiversity policy in the context of climate change.

1. Background

1.1. Ireland's biodiversity

Marine, freshwater, and terrestrial habitats

Ireland's terrestrial, freshwater and marine environment encompasses a diverse range of habitats (DAHG, 2014). Habitats such as limestone pavements, turloughs, active peatlands, species-rich grasslands, offshore reefs and intact dune and machair systems are of particular significance because of their scarcity in both Ireland and/or the rest of Europe.

Ireland is required to monitor habitats and species that are considered threatened across Europe and are listed in the Habitats Directive (92/43/EEC). Figure 1 shows the current status and trends of Ireland's habitats protected under the EU Habitats Directive (NPWS, 2013). Only 9% of habitats assessed have a 'favourable' conservation status, although the condition of 64% of habitats is either 'improving' or 'stable'. The habitats of greatest concern are those that have reduced range and/or area, such as raised bogs and species-rich grasslands (NPWS, 2013).

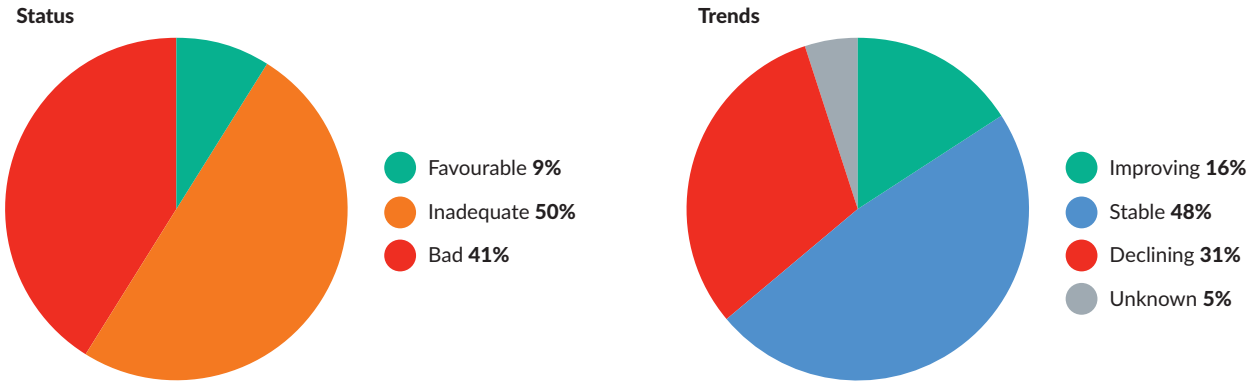


Figure 1. Overall assessment results for the status and trends in habitats protected under the EU Habitats Directive in Ireland 2007-2013.

Species

Due to its climate and topography, wetland habitats are well represented in Ireland. As a consequence, Ireland supports internationally significant populations of several aquatic species such as the otter *(Lutra lutra)*, Atlantic salmon *(Salmo salar)*, freshwater pearl mussel *(Margaritifera margaritifera)*, white-clawed crayfish *(Austropotamobius pallipes)* and some endemics including the amphipod *(crustacean)*

Niphargus wexfordensis, Killarney shad *(Alosa fallax killarnensis)* and pollan *(Coregonus autumnalis pollan)* (DAHG, 2014). Ireland is also relatively rich in bryophytes, algae and lichens, with over 8,000 species of algae and fungi yet to be discovered (DAHG, 2014).

Most of Ireland's known species are invertebrates totalling over 19,000 species (Ferriss et al., 2009). Ireland maintains important populations of certain butterfly species, for example, the wood white *(Leptidea sinapsis)* and the marsh fritillary *(Euphydryas aurinia)*, which is protected under the EU Habitats Directive (DAHG, 2014).

Figure 2 shows the current status and trends of Ireland's species protected under the EU Habitats Directive (NPWS, 2013). Fifty-two percent of species assessed have a 'favourable' conservation status and the condition of 88% of species is 'improving' or 'stable'. The pollution-sensitive freshwater pearl mussel is of pressing concern due to limited rivers containing populations with even near adequate recruitment (NPWS, 2013).

A total of 211 species of birds breed in Ireland. These species mainly comprise common and widespread birds that have adapted to agricultural landscapes (BirdWatch Ireland, 2012; Birdlife International, 2017).

Ireland is also required to report on the progress made with the implementation of the Birds Directive (2009/147/EC). Ireland reported to the EU on the long-term trends of Ireland's breeding and wintering bird populations in 2013 (EEA, 2015a). It found that 25.7% of breeding bird populations and 22.8% of wintering bird populations were either 'improving' or 'stable'. However, the trend in a large proportion of breeding and wintering bird populations could not be assessed and were recorded as 'unknown' (56.6% and 61.4% respectively).

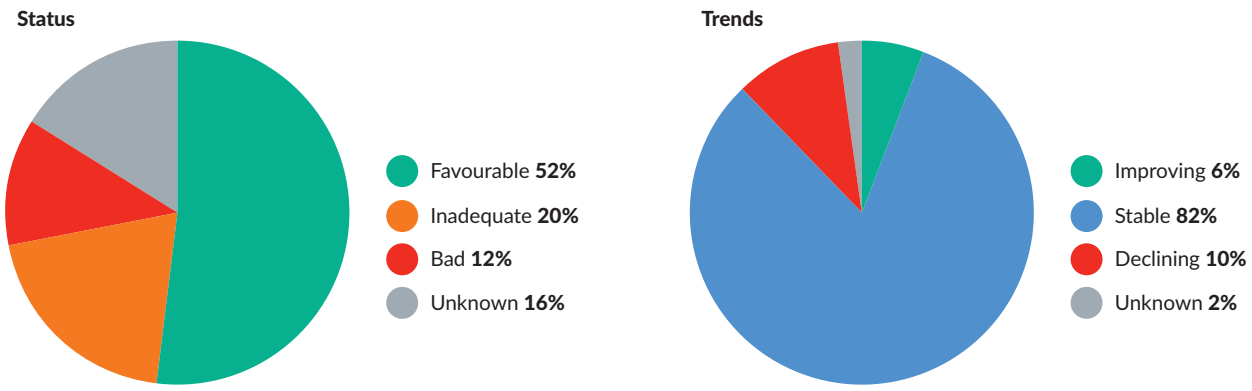


Figure 2. Overall assessment results for the status and trends in species protected under the EU Habitats Directive in Ireland 2007-2013.

1.2. Biodiversity policy in the context of Climate Change

As a Party to the UN Convention on Biological Diversity (CBD), Ireland must report on its progress towards implementation of the Strategic Plan for Biodiversity 2011-2020, which seeks to "take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication" (CBD Secretariat, 2010). The Strategic Plan outlines 20 Aichi Targets, with Target 15 focusing on climate change. It states "By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification".

The EU Biodiversity Strategy to 2020 reflects the commitments made in the global Strategic Plan and aims to halt the loss of biodiversity and ecosystem services in the EU and help stop global biodiversity loss by 2020.

National Biodiversity Strategies and Action Plans are the principal instruments for implementing the CBD at the national level. Figure 3 illustrates biodiversity policies from the global to national scales. Climate change is a pressure that is already impacting on habitat and species in Ireland and as a result it is cross-cutting with many of the objectives, targets and actions of Ireland's National Biodiversity Action Plan 2017-2021. As our understanding of climate change risks and impacts increases more actions can be integrated into future updates of Ireland's NBAP.

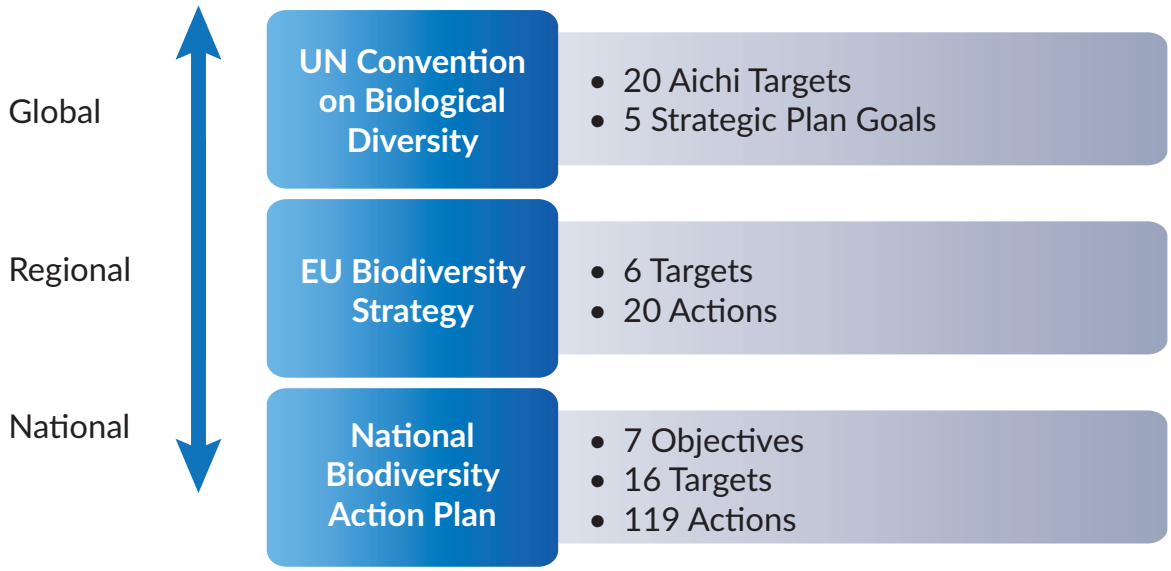


Figure 3. Biodiversity policies from a national to global scale. These policies set out the goals and planned activities at the national, regional, and global scales and are often achieved through institutional and legal frameworks such as the EU's Habitats Directive and Ireland's Wildlife Act.

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC) Ireland has committed to "promoting sustainable management, and to promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems" (UNFCCC Secretariat, 1992). In December 2015 countries adopted the first-ever universal, legally binding global climate deal - the Paris Agreement. It aims to strengthen the global response to the threat of climate change by limiting global temperature rise this century to less than 2^{O} Celsius and to pursue 1.5^{O} Celsius. In their efforts to limit global temperature rise Parties must "note the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity" (UNFCCC Secretariat, 2015).

The Paris Agreement addresses adaptation, with the aim of "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal" (Article 7.1). The agreement calls on its parties to pursue actions "on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty" (Article 4.1). There is growing awareness amongst policy makers and practitioners that strategic conservation of biodiversity and ecosystem services can strengthen human resilience and reduce vulnerability to climate change, so-called "ecosystem-based adaptation" (EbA). Therefore, to meet commitments mandated under the Paris Agreement, Ireland will need to scale-up the conservation and restoration of biodiversity and ecosystem services within the context of adaptation.

Biodiversity features within the SDG framework as Goal 15 (protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss), and is implicit in Goal 14 (conserve and sustainably use the oceans, seas and marine resources for sustainable development). Furthermore, the conservation and restoration of biodiversity and ecosystems is fundamental to meeting many other societal goals including food security (Goal 2), water security (Goal 6), mitigation and adaptation to climate change (Goal 13) and livelihood diversification (Goal 8).
The following sections cover the Sectoral Adaptation Planning Guideline steps: i) Preparing the Ground; ii) Climate impact screening; iii) Prioritisation; iv) Priority impact assessment; v) Plan development; and vi) Implementation, evaluation and review.

2. Preparing the ground (Step 1)

At the outset of the adaptation planning process it is important to ensure that the foundations for designing and delivering an effective adaptation planning process are established. A number of key elements are required to put these foundations in place. These include the establishment of a Sectoral Adaptation Planning Team that comprises of a Core Team and a Planning Team.

2.1. The sectoral adaptation planning team

Establishing a Core Team and a Planning Team ensures that a broad spectrum of relevant knowledge, know-how and technical expertise is considered in the development of the adaptation plan.

The Core Team

The Core Team is responsible for overseeing, coordinating and advocating climate change adaptation from planning through to implementation and beyond. The Core Team established to draft the Biodiversity Climate Change Adaptation Plan consists of Dr Deirdre Lynn, Dr Ciaran O'Keeffe and Dr Andy Bleasdale of the National Parks and Wildlife Service (NPWS) within the Department of Culture, Heritage and the Gaeltacht. NPWS brought in consultancy support for the development of the first draft of the Sectoral Adaptation Plan, Dr Eugenie Regan with academic assistance from Dr Alison Donnelly and Prof Nathalie Seddon. Dr Tara Shine, Environment and Development consultant, assisted by Dr Stephen Flood, Research Scientist at Centre for Marine and Renewable Energy at University College Cork have been engaged to support the development of this revised draft, the facilitation of the stakeholder workshop and the consultation process.

Key responsibilities of the Core Team include:

- Identifying stakeholders and assembling the Planning Team;
- Developing the plan to engage and involve stakeholders, including identifying their specific roles and supporting capacity building;
- Communicating goals and parameters;
- Creating working groups and designating leaders;
- Establishing roles and responsibilities and defining expectations;
- Setting a schedule and managing the process.

The Planning Team

The first task of the Core Team is the establishment of the Planning Team. A Planning Team is a vital component as planning for climate change adaptation relies on a wide variety of partners representing key sectoral interests and activities. These partners provide technical know-how and information, and

expertise on applying the science to decipher the sensitives within the sector. The Planning Team consists of the Irish Biodiversity Forum (Appendix IV) and the Irish Biodiversity Working Group (Appendix V).

2.2. Developing understanding, engagement and collaboration

An integral component of any sectoral climate change adaptation plan is the development of shared understanding of climate change and the creation of an overall vision/goal for adaptation. It is important to communicate a common understanding of the adaptation planning process and communicate process goals and parameters. In developing the Biodiversity Climate Change Adaptation Plan this shared understanding was facilitated by holding a stakeholder workshop that provided feedback on the initial draft plan (see Appendix II for workshop participants and Appendix III for workshop agenda). In addition, information on impacts of extreme weather events on Irish biodiversity was sourced from National Parks and Wildlife Conservation Rangers and Divisional Ecologists, and Irish Academics. Furthermore, workshop participants, the Planning Team and other identified stakeholders have provided feedback that has helped to shape this common understanding and reflected these understandings in the plan.

3. Climate impact screening (Step 2)

In order to plan for the consequences of changes and impacts on Ireland's biodiversity it is essential that a preliminary assessment (screening) of current and potential future sectoral vulnerability (including those which result from cross-sector dependencies and independencies) to these changes in undertaken. The purpose of this exercise is to allow the Planning Team to develop a broad understanding of sectoral vulnerability to climate change, the sectoral consequences of these, and to collect all the relevant preliminary information to allow for the prioritisation of the most urgent climate changes and impacts for further and more detailed analysis.

3.1. Screening for current climate impacts

In screening for sectoral vulnerability and consequences of current climate impacts on biodiversity the Core Team in conjunction with the Planning Team identifies past weather events and periods of climate variability that have been identified as having impacts on Irish biodiversity and the agencies who are tasked with protecting and enhancing it. Specifically, this task entails providing an overview of an impact (accounting for the exposure, sensitivity and adaptive capacity) and outlining the consequences of these changes on Irish biodiversity as a sector. This exercise should be carried out with reference to a relevant weather event, or period of climate variability or change. If possible, this exercise should also provide an estimate of the magnitude of the impact in terms of social, environmental and economic impact.

Identifying past weather events, periods of climate variability and change that have impacted upon biodiversity

As referenced above (Section 1.2 Developing Understanding, Engagement and Collaboration) an exercise in the identification of past extreme weather events and their impact on Irish biodiversity was carried out through an online request issued by the NPWS to 182 NPWS staff, 6 Environmental NGOS, 4 academics, and 1 ecological consultancy. Full results of this information request are presented in Appendix VI. In summary, the results present qualitative details on a series of extreme events from a ten-year period from 2018 to 2008 (Figure 4). In addition to the date of occurrence and event name (if a named storm) each event includes a brief description of the main climatological features (such as precipitation, wind and temperature extremes) along with observed impacts on habitats and species, the impacts the event had on capacity to carry out work (and associated impacts on operations, resources and infrastructure) as well as the source of the particular observed impact/s. One example from the summer drought and heatwave event of 2018 (from an ecologist in the Irish Peatland Conservation Council) identifies water shortages and high temperatures in the event description. It reports the observed impact of low water

levels in Girley Bog in County Meath, particularly in the cutover bog, and recalls how these conditions had negative impacts on Sphagnum transfer trials established in 2014 and 2015.

Over 90 listed impacts (either directly on habitats or on provision of services) are listed in the complete table.

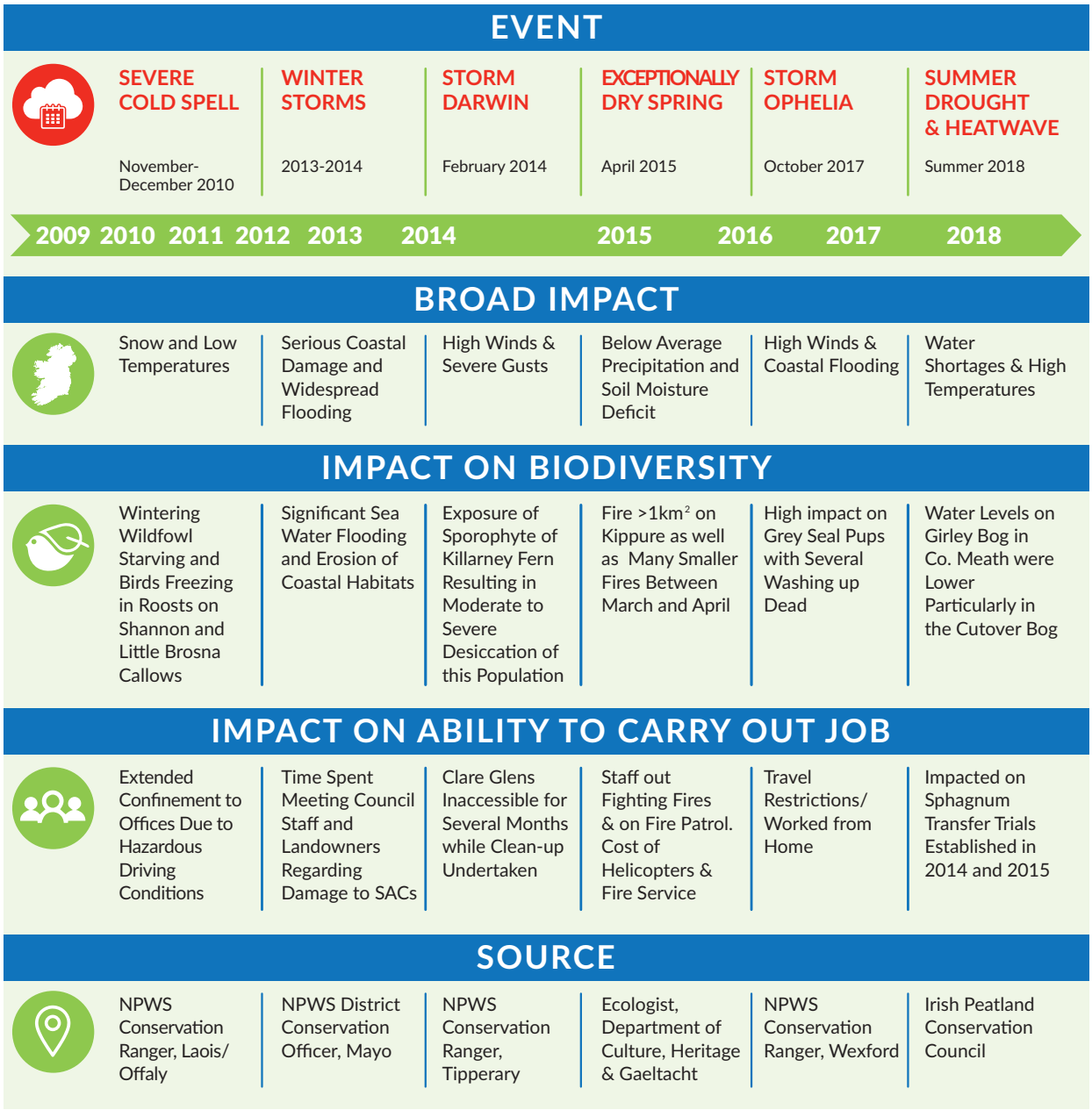


Figure 4: Ten-year extreme event timeline with observed impacts on the biodiversity

Identifying magnitude of impact

Ideally the magnitude of impact on the sector under consideration is listed under the categories of environmental, economic and social. In the impacts of extreme weather events examples (Appendix VI) respondents have primarily indicated qualitative environmental impacts. Qualitative social and economic impacts are captured though reported days off work as a result of winter storms, and inability to access nature sites. These qualitative data can form a basis for the development of quantitative impacts through delving deeper into impact specifics such as number of days lost, impact on nature site species and potential irrecoverable loss of habits as associated economic and social costs. This data is not being routinely collected, stored, and assimilated and a specific action to do so is noted in the Adaptation Action Plan.

3.2. Biodiversity and climate change

There is consensus among scientists globally that climate change has direct and indirect effects on biodiversity (Table 1) and that by the end of the century it is likely to become one of the most significant drivers of biodiversity loss (CBD Secretariat, 2016; Segan et al., 2016). There is clear evidence to show that biodiversity is already responding to climate change and will continue to do so. An average warming of ~1°C, has documented impacts across every ecosystem on Earth (Scheffers et al., 2016). These impacts have been recorded at different levels of biological organisation from genes, to communities to ecosystems. Of the 94 identified ecological processes, across terrestrial, marine and freshwater ecosystems, that underpin ecosystem functioning and support services to people, 82% showed evidence of impact from climate change (Scheffers et al., 2016).

The main observable direct impacts of climate change on species and communities are changes in phenology, species abundance and distribution, community composition, habitat structure and ecosystem processes. Although such impacts have been documented in many species and habitats, there remains great uncertainty about the timeframes over which these impacts will unfold across whole biological communities. Some biological responses will be rapid, others may take decades to materialise. Species respond to changes in their environment in their own individual ways. Some species may be able to move if local conditions become unsuitable. Evolutionary change and adaptation, however, is thought to occur more slowly than current and predicted rates of climate change (Hoffman & Sgro, 2011). This means that if species do not have the capacity to move at the rate dictated by climate change (due to poor dispersal capacity or an impermeable landscape) then they will go locally extinct. Variation in rates of movement and extinction can result in the decoupling of present day interactions between species and the disassembly of communities. It can also result in the creation of novel communities, which may not be stable or able to provide ecosystem services.

Temperature plays a key role in the timing of phenological processes in the annual cycle of plant species, such as the start of the growing season and the timing of fruit set. Shifts in the annual cycle of organisms can lead to mismatches in the interactions between species, for example in the relations between predators

and their prey and between plants and their pollinators, which can cause structural changes in the functioning of ecosystems (Ockendon et al., 2014). An ecosystem consists of relations between species in various functional groups. A functional group consists of species that perform more or less the same function in an ecosystem, such as pollinators, litter decomposers, herbivores and insectivores. There is a risk that key representatives of functional groups or even whole functional groups will disappear locally as a result of extreme weather events, such as flooding, leading to impaired ecosystem functioning (Scheffers, 2016). Extreme weather events and more erratic weather patterns may cause population sizes to fluctuate, which may increase the likelihood of small populations becoming extinct (Bellard et al., 2012). Populations may also take longer to recover from the effects of extreme weather when their habitat is fragmented.

Climate change will have a significant impact on the freshwater environment. For example, increases in the variability of river flows, wetland inundation and groundwater recharge will influence aquatic biodiversity (Hall et al., 2012; Jones et al., 2013), particularly species that respond to seasonal flow or inundation cues, such as fish and aquatic plants. Meanwhile, marine ecosystems are impacted by warming temperatures, changing wind patterns, shifting oceanic circulation patterns, increasing acidification and altering precipitation rates and hence salinity. These changes have the potential to change the distribution, abundance, size and behaviour of aquatic organisms, including economically important fish (Molinos et al., 2015). For example, intertidal and coastal ecosystems will be at risk from rising sea level, with the risk that intertidal habitats will be permanently under water over time, losing their intertidal nature and the species that depend on this diurnal change.

Climate change also has major indirect impacts on biodiversity through its interaction with other stressors, in particular habitat fragmentation and loss; over-exploitation; pollution of air, water and soil; and spread of invasive species. Some land use practices and planning decisions, as well as unsustainable use of the sea have rendered ecosystems and socioeconomic systems more vulnerable to climate change and thus less capable of adapting. These indirect, amplifying effects may be more damaging than the direct impacts due to their scale, scope and speed (Buma, 2015). They will further reduce the resilience of ecosystems to climate change and their capacity to deliver essential services, such as climate regulation, food, clean air and water, and control of floods or erosion (Box 4).

Box 4: Case Study – North Bull Island and Dublin Bay

Dublin Bay is bisected by the shipping lane of Dublin Port. The North Bull Island is the most designated site in the Republic of Ireland and has been officially recognised for its important biodiversity for a century. North Bull Island was designated as a UNESCO Biosphere Reserve in 1981 and was extended and re-designated in 2015 as Dublin Bay Biosphere Reserve (DBBR) to create a model for managing biodiversity at a landscape level in an urban area (http://www.dublinbaybiosphere.ie/about).

It presents a concept which is more identifiable to the public and fosters greater awareness and wider engagement in active management by citizens. The Biosphere is composed of a core area of wetland areas designated as part of the EU's Natura 2000 network. Each of the core zones contains unusual flora and fauna communities found in many remnant pockets of vegetation which exemplify the landscape history of the Dublin region prior to its development as a capital city. North Bull Island has two Natura 2000 sites: Special Protection Area (SPA) for birds under the Birds Directive and a Special Area of Conservation (SAC) under the Habitats Directive. Additionally, South Dublin Bay also has both an SPA and SAC. The core is supported by terrestrial buffer zones of parklands, greenbelts, golf courses and greenspace along watercourses that directly supply the protected wetlands and a marine buffer. A transition zone surrounds the core and buffer and is where people live and work sustainably to manage the Bay.

Dublin Bay comprises a wetlands complex of international importance for its coastal and estuarine habitats and its overwintering migratory bird populations. The DBBR has recorded 180 species of birds. It provides habitat for 30 species of water birds, with in excess of 37,000 water birds spending the winter in the bay complexes each year (30,000 in Dublin Bay and 7,000 in Baldoyle Bay) (Birdwatch Ireland). It is internationally important for Light-bellied Brent Goose, Knot, Black-tailed Godwit and Bar-tailed Godwit, and supports nationally important numbers of a further 18 species. These birds are protected under the EU Birds Directives and covered by the African-Eurasian Migratory Waterbirds Agreement (AEWA) of the Bonn Convention. There are two wetland complexes designated under the RAMSAR Convention - North Bull Island and Sandymount Strand - in Dublin Bay. North Bull Island alone has five Red Data Book vascular plant species, four rare bryophyte species, and is nationally important for three insect species (McCorry and Ryle, 2009).

Many plants in the DBBR are known to show great adaptation to extreme coastal conditions and variations of microclimate, and significant genetic variation and hybridisation can occur (Doogue, et al 1999; Curtis and Wilson, 2013). The North Bull Island and parts of the DBBR buffer zone in north Dublin include populations of Irish Mountain Hare (*Lepus timidus hibernicus*), a uniquely Irish sub-species of a species of national and international importance, but under severe pressure in this location from recreational disturbance and illegal poaching (Nulty and Hayden, 2012). Management of the DBBR takes climate change impacts such as flooding and coastal erosion into account. The management strategies aim to strengthen the resilience of the ecosystems and species to climate change, while maintaining the ecosystem services the reserve provides to local communities (e.g. protection from storms)

Dublin Bay Biosphere Reserve (photo courtesy of Dublin Port Company)

3.3. Screening for future climate change impacts and consequences in Irish biodiversity

Once known impacts and consequences of past extreme events have been identified and assessed in terms of their impact on biodiversity, the potential future impacts and sectoral consequences of projected changes in Ireland's climate can be assessed and should be carried out in consultation with the Planning Team. This task involves assessing how projected changes in climate might affect current levels of impact (causing increases or decreases), the sectoral consequences of these changes, and whether projected climate change will result in any other emerging impacts with consequence for sectoral activities.

In line with global patterns of climate change, the last century has been a period of unprecedented climate change in Ireland (Climate Ireland, 2017a). Box 5 provides a synopsis of evidence of climate change in Ireland. Ireland's biodiversity may be affected by this change in a number of important ways.

Box 5: A selection of observed and projected climate changes in Ireland. Source: Desmond et al. (2017)

Observed	Projected
Mean annual temperature increase of 0.8°C between 1900 and 2011	Mean annual temperature increase of 1-1.6°C by 2050
The number of warm days increased. The number of frost days decreased.	Increased frequency of heatwaves. Decrease of 50% of frost days by 2050
Increase in mean annual rainfall	Up to 20% decrease in summer rainfall by 2050 and 35% increase in extended dry periods
Increased mean annual flow	Increasing seasonality in hydrological regimes, with increases in winter/spring and decreases in summer.
	Fewer more intense storms
0.8°C increase in sea surface temperature since 1982	Ongoing increases in mean temperature
Increased seawater acidity	Ongoing increases in acidity
Sea level rise of 3.4 mm per year	Sea level rise of 25-44 cm by 2080
Increase in significant wave heights of 20 cm per decade since 1950	Surge events are likely to increase by c9mm per year

The observed and projected climate change impacts on Ireland's biodiversity can be categorised into four broad categories:

a) Changes in phenology (the timing of lifecycle events);
b) Changes in the geographical range of species;
c) Increased degradation of habitats and changes in ecosystem processes;
d) Increased occurrence of invasive species;

An overview of these impacts is shown in Table 1.

Category	Priority impacts
Phenology	• Changes in the timings of seasonal events • Disruption of species interactions
Geographical range and species abundance	• Shifts in suitable climate conditions for individual species leading to change in abundance and range • Loss of species (especially range restricted species) • Increased stress on species from more frequent extreme events (drought, flooding, fire, disease)
Degradation of habitats and changes in ecosystem processes	• Loss or changes in the structure and functionality of the habitats which species occupy • Changes to the composition of plant and animal communities • Loss of space due to sea level rise and associated salt water intrusion • Increased ocean acidification
Invasive species	• Arrival of new species better able to survive the new conditions, some may have negative impacts on the economy (e.g. via impacts on farming) • Existing species change in range as a result of climate change and become problematic

Changes in phenology

Increasing spring temperature in recent decades has been shown to impact the timing of key life-cycle events (phenology) in a range of plant (Donnelly et al., 2004 & 2006; Carroll et al., 2009; Gleeson et al., 2013), bird (Donnelly et al., 2009 & 2016; Carroll et al., 2009; Stirnemann et al., 2012) and insect (O'Neill et al., 2012) species in Ireland. The timing of leaf-out of a range of deciduous tree species at a number of locations has become earlier since the 1960s (Fig. 5). The arrival time of a number of sub-Saharan migrant bird species, such as the barn swallow (Hirundo rustica), has also become earlier since the 1970s; Greenland White-fronted geese departed the Wexford Slobs 22 days earlier in 2012 than in 1969 (Fox et al., 2012) while the departure of an over-wintering bird, the Whooper Swan (Cygnus cygnus), has shown a similarly early trend. In addition, analysis of 59 moth species over a 36-year period (1974–2009) revealed that many of the common moth species in Ireland, such as the flame carpet moth (Xanthorhoe designata), are emerging earlier now than in the 1970s and have a longer period of activity (O'Neill et al., 2012).

The response of these interdependent groups of organisms to increasing spring temperature has not been uniform thus demonstrating the potential for a mismatch to occur in the timing of when food becomes available and when it is needed (Donnelly et al., 2015). These findings suggest that there is a strong likelihood that ecosystem function will become disrupted in future as temperatures rise due to differing response rates of organisms to warming.

Overall, there is strong evidence that spring warming is having a detectable impact on the timing of phenological phases of Irish wildlife which is likely to continue as temperatures rise (Caffarra et al., 2011a&b; 2014). The implications of these changes may be reflected in our biodiversity in a number of ways including a disruption to previously synchronized ecosystem functioning which could lead to a change in species composition and ecosystem functioning.

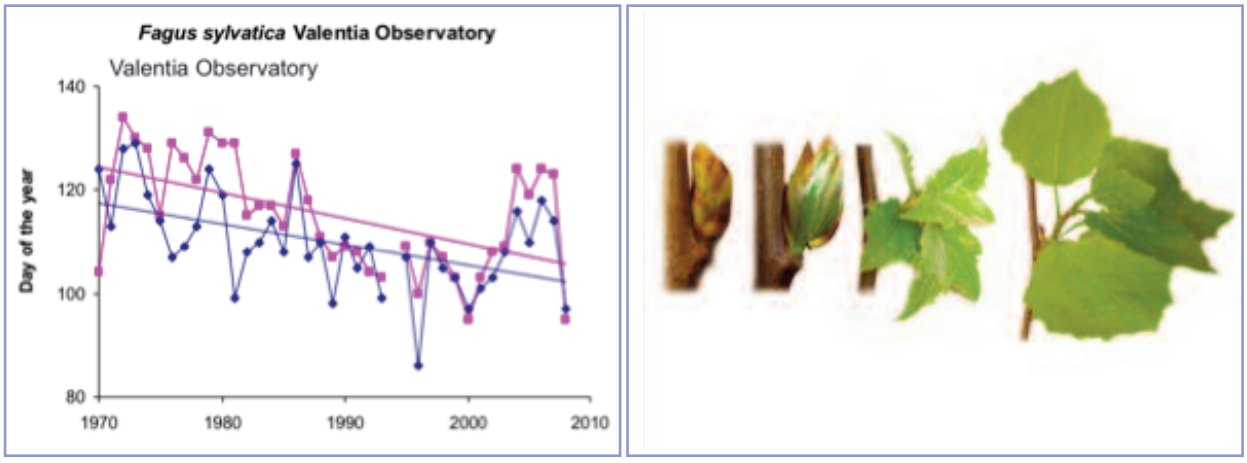


Figure 5. Increasing spring temperatures has impacted upon the phenology (the timing of lifecycle events) of species native to Ireland. For example, leaf unfolding of two varieties of Beech in Ireland has steadily occurred earlier since the 1970s. Source: Donnelly et al., 2006.

Changes in the geographical range of species

Increasing temperatures will impact upon the geographical range of species. Sightings of some bird species typical of warmer climates have increased in Ireland in recent decades even though a suitable food source and habitat has always been present. A warmer climate may certainly contribute to an increase in the frequency of birds such as the Mediterranean Gull *(Larus melanocephalus)* (Donald and Bekhuis, 1993). The expansion northwards in Europe of the Little Egret *(Egretta garzetta)* has been attributed to the absence of severe winters (Voisin, 1991) and has been observed breeding in Ireland since 1997 (Smiddy and O'Sullivan, 1998). According to Huntley et al. (2007) Ireland has the potential to gain at least 20 new breeding species over the next 100 years based on species climate response models.

Modelling of species and habitat distributions project that under future climate scenarios many species in Ireland will experience significant changes to their ranges (Coll et al., 2013; EPA, 2012b; MONARCH partnership, 2007). For example, in general, moss, liverwort, and fern species will experience range contractions, while angiosperm species will see more variation in their response, with some angiosperms expanding while others contract. Species most vulnerable to climate change will include those representatives of arctic-montane, boreal-montane and boreo-arctic montane biomes (Coll et al., 2013).

The Emperor Dragonfly (Anax imperator), the largest dragonfly in Ireland, arrived in 2000 and has since spread to most of island. This is part of trend that has occurred across northern Europe since 1980s (Photographer: Colin Stanley)

Deraeocoris flavilinea, a true bug, once confined to Sicily has undergone a major expansion into Europe since 1980 reaching Ireland in 2017(Photographer: Brian Nelson)

Within Ireland's protected habitats, plant communities are likely to see significant changes in their composition with the addition of some species and the loss of others. The EPA report (2012b) indicated that the current protected area network would need to adapt to these changes. It also highlighted the habitats most vulnerable to climate change impacts are upland habitats (siliceous and calcareous scree, siliceous and calcareous rocky slopes, alpine and subalpine heath); peatlands (raised bog, blanket bog); and coastal habitats (such as fixed dunes and salt marshes) which have the additional threat of sea-level rise.

Changes in species abundance

In Ireland, the main three species of diadromous

(migratory) fish (salmon, sea trout and eels) have all shown a decline in numbers and marine survival over the past three decades (Limburg & Waldman, 2009). It is thought to be at least partly related to the interactive effects of changing climate and oceanic conditions, along with human impacts such as pollution, habitat loss and over-exploitation (Marine Institute, 2009). Fish stocks of commercial interest to Ireland may be adversely impacted by climate change in ways that are not yet fully understood. This could have implications for quota-sharing and relative stability that may put stress on fisheries management systems. For instance, cold water species for which Ireland has an important quota share, like cod and herring, may dwindle, whilst warmer water species, for which Ireland have either a small share or no track record, like hake, Bluefin tuna and sardine, may increase in our waters.

To obtain a clearer view of the likely changes in the Irish flora composition over the next few decades and thereby guide plant conservation priorities, an assessment of the possible impact of climate change on the native flora was undertaken (Wyse Jackson, 2007). This assessment revealed that 20% of Ireland's total native flora are particularly vulnerable to climate change in the period up to 2050. As a result of climate change, 74 out of a total of 143 species (52%) currently included in the Irish threatened plants list, may have their situation made potentially worse due to climate change. In addition, 28 (3%) species currently not threatened in Ireland are likely to become so.

Increased degradation of habitats and changes in ecosystem processes

Projected increases in the occurrence of extreme weather events, such as heat waves, droughts, floods and storms, may have devastating consequences for Ireland's habitats (Climate Ireland, 2017b). All habitats will need to adapt to climate change but fragmented, isolated habitats are likely to be the most vulnerable (Segan et al., 2016).

In a 2013 report to the EC, climate change was recorded as being a high intensity pressure, currently impacting 10% of EU protected habitats (NPWS, 2013). Climate change will likely increase degradation of some habitats. For example, drier summers may impact wetland habitats as a result of desiccation or erosion. It has been projected that 40% of the suitable climatic areas for peatlands in Ireland will be lost by 2075 (Jones et al. 2006; Donnelly et al., 2008).

More recent predictive analyses, undertaken by Coll et al. (2014), indicate that the distribution of active blanket bog in Ireland is regionally sensitive to climate change, most notably for lower-lying areas in the south and west of the country. Increasing temperature and precipitation changes will reduce the area that is suitable for active blanket bog development. This could have major implications for the lowland blanket bog distribution along the western Atlantic sea-board where the projected losses are greatest. In addition, current models predict that drier summers and higher levels of more intense rainfall, which are likely to result in bog bursts and landslides, may indirectly impact other habitats such as lakes (Kiely et al., 2010). Evidence is accumulating that climate change is already negatively impacting coastal habitats, with the 2014 storms resulting in considerable erosion to parts of Ireland's coastline.

Increased levels of winter precipitation may

Storm damage to coastal habitats in the west of Ireland (Photographer: Karen Gaynor)

result in increased nutrient runoff, affecting water quality and fish survival; and soil erosion, possibly impacting upon salmon and trout spawning areas (Climate Ireland, 2017b).

Increased occurrence of invasive species

Terrestrial and freshwater

Despite there being significant knowledge gaps in our understanding of the relationships between climate change and invasive species, climate change has been highlighted as having a major impact on the distribution and spread of invasive species (Mainka & Howard, 2010). Projected shifts in climate, temperature and precipitation, will likely result in the increased occurrence of invasive species and competitive pressures for Ireland's native species. Specific habitat types currently under threat in Ireland from invasive species include freshwater river systems, ponds, mesotrophic lakes, native woodland, lowland heath, coastal floodplain, coastal salt marsh and coastal sand dunes (Kelly et al., 2013). To date only 13% of the invasive species recorded are considered to be high impact (O'Flynn et al., 2014). Although the majority of invasive species in Ireland are plants, the future trend may be towards invertebrate and vertebrate species comprising a greater percentage of all new arrivals, with invertebrates dominating the terrestrial environment and vertebrates the freshwater environment. The threat from high impact invertebrates is of greatest concern for freshwater environments (O'Flynn et al., 2014).

Marine

Bord Iascaigh Mhara (BIM) is undertaking a significant programme of work in relation to marine invasive species. They have set up a cross department and inter agency working group to examine invasive alien species in the context of aquaculture and have committed resources to baseline studies, risk assessments and training until 2020. Climate change will bring about increased occurrences of invasive species in the marine environment and BIM's work to develop a marine baseline for alien species will provide critical information for their management.

4. Prioritisation (Step 3)

Through the Climate Impact Screening (Step 2), a first pass understanding of Irish biodiversity's vulnerability to climate change and associated impacts has been developed. This next step prioritises these vulnerabilities and impacts. This prioritisation is then used to focus adaptation efforts and to set the goals and actions that the biodiversity sector will take to meet them. A watching brief should be maintained for those vulnerabilities and associated impacts that are not currently a priority.

Irish biodiversity is highly vulnerable to the impacts of climate change and has a low adaptive capacity compared to other vulnerable sectors (Coll and Sweeney, 2013). As biodiversity systems are highly interconnected and interdependent it is challenging to list specific priorities in relation to vulnerabilities and impacts. The ecological impacts associated with climate change will not occur in isolation; rather climate-driven changes will combine with, and exacerbate, existing stresses on Ireland's natural systems. An understanding of those interactions will become increasingly critical in defining and implementing effective conservation measures. As a result, conservation in an era of climate change will require that not only are the environmental problems of the past acknowledged and addressed, but that those of an increasingly uncertain future are also anticipated and prepared for.

It is projected that many species in Ireland will experience significant changes to their ranges under future climate scenarios. Species with disjunct and narrow distributions are projected to experience the largest range changes, contracting and expanding, respectively. In general, moss, liverwort, and fern species will experience range contractions, while angiosperm species will see more variation in their response, with some angiosperms expanding while others contract (Coll and Sweeney, 2013). Species representative of arctic- montane, boreal-montane and boreo-arctic montane biomes will be most vulnerable to climate change. On the island of Ireland, these species do not have higher altitudes and latitudes to move to. Plant communities from many of Ireland's protected habitats are likely to see significant changes in their composition, with species moving in and out. Although not all species in the plant communities of these habitats were modelled, the following habitats may be the most vulnerable to climate change impacts (Coll and Sweeney, 2013):

- Upland habitats (siliceous and calcareous scree, siliceous and calcareous rocky slopes, alpine and subalpine heath);
- Peatlands (raised bog, blanket bog); and
- Coastal habitats (fixed dunes – combined with the additional threat of sea-level rise to coastal habitats).

Coll and Sweeney's findings reinforce the strongly emerging global consensus in

conservation science, whereby rapid climate change is widely considered to be the defining conservation issue for this generation. They find that:

- Widespread changes are already occurring in natural systems and these will continue;
- These changes will accelerate in scope and scale in the coming decades due to greenhouse gases already in the atmosphere;
- The scale and extent of changes will continue to accelerate over longer timescales if greenhouse gas emissions continue unabated or increase; and
- Conservation decisions will have to be made based on longer timescales than has traditionally been the case.

Despite knowledge gaps and uncertainty in relation to conservation planning under a changing climate, a number of general habitat types can be identified as key areas for intervention (Coll et al. 2013).

1. The first category is that of stationary refugia, or range retention areas, identified as regions where species are most likely to survive despite climate changes. Such stationary refugia escape the more dramatic climate changes, maintaining climate variation within the range of tolerance of most species and, hence, allow species to persist through short-distance dispersal (e.g. Newton, 2003; Araújo, 2009);

2. The second category is that of displaced refugia, where species are able to find suitable habitats after they have been displaced by climate change from their original location. Typically these are areas at the leading edge of species ranges and their distribution can be inferred using bioclimatic envelope models (e.g. Levinsky et al., 2007; Huntley et al., 2008);

3. The third category comprises regions of high connectivity that allow species to track climate changes through dispersal. This has been extensively explored, and some work has begun to develop quantitative approaches for identification of dispersal routes between protected areas under climate change (e.g. Williams et al., 2005; Phillips et al., 2008; Vos et al., 2008). However, it must be remembered that species dispersal ability can vary considerably.

Any policy initiatives geared to mitigating climate change impacts on biodiversity needs to identify and manage these three types of areas. However, in the fragmented landscapes of Ireland there are few remaining areas of stationary refugia and, hence, policy initiatives will have to focus on the latter two options. Therefore, concerted efforts are required to integrate protected areas into wider landscapes, seascapes and sectors through the use of connectivity measures such as the development of ecological networks and ecological corridors. Similarly, the restoration of degraded habitats and landscapes is required to address climate change impacts and increase resilience to climate change.

It should also be borne in mind that most of the actions that can be taken to protect species and

habitats from climate impacts are similar to those currently being implemented, or at least being provided for in the National Biodiversity Action plan, to counter other pressures on natural systems. Nevertheless, climate change vulnerability assessments facilitate adaptation planning (Dale et al., 2000; Hulme, 2005), and should be considered in conjunction with, for example, the guiding principles in Hopkins et al. (2007).

5. Priority impact assessment (Step 4)

A priority impact assessment provides a description of the impact under investigation including a description of factors that contribute to exposure and sensitivity. It provides a detailed assessment of ongoing and projected future climate and weather-related impacts accounting for spatial and temporal variations in these and associated uncertainties. Through this process it develops plausible climate change and sectoral outcomes.

This step has not been fully completed in the case of the development of this plan due to a) data constraints; b) the absence of a comprehensive vulnerability assessment for ecosystems and biodiversity and c) the cross cutting nature of biodiversity which means assigns ownership and responsibility across multiple sectors. As a result, an action is included in the Adaptation Plan to provide a description of sensitivity and exposure for the current and expected impacts of climate change on ecosystems and species.

6. Developing the plan (Step 5)

Once the vulnerability assessment and prioritisation for the biodiversity sector is completed the Sectoral Adaptation Team should have sufficient information to inform the identification and selection of the required adaptation efforts. Developing the adaptation strategy then consists of establishing goals, sequencing objectives and identifying and prioritising actions that can help to achieve these.

6.1. Goals and objectives

Goals are general guidelines framed as long-term broad statements while objectives outline the steps to achieve these goals. It is important to note that identified goals and objectives may change over time, based on new scientific findings, improved vulnerability assessment, observed climate impacts and consequences, socio-economic, political and technological changes, and implementation successes and failures.

Biodiversity is already under threat and climate change will exacerbate these threats. Degraded habitats are less resilient to the impacts of climate change and they are less able to provide the ecosystem services humans need to be resilient to climate change. Healthy ecosystems and the full diversity of natural life need to be conserved to increase resilience to climate impacts. This is in the interests of people and the planet. Climate change creates another imperative to safeguard biodiversity and increase resilience and nature based solutions offer win wins for adaptation, mitigation & the SDGs.

Goal: To protect biodiversity from the impacts of climate change and to conserve and manage ecosystems so that they deliver services that increase the adaptive capacity of people and biodiversity.

The **objectives** set out in this plan are:

1. Protect and restore biodiversity to increase the resilience of natural and human systems to climate change;
2. Improve understanding of the impacts of climate change on biodiversity;
3. Improve landscape connectivity to facilitate mobility in a changing climate;
4. Engage society to protect biodiversity to enhance resilience; and
5. Ensure sufficient financing is available to implement the Biodiversity Climate Change Adaptation Plan

6.2. Cross-sectoral considerations

Biodiversity is not a sector. It is a cross cutting issue with implications for all sectors and all levels of decision making. As such ownership for this plan is shared with the citizens of Ireland, state agencies, local authorities and all

government departments. Effective biodiversity adaptation requires bottom up and top down planning across all sectors based on coordination and cooperation.

Many of the adaptation options identified in Table 2 are cross-sectoral in nature. Where engagement with other agencies/departments and stakeholders is required, this has been indicated. A suite of sectoral Climate Change Adaptation Plans is currently being drawn up across sectors. It is imperative that other sectors recognise their role in reducing the pressures on biodiversity and contributing to adaptation measures in their respective plans. For example, the permeability of the landscape and potential avenues for the spread of invasive species should be considered by the transport sector; Local and national planning authorities should incorporate green infrastructure into future development plans; Agriculture, forestry and fisheries should evaluate measures undertaken in government programmes to ensure no further degradation of biodiversity occurs; A cost benefit analysis of employing nature-based solutions should always be undertaken before any major operations are undertaken (e.g. for flood defence) and sectors should work together to garner the necessary funds to facilitate implementation of adaptation actions.

Good practice is examples exist of integrated and all of governmental approaches. For example, Our Ocean Wealth is an integrated marine plan that was developed under the leadership of the Taoiseach, supported by the Marine Coordination Group (MCG) and two operational Task Forces on Enabling actions and Development actions. The implementation of Harnessing Our Ocean Wealth is a whole-of-Government initiative under the supervision of the Marine Coordination Group, with strong horizontal coordination and collaboration between government ministries and agencies.

Adaptation and mitigation options from other sectors can have positive and negative impacts on biodiversity. The development of seawall defences, for example, is a climate change adaptation addressing rising sea levels but it can have negative effects on biodiversity and may not offer the optimal long term defence against climate change. Likewise flood defences schemes may alter water flows and habitat characteristics with impacts on biodiversity. Therefore, each sector needs to actively consider its interaction with biodiversity.

6.3. Adaptation Actions

Adaptation actions deliver progress in responding to climate change and build adaptive capacity. The Actions needed to achieve the objectives of this Plan are set out in full in Table 1. They were developed in the first instance by the Core Team and were the subject of consultation with the Planning team as well as participants at the Stakeholder workshop. Further refining of the actions can be anticipated as a result of the consultations on this draft.

The Actions are informed by existing national policy, for example the National Biodiversity Action Plan, and EU Directives. They take into account cross sectoral linkages and the decentralised nature of responsibility for biodiversity conservation.

Table 2. Adaptation Objectives and Actions

1. Protect and restore biodiversity to increase the resilience of natural and human systems to climate change	Actors	Timeframe	Resources
1.1 Resource and implement the National Biodiversity Action Plan 2017-2021 in full	All Government Departments, Local Authorities, schools, citizens, NGOs, businesses	Immediate and ongoing to 2021	High
1.2 Enhance and restore natural systems through management to increase resilience – starting with hydrological processes (freshwater and marine), carbon processes and pollination {e.g. use OPW flood maps (see www.floodinfo.ie) to assess the exposure of known habitats/ Natura sites to current and future flood risk and update of the site management plans to ensure steps are taken to adapt / restore bog lands to increase their role in carbon sequestration and to increase their resilience to drying associated with temperature rise}	DCHG, DAFM, MI, BIM, OPW, DCCAE (IFI), LAs, Bord na Mona, Coillte, eNGOs	On-going (for bogs) Immediate priority	High
1.3 Establish an all-island invasive species programme to monitor the spread of terrestrial, aquatic and marine invasive species in a changing climate and control invasive species where their spread is considered problematic [building on Colette O'Flynn / National Biodiversity Data Centre's work on invasive species and BIM's work on marine invasive species]	DCHG, DAFM, BIM, DCCAE (IFI), TII, NBDC, LAs	Short term	Medium
1.4 Develop and implement a national soil strategy to increase the resilience of soils to climate change and to capture co-befits for carbon sequestration. (building on the EPA Soil Protection Strategy (2002)[3] and the Teagasc soil quality monitoring programme[4])	DAFM, Teagasc, EPA	Medium term	High
1.5 Develop an integrated coastal management strategy which includes ecosystem based adaptation actions to manage climate risk and build resilience to climate change	DHPLG, DAFM, DCHG, DCCAE, Academia, Marine Institute, DTTAS, EPA, LAs	Short term	Medium
1.6 Promote ecosystem restoration and conservation though Payment for Ecosystem Services (e.g. through GLAS) and investment in actions that increase carbon sinks while promoting biodiversity (e.g. woodlands, soil management, hedgerows)	DAFM, DCHG, Teagasc, DCCAE, EPA, Dept Finance	Medium term	Medium

[3] http://www.epa.ie/soilandbiodiversity/soils/ (accessed 19/12/2018)

[4] https://www.teagasc.ie/crops/soil--soil-fertility/county-soil-maps/ (accessed 19/12/2018)

2. Improve understanding of the impacts of climate change on biodiversity	Actors	Timeframe	Resources
2.1 Carry out a comprehensive vulnerability assessment of biodiversity in Ireland, including a priority impact assessment to determine the factors that contribute to exposure and sensitivity and to identify the most at risk species and habitats for priority attention. [This can include updating previous studies on the vulnerability of plant biodiversity to climate change (Wyse Jackson, 2007 and Coll, 2013) and commissioning research on the vulnerability of animal biodiversity to climate change. It could also include integrating climate projections into reporting on Natura 2000 sites.]	DCHG, EPA, BIM, MI, DCCAE, Academia, DAFM, OPW, Teagasc	Medium term	Low
2.2 Monitor on an ongoing basis the current impacts of climate change on biodiversity (marine, terrestrial and freshwater) and hold all data in a central clearing house to inform adaptation and biodiversity activities	DCHG, EPA, BIM, MI, LAs, NBDC, Academics	Ongoing (start immediately)	Medium
2.3 Undertake scenario planning to assess the projected impacts of climate change on biodiversity to inform strategic decision-making. (Action to follow 2.2 on understanding current climate impacts)	DCHG, DAFM, DCCAE, EPA, BIM (IFI), DHPLG, OPW	Medium term	Low
2.4 Establish a citizen science programme to collect data on how climate change and extreme weather is affecting biodiversity and to increase societal engagement with climate action and biodiversity conservation.	DCHG, DCCAE, NBDC, eNGOs	Medium term	Medium
2.5 Conduct research into the ecological and social effectiveness of ecosystem-based approaches to climate change adaptation to inform actions to safeguard ecosystem services in Ireland	DCHG, EPA, DCCAE, DAFM, MI, OPW	Medium term	Low
2.6 Collect information on biodiversity and ecosystem based adaptation actions being implemented in Ireland and store this information centrally to facilitate lesson learning and experience sharing	DCHG, MI, EPA, DCCAE, LAs	Short term	Low

3. **Improve landscape connectivity to facilitate mobility in a changing climate**	Actors	Timeframe	Resources
3.1 Assess the risks associated with a changing climate in the context of i) landscape fragmentation and ii) landscape connectivity in order to inform site designation, protection and connectivity and to prevent the spread of invasive species [e.g by overlaying a national land cover maps with climate projections maps]	DCHG, EPA, WI, OPW, DHPLG, Academia	Short term	Low
3.2 Identify vulnerable ecosystems and species that through enhanced landscape connectivity would be less impacted by climate change	DHPLG, DCHG DHPLG, DCHG, MI, BIM, EPA, Las, DAFM, Academia	Short term	Low
3.3 Design corridors and buffer zones to enhance the resilience of protected areas and designated sites by increasing opportunities for dispersal across the landscape (e.g. as employed in Killarney NP and Dublin Bay)	DCHG, LAs, DAFM	Medium term	Medium
3.4 Implement measures to reduce the barrier effects of roads, railways and technical objects in rivers and streams to facilitate species spatial responses to climate change	TII, OPW, DCCAE (IFI), LAs	Medium term	Medium
3.5 Use Agri- environment measures to maintain heterogeneity and connectivity in the wider landscape.	DAFM, DCHG, Teagasc	Short term	Low

4. Engage society to protect biodiversity to enhance resilience	Actors	Timeframe	Resources
4.1 All sectors systematically consider nature based solutions as potential low cost win-win climate change adaptation and mitigation solutions and report on relevant action as part of the review of this and other sectoral adaptation strategies	All sectors	Short term	Low
4.2 Design and implement a citizen engagement and awareness campaign on climate change and biodiversity conservation to capture case studies, tell stories and engage citizens in data collection and monitoring	DCHG, DCCAE, LAs, NBDC, An Taisce etc.	Short term	Low
4.3 Co-design green spaces and wildlife refuges in cities and peri-urban areas with local communities to provide habitats for species under threat from climate change and to connect people to biodiversity.	DCHG, DHPLG, LAs	Short term	Low
4.4. Ensure that the next national agri-environment scheme (e.g. successor to GLAS) has a focus on protecting biodiversity to increase resilience to climate change in rural areas	All relevant sectors	Medium term	Low
4.5 Build and strengthen partnerships and promote cross-sectoral communication and cooperation in the implementation of adaptation and planning	Biodiversity working Group, Biodiversity Forum, All relevant sectors	On-going	Low
4.6 Use the National Biodiversity Conference and other fora to engage stakeholders in all sectors to protect biodiversity in order to increase resilience to climate change	DCHG, all stakeholders	Ongoing	Low

5. Ensure sufficient financing is available to implement the Biodiversity Climate Change Adaptation Plan	Actors	Timeframe	Resources
5.1 Develop a financial strategy to implement this plan	DCHG, Dept Finance, Private sector	Short term	Low
5.2 Set up an interdepartmental group to prioritise, access and administer funding under EU LIFE Climate sub programme	DCHG, DAFM, DCCAE, DHPLG, OPW	Short term	Low
5.3 Undertake natural capital accounting in all sectors to ensure natural capital is being valued and Ecosystem Based Adaptation and green infrastructure options are being employed	Dept Finance, DCHG, OPW, DAFM, MI, BIM, DCCAE, LAs	Short term	Low
5.4 Analyse the effectiveness of the Common Agricultural Policy Greening rules and measures under the European Maritime and Fisheries Fund to protect biodiversity and increase climate resilience. (building on Regulation (EU) No 1303/2013 which sets down common provisions for a number of European funds)	DAFM	Medium term	Low
5.5 Commission research to explore the potential for innovative finance for biodiversity conservation to increase resilience to climate change e.g. Green Bonds, Payment for Ecosystem Services, carbon offsetting, business investment.	Dept Finance, Climate Change Advisory Council, EPA, Academia	Short term	Low

7. Implementation, evaluation and review (Step 6)

The final step in the sectoral climate change adaptation process involves the implementation, monitoring and evaluation of the plan. This involved ensuring that the plan is widely disseminated, includes effective tracking and evaluation to track the progress and continued validity of the plan, communicating plan progress and assessing the need to update the plan. It is important to leave the plan flexible enough to accommodate revisions and updates when and where necessary.

7.1. Implementation

The draft Sectoral Action Plan has been published for full public consultation in February 2019. In April 2019 the public consultation submissions will be collated and reviewed and a summary review report capturing all consultations within the process will be compiled. In May 2019 the final version of the document will be screened to determine Strategic Environmental Assessment (SEA) and/or and Appropriate Assessment needs. The updated plan will then be presented to the Biodiversity Working Group for final comment. Once the plan is adopted it is important to disseminate widely and acknowledge the contribution of stakeholders. This is because actions arising from the plan will require stakeholder support and in many cases stakeholder action.

7.2. Monitoring and evaluation

Once the plan is under implementation there will be a requirement to track its actions and evaluation its progress in achieving its identified goals. By designing a tracking and evaluation programme as part of the implementation plan, the planning team will be in a position to demonstrate the progress of actions and to identify where and when further actions may be needed. The evaluation programme should identify schedules and milestones for individual adaptation actions and there should be clear identification of responsibilities for monitoring and evaluation. When developing a tracking and evaluation programme the Sectoral Adaptation Team should consider:

- How often the planning team meet to review progress;
- How will the planning team keep senior management updated on progress;
- How will other sectors be kept informed of plan progress to ensure that synergies and cross-benefits between plans are full realised;
- How should progress be reported to the stakeholder group, e.g. progress reports;
- What are the key signals (thresholds) for updating the plan.

Reviewing, monitoring and evaluation are key elements of an iterative adaptation process as

they help us to understand progress and performance, learn and share lessons and inform future policy and practice. Adaptation plans should be reviewed frequently and systematically to take account of current research on the impacts of climate change on biodiversity, so that measures can be adapted in line with new evidence that comes to light. This Plan will be reviewed and updated by DCHG in consultation with the Biodiversity Working Group and the Biodiversity Forum. Furthermore, due to the cross-sectoral nature of the biodiversity sector a proactive approach needs to be taken to ensure integration and coherence across sectors and this should also be reflected in the monitoring and evaluation of the Plan.

7.3. Review

In accordance with the Climate Action and Low Carbon Development Act 2015, this plan will be reviewed and updated over time. It is anticipated that an interim review of this plan will be conducted in 2021 to coincide with the end date of the National Biodiversity Action Plan.

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Appendix I: List of Acronyms

BnM	Bord na Móna
BWG	Biodiversity Working Group
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CFP	Common Fisheries Policy
CSO	Central Statistics Office
DAFM	Department of Agriculture, Food and the Marine
DCHG	Department of Culture, Heritage and the Gaeltacht
DCCAE	Department of Communications, Climate Action and Environment
DHPLG	Department of Housing, Planning, Community and Local Government
DPER	Department of Public Expenditure and Reform
DTTAS	Department of Transport Tourism and Sport
EMFF	European Maritime and Fisheries Fund
EPA	Environmental Protection Agency Ireland
IFI	Inland Fisheries Ireland
LAWCO	Local Authorities Water and Communities Office
LLAES	Locally led agri-environmental schemes
MSFD	Marine Strategy Framework Directive
NBDC	National Biodiversity Data Centre
NESC	National Economic and Social Council
NPBR	National Platform for Biodiversity Research
NPWS	National Parks and Wildlife Service
NGO	Non-governmental organisation
OPW	Office of Public Works
OSI	Ordnance Survey Ireland
OSPAR	Convention for the protection of the marine environment in the North-East Atlantic
RBMP	River Basin Management Plan
RDP	Rural Development Programme
SAC	Special Area of Conservation

SEA	Strategic Environmental Assessment
SEEA	System for Environmental-Economic Accounting
SFPA	Sea Fisheries Protection Authority
SPA	Special Protection Area
TII	Transport Infrastructure Ireland
WFD	Water Framework Directive

Appendix II: Workshop Participants

Biodiversity Climate Change Adaptation Workshop Invited Participants List, Oct 16th, 2018, Collins Barracks, Dublin 7

1. Ciaran O'Keeffe (NPWS)
2. Deirdre Lynn (NPWS)
3. Andy Bleasdale (NPWS)
4. Ferdia Marnell (Species, NPWS)
5. Caitriona Douglas (Peatlands, NPWS)
6. Tara Shine (Facilitator)
7. John O'Neill (DCCAE)
8. Avril Rothwell (DAFM)
9. Cliodhna Tuohy (DTTAS)
10. Stephen Flood (MAREI, UCC)
11. Yvonne Buckley (Biodiversity Forum, TCD Academic)
12. Mike B Jones (TCD Academic)
13. Harriet Walsh (EPA)
14. Gerry Gallagher (OPW)
15. Jacqui Donnelly (DCHG, Built Heritage)
16. Cathal Gallagher (IFI)
17. Fiona Kelly (IFI)
18. Paul Nolan (Irish Centre for High-End Computing (ICHEC) and Met Eireann)
19. Paul Greene (An Garda Síochána)
20. Martin Hehir (DHPLG)
21. John Coll (Maynooth Academic)
22. Duff, Katharine (DAFM, Forest Service)
23. Paul Harris (Bank of Ireland)
24. Vincent Upton (Forester, DAFM)
25. Tomás Murray (NBDC)
26. Niamh Ni Cholmain (Climate Adaptation Regional Office, Dublin)
27. David Dodd (Climate Adaptation Regional Office, Dublin)

28. Eamonn Aylward (DAFM, Marine)
29. Hannah Denniston (DAFM, Farm biodiversity)
30. Maurice Clarke (Marine Institute)
31. Maria Talbot (DAFM, Climate and Bioenergy)
32. David Mellett (Climate Adaptation Regional Office, Mayo)
33. Jenny Neff (CIEEM)
34. Gerry Clabby (NPWS, Ecological Assessments) morning only
35. Tony Brew (OPW, Engineer)
36. Phillip O'Brien (EPA, Climate Change Advisory Council)
37. Noeleen Smyth (Taxonomist, National Botanic Gardens)
38. Caroline Engel Purcell (Carrig Consultants)
39. Matthew Jebb (Director, National Botanic Gardens)
40. Enda Mullen (NPWS, Ecological Assessments)

Appendix III: Workshop Agenda

Stakeholder workshop: developing a Biodiversity Sectoral Climate Change Adaptation Plan for Biodiversity

Date: Tuesday 16th October 2018

Venue: Collins Barracks, Dublin

Time	Description	Responsible
09.50 - 10.00	Registration and tea / coffee available	
10.00 – 10.10	Welcome	Dr Ciaran O'Keeffe
10.10 – 10.20	Introductions, agenda and objectives of the workshop	Dr Tara Shine – facilitator
10.20 - 10.35	National Adaption Framework	John O'Neill, DCCAE
10.35– 10.50	Sectoral Adaptation Guidelines	Dr Stephen Flood, MARel, ERI, UCC
10.50 - 11.05	Ireland's changing climate – what can we expect?	Paul Nolan, ICHEC
11.05 – 11.20	Biodiversity Adaptation Plan: the process to date	Dr Deirdre Lynn, NPWS
11.20 – 11.40	Questions and discussion - experiences from the processes to develop other sectoral climate change adaptation plans	Facilitator
11.40 – 11.45	Introduction to group work	Facilitator
11.45 – 12.30	Group work: Observed and future impacts and consequences Inputs: - Draft Biodiversity Sectoral Climate Change Adaptation Plan - Excel tool of impacts and consequences Discussion questions: • What is the state of knowledge based on current and past climate events? • What are the future climate change impacts for the sector? What are the consequences? • What is missing from the draft plan? • What additional sources of information can be identified?	All participants
12.30 – 1.15	Lunch	
13.15 – 13.30	Feedback from group discussions	Group facilitators
13.30 – 13.40	Biodiversity Sectoral Climate Change Adaptation Plan: goals, objectives and actions	Dr Deirdre Lynn, NPWS
13.40 – 13.55	Plenary discussion: reactions to proposed goals and objectives (10 mins) Introduction to group work (5 mins)	Facilitator

Time	Description	Responsible
14.00 – 15.00	Group work: Adaptation actions Inputs: As before Discussion questions: • What actions are missing from the proposed action plan? Consider: • existing / ongoing adaptation actions • additional actions required to cope with existing conditions • actions to build capacity to ensure long-term climate resilience • actions to raise awareness around climate change and biodiversity • actions to deliver long-term climate resilience • actions related to NPWS resources and operations	All participants
15.00 – 15.15	Coffee	
15.15 – 16.00	Plenary: Feedback from group work (10 mins) Discussion on the cross sectoral implications of proposed actions - Opportunities and risks - Duplication and redundancies - Gaps	Group facilitators Facilitator
16.00 – 16.15	Take aways, follow up actions and close	Facilitator and Dr Deirdre Lynn
16.15 – 16.30	Closing remarks	Dr Ciaran O'Keeffe

Appendix IV: Biodiversity Forum Members

Name	Affiliation
Yvonne Buckley	Trinity College Dublin
Simon Berrow	Irish Whale and Dolphin Group
Séamus Boland	Irish Rural Link
Ken Bradley	Department of Environment (Northern Ireland)
Tasman Crowe	University College Dublin
Padraic Fogarty	Environmental Pillar
Paul Giller	University College Cork
Paul Harris	Bank of Ireland, Global Markets
Brendan Joyce	Irish Natura & Hill Farmers Association
Elaine McGoff	An Taisce
James Moran	Galway-Mayo Institute of Technology
Jenny Neff	Chartered Institute of Ecology and Environmental Management
Aoife O'Donovan	Irish Business and Employers Confederation
Mark Robins	Birdwatch Ireland
Siobhán Ryan	Heritage Council, Sligo

Appendix V: Biodiversity Working Group Members

Name	Affiliation
Laura Behan	Department of Transport, Tourism and Sport
Tony Brew	Office of Public Works
Yvonne Buckley	Biodiversity Forum
Colin Byrne	Department of Housing, Planning and Local Government
Brian Deegan	Irish Water
Kathrine Duff	Department of Agriculture, Food and the Marine
Cathal Gallagher	Inland Fisheries Ireland
Margaret Gormley	Office of Public Works
Paul Greene	An Garda Síochána
Harry Harris	Department of Health
Georgina Hughes-Elder	Department of Public Expenditure and Reform
Karen Hynes	Department of Business, Enterprise and Innovation
Catherine Keena	Teagasc
Colin Kelleher	Office of Public Works
Liam Lysaght	National Biodiversity Data Centre
Finola Moylette	Department of Rural and Community Development
Anne Murray	Department of Education and Skills
Jack Nolan	Department of Agriculture, Food and the Marine
Francis O'Beirn	Marine Institute
Tadhg O'Mahony	Environmental Protection Agency
Brian O'Malley	Department of Public Expenditure and Reform
Ruairi O'Rua	Department of Public Expenditure and Reform
Owen Ryan	Department of Communication, Climate Action and Environment (to nominate future rep)

Appendix VI: Extreme events timeline 2008-2018: Impacts and consequences for biodiversity

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
2018	**Summer drought and heat wave**	Water shortages, high temperatures	Noticeable increase in aquatic plant growth on Lough Ennell (persistence of this process coupled with lower water levels could lead to future eutrophication issues) Scorched vegetation in calcareous species rich grassland	Could not access Lough Ennell by boat to conduct summer breeding bird surveys as water levels were so low. Could not access some areas on Lough Ree due to low water levels during summer breeding bird surveys	Conservation Ranger, South Westmeath, NPWS
			Water levels on Girley Bog in Co. Meath were lower particularly in the cutover bog Water levels in Lodge Bog Co. Kildare were significantly lower than usual for a long period of time. On Lullymore West Bog in Co. Kildare water levels in a pond and drain were dropped well below the surface	Impacted on Sphagnum transfer trials established in 2014 and 2015 This may have had knock on effects for breeding curlew on site. It was not possible to monitor invertebrates which we do on a regular basis.	Irish Peatland Conservation Council
			Low water levels at Lady's Island Lake facilitated terrestrial predators access to islands where Tern colonies located, predators included Pine Marten, American Mink, Hedgehog. Impacts on Arctic, Common & Roseate Terns. https://www.npws.ie/protected-sites/spa/004009	Low water levels hampered boating	Conservation Ranger, Wexford, NPWS
			Vegetation showing drought stress. Low lake levels, increased levels of filamentous algae	Heat stress impairing work rate	Conservation Ranger, Killarney National Park

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
			Earlier start to turf cutting and second cut in some areas, prolonged disturbance to ground nesting birds in SPA and NHA. Very low water levels in rivers and lakes.		Conservation Ranger, Monaghan, NPWS
			Fires on Liffey Head Bog and L. Bray that went on for weeks in May, burned into the peat and kept re-igniting. In heath away from those fires, bilberry plants died if they were on any rocky areas	Huge cost for helicopter, Fire Service etc. Staff got no other work done, were exhausted, one suffering from smoke inhalation and worked many, many more hours than normal working week	Ecologist, Department of Culture, Heritage and Gaeltacht
			Breeding wader chick rearing habitats drying out Intense Fires on Slieve Blooms SPA/SAC – ground nesters and young deer Bog Fires e.g. Mouds Bog	Water pumped to wader scrapes on the Shannon Callows Very dry vegetation led to very intensive fires that were difficult to control by authorities	Conservation Ranger, Laois Offaly, NPWS
			Resident breeding bird populations reduced. CES ringing at Cabragh Wetlands (13 years now) showed that resident bird numbers were the lowest since we began ringing at the site. Also migrant numbers to the site were lowest recorded too. Either upon arrival birds moved elsewhere/did not breed/or habitat never fully established due to cold spring and dry summer combo. Certainly the reed bed at the Cabragh Wetlands is beginning to be succeeded by Greater Willow Herb as it appears the site is drying out.		Conservation Ranger, Tipperary, NPWS
				Increased mortality of tree seedlings	Wildlife Inspector, Dublin, NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
			Exceptionally low, and prolonged, water tables recorded at Clara Bog SAC. This resulted in the first recorded absence of runoff (near 2 months) from the bog (since 1991). This means that there was no water held in 'storage' on the bog near-surface. This affects the habitat and its keystone species, *Sphagnum*, as there was no water availability for its growth and maintenance. Similar observations were recorded at Abbeyleix Bog (NHA); and presumably all midland raised bogs. Immediate impact on *Sphagnum* (active raised bog) unknown; but will be assessed in near-future ecotope surveys. The resilience of *Sphagnum* to regular 'drought' events such as this is also unknown; again, periodic monitoring is necessary to quantify this.		Ecologist, Offaly, NPWS
			Numerous fires on the sand dunes noted in areas outside the Natura site boundary. Boyne Coast and Estuary 001957 None recorded inside the Natura site as I was no longer a Conservation Ranger for Meath but I expect there were fires within the designated areas.		Conservation Ranger, Meath, NPWS
			Increased fire and possibly increased regeneration of Bracken post-fire in Co. Wicklow. Desiccation of habitats – short turf on an area of Bull Island (Co. Dublin) that has been monitored for many years showed almost complete die back of above ground biomass (apart from Salvia verbenaca): subsequent recovery (as of 13/11/18) seemed patchy and may facilitate establishment of Salvia		Researcher, Trinity College Dublin

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
			seedlings - several fens dried, e.g. water levels very low at Scragh Bog (c. Westmeath)		
			Lake and river levels low, any nests on exposed rocks, likely to be inundated with water again. Impact on fisheries and therefore food sources. Low number of salmonids running until late season. Native woodland establishment projects sustained increased losses. Wet and marginal pasture land bordering National Park in better condition this autumn due to dry summer. Higher risk of fires Ponds drying up – impacting on newts and frogs	Staff availability to respond to extreme events, for example bog fires, needs to be considered Important to prepare and pace correctly for field survey work. More water required than normal, sun block etc. Risk of over exposure/sun stroke. Fire management strategy highlighted	District Conservation Officer, Mayo, NPWS
2018	**Spring late arriving**	Slower growth, wet ground, cool temperatures	Waterlogged soils, complicated grazing at Ballyteige NNR. https://www.npws.ie/nature-reserves/wexford/ballyteigue-burrow-nature-reserve		Conservation Ranger, Wexford, NPWS
			Low butterfly numbers (Butterfly survey)		Conservation Ranger, Killarney National Park
			Delayed breeding of some bird species.		Conservation Ranger, Monaghan, NPWS
			Small mammal populations were reduced or breeding delayed resulting in numbers peaking later. Underweight Barn Owl Chicks (based on nest recording in Tipperary)		Conservation Ranger, Tipperary NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
			and several phonecalls in September of dead or underweight Barn Owl Chicks.		
			Late nesting for curlew and other birds	Delays in survey dates impact work scheduled later in the season	District Conservation Officer, Mayo, NPWS
2018	**Storm Emma**	Feb / March – Snow and cold temperatures	Trees blown over in publicly accessible woodland trail (split Hills & Long Hill esker SAC). Bats may have been disturbed or damaged as one tree had a bat box attached to it and inspection of the bat box showed it had been recently occupied.	Could not drive for work during the storm.	Conservation Ranger, South Westmeath, NPWS
				The Bog of Allen Nature Centre was closed to visitors and we lost revenue as a result as groups could not reschedule. Also the officer was closed for three days which prevented four staff from working on site	Irish Peatland Conservation Council
			Fallen trees	Travel restrictions, worked from home.	Conservation Ranger, Monaghan, NPWS
				Confined to offices	Conservation Ranger, Laois Offaly, NPWS
			A number of bird species accessing supplementary feeding at Bird Feeders. Fieldfare/Redwing feeding on apples provided at feeding station in my back garden. Lapwing also observed foraging in garden in areas cleared of snow where my children had made snowmen.	Several days off work due to being snowed in. Road conditions not great.	Conservation Ranger, Tipperary, NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
			Snipe seen in the garden in Co Meath not normal habitat for this species	Unable to get to work for three days	Conservation Ranger, Meath, NPWS
			Many overwintering birds seen close to urban areas, farmyards – exposure to predators greater. Trees windthrown around perimeter of Moorehall coach house. Increased risk of mortality for all species	Requires GO to cut down trees undermining SAC structures for Lesser horseshoe bats. Could not go to the field two days due to ice and snow. Staff notified to stay at home.	District Conservation Officer, Mayo, NPWS
			Trees broken and had to be felled in hedges at the Bog of Allen Nature Centre		Irish Peatland Conservation Council
				Trees down, internal roads and paths closed, time taken up monitoring storm damage, clearing branches etc.	Conservation Ranger, Killarney National Park
2017	**Storm Ophelia**		Fallen trees	Travel restrictions, worked from home.	Conservation Ranger, Monaghan, NPWS
				Confined to offices. Post-Storm clean up Offaly, NPWS	Conservation Ranger, Laois
			High impacts on grey Seal pups. Having just surveyed them before the storm several washed up alive and dead on mainland, after storm. Full scale of impact, unknown. https://www.npws.ie/protected-sites/sac/000707	Travel restrictions, worked from home.	Conservation Ranger, Wexford, NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
				Two days off work due to weather conditions. Caution exercised thereafter accessing woodland areas.	Conservation Ranger, Tipperary, NPWS
			Trees down within natural heritage area along an amenity walkway. Girley Bog NHA 001580	Some roads blocked into the site that needed to be cleared	Conservation Ranger, Meath, NPWS
			Removal of annual vegetation and a lone Lavatera arborea at the N end of the developing spit and sand dune at Booterstown (Co. Dublin): subsequent development of this community which had increased and spread N over past three years was checked back. Deposition of sediment and algae on beachfront communities and some erosion of these communities at the south end of the same site.		Researcher, Trinity College Dublin
			Trees windthrown around perimeter of Moorehall coachouse and Manor House.	Requires GO to cut down trees undermining SAC structures for Lesser horseshoe bats. Couldn't launch boat for lake patrols. District office and Visitor Centre more exposed to power cuts.. etc Risks for all staff when driving	District Conservation Officer, Mayo, NPWS
2016	**Storm Barbara**	December – high winds, especially Northern Ireland		Post Storm clean up on Woodland sites	Conservation Ranger, Laois Offaly, NPWS
				District office and Visitor Centre more exposed to power cuts.. etc Risks for all staff when driving NPWS	District Conservation Officer, Mayo,

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
2015	**Storm Eva**	December – high winds	Flooding along the River Boyne and River Blackwater SAC 002299. Flooding the Boyne canal towpath		Conservation Ranger, Meath, NPWS
				District office and Visitor Centre more exposed to power cuts. etc Risks for all staff when driving	District Conservation Officer, Mayo, NPWS
2015	**Exceptionally dry spring**	April – Dry spring	fire >1km2 on Kippure as well as many smaller fires between March and April. The first fire was lit during a Yellow wind warning on 6/3/15. 30,000+ young trees burned. Nesting areas of rare Whinchats burned at Coronation	Staff out fighting fires, and on fire patrol. Cost of helicopters, Fire Service etc.	Ecologist, Department of Culture, Heritage and Gaeltacht
	Storm Frank	December – high winds. North West	Multiple trees down – severe damage to woodlands in places.	Trees down, internal roads and paths closed, time taken up monitoring storm damage, clearing branches etc.	Conservation Ranger, Killarney National Park, NPWS
2014	**Storm Darwin – February**	High winds, severe gusts, trees down.	Lots of damage to trees	Had to send staff home and cancel education programme. No electricity for a number of days	Ecologist, Department of Culture, Heritage and Gaeltacht
			Grantstown Lake NNR flooding	Little Brosna Bird Hide (IWeBS VP) Tipp side obliterated by storms Grantstown NNR Fishing stands damaged by flooding	Conservation Ranger, Laois Offaly, NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
				Trees down, time taken up monitoring storm damage, clearing branches etc. NPWS	Conservation Ranger, Killarney National Park,
			Tacumshin Water outlet blocked, huge flooding. https://www.npws.ie/protected-sites/sac/000709		Conservation Ranger, Wexford, NPWS
			Large number of trees downed in the Clare Glens (SAC). Exposed the sporophyte population of Killarney Fern resulting in moderate to severe desiccation of this population.	Clare Glens inaccessible for several months while clean-up undertaken.	Conservation Ranger, Tipperary, NPWS
			Extensive erosion along the Nanny SPA 4158 and Boyne Coast and Estuary 001957.		Conservation Ranger, Meath, NPWS
2013/14	**Winter Storms**	An exceptional run of winter storms, serious coastal damage and widespread, persistent flooding.	Jan 2013 Flock of fieldfares but no small birds. Feb-Mar 13 snow in Wicklow Mountains with road closures. Floods 22/3/13 on top of snow drifts. Landslide near Enniskerry Buzzard appeared a number of times at Kippure in March 2013. First regular appearances of this species here. May 2013 Grasshopper warbler called but disappeared unlike previous years when they seem to have bred. Three merlins fledged in the locality and I saw a female hen harrier hunting in August 13. Good year for wheatear. Jan 14 saw juvenile White-tailed eagle at Luggala	Worked from home last week of March 13 when roads impassable with snow. Many "snow tourist" vehicles stuck on Sally Gap, meaning staff involved in Mountain Rescue called out regularly.	Ecologist, Department of Culture, Heritage and Gaeltacht

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
			Woodland Nature Reserves in Laois had a lot of trees down. Grantstown Lake NNR flooding	A lot of resources activated to clear woodland sites of storm damage and reopen to the public Extended period of flooding due to lake outfalls being blocked led to some standing trees being adversely affected	Conservation Ranger, Laois Offaly, NPWS
			The highest flood spates I have seen in the Liffey in all the years I have been here. In the flood event 24/10 25m of track was washed into the Liffey at Gamekeeper' Cottage September 2011 3 bats moved into my garage. This has since become a hibernacula and I've installed a hibernation box	Death of a local off-duty Garda trying to prevent people crossing a bridge. Very tragic human cost Cost of repairing this track	Ecologist, Department of Culture, Heritage and Gaeltacht
			Coastal damage along Boyne coast and estuary SAC/SPA. Coastal damage along the Nanny Estuary and Shore SPA		Conservation Ranger, Meath, NPWS
			Significant flooding and inundation of seawater of coastal habitats (machair, sand dunes). Significant erosion of these dynamic systems. Movement/changes of shingle barriers. Significant amounts of rubbish and plastics washed onto lands and deposited above the high tide lines Grey seal pups separated from mothers	Large scale infrastructural damage resulted in requirement for emergency works by CoCo. Large amount of time involved in site inspections and meeting CoCo staff and landowners regarding damage to SACs. More time required to process ARCs and to review CoCo screening documents. District office and Visitor Centre more exposed to power cuts.. etc Risks for all staff when driving	District Conservation Officer, Mayo, NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
2011	**Intense rainfall Dublin - 24 October**	Flooding in the greater Dublin area	Change in bat distribution in winter sites – moved to the most well buffered sites.	Dangerous driving conditions.	Conservation Ranger, Killarney National Park, NPWS
2010	**Severe cold spell - Nov/Dec**	Snow and low temperatures	Shannon and Little Brosna Callows. Wintering wildfowl starving and birds freezing into roosts, Passerine die off	Extended Confinement to offices due to hazardous driving conditions	Conservation Ranger, Laois Offaly, NPWS
				Burst pipes in the Bog of Allen Nature Centre, centre closed and staff off	Irish Peatland Council
			A report Re. Pollution incident within the River Boyne and River Blackwater SAC/SPA. The clean-up could not be completed until after the freeze.	Field visits postponed due to road conditions	Conservation Ranger, Meath, NPWS
2009/ 10	**Coldest winter for almost 50 years**	Lowest temperatures December – January. Air temp fell below -10°C. Long period high pressure	Deer suffered from lack of food. Deer culled after the snow were very thin. They gathered under the trees in Coronation, scraping to try to get to the grass underneath, calling the whole time.	I was snowed in during December and then out for 3 weeks in January 10. Trying to work remotely	Ecologist, Department of Culture, Heritage and Gaeltacht
				Access to large proportion of work area prevented due to flooding	Conservation Ranger, Killarney National Park, NPWS
			Many birds found dead having starved. Stonechat and Grey wagtail effectively wiped out in Tipperary – based on observations and ringing effort.	Road conditions in Tipperary extremely challenging making working difficult.	Conservation Ranger, Tipperary, NPWS

Date	Event	Description	Observed impacts on habitats and species	Impacts on your capacity to do your job, on NPWS (or another organisation) operations, resources and infrastructure	Source
2009	**Severe flooding – November**	Twice average monthly rainfall. Heavy rainfall > 100ml / day.		Record flood levels on Shannon and Little Brosna Callows leading to an increase in (misplaced) public complaints on NPWS management of the Callows	Conservation Ranger, Laois Offaly, NPWS

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