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An Taisce wish to make the following submission as part of the National Marine Planning Framework Baseline Report, Published October 2018

1 Opportunity for Ireland

The National Marine Planning Framework should be the means for Ireland, as an island nation with c 7,000km of coastline, and some of the best marine ecosystems in Europe, to take an international lead in climate mitigation, and the required action to reverse ocean acidification and biodiversity loss. As we face the sixth, and for the first time human caused, great extinction in global species, there is an imperative for developed countries to protect the natural world including the marine ecosystem both at national level, and in international action.

The basis for this was established by the UN Convention on Biological Diversity 1992. This was furthered by the 2012 UN Rio Plus 20 Conference which recognised and gave further status to *"the intrinsic value of biodiversity*" and "*its critical role in maintaining ecosystems that provide essential services, which are critical foundations for sustainable development and human well-being*". Following on from this, in 2015 the UN Sustainable Development Goals

provided the overarching framework for integrating the future of the marine ecosystem with planetary sustainability. In particular, Goal 14: Life Under Water sets out the overarching objective "*To conserve and sustainably use the ocean seas and marine resources*". In addition, Ireland has a range of obligations as a party to the OSPAR Convention for the North East Atlantic. Further to that, Ireland has compliance obligations under EU law in relation to the Marine Strategy Framework Directive, and other EU Directives including the Birds and Habitats Directives.

Ireland's marine and coastal zone environment is experiencing increasing development pressures and conflicts from fishing; aquaculture; oil and gas extraction; shipping activities and port development; and increasing maritime recreational and tourism activity. These must be reconciled with meeting international and national commitments in respect of climate emissions, biodiversity and water quality. At the same time the development of alternative energy, whether off shore wind, wave or tidal, or exploitation or cultivation of biomass brings new challenges to the marine environment.

2 Benefits of Marine Spatial Planning

Marine spatial planning that is ecosystem based, and coordinated among all sectors and users of the marine area can help achieve marine nature conservation goals and objectives without limiting future economic development. It facilitates the necessary designation of marine protected areas which are essential to sustainable fisheries, in addition to more general but critical biodiversity benefits.

These benefits are:

- MSP can provide greater certainty to all sectors concerning potentially acceptable locations for different types of activity;
- MSP allows for early identification of potential conflicts between industry and development and important wildlife areas, and therefore offers a chance to resolve them. MSP can offer transparency in both human and environmental impacts, and

enable potential conflicts to be identified and resolved at the planning stage, rather than at a later stage when considerable investment has been made for individual proposals or damage to the environment is irreversible;

- MSP, in the guise of an Integrated Coastal Zone Management approach, would allow for a more strategic approach to management in that it would improve our understanding and consideration of the cumulative and combined effects between different activities and the environment itself. This understanding allows for proactive planning, rather than just reacting to applications, changes and situations.

3 Legislative Framework

A comprehensive legal basis for a National Marine Planning Framework is required to provide for strategic, integrated and forward-looking governance for all uses of the sea. This should take social and economic benefits into account, while climate action, mitigation of ocean acidification and nature conservation commitments are placed at the heart of planning and management.

Ireland has a comprehensive and well established terrestrial land-use planning system. As such it is recommended than an analogous statutory sea-use planning system is adopted with broadly similar characteristics to the terrestrial system. The statutory sea-use planning system should incorporate the three central elements of the land-use planning system i.e. Forward Planning, Development Management, and Enforcement, and ensure integration with the National Planning Framework.

While much can be learned from the terrestrial land-use planning system there are some important differences when managing the marine environment. The marine area is dynamic in nature, and multiple uses of the same location, simultaneously, or during different times or seasons will occur more than on land. Above all the sea must be managed as a public rather than a private resource for individual vested interests.

It is recommended that the key principles of a National Marine Planning Framework for Ireland are as follows:

1. NMPF should be implemented as a legally-binding process with the purpose of achieving sustainable development of the marine environment for the common good;
2. An Integrated Coastal Zone Management approach should be implemented, to harmonise marine planning across all sectors and industries, and to fully account for the cumulative pressures;
3. A statutory marine and coastal zone plan-making body should be established and empowered as the guardian of the NMPF and management process, in the same way a planning regulator is being put in place arising from land use planning legislation;
4. An ecosystem approach should be implemented to maintain the marine ecosystem in a healthy, productive and resilient condition so that it can provide the goods and services people want and need;
5. NMPF should be developed to take full account of the fact that Ireland's marine waters form part of a broader region and sub-region set out in the Marine Strategy Framework Directive;
6. Public participation should be fully integrated into the NMPF process in a systematic manner and, in line with Ireland's ratification of the Aarhus Convention. It should be wholly consistent with all aspects of marine activity including review of decision making and include fisheries and quota management;
7. NMPF should plan for the long term, with a 2040 date to harmonise with the National Planning framework, with mechanisms established to measure and monitor key indicators, and which can trigger adjustment and review if required as provided under the SEA Directive;
8. NMPF should be used to identify preferred locations for future development for specific sectors (zoning) with flexibility to incorporate changes in technology, science and economics;
9. NMPF should be fully integrated into the statutory land-use planning system and National Planning framework.

4 Current Marine Planning System

In many respects planning in the Irish marine environment today resembles terrestrial planning in Ireland in the 1980s and 1990s. Ireland currently implements a disjointed 'project-by-project, permit-by-permit' approach to marine, aquaculture, and oil and gas exploration licencing.

Currently, marine policy and development consents are spread across a number of Government departments and agencies, and major projects on the coast or in the marine area require a multiplicity of consents. For example:

- Designations under the Birds and Habitats Directives are made by the Minister for Culture, Heritage and the Gaeltacht.
- Irish Sea fisheries are managed as a common resource at an EU level under the Common Fisheries Policy (CFP), setting out quotas for how much of each species can be caught in defined marine areas. Implementation is governed by the Sea Fisheries and Marine Jurisdiction Act 2006.
- The Department of Housing, Planning and Local Government is responsible for Foreshore Licenses up to a 12 nautical mile (22.4 km) limit.
- Developments within local authority jurisdiction are subject to the Planning Acts, which are open to appeal to An Bord Pleanala.
- Strategic Infrastructure Development (SID) and local or state authority applications coming under the EIA Directive are lodged directly with An Bord Pleanála, the former following the 2006 amendment to the Planning and Development Act 2000.
- Gas pipelines and electricity inter-connectors are subject to a range of consent.
- The Department of Communications, Climate Action and Environment is responsible for the promotion of oil, gas and mineral exploration, as well as its licencing.
- Aquaculture license applications are made to the Department of Agriculture, Food and the Marine with an appeal provision to the Aquaculture License Appeals Board (ALAB).

- Other developments on land, such as an incinerators, which have an impact on the marine area, come under EPA Waste and IPPC licensing provisions.
- The EPA determines Dumping at Sea permits from port dredging under the Foreshore and Dumping at Sea (Amendment) Act 2009.

The carrying out of Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) in the marine area is fragmented on a sectoral basis by different Government departments or agencies. The application of the Strategic Environmental Assessment (SEA) Directive has proved disappointing. Major strategy documents which include sectoral growth targets have been published by Government Departments, such as '*Harnessing Our Ocean Wealth 2012* (HOOW) and Food Harvest 2020 without SEA. While Foodwise 2025 has been subject to SEA, there is no evidence of the monitoring require by the SEA Directive for assessing and addressing significant adverse effects

5 The Baseline Considerations Required To Inform the National Marine Planning Framework

5.1 The State of the Global Marine Ecosystem

The diminution of the global marine environment is overwhelming. 6 billion tonnes of fish and invertebrates have been removed from the ocean since the 1950's, and plastic pollution is pervasive, even in the deepest parts of the ocean[1]. Fishing activities, trawling in particular, have exposed shallow coastal marine ecosystems to potential long term damage. A 2015 WWF report[2] established that marine vertebrates fell by 49% between 1970 and 2012. In addition, an international study by Paleczny *et al.* (2015)[3] found a 70% decline in the population of seabirds. Despite the increasing human impact through fishing, waste and chemical release on the ocean

[1] WWF. 2018. Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland.
[2] WWF (2015) Living Blue Planet Report Species, habitats and human well-being
[3] Paleczny M, Hammill E, Karpouzi V, Pauly D (2015) Population Trend of the World's Monitored Seabirds, 1950-2010. PLoS ONE 10(6): e0129342. https://doi.org/10.1371/journal.pone.0129342

ecosystem remains inadequately understood. In 1995 internationally recognised marine biologist Daniel Pauly defined the term ‘shifting baselines’ to describe a phenomenon of lowered expectations, in which each generation regards a progressively poorer natural world as normal. This allows the avoidance of addressing the long term decline of fish and other marine species so that ‘normal’ is seen as an ever deteriorating point of reference with fewer fish and fewer species. Eventually what Pawley defines as ‘fishing down the food web’ leads to tipping points which are reached whereby the larger fish are removed leaving less fertile specimens leading to ‘trophic cascade’ with the breakdown of the marine food web and a diminished marine environment where crustaceans and jelly fish dominate.

Any assessment of sustainability should be mindful of the The Stockholm Resilience Institute’s identification of nine planetary boundaries, which are gaining increasing acceptance in assessing global sustainability and human interface with the boundaries being biosphere and atmospheric; terrestrial and marine; climate; and eco systems. It defines a safe operating space for humanity, and transgressing these will potentially be catastrophic for planetary scale systems. (Appendix I)

5.2 The State of Ireland’s Marine Ecosystem

The history of Irish marine exploitation is a cycle of over exploitation and collapse, before moving on to the next species. Over the last few centuries Ireland has lost the once abundant shoals of pilchards (sardines), mackerel, herring and oyster beds around the coast. The basking shark was fished to near collapse by the mid-20th century, and the angel shark is now endangered.

There is a requirement for the NPWS to complete a 6 yearly Article 17 report under the Habitats Directive on the status of habitats and species. The last report is from 2013, and demonstrates the scale of the challenge facing Ireland across all habitats. Of the 59 primarily terrestrial overall habitat assessments, only 5 stood at ‘Favourable’ status, 30 ‘Inadequate’ and 24 at ‘Bad’. The lack of data on a range of cetacean species left their status ‘Unknown’.

For marine fish species, which are not reported under the Habitats Directive, the latest figures from the European Commission's Scientific, Technical, and Economic Committee for Fisheries

confirms that overfishing continues. According to the most recent updated data, 41 % of fish stocks were still being overfished in 2015. Assessment and conservation status data on marine mammals and habitats is generally inadequate in Irish waters.

Data reported to the EU by the STECF (2016) [4] on Stocks at Risk (SAR) found that for all the 32 active fleet segments in 2014, six were exploiting one stock at risk, six were exploiting two stocks at risk, and one was exploiting four stocks at risk.

With no fish or vertebrate afforded legal protection under the Wildlife Act of 1976, Ireland is the only country bordering the North Atlantic where marine life is not officially acknowledged as wildlife. Irish inshore waters within the 6 mile limit are facing multiple threats and pressures. Dredging for scallops and clams is continuing in a manner entirely damaging to the sea bed, and ultimately destructive to the resource which is being exploited. Bottom trawling generally is irrevocably degrading the sea bed ecosystem. New pressures to exploit marine vegetation are being allowed without proper assessment including mechanical kelp extraction in Bantry Bay. The sustainably of continued aquaculture needs to be reviewed.

5.3 Climate Change

The interdependence between all aspects of marine life and climate is only now beginning to be understood. A summer 2018 report from the RSPB[5] on the Shetland Islands revealed catastrophic sea bird population collapse, attributable to climate change impacts on marine feed sources. There has been significant drops in the number of Arctic Terns, Kittiwakes and other birds. Puffin numbers have fallen from 33,000 in 2000 to 570 in 2017.

Climate change also poses an increased risk to, and impact on, coastal ports, marine transport, energy and communications infrastructure, with future impacts on Ireland including an increased exposure to, or regularity of, Atlantic storms like 2017 Ophelia.

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[4] Scientific, Technical and Economic Committee for Fisheries (STECF) Assessment of balance indicators for key fleet segments and review of national reports on Member States efforts to achieve balance between fleet capacity and fishing opportunities (STECF-16-18).); Publications Office of the European Union, Luxembourg; EUR 27758 EN; doi:10.2788/245471

[5] https://www.theguardian.com/environment/2018/jun/03/shetland-seabirds-climate-change-catastrophe-terns-kittiwakes-puffins

Despite this, climate change is given only token reference in the Baseline report. In section 3.40 it is outlined that:

> *"The marine spatial plan will consider climate change from two perspectives; how actions under the plan may help mitigate climate change and how actions under the plan need to be adapted to take account of the effects of climate change."*

Yet, the only substantive reference to Climate Change is in 3.39 and 3.40. This stated ambition is not reflected in the consideration of any of the individual sectors, most notably in Chapter 8, Energy-Petroleum. The framing of consultation question 6 asks *"How can Ireland's marine plan be used as part of Ireland's climate change adaptation measures*?" An Taisce would highlight that there is no reference to climate mitigation.

5.4 Ocean acidification and warming

Following on from point 5.3 above, there is a parallel impact of increasing anthropogenic CO_2 on ocean chemistry. Ocean acidification is caused by the absorption of carbon by the ocean, which is then converted to carbonic acid. This has the potential to undermine the functioning of ocean ecosystems. At no point in the document is this outlined, despite the significant and increasing impact this will have on marine ecosystem and fisheries

The impact of ocean acidification is insufficiently recognised. Even if continuing levels of CO_2 were not an issue in generating climate change, its impact on ocean acidification would require the same level of international action to reduce and cap emissions to scientifically acceptable limits. However, the Marine Institute, which should be aligned with the most progressive international research on ocean warming and acidification, is not communicating the need for Ireland to take leadership in international action on reducing carbon emissions, or addressing ocean acidification. Indeed, from a recent presentation to the Joint Oireachtas Committee, in April of 2018, it would seem that when considering potential climate impacts on the marine area the Marine Institute focus more heavily on the economic benefits which they consider this can bring. In his presentation to the committee. Dr. Paul Connolly of the Marine Institute referred to the increase in sea temperature in the next ten to 20 years which will cause stocks fished off Ireland like cod and haddock "*to move north to get to the colder waters*". In turn

other species like hake and monkfish would move north and take their place providing *"another opportunity here in that the market value of the new species that will move into the waters, such as hake and monkfish, are much more valuable than species such as haddock and cod*.". There was no scientific explanation as to how this would be part of a transition compatible with a rapidly changing marine ecosystem.

At the same meeting, Dr. Peter Heffernan of the Marine Institute raised the potential of significant methane reduction by *"the integration of marine plat materials, seaweeds into the diet of cattle and other bovines*". The sustainability of any large scale extraction and impact on coastal ecosystems was not addressed.

All Government agencies and Departments, all sectors involved in all aspects of the marine and the public generally need to have confidence that the State has access to independent and scientifically credible advice on ocean acidification and the state of the marine ecosystem generally. The Marine Institute as currently constituted is not meeting this obligation.

6 International and EU Policy Obligations

6.1 Sustainable Development Goals (SDGs) 2015

Ireland ratified the 2015 UN Sustainable Development Goals SDGs including Goal 14 Life Below Water, which aims to conserve and sustainably use the ocean and marine resources.

The Department of Communications, Climate Action and Environment has promised that the SDGs would be adopted through a 'whole of Government' approach. However, no reference is even made to the SDGs in the Baseline report. This is despite one of the themes outlined in Section 24.5 relating to the promotion of the sustainable development of the ocean economy:

"Promote the sustainable development of thriving ocean economy"

Throughout the document sustainability appears to be a secondary consideration to economic targets only after "Issues for Delivery" and sectoral objectives are considered. At the root of this is a flawed conceptual bias which underpins the entire document in treating sustainability, or the overarching environment, as a consideration to think about only after quantitate

economic targets are adopted. Attached is a Venn diagram explaining this conceptual failure, and how to remedy it (Appendix I)

6.2 The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention')

Sections 15.8 to 15.12 of the baseline report references the OSPAR Convention as a consideration. Ireland, along with 14 other EU states, is a contracting party to the OSPAR Convention (Oslo and Paris Conventions for the protection of the Marine Environment of the North East Atlantic).

This was adopted in 1998, embracing a more holistic responsibility for environmental protection in the region, including its biodiversity. It provided for the development of lists of species and habitats in need of protection, identification and selection of marine protected areas, and the prevention and control of adverse impacts from human activities. The OSPAR convention parties are using the OSPAR Commission to provide resources, co-ordination and guidance on the implementation of the MSFD. Any Marine Spatial Plans should be cognisant of our commitments under this convention, and draw on the expert guidance which is available from the OSPAR Commission.

6.3 EU Legal Obligations

6.3.1 Directives and Policy Developments on Marine Environment

Article II of the Treaty on the Function of the European Union states:

> *'Environmental protection requirements must be integrated into the definition and implementation of the Union policies and activities, in particular with a view to promoting sustainable development'.*

The Marine Strategy Framework Directive (MSFD) was adopted in 2008, and represents the environmental pillar of the EUs Integrated Maritime Policy. The aim of this Directive is to

promote the sustainable use and conservation of Europe's seas and marine ecosystems, through the objective of reaching Good Environmental Status (GES) for all marine waterbodies by 2020. It places considerable emphasis on adopting the eco-system approach, adaptive management and public participation in its implementation, while facilitating greater transparency with regard to marine management decisions. If implemented correctly it could result in a significant improvement in the quality of the European marine environment.

However, there are issues with the implementation of this Directive. The MSFD transboundary ecosystems based approach conflicts with the continued pressure to maximise fisheries quotas under the Common Fisheries Policy (CFP) over scientific advice on safe levels of individual species stability. In addition, the MSFD provides the means for Ireland to take leadership in marine conservation. This includes the key provisions to designate Marine Protected Areas (MPAs). To date these have not been designated in Ireland, beyond those areas which are already covered by the Natura 2000 network. Marine protected areas are discussed in Chapter 15 of the Baseline report. While it is outlined that Article 13.4 of the MSFD requires a coherent and representative network of MPAs, section 15.26 refers only to legislation 'being prepared'. No time commitment is given for legislation or designation of MPAs, with section 15.27 just stating that the Minister will 'shortly commence' a process to identify what additional MPAs are required for marine protection. MPAs could include locations to protect a range of marine species and habitats including nursery areas for a range of fish species the vital feed source for sea birds. The use of MPAs to restrict fishing have been internationally demonstrated to be of major benefit for population regeneration with an impact on areas outside the MPA.

Further to that, the Water Framework Directive (WFD) (2000/60/EC) requires Member States to achieve good status by 2012. This Directive also covers coastal and transitional waters, up to 1km off the coast.

6.3.2 The Impact of the EU Common Fisheries Policy.

The EU Common Fisheries Policy (CFP) has presided over continuing decline of North East Atlantic fish stocks, with a 50% reduction in catches over the last 20 years. There are three years remaining to meet the legally binding deadline to end overfishing by 2020. This is not

being achieved. A February 2018 Pew Charitable Trusts report[6] carried out by fisheries consultancy Poseidon Aquatic Resource Management Ltd. measured the progress that EU fisheries ministers have made in setting sustainable fishing limits to implement the EU's reformed Common Fisheries Policy (CFP), which took effect in 2014.

It found that in 2017, 55 percent of fishing limits were set above scientific advice. The analysis found that fisheries ministers have set more than half of catch limits above scientific advice in recent years, making limited progress toward the CFP's requirement to end overfishing by 2015 where possible and by 2020 at the latest (Figure 1). Yet in Chapter 13 of the Baseline report it is asserted that:

> *'Fish populations are generally improving since reform of the CFP and more sustainable management of fish populations with the setting of Maximum Sustainable Yield (MSY) for commercial species.'*

[6] Nimmo, F., Cappell, R., 2017. Taking Stock – Progress towards ending overfishing in the EU. Report produced by Poseidon Aquatic Resource Management Ltd for The Pew Charitable Trusts

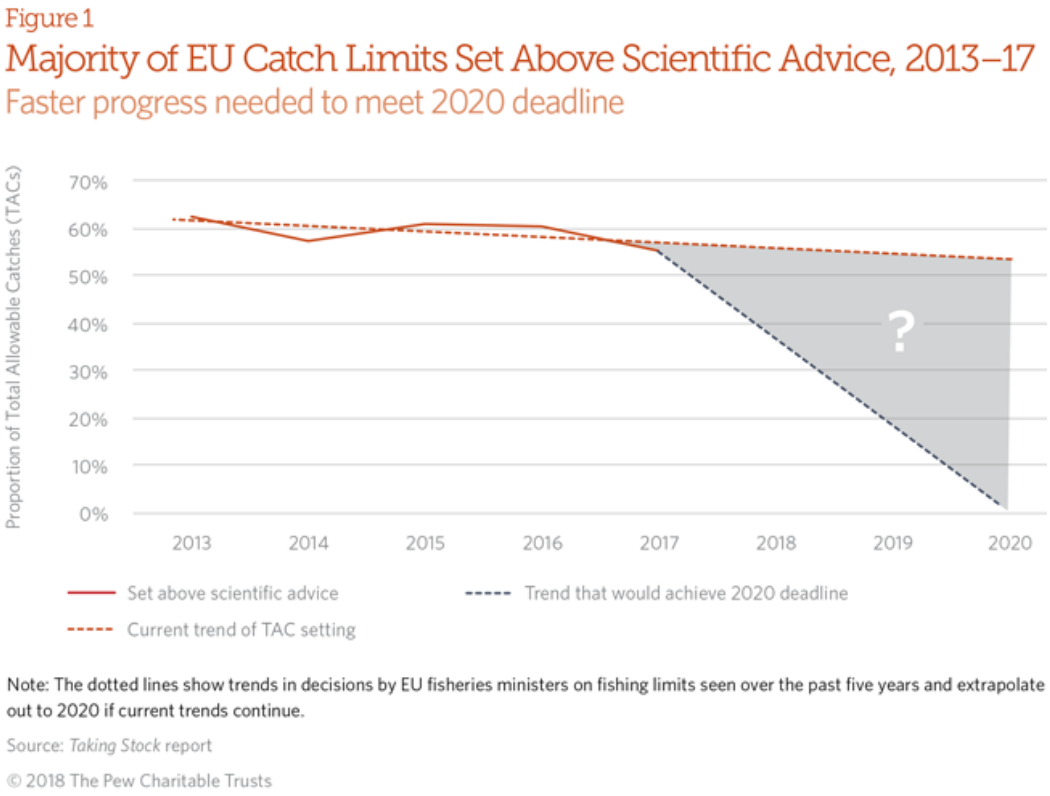


Figure 1: Graphic from Taking Stock report, outlining the historical and projection trends for overfishing

Ireland stands out particularly in undermining fisheries conservation at EU level. In a 2018 report by the New Economics Foundation, Ireland was placed as one of the worst EU member states for overfishing in the Atlantic, undermining international efforts to restore fish stocks to sustainable levels[7]. It cited Ireland's decision in late 2017 *"to once again push for fishing quotas which ignore scientific advice is undermining efforts to end overfishing by 2020*" and that "*In the negotiations last December for 2018, Ireland, represented by Minister for the Marine Michael Creed, "topped the league table of setting quota at 18 per cent [of their total TAC] above scientific advice"* (this was based on 124 TAC decisions). The continued practice of setting fishing quota above scientific advice:

[7]https://neweconomics.org/uploads/files/NEF_LTB_ATLANTIC_2017.pdf

"*harms the environment, is short-sighted politics, and goes against the objectives of the CFP….Ireland celebrated its achievement at 'winning' quota for its fishing fleet above scientific advice….Topping the overfishing league table should be criticised – not celebrated – as it comes at the cost of delaying the recovery of European fish stocks and more sustainable jobs"*

While this approach makes Ireland's seafood industry a '*key natural resource and an important contributor to the Irish economy',* it undermines any commitment to developing this in a sustainable way. Indeed, as outlined in section 13.20, '*sustainable use of natural resources creates a more resilient seafood sector'.* However, the actions of the Irish Government in their approach to the CFP would not ring true with the assertion that there is '*general recognition'* of the need for sustainable approach.

7 Irish Policy Documents

7.1 Harnessing Our Ocean Wealth 2012

In July 2012, the Irish government released Harnessing our Ocean Wealth: An Integrated Marine Plan for Ireland (HOOW) following a public consultation period by the Minister for Agriculture, Food and Marine, Simon Coveney. This plan aims to double the value of Ireland's ocean wealth to 2.4% of GDP by 2030, and to increase the turnover from the country's ocean economy to more than €6.4 billion by 2020. Norway and Iceland were held as international exemplars of marine development for Ireland to emulate. The quantity based focus of this document has been highly criticised by environmental NGOs. The document has a narrow focus on GDP economic growth. It adopts the objective of creating a 'thriving maritime economy' and supports 'sustainable economic growth', which does not address ecological boundaries. Sustainable growth is an oxymoron: growth cannot be sustainable on a finite planet (Daly, 1993)[8].

[8] Daly, H.E. (1993). Sustainable Growth: An Impossibility Theorum. In H.E. Daly and K.N. Townsend (Eds), Valuing the Earth: Economics, Ecology, Ethics. Cambridge, MA: The MIT Press.

No review is proposed on the compatibility of the economic targets of HOOW, with the overarching goals laid out in Chapter 2 of the Baseline document, namely Goal 2.4 to '*protect, preserve, and where possible, restore our rich biological diversity and ecosystems'*. The National Marine Planning Framework is described as being the spatial articulation of the policy vision outlined in HOOW 2012, but it is difficult to see how this will result in a reversal of biodiversity loss and compliance with SDG 14. HOOW was adopted without Strategic Environmental Assessment (SEA) or integration with the MSFD, and is based on an exploitative rather than ecosystems based vision.

7.2 Food Wise 2025

This was an industry driven strategy focusing on agricultural growth in Ireland, including the marine sector. The oversight of Foodwise 2025 is undertaken by a High Level Implementation Committee chaired by the Minister for Agriculture Food and the Marine. A presentation given to this Committee in May 2018 by the seafood sector was revealing in what is driving the industry, and what is being uncritically accepted by policy makers. It was outlined that the top three priorities for the seafood section were:

1. Expand the raw material base
2. Enhance the industry's structure and skills
3. Optimise product added value and export markets

The same presentation also outlined that there is an opportunity to expand fishing out in to the mesopelagic region. The sole focus of this is on it being an economic opportunity. There is no indication that this plan addressed any concern for the marine ecosystem, or the carbon store which this provides, which is estimated to be 10 billion tonnes of biomass. Removing this biomass from the system will facilitate the release of this carbon in to the atmosphere.

No data is provided on the EU legal obligation for Strategic Environmental Assessment monitoring of Foodwise 2025. This data should be a vital element of this Baseline document to determine if any significant adverse effects are already arising requiring remedial action

8 Other Issues to be addressed

The first Consultation Question posed at the end of the Baseline report asks:

"This Baseline report is intended to capture and summarise all the sectoral activities that are taking place in Ireland's marine spaces… are there gaps in what is presented and if so, how can they be addressed in this report?"

An Taisce believe that there are significant gaps in this report, which include: addressing SDG targets; EU legal obligations; climate and ocean acidification; aquaculture issues; and reversing diversity loss. These are further outlined below.

8.1 Baseline information on the marine ecosystem is not provided.

Chapter 16 on Nature Conservation does not provide any baseline overview of the state of the Irish marine ecosystem, or on the health of the marine ecosystem or of fish, marine mammals and bird species. As evidenced in Section 16.3, Ireland has yet to conclude an assessment of bird data from offshore waters to determine if SPAs are required there, and in Ireland's 2013 Article 17 Report the status of cetaceans was reported as unknown.

8.2 No unification of consent regime

A strong divide between marine and terrestrial planning frameworks still exists in coastal planning and management. There is a lack of coherence between the two planning regimes, with the latter being managed using a sectoral approach, often with no co-ordination between activities. Section 3.34 states *"the National Marine Planning Framework will not replace or remove existing regulatory regimes or legislative requirements governing the operation of various marine activities. Rather it will provide an overarching framework for their continued operation*.' An Taisce would express concern that this leaves fish quota management, oil and gas drilling and other activities to be regulated without effective co-ordination. It may lead to a biased framework as currently there are agencies which are charged with both promoting and regulating marine activities**,** such as oil and gas drilling**.**

In March 2013, Fianna Fail Front Bench T.D Éamon Ó Cuív accused the minister for Agriculture, Food and the Marine Simon Coveney of conflict in his role in considering the development of a major salmon cage farm in Galway Bay after he request support for the project:

> *'Fianna Fáil agriculture spokesman Éamon Ó Cuív says Minister for the Marine Simon Coveney approached him a year ago on the issue of the proposed €60 million fish farm for Galway Bay, and "made it clear that he supported the project in advance of the application being made to his department". Mr Ó Cuív believes the project application should be withdrawn by BIM for this reason.*' – The Irish Times, 24th March 2013.

The Department of Communications, Climate Action and Environment is responsible for the Petroleum Affairs Division (PAD) which as part of its mission statement outlines that it is *'responsible for the* ***promotion****, regulation and monitoring of the exploration and development of oil and gas resources onshore in Ireland and offshore'*. [An Taisce emphasis]

Previous Minister Pat Rabitte, responsible for assessing and approving oil and gas exploration and extraction projects stated:

> *'The ultimate goal of the Government was to maximise the benefits to Ireland of its indigenous oil and gas resources'* – The Irish Times, April 18th 2013

This is based on an entirely economic driven agenda of resource extraction. In February 2013, the legal challenge by An Taisce against the Foreshore License granted by the Department of Environment, Community and Local Government to Providence Resources for an oil and gas exploration well off Dalkey resulted in the withdrawal of the application by Providence Resources as the pleadings established the EIA Directive Annex on deep drilling had not been

transposed into Irish law. Minister of State Jan O'Sullivan said she would review the EIA regulations in question *'with a view to remedying any difficulties that may exist'*[9].

Most recently the official in the Department of Communications, Climate Action and Environment who signed an exploration licence for activity at Barryroe off the Cork coast for Exola DAC an associated company of Providence Resources, on 9th October had also on 27th December 2017 personally edited the End of Year Trading Statement for Providence Resources, after having been emailed it directly that day by the CRO of Providence resource Tony O Reilly.

What is required for an effective and unbiased marine spatial plan is an integrated science and ecosystem based strategic planning and regulatory regime for the marine environment, at both plan and programme and individual consent project stage.

8.3 Oil and Gas Exploration

Offshore exploration drilling has taken place off the Irish Coast since the 1970's with gas extracted from the now depleted Kinsale Field, the Seven Heads field adjacent, and work advancing on the Corrib project in North West Mayo. Developing technology and the depletion of conventional oil fields is leading to a new wave of marine oil and gas exploration globally.

Offshore oil and gas rigs can have huge environmental impacts, and accidents such as the 2010 catastrophe on the Deepwater Horizon in the Gulf of Mexico showed how much damage can be caused. Environmental damage led to the mass fatalities of a huge amount of wildlife including dolphins, whales, turtles and fish. The tourism and the seafood industry of the area were also affected.

Overshadowing this is Ireland's commitment to meeting the Paris Agreement 2015 target to stabilise global temperature rise at as near as possible to 1.5 degrees Celsius. The meeting of Paris Agreement targets means that most existing known fossil fuel deposits needs to be left in

[9] Irish Times, February 13th, 2013

the ground as un-burnable carbon, leaving no justification for continued exploration (See Appendix II). Moreover, this offshore exploration has continued despite internationally accepted research on the very significant adverse impacts of the deployment of Seismic Air-Gun Blasting on marine life, including impacts on fish stocks, spawning, migration and phytoplankton. There have been extensive governmental consents granted for the deployment of Seismic Air-Gun Blasting within the Irish Exclusive Economic Zone throughout the past three years, with no public participation, no environmental impact assessment and no appropriate assessment associated with the grant of any such consent(s). The impacts of Seismic Air-Gun Blasting have not been taken into account by the Marine Institute or by ICES in the assessment of the sustainability of fish stocks within the NE Atlantic, specifically within Ireland's EEZ (Exclusive Economic Zone).

There has been little or no public awareness within Ireland, or further afield, of the ongoing Seismic Air-Gun Blasting within Ireland's EEZ, or the negative impacts associated with it. In addition, there is a lack of public participation in the granting of consents, and a distinct lack of transparency.

8.4 Marine Renewable and Bio Energy

The extent of Ireland's coastal and marine area creates major potential for future renewable energy. The 2012 HOOW states that:'*Our renewable energy resources, both onshore and offshore, are significantly greater than the national energy requirement'*[10]. However, the plan goes on to state that Ireland will '*continue to implement research supporting increased hydrocarbon prospectivity through government-industry and international collaboration.....to support and enable offshore exploration for indigenous oil and gas resources*'[11].

The impacts of wave and tidal renewable energies on marine mammals are not properly understood. Research has begun in Kilrush on the impacts of noise from wave energy machines

[10] Harnessing our Ocean Wealth: An Integrated Marine Plan for Ireland (2012), Department of Agriculture, Food and the Marine, pg 29.
[11] Ibid, pg 40

on the Bottlenose Dolphin (*Tursiops truncatus*), but this research is in its infancy. Similar impacts of noise on the moulting/breeding sites for Irelands Common Seal (*Phoca vitulina*) and Grey Seal (*Halichoerus grypus*) species are not understood. An Taisce supports the development of marine renewable energy but submits that caution should be taken by the government. We recommend that no licences for renewable energies sites, including test sites, should be granted unless they have had a full and thorough environmental impact assessment carried out, having regard to ECJ Judgement 66-O6 on a trial aquaculture licence in the Kenmare River.

In addition, research needs to be carried out on the impact of the germination, harvesting and refining of algae or seaweed as a bio fuel or fossil fuel substitute. This could potentially act as a major new energy resource but the environmental impact of its large scale application needs to be assessed.

8.5 Aquaculture

Jeffery *et al.* (2014) outlined that:

> *'High quality aquatic environments and the prevention of their deterioration are fundamental to the sustainable development of European aquaculture'*

When establishing and implementing maritime spatial planning, Member States are obliged by the MSP Directive to consider economic, social and environmental aspects to support sustainable development and growth in the maritime sector, applying an ecosystem-based approach. The Fisheries and Aquaculture Department of the Food and Agriculture Organisation of the United Nations (FAO) ecosystem approach to aquaculture fits neatly within this requirement:

> *'An ecosystem approach to aquaculture (EAA) is a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development, equity, and resilience of interlinked social-ecological systems.'*

An integrated approach to aquaculture development is required. One which fully accounts for the needs and impacts of other sectors. The widespread adoption of an EAA will require a much tighter coupling of science, policy and management. It could also address the myriad issues outlined below.

8.5.1 Cumulative Impact

There is a historical and ongoing lack of cumulative assessment for aquaculture activities in Ireland, and to date no Strategic Environmental Assessment (SEA) has been carried out for this industry. The European Court of Justice ruling in case C-418/04: Commission v. Ireland on 13th December 2007 found that Ireland had systematically failed to ensure that aquaculture projects, likely to have a significant effect on SPAs, either individually or in combination with other projects, are subject to an Appropriate assessment under Article 6 of the Habitats Directive.

> *"the failure to take account of the* ***cumulative effect of projects*** *in practice leads to a situation where all projects of a certain type may escape the obligation to carry out an assessment, whereas, taken together, they are likely to have significant effects on the environment" (C-418/04, C 392/96 paragraphs 76, 82)."* [An Taisce emphasis]

As such, the licensing of aquaculture projects should only be permitted within Natura sites where adverse impacts of the project, in combination with other activities in the area, can be excluded. The granting and operating of a large number of licenses in one particular area should be avoided, preventing not only detrimental impacts on the area, but also over-stocking within the industry itself. In addition, Environmental Impact Assessments (EIA) should be carried out to assess the in-combination effects of all activities within each bay, rather than assessing aquaculture licences on an individual basis, in isolation from other impacts. Annex III of EIA Directive 2011/92/EU refers to the characteristics of projects that must be considered for an EIA. Paragraph 1(b) of Annex III refers to the cumulation with other projects. EIAs should

also take into account the potential impact of the aquaculture facility over its entire lifecycle, including the construction, operation and decommissioning phases of the facility.

The impacts associated with aquaculture pose a risk for many of Ireland's marine habitats. Organic enrichment from faecal matter (finfish and shellfish farming) and excess fish food (finfish farming) can build up in systems, altering the trophic structures in the ecosystem, and decreasing the available oxygen, thereby negatively impacting on the benthic fauna. It is generally assumed that organic outputs fall to the sea floor directly beneath the structures, only causing localised enrichment. While this is true for small scale projects, it is difficult to accurately predict the impacts of aquaculture as it intensifies and expands, as encouraged to do under the HOOW plan and the Foodwise 2025 policy.

Indeed, studies suggest that the environmental effects associated with oyster cultivation, such as increase in organic and silt composition become more severe in areas of large-scale cultivation as the water velocity can be decreased by the presence of the trestles (Nugues *et al*. 1996)[12]. This may be exacerbated in more sheltered bays, which will prevent sufficient flushing of the organic matter. This has been repeatedly raised as a concern by An Taisce when consulted on multiple aquaculture licences for single bays. However, the licences have generally been granted in spite of the absence of a cumulative assessment, and consideration of the potential baffling effects. To underline the urgent need for such an assessment, the Baseline report outlines that oyster production increased by 25% from 2007 to 2016, indicative of the ever increasing numbers of such oyster trestles in Irish bays, with each being considered individually in regard to organic matter deposition and flushing potential. A holistic approach is necessary.

[12] Nugues, M.M., Kaiser, M.J., Spencer, B.E and Edwards D.B. (1996). Benthic community changes associated with oyster cultivation. Aquaculture Research, 27, 913-924.

In regard to the appropriate assessment of aquaculture on Ireland's SACs and SPAs, there are two major weaknesses in the system. Firstly there is a lack of baseline data; and secondly a lack of cumulative assessment (discussed above). In regard to the lack of baseline data, in many instances the appropriate assessments of the bays refer to the need for further studies, in regard to QI birds in SPAs, an/or an adaptive management plan due to lack of data. Negative impacts on birds caused by aquaculture have been demonstrated in Irish SPAs by Gittings and Donoghue (2014). In addition, from the MSFD document Article 19 report (2013), it is apparent that in Ireland there exists significant knowledge gaps regarding the current status of the marine environment, particularly in regard to cumulative impacts. To date these gaps have not been sufficiently filled, and there have not been enough baseline scientific studies or studies of the long-term impacts undertaken. Thus, it is difficult to accurately predict the impacts of aquaculture as it intensifies and expands, particularly in the absence of an SEA.

An Taisce would highlight the ECJ ruling for C-404/09 [Commission v Spain] which held that:

> "*[a]n assessment made under Article 6(3) of the Habitats Directive cannot be regarded as appropriate if it contains gaps and lacks complete, precise and definitive findings and conclusions* ***capable of removing all reasonable scientific doubt*** *as to the effects of the works proposed on the SPA concerned*." [An Taisce emphasis]

Similarly, the court held in the case of the Commission v Italy that:

> "*assessment must be organised in such a manner that the competent national authorities can be certain that a plan or project will not have adverse effects on the integrity of the site concerned, given that,* ***where doubt remains as to the absence of such effects, the competent authority will have to refuse permission***." (C304/05. Para 58) [An Taisce emphasis added]

Ireland's obligations under the Habitats Directive require that the Precautionary Principle should be applied until there is sufficient baseline knowledge from which to make a qualified decision, but to date that is not well applied for aquaculture licensing. It is vital that baseline

studies been completed prior to licensing of aquaculture. There is a legal imperative where a lack of data exists, and the Relevant Authority cannot conclude beyond reasonable scientific doubt that it will not negatively impact on the conservation objectives of the Natura 2000 site, that the aquaculture licence should be refused. In addition, any aquaculture licensing should take account of Ireland's continuing legal obligation to avoid, in such sites, the deterioration of natural habitats and the habitats of species, as well as disturbance of the species for which the areas have been designated. To that end, there should be a requirement for regular monitoring, prior to, and after, an aquaculture license is granted. This ensures that negative environmental consequences are identified and addressed quickly. At present there is no such monitoring or environmental assessment undertaken post licensing. An SEA could address this lacuna.

8.5.2 Water Quality Concerns

The appropriate assessments compiled for aquaculture in Irish Natura Sites frequently rely on the argument that there is sufficient flushing of bays to prevent an accumulation of organic matter. However, as already outlined, there is a systemic failure to assess the cumulative baffling effect and ensuing organic enrichment which could pose a significant threat to the water quality, and on the QI communities with Natura 2000 sites. An Taisce would highlight that coastal and transitional waters are subject to the legal obligations of the Water Framework Directive (2000/60/EC), which requires that all waterbodies reach good status by 2021. They are also protected by the Marine Strategy Framework Directive, which aims to achieve good ecological status (GES) of the EU's marine waters by 2020, and to protect the resources on which marine-related economic and social activities depend.

Chapter 5 of the Baseline report clearly demonstrates a lack of fundamental knowledge regarding the nutrient dynamics associated with aquaculture activities across a range of scenarios, when aquaculture is simultaneously held up as a threat to tourism, due to eutrophication and degradation of water quality, while also being lauded as a benefit to wild fisheries due to the addition of nutrients to the system.

An Taisce submit that prior to any Marine Plans being drawn up, it is vital that a carrying capacity study be carried out for each of the bays within which aquaculture will be situated. "Carrying capacity" is a term used to describe the maximum average number of organisms that can be sustained so that they can survive and reproduce in the long term (i.e. without degrading the surrounding environment). The extent of aquaculture should not exceed what an area can naturally sustain and assimilate to ensure no environmental degradation. Foodwise 2025 does mention the need to assess the carrying capacity of bays for aquaculture, but the ongoing lack of such assessments, and of an SEA, is a weakness in this system. The onus should be on aquaculture developers to demonstrate beyond reasonable scientific doubt that there will not be such adverse impacts.

8.5.3 Public Participation

The participation of stakeholders is at the base of an EEA approach. This is extremely pertinent within an Irish context, as there is a demonstrable lack of transparency within the Irish system. While aquaculture applications are automatically referred to An Taisce, other NGOs and members of the public find it difficult to keep abreast of aquaculture licence applications, with a lack of easily accessible notice or information regarding each application. Public participation is mentioned as one of the stages of an aquaculture application, but in practice this process very much lacks transparency.

The Baseline report outlines that the DAFM is working towards the achievement of 300 licence determinations in 2018, with a further 300 in 2019. As a statutory consultee, An Taisce have received over 400 licence applications, both renewals and new licences, for 2018, with the majority of those being received within a 5 month period. This has serious implications for the licensing process, as it was a huge undertaking for An Taisce to review and comment on all of these applications. While we appreciate that the elimination of the backlog is a high priority, this should not come at the expense of a transparent and participatory system. Consultation with statutory consultees is an essential part of the licensing of aquaculture, but overloading the system with a deluge of licence applications in order to rush through decisions undermines this process, and potentially limits the role statutory consultees can play.

8.5.4 Salmon Farming

Globally, salmon farming continues to be the subject of serious environmental and social concerns. The Baseline report outlines that salmon farming sector has increased production by 60% from 2007-2016, and it is outlined that aquaculture will increase production to '*lower seafood imports and reduce pressures on fish stocks*'. In the case of farmed salmon this does not ring true. Farmed salmon require wild fish to be caught to feed them, and it takes more fish to make the feed than the yield in salmon. Thus, this type of aquaculture does not reduce our dependence on wild fisheries, and cannot be considered to be a viable method to reduce pressure on fish stocks. As salmon farming increases, there will be further pressure on these wild populations. In terms of sustainability, feed provision has been found to be the "*single most important contributor to resource use and emissions associated with the farm-gate production of salmonids cultured in net-pen systems*" (Pelletier et al., 2009)[13].

The source of the fish food for Salmon must also be taken in to consideration when determining that salmon farming is sustainable. The majority of fish food is imported from Chile and Peru. The licensing process and policies need to take account of resource use and emissions associated with the salmon farming supply chain in its entirety. EIAs for salmon farming should consider the functional interdependence of the source of the fish food when considering the environmental impact of the licensing of a salmon farm. At a time when a huge number of the world's fisheries are overfished, it is important to ensure that the fish going into salmon food is sustainably caught by responsible operators.

In addition, the escape of farmed salmon must be addressed. Official statistics indicate that approximately 415,000 salmon were reported to have escaped from salmon farms in coastal waters of the Republic of Ireland in the period 1996-2004. In the Irish context, the primary cause of escapes from salmon farms has been storm damage. With climate change, there will

[13] Pelletier, N., P. Tyedmers, U. Sonesson, A. Scholz, F. Ziegler, A. Flysjo, S. Kruse, B. Cancino, and H. Silverman. (2009) 'Not All Salmon Are Created Equal: Life Cycle Assessment (LCA) of Global Salmon Farming Systems'. Environmental Science and Technology: 49 (24), 14176-14183.

be storms of increasing strength, and as such the risks of salmon escaping will increase. This is particularly pertinent given the assertion that there will be a:

> *'Move out into areas that would previously have been considered unsuitable due to hydrodynamic conditions'*

Any such move must be implemented with regard to increasing storm strength as outlined under current climate change models, and the need for ongoing inspection of the equipment to ensure its integrity.

8.6 Port Development and Shipping

The widening of the Panama Canal, has led to larger tankers and container ships in the North Atlantic. In February 2013 Shannon Foynes Port Company published a plan to cater for larger vessels, doubling annual trade. The state owned ports of Dublin, Cork and Galway are all proposing or undertaking expansion based on increasing tonnage.

The Department of Transport published a National Ports Policy in March 2013[14]. This does not provide increased tonnage targets but identifies ocean energy and cruise liners as major growth areas. Galway Port Company has lodged an application for a major cruise ship berthage extending into the Natura 2000 designated area for which invoking of the IROPI clause of Article 6 of the Habitats Directive is being sought.

In Chapter 17, in regard to the sustainability of port development and shipping, the issues for sustainability do not include or address the impact of the transboundary resource consumption placed on planetary boundaries, by continued increase of goods produced in, or for, developed countries. The polluting potential of such an increase in shipping and cruise ship docking must also be considered. The global growth of cruise tourism has brought increasing concern for the

[14] Department of Transport, Tourism and Sport (2013) http://www.transport.ie/viewitem.asp?id=9552 and lang=ENG and loc=1925

pollution of the marine environment. Marine pollution from sanitary wastewater is a problem especially pronounced on large cruise ships (Peric, 2016)[15]

8.7 Biomarine exploitation such as kelp harvesting in Bantry Bay

Chapter 18 on Seaweed Harvesting is limited in consideration. The impact of Kelp extraction is not addressed nor, specifically, the mechanical extraction of Kelp and mechanical harvesting of seaweed.

8.8 The role of the fishing industry in marine waste and litter

The influence of David Attenborough's Blue Planet documentary has created a welcome increase in awareness of the problem of marine waste, for plastic in particular. Although originating in part from outside Irish waters, and in the wider zone from foreign fleets, much of the littering of the Irish coast with bits of ropes, floats and breaking down containers is Irish in origin and reflects major discredit on the Irish fishing industry. A 2018 report[16] on the Skelligs highlights the impact of decades of irresponsible management of discarded material by the industry, with large volumes of blue and orange nylon rope material being used in nesting by the Gannet colony.

There is major onus on the fishing industry in allowing the discarding of unidentified waste and debris into the seas. This will not be solved by shifting to biodegradable material, which will further promote a throw-away culture. Moreover, there is a significant regulatory lacuna within Ireland's Exclusive Economic Zone insofar as the vast majority of fishing vessels working within Ireland's Waters operate under the flags of Spain, France, UK and Netherlands, and Ireland is unable to regulate their activities in anything other than their fishing operations and fish catches. There is little point in Irish fishermen engaging in environmentally sustainable practices in the control of, and loss or discarding, of fishing gear and in the area of wastes

[15] Perić, Tina and Komadina, Pavao and Račić, Nikola. (2016). Wastewater Pollution from Cruise Ships in the Adriatic Sea. PROMET - Traffic and Transportation. 28. 10.7307/ptt.v28i4.2087.

[16] https://www.irishtimes.com/news/environment/little-skellig-looks-like-a-rubbish-tip-due-to-plastic-pollution-1.3523185

generated onboard fishing vessels if fishing vessels flagged in other EU Member States fail to engage in like-minded good environmental practises.

8.9 Fishing and Marine Industry Worker Conditions Not Addressed

The June 2018 United States' State Department, Trafficking in Persons (TIP) report downgraded Ireland's status, from Tier 1 to Tier 2, by the Irish fishing sector. Tier 1, the highest possible ranking, applies to "*countries whose governments fully meet the Trafficking Victims Protection Act's (TVPA) minimum standards*." Tier 2 countries, however, "*do not fully meet the TVPA's minimum standards, but are making significant efforts to bring themselves into compliance with those standards*." Very few western democracies fall below Tier 1.

The country report for Ireland states that:

> "*Foreign trafficking victims identified in Ireland are from Africa, Asia, and Eastern Europe. Authorities have reported an increase in suspected victims from Nigeria, Romania, Indonesia, Brazil, and Pakistan. Victims of forced labour have been identified in domestic work, the restaurant industry, waste management, fishing, seasonal agriculture and car washing services.*"

The report also details concerns specific to the fishing industry:

> "*An NGO criticised the government's immigration scheme for making crew members of Irish fishing fleets vulnerable to forced labour by linking sponsorship to a single employer and by limiting registration of existing workers to those who came forward within three months of the commencement date of the scheme. A parliamentary committee published a report recommending changes, including a moratorium on issuing permits to out-of-country non-EEA foreign nationals until the permit could be decoupled from a single employer and until the position of all in-country non-EEA nationals could be regularized. The committee also recommended a single department be given overall responsibility for the fishing industry*."

A 2017 investigation[17] revealed that *"A quarter Irish fishing vessels that were inspected by the state were caught with illegal workers on board last year".*

It found that

> *"in 2015, an investigation by the Guardian found that workers from Africa and Asia were routinely being employed illegally on Irish fishing trawlers and were being exploited as a source of cheap labour. It claimed that undocumented workers often worked for days on end without sleep or basic safety training, while often being paid below the minimum wage*."

In October 2018 the International Transport Worker's Federation (ITF) brought proceedings seeking an immediate moratorium on the grant or renewal of work permits under the permit scheme for non-EU fishing industry workers.

Section 2.7 of the Baseline report refers to a 10% increase in employment in the Ocean Economy in 2016 in comparison with 2014. Given the continuing negative publicity arising from exploitation of Non-EU workers in the fishing industry, this conditions and regulations surrounding employment in this sector need to be addressed.

8.10 Addressing Brexit

The future management of the UK marine area needs to be a key part of Brexit negotiations, particularly as the UK also proposes to exit from the London Fishing Convention 1964. This has particular impact on Ireland as any downgrading of EU MSFD and Habitats Directive protection would have transboundary impacts and needs to be addressed in Brexit negotiations.

However the UK is remaining a party to OSPAR, and it is encouraging that as of March 2018 approximately 24% of UK waters are within MPAs in accordance both OSPAR and MSFD. Unlike Ireland, the UK has signed up to the Convention on Biological Diversity and the

[17] https://www.thejournal.ie/fishing-vessels-illegal-workers-3331949-Apr2017/

OSPAR Convention, established an ecologically coherent network of well-managed Marine Protected Areas (MPAs), with the objective that:

> *"The sites in the network will work together to provide more benefits than an individual area could on its own. MPAs established under international conventions, European and national legislation will all contribute to an ecologically coherent network of MPAs*."

9 Conclusion

The framing of this consultation reflects the public policy conflict between fisheries exploitation in Ireland and fossil fuel consumption, with the maintenance of healthy ecosystems, a stable climate and a thriving natural environment on which the marine fishing sector depends. Government Departments and state agencies have a duty to be informed by science, and should be bound by the international imperative to protect biodiversity, and to take action on climate in the strategic, public and national interest. The lobbying power of commercial interests for narrow short term economic gain should not be allowed to prevail over climate and biological science, as occurred in the development of Harnessing Our Ocean Wealth and Foodwise 2025.

The SDGs provide a new and integrated framework to define our future relationship with the natural world on which we depend, and our legacy for the future. International cooperation and the global and the multi-generational interest must define public policy and action for any sector. Public engagement is paramount to address the range of actions needed to enhance our relationship with the marine world, and for maintaining fish stocks. This means embracing a new sustainable relationship with marine ecosystem. Where practices need to be changed, new livelihood opportunities must be identified and supported for those affected. In many cases the issue causing ecological damage, such as bottom trawling and scallop dredging is a new practice which is doomed by its nature to destroy the species or habitat which is being exploited. This needs to be clearly communicated to avoid previous controversies which have been generated such as the necessary restriction of salmon drift netting or turf cutting.

Reconstitution of the legal remit and mandate of the Department of Agriculture Food and the Marine and all agencies under it, including the Marine Institute and Bord Iascaigh Mhara, is required to apply and implement the UN Sustainable Development Goals for SDG 13 Climate Action, SDG 14 Life Below Water and SDG 15 Life on Land.

Ireland should be an international leader in protecting marine biodiversity, giving legal status to the protection of all marine life and habitats. The provisions of the Marine Strategy Framework Directive provide the means for Ireland to take European leadership in marine conservation through identification and scheduling of Marine Protected Areas to restrict dredging, bottom trawling and inappropriate aquaculture, and to allow fish population renewal, the protection of whales, dolphins and other marine mammals, and the enhancement of feed sources for marine birds. If the emerging National Marine Planning Framework does not address the conflicts and deficiencies outlined above, An Taisce believe that any plan adopted will expose Ireland to reputational damage, and potentially to legal action at national, EU and international level.

10 Recommendations

In order to overcome these challenges, Ireland needs to adopt a National Marine Planning Framework that:

a. Is science based in addressing planetary boundaries on human impact in ecosystems loss and resource depletion;
b. Is credible in international action of sustainability, climate and ocean acidification and biodiversity loss;
c. Adopts SDG 14 " Life Under Water" targets and other relevant SDGs as an overarching part of an all of Government SDG strategy;
d. Takes international leadership in mitigating climate change to meet the Paris Agreement;
e. Targets mitigation of ocean acidification as a parallel action;
f. Meets EU MSFD and OSPAR Convention obligations in providing legislation for Marine Protected Areas by 2019, and substantive preparation of an ecologically coherent network of designations by 2020;

g. Puts in place effective science based fisheries management based on conservation in EU negotiations, and provides for public participation in the decision making process;
h. Applies a uniform consent and enforcement regime to all marine and terrestrial activities, utilising an integrated management approach, with public participation in accordance with the Arhus Convention. This would remove the conflict of a Government agency or Department promoting a sector while simultaneously being a consent and environmental enforcement body at the same time;
i. Puts in place an effective regulatory regime, investment incentives and research support for sustainable marine renewable energy;
j. Places a moratorium on oil and gas exploration licenses to meet Paris Agreement targets;
k. Permits aquaculture only with strict adherence to the Precautionary Principle, and with rigorous environmental assessment and ongoing monitoring as standard;
l. Adequately implements cumulative assessments for all marine pressures within a given area;
m. Takes leadership in combating marine waste and litter including in shipping and fishing industries;
n. Addresses worker conditions and welfare in the marine sector.

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11 Appendix I

11.1 The Planetary Boundaries

The Stockholm Resilience Institute's identification of nine planetary is gaining increasing acceptance in assessing global sustainability and human interface with the overarching biosphere and atmospheric, terrestrial and marine, climate and ecosystems.

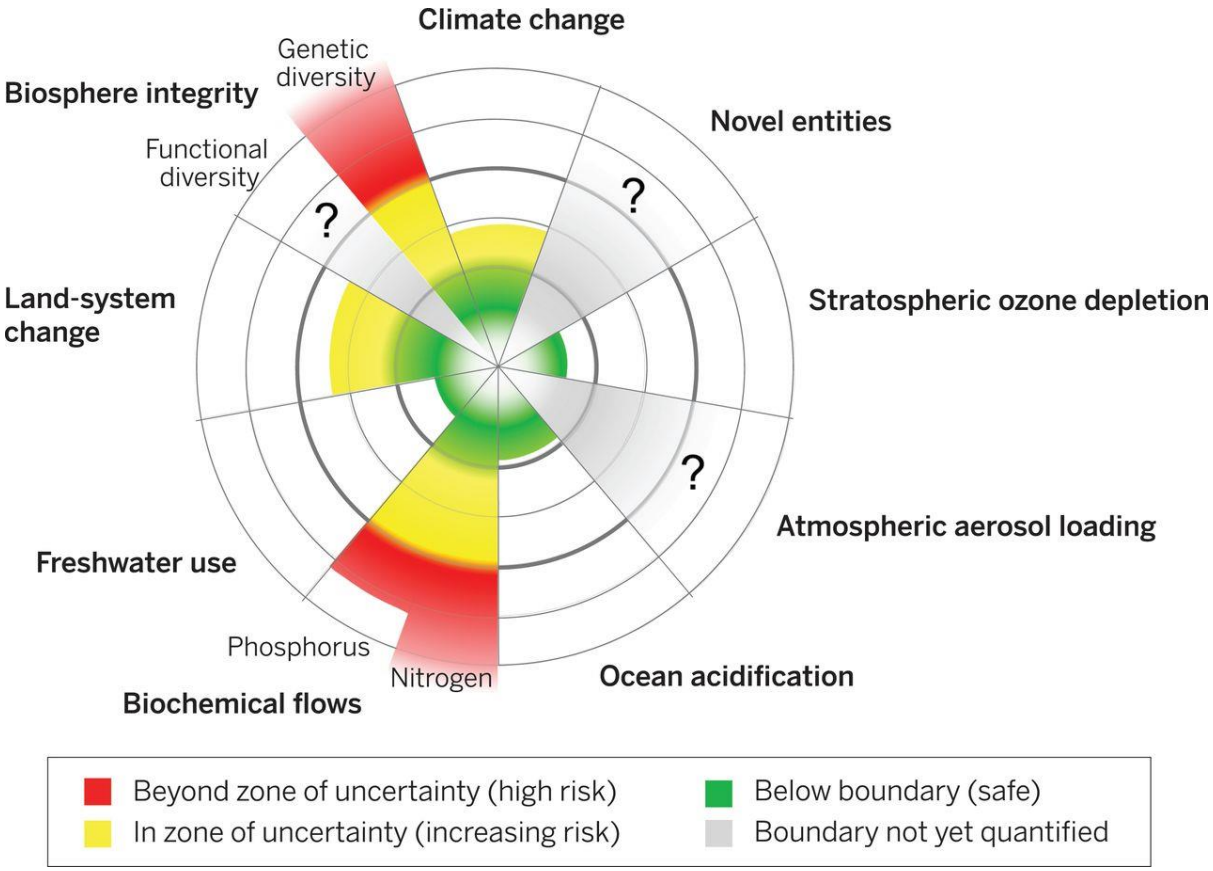


Figure 2: Estimates of how the different control variables for seven planetary boundaries have changed from 1950 to present. The green shaded polygon represents the safe operating space. (Source: Steffen et al. 2015)

The nine boundaries delimit: climate change, ocean acidification, stratospheric ozone depletion, disruption of the nitrogen and phosphorus cycles, global freshwater use, land use changes, biodiversity loss, aerosol loading in the atmosphere, and chemical pollution. Many of these systems may react abruptly once a certain threshold is breached, so boundaries are set at a safe distance from the tipping points. Human beings have already crossed the boundaries for climate change, biodiversity loss, and interference with the nitrogen cycle; and we are fast approaching the boundaries for freshwater use, land use changes, ocean acidification, and interference with the global phosphorus cycle (Table 1).

Table 1: Current status of planetary boundaries

Planetary Boundary	**Parameters**	**Boundary**	**Current Status**	**Pre-Industrial**
Climate change	CO2 parts per million (ppm)	350	392	280
	Radiative forcing: watts per meter squared	1	1.5	0
Ocean acidification	Saturation state of aragonite in water	2.75	2.90	3.44
Stratospheric ozone	Dobson Units	276	283	290
Nitrogen cycle	Millions of tonnes/yr removed from atmosphere	35	121	0
Phosphorus cycle	Millions of tonnes/yr entering ocean	11	8.5-9.5	-1
Freshwater use	km^3/yr human consumption	4,000	2,600	415
Land use change	% of global land converted to cropland	15	11.7	low
Biodiversity loss	Species per million/yr extinct	10	>100	0.1-1

Aerosol loading	Particulate concentration in atmosphere	To be determined		
Chemical pollution	Several possibilities	To be determined		

11.2 Climate Change

The effects of climate change are already evident in the loss of summer sea ice in the Arctic Ocean, the melting of glaciers, the shrinking of the Greenland and West Antarctic ice sheets, and sea level rise. Scientists measure climate change by the amount of CO_2 in the atmosphere (parts per million) and the level of radiative forcing, i.e. change in the input or output of radiation to or from the atmosphere. Using pre-Industrial Revolution era measurements as a baseline or background measure, the background levels for CO_2 are 280 parts per million (ppm), and for radiative forcing, 0 watts per square meter (a positive number indicates warming). The boundary is 350ppm for CO_2 and 1 watt per square meter above background levels; however, radiative forcing already measures 1.5 watts per square meter and CO_2 levels reached 391.92 ppm in April 2011. The scientists believe crossing these boundaries can increase the risk of triggering irreversible changes, such as the loss of major ice sheets, accelerated sea level rise and sudden shifts in forest and agricultural systems.

11.3 Ocean Acidification

25% of all manmade CO_2 emissions are removed from the atmosphere and taken up by oceans. But the more CO_2 the oceans absorb, the more seawater becomes acidic and less saturated with aragonite, a form of calcium carbonate used by marine organisms such as corals to make their shells. It's estimated that by 2050 only 15% of coral reefs will have enough aragonite for adequate growth. The background measurement of the saturation state of aragonite is 3.44, and the boundary is set at 2.74. Today, at a level of 2.90, ocean acidification is happening over 100 times faster than at any time in the last 20 million years. We are in danger of losing the coral

reefs and their ecosystems, as well as certain marine plankton that could affect the entire food chain.

11.4 Stratospheric Ozone Layer

The stratospheric ozone layer filters out the sun's ultraviolet (UV) rays that can cause skin cancer in humans and damage plants and plankton. When chlorofluorocarbons and other halocarbon refrigerants rise into the stratosphere, they release chlorine and bromine atoms, which break down ozone molecules and deplete the ozone layer. Ozone depletion is also exacerbated by the presence of polar stratospheric clouds over the Antarctic, which enhance the chemical reactions that destroy ozone. The 1989 Montreal Protocol, banning ozone-depleting chemicals, has helped shrink the hole in the ozone layer over the Antarctic and keep us within the planetary boundary of 276 Dobson Units (a measure of ozone density) against a background level of 290 Dobson Units.

11.5 Interference with the Nitrogen and Phosphorus Cycles

Human activities convert around 120 million tonnes (one tonne = 1000 kg) of naturally occurring nitrogen from the atmosphere into reactive nitrogen, mainly as fertiliser to help feed the world. But reactive nitrogen pollutes waterways and coasts, and in nitrous oxide form, exacerbates global warming. Synthetic fertiliser, leguminous crops (soybeans, peanuts, alfalfa), many types of manufacturing, and fossil fuel burning industries and vehicles all produce reactive nitrogen. The planetary boundary for the nitrogen cycle is figured in millions of tonnes per year removed from the atmosphere; the background level is 0, the boundary is set at 35, and we are already at 121. Phosphorus is a mineral that is mined for use in fertilisers, detergents, pesticides, steel production, and even toothpaste. It is measured in millions of tonnes per year entering the ocean. The background level is -1, the boundary is 11, and currently 8.5 to 9.5 million tonnes end up each year in the ocean where it depletes oxygen levels, harming marine life.

11.6 Global Freshwater Use

Around the world, freshwater is becoming increasingly scarce because of human impacts on global resources. Humans have altered the flow of rivers so that 25% of the world's river basins run dry before the rivers reach the ocean, and have manipulated the water cycle through land use changes. Moreover, the freshwater cycle is greatly affected by climate change. Before the Industrial Revolution, humans consumed 415 cubic kilometers (km3) of freshwater per year. The boundary of 4,000 km3 allows for sufficient water in the system to regenerate precipitation and provide for ecoservices and aquatic habitats, and we now consume 2,600 km3.

11.7 Land System Change

The conversion of forests and other ecosystems mainly for agriculture has had significant impacts on biodiversity, water flow and CO_2 emissions. It's estimated that 12% of global land is currently being used as cropland. A boundary of 15% is set because beyond that the most productive land on the planet will have been used up, which would necessitate clearing much more marginal land for incremental gains in agriculture. To keep within the 15% boundary, the scientists recommend that crops only be grown in the most productive areas, agriculture be based on natural processes, and the demand for food be better managed.

11.8 Rate of Biodiversity Loss

Changes in land use, the introduction of invasive species, and climate change are critical factors in the rate of biodiversity loss, which today is 100 to 1,000 times more than the background extinction rate. And while extinctions of particular species occur locally, they can leave large-scale land and marine systems more vulnerable to changes in climate and ocean acidification since biodiversity plays a key role in keeping ecosystems resilient. With the global extinction rate expected to increase 10-fold this century, the scientists concluded that humanity is already in the danger zone for this planetary boundary. And just recently, a study by United Nations University found that the strategy of creating land and marine preserves to protect vulnerable species is not preventing global biodiversity loss. The authors of the study stressed that

approaches that tackle the root causes of biodiversity loss, human population growth and resource conservation, are what is needed.

11.9 Aerosol Loading

Aerosol particles in the atmosphere influence climate globally and impact human health. Some particles, like sulfur dioxide from coal-fired power plants and volcanoes, reflect the sun and cool the earth. Others, like soot or thin high clouds, behave like greenhouse gasses to warm the planet. Aerosol particles can also influence the hydrological cycle and monsoon circulation, cause forest degradation and acid rain, and they are responsible for respiratory illnesses that result in 800,000 human deaths each year. The scientists have not yet been able to define a boundary, however, because of the variety of aerosol particles and their complex interplay. A new study by the National Oceanic and Atmospheric Administration found that aerosol particles slowed global warming, preventing 0.07˚C of warming since 2000.

11.10 Chemical Pollution

Chemical pollution of the Earth from radioactive compounds, heavy metals and organic compounds produced by humans, affect human health, ecosystems, biodiversity, and global warming. It can also cause reduced fertility and genetic damage, which can result in species loss. But as with aerosols, there are too many diverse chemicals in the environment and not yet enough understanding about their combined effects to establish a boundary.

The 28 scientists acknowledge that the 9 planetary boundaries are rough estimates because many uncertainties and knowledge gaps remain. Moreover the established boundaries are based on the assumption that no other boundaries are being transgressed. And it is not known how much time we have after crossing the boundaries before we reach tipping points that could produce irreversible changes.

But we do know that the 9 boundaries are inextricably linked, breaching one makes it more likely that others will be breached. Land use changes in the Amazon rainforest can affect

weather systems, and alter precipitation and freshwater resources. Exceeding the nitrogen and phosphorus boundary can damage the resilience of the ocean and reduce its ability to absorb CO_2. Global climate change is hastening glacial melt, which will also affect freshwater supplies.

The 9 planetary boundaries are meant to offer a new, albeit incomplete, global approach to sustainable development that can help guide future policy and governance. Within these boundaries, we still have options for our future development and well-being. Crossing them could be disastrous for humanity.

12 Appendix II

12.1 The Strategic Justification for New Irish Fossil Fuel Exploration Extraction

The justification for continued oil and gas offshore exploration in Ireland needs to address:

1. The limit on future oil and gas consumption set by meeting Paris Agreement targets to stabilise global climate to as near as possible to 1.5 degrees over pre industrial levels. Requiring most known existing oil and gas to be left in the ground known as *"Unburnable Carbon*"
2. The impact of directing investment resources into continued fossil fuel exploration in undermining the investment needed in the level of energy conservation and renewable needed to supersede fossil fuel.
3. The safety risk in offshore oil and gas drilling from increasing Atlantic storm and hurricane conditions, like Hurricane Ophelia.
4. The transboundary legal and cost exposure of Directors of oil and gas exploration companies, their professional advisors and consultants and regulatory bodies licensing exploration from climate litigation,

12.2 Impact of Continued Exploration

Globally energy companies are in an exploration race to continue a level of fossil fuel extraction which if burned is incompatible with the level of decarbonisation required to stabilise global climate at as near as possible to 1.5 degrees as required by the Paris Agreement.

The extension of oil and gas exploration into new areas, and using problematic new technologies, extends from the Arctic wilderness to Central Africa. The 2010 Deepwater Horizon spill clearly highlights the risks involved in deep sea drilling. Oil and gas extraction in the Niger delta has a high carbon impact and is the cause of major local pollution. The increased level of extraction from Canadian Tar Sands is devastating in environmental impact and generates a much higher level of emissions than conventional wells. The Keystone XL

pipeline proposal to link Alberta to the southern United States highlights the mounting conflict between the fossil fuel lobby and climate science. Fracking in the US has created new environmental risks and has significant additional climate impact through methane leakage during the extraction process.

12.3 The Rise of Climate Litigation

There is growing litigation across the world against fossil fuel exploration and extraction companies and State regulatory bodies. Oil and gas exploration and extraction companies and regulatory bodies are facing an increasing number of lawsuits that aim to hold them responsible for the impacts of climate change. What the companies or regulators knew about their contributions to global warming will answer some key legal questions, including whether they have continued or issued exploration extraction of fossil fuel while knowing they would cause public harm. Liability also extends to state and public bodies granting licenses for oil and gas exploration and extraction.[18] These issues now face all oil and gas exploration and extraction companies and regulatory bodies in Ireland.

At the same time there is a growing momentum for institutional and pension fund divestment from fossil fuels, as fund managers may also be joined to legal action. New York joins a growing chorus of institutional investors that have committed to divest in full or part. Cities like Paris, Capetown, and San Francisco; pension funds like the California Public Employees' Retirement System; faith-based groups like the Church of England; philanthropies like the Rockefeller Family Fund; and universities like Oxford, Stanford, and Georgetown have mobilised to divest over $6 trillion in total assets from the fossil fuel industry.

[18] https://www.climateliabilitynews.org/2018/04/05/climate-change-oil-companies-knew-shell-exxon/

New York City is also suing five oil majors[19], BP, Chevron, Conoco Phillips, Exxon, and Royal Dutch Shell—for their contributions to climate change and efforts to cover up scientific evidence of its reality[20]

12.4 The Global Carbon Budget

Rapid global warming and resulting climate change now taking place has a simple cause: Every addition of carbon dioxide (CO_2) due to human causes traps a corresponding additional amount of solar energy in Earth's atmosphere and ocean. This warming due to the accumulation of CO_2 is irreversible on human timescales, once emitted the CO_2 levels remain raised. Therefore, limiting climate change will require substantial and sustained reductions of greenhouse gas emissions from now on. At some point net emissions will need to be zero to stop further warming. The agreed 2^{o}C limit to global warming (above pre-industrial temperatures) therefore requires an absolute limit on the net carbon emissions that can ever be emitted globally. This remaining total amount of future CO_2 emissions to limit warming to 2^{o}C is called the 'global carbon budget'.

Even such a small change in the Earth's average surface temperature can have profound changes on the climate, geography, and biosphere that are the basis for all life, and for modern society, including the supply of crops for food. During the last ice age the average global temperature was only about 5^{o}C colder than today, yet sea level was 120m (400ft) lower and many areas populated today were deep under ice. In the last 10,000 years, a very stable climate, due to very steady natural CO_2 levels, enabled agricultural civilisation to emerge and to thrive. The problem for modern human civilisation which depends on large scale burning of fossil fuels for energy, thereby releasing CO_2, is that at current increasing rates of annual emissions, the remaining less than 2^{o}C global carbon budget will be entirely exhausted within as little as

[19] https://blogs.ei.columbia.edu/2018/01/11/nyc-climate-change-lawsuit/
[20] https://phys.org/news/2018-01-nyc-fossil-fuel-investmentshere.html

15 to 30 years. Moreover, there is enough carbon stored in proven reserves of peat, coal, oil and gas to result in extremely dangerous global warming of 6^{o}C or even more.

Due to greenhouse gases from fossil fuel burning, livestock agriculture and deforestation, about 0.8^{o}C of warming has occurred since industrialisation. Now though, due to rapidly rising CO_2, and also due to other greenhouse gases, especially methane, oceans and atmosphere are warming rapidly by accumulating very large amounts of additional solar energy. Continuing the current pathway of ever increasing emissions would mean that a rise of 4^{o}C is entirely possible by 2100. This is a very dangerous rate of warming, faster than any known rise, even faster than during geological extinction events. On this dangerous track, it is quite certain that within ninety years every part of the world will be entirely changed and will continue to change, with very serious negative consequences for human civilisation and for all ecosystems. The only certain way for humanity to limit dangerous climate risk is to limit emissions within the available carbon budget. This means rapid and major changes in consumption patterns and energy production are needed. To do this at least cost means starting very soon and proceeding very quickly. The biggest question for humanity is how to divide the less than 2^{o}C carbon budget equitably between nations and future generations. There is no doubt though, that the greatest responsibility to act for change, and act fast, lies with wealthy nations and institutions.

Arguments justifying the continued exploration for fossil gas as a "transition" are also unjustified. In 2018 Oil Change International, alongside 20 partners from around the world, released a new briefing on gas production in G20 countries and why fossil gas is not a bridge fuel. [21]

[21] http://priceofoil.org/debunked-g20-clean-gas-myth

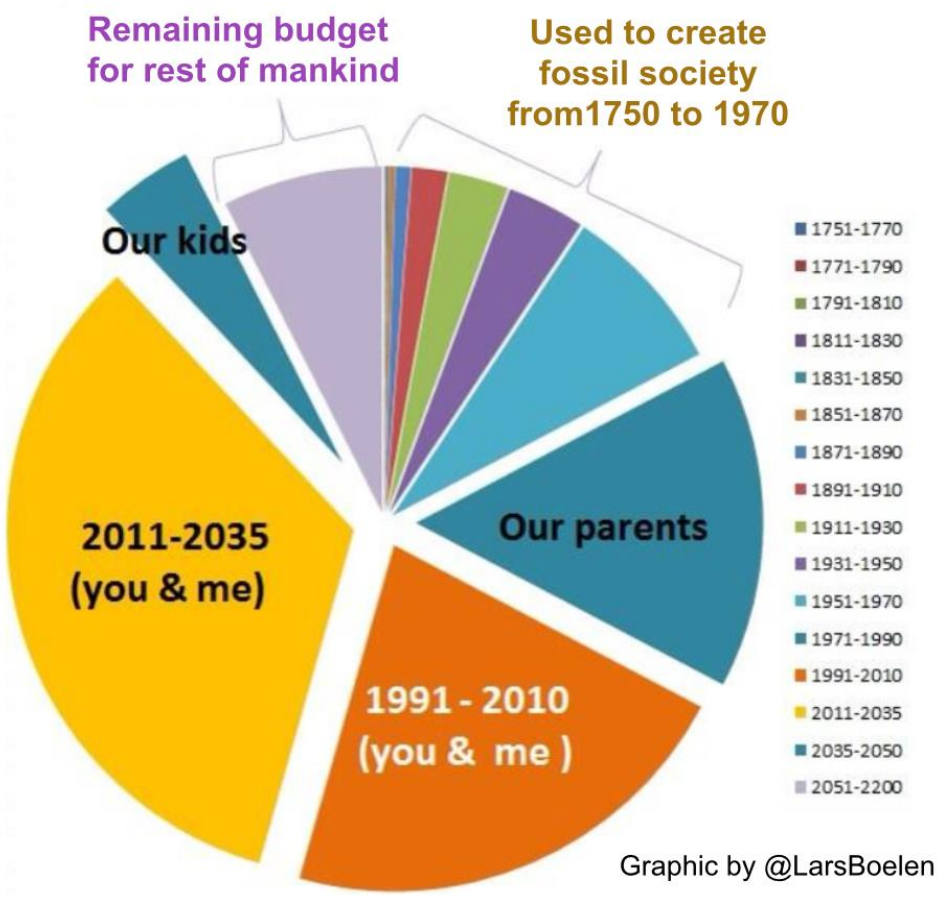


Figure 3: Carbon Budget per Generation for 2ºC: more than a third of emissions have been since 1970. The available remaining budget to limit warming to 2ºC is being exhausted rapidly

12.5 The Scientific Case for Ceasing Fossil Fuel Exploration

There is a convergence of research and reports by leading scientific authorities on the implication of allowing warming to exceed 2 degree celsius, and the action needed in limiting burning of fossil fuel other climate impacts.There is an extensive peer review literature on

Unburnable Carbon by recognised independent scientists. A good overview is provided in an article in the journal Nature by Christophe McGlade and Paul Ekins[22] who found:

> *"Policy makers have generally agreed that the average global temperature rise caused by greenhouse gas emissions should not exceed 2°C above the average global temperature of pre-industrial times. It has been estimated that to have at least a 50 per cent chance of keeping warming below 2°C throughout the twenty-first century, the cumulative carbon emissions between 2011 and 2050 need to be limited to around 1,100 gigatonnes of carbon dioxide (Gt CO_2). However, the greenhouse gas emissions contained in present estimates of global fossil fuel reserves are around three times higher than this, and so the unabated use of all current fossil fuel reserves is incompatible with a warming limit of 2°C……Our results suggest that, globally, a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2°C.*
>
> *We show that development of resources in the Arctic and any increase in unconventional oil production are incommensurate with efforts to limit average global warming to 2°C. Our results show that policy makers' instincts to exploit rapidly and completely their territorial fossil fuels are, in aggregate, inconsistent with their commitments to this temperature limit. Implementation of this policy commitment would also render unnecessary continued substantial expenditure on fossil fuel exploration, because any new discoveries could not lead to increased aggregate production."*

Among the other most significant reports are the following:

[22] https://www.nature.com/articles/nature14016

1. Carbon Tracker Initiative and the Grantham Research Institute on Climate Change and the Environment (2013). *Unburnable Carbon 2013: Wasted capital and stranded assets*. London: (Carbon Tracker and The Grantham Research Institute.[23]

This assessed the consequence of burning existing total fossil fuel reserves against global atmosphere capacity to absorb the emissions generated if temperatures are not to exceed 2 degrees above preindustrial levels. It concluded that between 60-80% of coal oil and gas reserves of publically listed companies are unburnable if the world is to have any realistic chance of not exceeding global warming of 2 degrees Celsius. Conversely, if there is effective societal action to limit the extent of climate change, then this will raise the spectre of fossil fuel installations and distribution networks collapsing in value, with the global economy already facing the prospect of assets becoming stranded, with the problem only likely to get worse if current investment trends continue, in effect, a 'carbon bubble'.

2. The World Bank and Potsdam Institute for Climate Impact Research and Climate Analytics (2012). *Turn Down the Heat: Why a 4°C Warmer World Must be Avoided, The World Bank 2012*. Washington: The World Bank.[24]

This report assesses the scientific data on the implications of allowing emissions to exceed a 2 degree threshold. The abstract for the report states:

> *'This report focuses on the risks of climate change to development in Sub-Saharan Africa, South East Asia and South Asia. Building on the 2012 report, Turn Down the Heat: Why a 4°C Warmer World Must be Avoided, this new scientific analysis examines the likely impacts of present day, 2°C and 4°C warming on agricultural production, water resources, and coastal vulnerability for affected populations. It finds many significant climate and development impacts are already being felt in some regions, and in some*

[23] http://www.carbontracker.org/wp-content/uploads/2014/09/Unburnable-Carbon-2-Web-Version.pdf

[24] http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided

cases multiple threats of increasing extreme heat waves, sea level rise, more severe storms, droughts and floods are expected to have further severe negative implications for the poorest. Climate related extreme events could push households below the poverty trap threshold. High temperature extremes appear likely to affect yields of rice, wheat, maize and other important crops, adversely affecting food security. Promoting economic growth and the eradication of poverty and inequality will thus be an increasingly challenging task under future climate change. Immediate steps are needed to help countries adapt to the risks already locked in at current levels of 0.8°C warming, but with ambitious global action to drastically reduce greenhouse gas emissions, many of the worst projected climate impacts could still be avoided by holding warming below 2°C'

3. Price Waterhouse Cooper (2014). *Two degrees of separation: ambition and reality Low Carbon Economy Index 2014*. London: Price Waterhouse Cooper.[25]

The 6th Annual index published by PWC shows the mounting failure in global action on decarbonisation to meet the 2 degree target:

'The 2014 Low Carbon Economy Index (LCEI) shows an unmistakeable trend. For the sixth year running, the global economy has missed the decarbonisation target needed to limit global warming to 2˚C. Confronted with the challenge in 2013 of decarbonising at 6% a year, we managed only 1.2%. To avoid two degrees of warming, the global economy now needs to decarbonise at 6.2% a year, more than five times faster than the current rate, every year from now till 2100. On our current burn rate we blow our carbon budget by 2034, sixty six years ahead of schedule. This trajectory, based on IPCC data, takes us to four degrees of warming by the end of the century'

[25] http://www.pwc.co.uk/assets/pdf/low-carbon-economy-index-2014.pdf

4. Christophe McGlade and Paul Ekins (2015). The geographical distribution of fossil fuels unused when limiting global warming to 2°C. *Nature* 517 (187–190).[26]

In January 2015 the international scientific journal Nature published a major paper the level of fossil fuel burring compatible with maintaining a stable climate:

> *'If global warming is to be limited in this century to the much-publicized 2 °C rise compared to pre-industrial levels, fossil fuel use and the associated release of greenhouse gases will need to be severely limited. This raises questions regarding the specific quantities and locations of oil, gas and coal that can be safely exploited. Christophe McGlade and Paul Ekins use an integrated assessment model to explore the implications of the 2 °C warming limit for different regions' fossil fuel production. They find that, globally, a third of oil reserves, half of gas reserves and over 80% of current coal reserves should remain unused during the next 40 years in order to meet the 2 °C target and that the development of resources in the Arctic and any increase in unconventional oil production are incompatible with efforts to limit climate change'*

12.6 CONCLUSIONS

Ireland has taken international leadership in the divestment of the State investment fund, where the Fossil Fuel Divestment Bill has passed second stage in the Dail in January 2017. The leadership can now be followed by the cessation of issue of any further licences for hydrocarbon exploration whether on land or in the marine area.

[26] http://www.nature.com/nature/journal/v517/n7533/full/nature14016.html