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AND NATURAL HABITATS

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GUIDANCE ON MARINE BIODIVERSITY AND CLIMATE CHANGE

- FINAL

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APPENDIX

Guidance

This guidance draws on the expert reports commissioned by the Council of Europe and discussed by the Group of Experts on Biodiversity and Climate Change at its meeting in 2011. The conclusions and recommended actions provided below stem from expert reports and the discussions on marine ecosystems in the Group of Experts. This guidance complements the suggested actions endorsed by the Standing Committee in 2011 (Recommendation No. 152), which in turn should be further completed and updated in the future, including a potential revision of the proposed recommendations. Measures that may be considered as appropriate for addressing the impacts of climate change on marine biodiversity, for the purposes of the application of the Convention, are listed for consideration by Contracting Parties.

This guidance aims at providing Parties and Observer States with suggestions of concrete conservation actions to be implemented voluntarily to deliver effectively against the objective of Recommendation No. 152 (2011). Other complementary measures may be identified by governments as equally appropriate to their particular circumstances and concerns. Notwithstanding these adaptation measures, there is an urgent need for climate change mitigation actions at local, regional, country and global levels. Effective mitigation is crucial to contain climate change to levels within which we may have a reasonable chance of achieving effective adaptation. However, addressing mitigation lies outside the scope of these recommendations.

The effects of climate change on marine ecosystems and their biological communities are complex. The impacts of a changing climate on the species and habitats protected by the Bern Convention may differ widely, depending on the species and the interactions with other species and/or their habitats, as well as according to location. The negative effects that climate change mitigation and adaptation measures, taken in other sectors, may have on species, habitats and ecosystems services provided, should also be considered in order to avoid further degradation.

I. Marine systems vulnerability to climate change

Climate change is one of the most critical issues currently facing biodiversity conservation, and marine ecosystems are among the most vulnerable to its impacts. Climate change impacts on the oceans are complex and diverse, and include changes in water temperature, salinity, sea level, ocean circulation and mixing, nutrient levels, ice cover, pH, and the frequency and intensity of storm events.

Global climate models predict, with high confidence, a 1.8-4ºC rise in average surface air temperatures, associated with a 1.5-2.6 ºC increase in sea surface temperature along with a 0.18-0.59 m rise in average sea level by the end of this century[1]. In European waters, sea surface temperatures are increasing more rapidly than the global average, and the level of some European seas may also rise more than global average projections[2]. Given the magnitude of predicted climatic changes and the wide range of chemical and physical changes that may result within the oceans[3], it is clear that marine ecosystems will also be significantly affected by climate change, although the precise nature of these changes is difficult to predict.

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[1] Pachauri, R.K. and Reisinger, A. (Eds.) (2007): *Contribution of Working Groups I, II and III to the 4th Assessment Report of the Intergovernmental Panel on Climate Change;* IPCC, Geneva, Switzerland. http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch6s6-3-2.html#table-6-3; http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms3.html#table-spm-1

[2] European Environment Agency (EEA), JRC and WHO, (2008): Impact of Europe's changing climate – 2008 indicator-based assessment. EEA Report no 4/2008 – JRC Reference Report no. JRC47756.

[3] Brierley, AS and Kingsford, MJ (2009): Impacts of climate change on marine organisms and ecosystems. *Current Biology* 19(14): R602-R614.

Nevertheless, a large and growing body of evidence suggests multiple, significant climate impacts on marine species, across trophic levels and ecosystems. For example, ocean chlorophyll records show that annual primary production in the global ocean has decreased by more than 6% since the 1980s in relation to rising temperatures[4]. Because primary production represents the basis of the marine food web, such changes have considerable implications for the marine biosphere. Climate-driven shifts in species distributions have been observed in many marine groups[5], including zooplankton[6], invertebrates, and fish[7,8] as reactions to climate warming are predicted to occur quicker in marine systems than terrestrial ones[9].

Such movements are projected to result in significant changes in the diversity of marine communities, through a combination of local extinctions, shifts in marine food web and species invasions, with resulting impacts on ecosystem function and the provisioning of ecosystem services[10]. Other climate change effects on marine ecosystems include changes in species physiology, abundance, phenology[11], and migratory patterns[12], the incidence of diseases[13], and the productivity and quality of temperate and tropical marine habitats[14], ranging from marine upwelling systems[15] to seagrass beds and coral reefs[16]. Precisely, warmer sea temperatures and increased CO_2 absorption by the seas will result in increasing ocean acidification which will reduce the availability of carbonate minerals in seawater, important building blocks for calcifying marine plants and animals. For example, it is predicted that 70% of cold-water coral communities will experience growth-limiting conditions by 2100, with associated impacts for the marine species that they support[17].

For marine ecosystems that are already under significant human pressure, climate change effects represent an added source of stress. In some cases, the additive/cumulative or synergistic impacts of climate change and other stressors may push marine species or ecosystems beyond their thresholds of tolerance. Where these thresholds represent "tipping points", such changes may be severe and irreversible

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4 Gregg et al., 2003: *Ocean primary production and climate: Global decadal changes,* Geophys. Res. Lett., 30, 1809

5 Intergovernmental Panel on Climate Change (IPCC), (2007) (a): *Synthesis of observed impacts. Climate change 2007: Working group ll: Impacts, Adaptation, and Vulnerability: Chapter 1*.

6 Southward, A. J., Hawkins, S. J. & Burrows, M. T, (1995): *Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature*. J. Thermal Biol. 20, 127–155.

7 Beaugrand, G., Reid, P. C., Ibanez, F., Lindley, J. A. & Edwards, M. (2002): *Reorganization of North Atlantic marine copepod biodiversity and climate*. Science 296, 1692–1694.

8 Perry,A.L., P.J. Low, J.R. Ellis and J.D. Reynolds, 2005: *Climate change and distribution shifts in marine fishes. Science*, 308, 1912-1915

9 MarClim project - Mieszkowska, N. et al (2006): *Marine biodiversity and climate change: assessing and predicting the influence of climatic change using intertidal rocky shore biota*. Scottish Natural Heritage.

10 Cheung WWL, Lam VWY, Sarmiento JL, Kearney K, Watson R, Pauly D., Fish and Fisheries. (2009) *Projecting global marine biodiversity impacts under climate change scenarios,* 10:235-51

11 M. Edwards, A. J. Richardson, (2004): *Impact of climate change on marine pelagic phenology and trophic mismatch*, Nature 430, 881.

12 Sims, D.W., Genner, M.J., Southward, A.J. and Hawkins, S.J. (2001): *Timing of squid migration reflects North Atlantic climate variability*. Proceedings of the Royal Society of London, B 268, 2607–2611.

13 C. D. Harvell et al, (2002) *Review: Ecology — Climate warming and disease risks for terrestrial and marine biota*, Science 296, 2158.

14 O. Hoegh-Guldberg, J. F. Bruno, (2010) *The impact of climate change on the world's marine ecosystems*. Science 328, 1523 –1528.

15 Bakun, A. (1990): *Global climate change and intensification of coastal ocean upwelling*. Science 247, 198–201.

16 CBD Technical Series No.46, (2010): *Scientific Synthesis of the Impacts of Ocean Acidification on Marine. Biodiversity*

17 Guinotte, J. M., Orr, J., Cairns, S., Freiwald, A., Morgan, L., George, R. (2006); *Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals?* Front Ecol Environ 4(3):141–146.

not only for biodiversity but with heavy impacts on economies, developments and socio-cultural contexts[18][19].

If negative climate change effects on marine ecosystems are to be minimised or avoided, there is a need for vigorous conservation policies and strategies that will support adaptation by marine fauna and flora. Such measures typically focus on building ecological resilience: "*the ability of an ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change"*[20].

The following overarching adaptation principles for marine biodiversity are derived from pre-existing guidance[21] and scientific literature[19], linked with more detailed measures and should be considered when developing adaptation strategies and actions to conserve marine and coastal species, habitats and ecosystems, and the services that they provide.

II. Understand and predict climate changes impacts on the marine environment

The current available scientific knowledge is predominantly focused at general aspects of climate change, and very limited on biodiversity impacts, even more limited on marine and costal biodiversity where gaps are large and uncertainties numerous.

The abundance and distribution of species is continuously changing (both seasonally and annually) and these dynamics are likely to accelerate and vary due to climate change. Consequently, long-term monitoring is necessary in order to evaluate these processes, particularly in most European regional seas where data on marine phenology changes are quite sparse. In order to improve our knowledge base to support effective conservation planning, further research is needed on the impacts of climate change on the biodiversity, processes, and function of marine ecosystems.

Proposed Actions:

1. Undertake increased monitoring and research actions into the potential impacts of climate change on marine species and ecosystems, including their resilience capacities and responses to climatic changes. For these purposes the following actions should be considered:

- Document species distributions, habitat requirements and community interactions (both at population and ecosystem levels) in order to predict likely responses to climate change and to permit conservation measures.
- Test the independent and interacting roles of climate change and other stressors in driving observed changes to the population dynamics and distributions of marine species, which will help to identify underlying causes, project future ecological responses, and prioritise systems and approaches for adaptive management.
- Make use of long-term field observations together with new technologies such as the use of satellite imagery and remote monitoring stations to identify and map threatened marine habitats and the species associated with them.
- Step up research and monitoring on emerging climate change effects on marine biodiversity (e.g. biological invasions and ocean acidification); as well as socioeconomic impacts of climate change which identify potential risks/hazards for coastal livelihood.

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18 O. Hoegh-Guldberg, J. F. Bruno, (2010) The impact of climate change on the world's marine ecosystems. Science 328, 1523-1528.
19 Monaco, C.J. and B. Helmuth. 2011. Tipping Points, Thresholds and the Keystone Role of Physiology in Marine Climate Change Research. Adv. Mar. Biol. 60: 123-162.
20 IPCC 4th Assessment Report (2007), Glossary.
21 Recommendations 146/(2010), 142 (2009), 143/(2009), 135/(2008), 122/(2006)

2. Develop predictive climate change models which take due account of specific ecological vulnerabilities and complexities for at least all Bern Convention listed marine species; and consolidate the information obtained from published modelling studies so that the results are easily accessible.

3. Undertake vulnerability assessments, for at least all Bern Convention listed marine species, which combine the predictions of bioclimatic models with other criteria (e.g., species threat levels, life history characteristics, dependence on vulnerable habitats, and other stressors): apply downscaling techniques to reflect local conditions and dynamics, and take into account sources and levels of uncertainty to identify taxa at greater risk due to climate change.

4. On the basis of predicted changes and noted vulnerabilities, identify best actions to favour, in particular ‘win-win’ scenarios delivering both climate mitigation/adaptation and biodiversity conservation benefits.

5. Assess how climate change may impact existing measures for the conservation and management of Bern Convention listed species. Continually monitor and re-assess the effectiveness of adaptation measures and adaptive conservation management as new information becomes available.

6. Strengthen existing monitoring schemes by identifying and using appropriate indicators to monitor the impacts of climate change on marine biodiversity and assess their vulnerability and cumulative impacts, including key biological groups identified in Actions 20 and 21.

7. Facilitate sharing of data and information and assist knowledge transfer and dissemination between partners of the Bern Convention through compatible and user-friendly information system, including clearing-house mechanisms, databases and inventories, mapping tools). Make use of already-established mechanisms including the Global Biodiversity Information Facility (GBIF), the Biodiversity Information System for Europe (BISE), The European Marine Observation and Data Network (EMODNET) and WISE-marine, or the European Network for Biodiversity Information (ENBI).

III. Maintain and enhance marine ecosystems’ resilience and adaptive capacity

In the face of these potential changes, robust and comprehensive policies and strategies are urgently needed for the marine environment, in order to address the impacts of climate change on biodiversity. Of particular importance are those approaches that will enhance the resilience and adaptive capacity of species and ecosystems.

Previous Recommendations 143/(2009) and 135/(2008) specifically called on making use of the large potential for synergies and co-benefits between biodiversity conservation and climate change mitigation and adaptation, including ecosystem-based approaches.

a) Integrate the effects of climate change on marine biodiversity into relevant policies

Existing legislative frameworks allow for Parties to anticipate and address the impacts of climate change on European marine species and ecosystems. International environmental conventions, such as the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC), together with European environmental *acquis* offer robust legislation and provide strategic and operational tools with which Parties may act to maintain and restore their marine natural ecosystems in relations to climate threats. Yet implementation remains weak and unequal across regions, and it is necessary that marine climate change considerations be further integrated within existing strategies and plans.

Proposed actions

8. Develop adequate carbon management schemes for marine and coastal ecosystems and include them in broader climate change discussions. Support efforts to assess and evaluate ocean’s carbon storage potentials and integrate these into climate change mitigation policies.

9. Further integrate climate change-related aspects issues regarding marine and coastal biodiversity into relevant international, regional or national strategies, action plans and programmes such as National

Biodiversity Strategies and Action Plans, existing EU strategies, regional agreements, national Red Books or Lists, etc. Ensure that conservation objectives reflect the challenges presented by climate change, and that where possible, those conservation actions are climate-proof [22].
10. Encourage the use of Tematea, the thematic module developed jointly by IUCN/UNEP to increase synergies when implementing obligations under multilateral environmental agreements and conventions[23].

11. Integrate marine ecosystem-based approaches (EBA) into climate mitigation and adaptation strategies, in order to improve marine ecosystems' ability to mitigate the effects of climate change whilst reducing their vulnerability and increasing their diversity. Specifically implement marine ecosystem management activities to move away from management based on single species/habitat and include the entire ecosystems in relation to human activities

12. Develop adaptive conservation strategies based on sound ecological research and integrate them into national planning and management practices to limit unpredictable climate effects.

13. Take care that adaptation and mitigation measures do not undermine biodiversity conservation principles. Take an integrated, cross-sectoral approach to assess responses to climate change, as both climate change and associated adaptation strategies may have either positive or negative effects on biodiversity and may favour certain species or groups of species over others.

14. Internalise the socio-economic value of marine biodiversity and ecosystem services into climate change strategies, taking into consideration the negative effects of climate change on further reduction of ecosystem services and their loss value with respect to their initial state.

15. Remove perverse incentives which undervalue ecosystems and their functions and contribute to their degradation into existing policies, and move toward achieving appropriate stewardship of ocean services and resources.

16. Develop adequate national financial support for marine biodiversity conservation and marine ecosystem-based approaches actions suggested in this Guidance; further explore access to regional and international funding sources including UN projects (e.g. WB, GEF, UNDP, UNEP…), EU programs and funds (e.g. LIFE, Cohesion and structural funds, FP7 etc.),or regional and specific bodies (e.g. development banks, international organizations etc.).

b) Actively conserve and restore marine biodiversity

Climatic changes on oceanic systems will affect the ecosystem services that they provide, such as fisheries, coastal protection, tourism, carbon sequestration and climate regulation. Effective actions can be undertaken to enhance the conservation, sustainable use and restoration of marine habitats that are vulnerable to the effects of climate change, and which contribute to climate change mitigation.

Proposed Actions

17. Note the urgency of addressing the impacts of climate change on European marine biodiversity, especially since most European seas restrict northward displacement of species. Attention should be given to most vulnerable regions (the Arctic Ocean, the Mediterranean Sea, the Baltic Sea, the North Sea, the Black Sea, the English Channel and overseas territories)[24].

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[22] According to Klein et al. (2007), climate proofing is the modification of existing and future projects/actions so that they are resilient to impacts from climate change and/or do not contribute to increased vulnerability of the projects/actions goals.
Klein, R. J. T., Eriksen, S. E. H., Naess, L. O., Hammill, A., Tanner, T. M., Robledo, C., & O'Brien, K. L. (2007). Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. Climatic Change, 84, 23-44. doi:10.1007/s10584-007-9268-x
[23] http://www.tematea.org
[24] Michael B. Usher document [T-PVS (2005) 21]

18. Prioritise conservation actions for endangered or threatened marine species and habitats covered by the Bern Convention, and take measures to build up population numbers to enhance resilience in the face of climate change and other stressors.

19. Conserve the range and variability of species, habitats and ecosystems and their natural services as part of the design, implementation and management of restoration projects and sites.

20. Accelerate the preparation and implementation of species-specific conservation plans focusing on Bern Convention marine features that may be most vulnerable to climate change, such as species that are known to depend on climate-sensitive habitats, or which already face an elevated risk of local extinction. The following lists are not comprehensive, but focus on some species/groups already identified as potentially threatened according to existing knowledge[25]:

- Marine mammals: Climate change can affect marine mammals directly (e.g. through changes in species ranges or migratory patterns), or indirectly (e.g. through changes in prey availability) Polar species may be particularly vulnerable, due to their restricted ranges. Most affected species include: *Monachus monachus* (Mediterranean monk seal); *Phocoena phocoena* (Harbour porpoise); *Balaena mysticetus* (Bowhead whale); *Eubalaena glacialis* (North Atlantic right whale); *Odobenus rosmarus* (Walrus)*; Monodon monoceros* (Narwhal); *Grampus griseus* (Risso's dolphin); *Lagenorhynchus acutus* (Atlantic White-sided dolphin); *Lagenorhynchus albirostris* (White-beaked dolphin); *Tursiops truncatus* (Common bottlenose dolphin); *Orcinus orca* (Orca);

- Fish: Many biological processes in fish are known to be sensitive to climate variation and change, including growth, survival, and reproduction. Particular attention should be paid to species with slower life histories (such as elasmobranchs), which are generally more vulnerable to overexploitation, and be less able to respond to climate change through distribution shifts. Particularly threatened species includes: *Aphanius iberus* (Iberian killifish); *Acipenser naccarii* (Adriatic Sturgeon); *Acipenser sturio* (European sea sturgeon); *Huso huso* (Beluga Sturgeon); *Pomatoschistus canestrinii* (Canestrini's goby); *Pomatoschistus tortonesei* (Tortonese's goby); *Hippocampus hippocampus* (Short-snouted seahorse); *Hippocampus ramulosus* (Long-snouted seahorse); *Carcharodon carcharias* (Great white shark); *Mobula mobular* (Devil fish).

- Seabirds or marine birds: Seabirds are vulnerable to climate change and other stressors, because of their slow life histories (i.e., late age of maturity, low fecundity, and high juvenile mortality), and their strong sensitivity to the availability of marine food. Climate change may impact the distribution, abundance, annual migrations, breeding and nesting behaviour, and may exacerbate other stress factors (e.g. introduction of invasive species, decline in prey). Northern species and migratory birds are likely to be more vulnerable, with the most affected families predicted to be Charadriidae;

[25] This section includes proposed actions and measures based on the work done so far under the Bern Convention, in particular in the reports: *Conserving European biodiversity in the context of climate change* by Michael B. Usher [doc. T-PVS (2005) 21]; *Climate change and the vulnerability of Bern Convention species and habitats*, by P. Berry [document T-PVS/Inf(2008)6 rev]; "*Climatic change and the conservation of European biodiversity: towards the development of adaptation strategies*" by Mr. Brian Huntley [doc. T-PVS/Inf(2007)03], and "*Impact of Climate Change on Marine and Coastal Biodiversity: current state of Knowledge*", by UNEP-MAP-RAC/SPA; Cushing, D. H. *Population Production and Regulation in the Sea: a Fisheries Perspective* (Cambridge Univ. Press, Cambridge, 1995); IUCN Red List of Threatened Species; M.Ferrer, I.Newton and K.Bildstein "*Climatic change and the conservation of migratory birds in Europe: Identifying effects and conservation priorities*"; Learmonth JA, MacLeod CD, Santos MB, Pierce GJ, Crick HQP, Robinson RA. (2006): *Potential effects of climate change on marine mammals*. Oceanography and Marine Biology: An Annual Review 44: 431–464; C. M. Wood, D. G. McDonald, Eds. (1997): *Global Warming: Implications for Freshwater and Marine Fish*, Cambridge Univ. Press, Cambridge ; Perry, A.L., P.J. Low, J.R. Ellis and J.D. Reynolds (2005): *Climate change and distribution shifts in marine fishes*. Science, 308, 1912-1915; European Environment Agency (2010): Impact of climate change on bird populations (SEBI 011); Hawkes, L.A., A.C. Broderick, M.H. Godfrey & B.J. Godley (2007): *Investigating the potential impacts of climate change on a marine turtle population*. Global Change Biology 9: 923-932.

Laridae; Hydrobatidae; Procellariidae; Recurvirostridae; Pelecanidae; Scolopacidae; and Phalacrocoracidae.

- Reptiles: Sea turtles are highly sensitive to climate change, for two key reasons; their nesting areas are threatened by sea level rise, and their reproductive success is affected because temperature determines the sex of their offspring. All marine turtle's species are at risk: *Dermochelys coriacea* (Leatherback turtle); *Lepidochelys kempii* (Kemp's Ridley Sea turtle); *Chelonia mydas* (Green turtle); *Caretta caretta* (Loggerhead turtle) and *Eretmochelys imbricata* (Hawksbill turtle).

- Invertebrates: Marine invertebrates may be affected through multiple climate change pathways, including warming, sea level rise (particularly in intertidal zones), and acidification (for calcifying organisms). Particular attention should be paid to calcifying/shell-building organisms in relation to ocean acidification. Most threatened species include: *Ocypode cursor* (Ghost crab) ; species of sea snails including *Tonna galea (Med.)* or *Zonaria pyrum* (Pear Cowry); *Ophidiaster ophidianus* (Starfish) ; *Centrostephanus longispinus (Med.)* (Sea urchin); and species of deep-sea corals and sponges including *Gerardia savaglia Med.* (Black coral); *Astroides calycularis (Med.)*; *Aplysina cavernicola* (Yellow cave sponge); *Asbestopluma hypogea (Med.); Petrobiona massiliana (Med.)*

- Marine plants: Seagrass meadows suffer from multiple impacts such as climate induced change in water chemistry, but also through invasive species which are likely to accelerate further their degradation. Endemic to the Mediterranean Sea, several seagrass species rank amongst the slowest growing plant in biosphere, requiring long life span for recovery and making them specifically vulnerable. Many of these species are normally used as biological indicator for healthy ecosystems. Species at risks include: *Posidonia Oceanica*; *Cymodocea nodosa (Ucria) Ascherson*; *Zostera marina L; Cystoseira* and *Laminaria* species*;* but also coralligenous red algae such as *Goniolithon byssoides; Lithophyllum lichenoides; Ptilophora mediterranea; Schimmelmannia schousboei.*

21. Take conservation measures to protect and restore habitats expected to be most affected by climate change, including in overseas territories, such as lowland coastal areas, beaches, seagrasses, kelp forests, mangroves, reefs etc. Focus efforts on species not covered by the Bern Convention but protected under other national or international agreements, including taxa identified in Annex A such as: *Alopias vulpinus* (Common Thresher Shark); *Anguilla Anguilla* (European eel); *Centrophorus granulosus* (Gulper Shark); *Dipturus batis* (Common Skate); *Gadus morhua* (Atlantic cod); *Galeorhinus galeus* (Whithound); *Pinna nobilis* (Pen shell); *Raja clavata* (Thornback Skate); *Raja montagui* (Spotted Ray); *Squalus acanthias* (Spurdog); *Thunnus thynnus* (Bluefin tuna); *Xiphias gladius* (Swordfish).

22. Consider the role of *ex-situ* conservation actions for European marine biodiversity as complementary to *in situ* conservation methods, and where no other options exist:

- Carefully assess the risks of *ex situ* conservation measures under climate impacts, such as seeding, transplanting, relocating, assisting migration/colonization and captive breeding in the target area.

- Focus on species/ecosystems threatened in their current location and situations where local conditions become untenable for them as they are unlikely to be able to reach other suitable location by natural dispersal.

- Assess the coverage and quality of existing seed banks, genes banks and aquarium collections so as to fit conservation purposes, ensuring sufficient genetic diversity within available collections.

- Take urgent action to collect and store seeds of the majority of marine species listed under the Bern Convention that are not at present covered by such collections.

- Improve captive breeding and artificial propagation programs and develop recovery plans for threatened marine species under the Bern Convention, with an ultimate objective of successful reintroduction into the wild.

- Consider the central role of zoos, aquaria, natural history museums and botanic gardens for research, education and public awareness.

23. Develop adaptive strategies and management to increase flexibility in conservation programs and enable direct learning from experiences and research. Communicate the successes and strengthen information sharing on a regional basis.

c) Develop and manage effective networks of Marine Protected Areas

Marine Protected Areas (MPAs) have long been one of the cornerstones of marine conservation policy, and are a key component of adaptation strategies to climate change. As MPAs directly enhance ecosystem diversity and resilience, they are effective tools for reducing anthropogenic stress on the marine environment; for protecting, maintaining and restoring key ecosystem functions; for helping to create climate refuges for many organisms[26]. It is therefore necessary to include MPAs as an important tool within broader climate change adaptation strategies, and conversely, to factor climate change impacts and responses into MPA planning and management.

Ecological coherence of networks of MPAs, particularly connectivity between sites, will help species to cope with climate change impacts and facilitate their movement between conservation areas, as species dispersal is likely to be the most important mechanism of species adaptation to climate change. The provision of 'stepping stone' habitats and assisting species shifts in distribution are expected to be crucial for the adaptation and long-term survival of marine communities.

Evidence further suggests that well-designed and well-managed networks of MPAs not only support marine biodiversity but also benefit coastal communities and economic activities (e.g. fishing[27], tourism). MPAs can play an important role in broader strategies for sustainability, particularly to engage with local users and communities in marine conservation. As the extent of biodiversity recovery increases with the age and size of MPAs, and because benefits build over time and increase the longer the MPAs remains functional, urgent efforts to establish networks of MPAs a required.

Proposed Actions:

24. Accelerate marine protected areas designations and management to comply with regional and international commitments, with the aim of establishing ecologically coherent, representative and well-managed networks of MPAs, pursuant at minimum to the 10% coverage target established by the CBD.

25. Pay special attention to the climate mitigation potentials of MPA, as maintaining and restoring marine natural carbon sinks will increase the CO_2 uptake by marine ecosystems. Focus research activities on the quantification of these carbon deposition rates within MPAs, as a way to integrate them into larger carbon management schemes.

26. Conserve existing populations of species within existing high biodiversity areas and MPAs networks, at national, regional and international level across Europe, including under Emerald, Natura 2000, Specially Protected Areas of Mediterranean Importance (SPAMI), Baltic Sea Protected Areas (BSPA), the Black Sea Commission or OSPAR Marine Protected Areas.

27. Respect commonly agreed criteria - replicability, representativity, connectivity, adequacy, viability - in the designation process of marine protected areas in order to insure ecological coherence of the network. An effective MPA network may help to ensure resilience and sustained ecological functioning of ecosystems under pressure, by spreading the risk of both damaging events and long term environmental change.

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[26] Micheli F, Saenz-Arroyo A, Greenley A, Vazquez L, Espinoza Montes JA, et al. (2012): *Evidence That Marine Reserves Enhance Resilience to Climatic Impacts*. PLoS ONE 7(7): e40832

[27] Harrison et al (2012): *Larval Export from Marine Reserves and the Recruitment Benefit for Fish and Fisheries*, Current Biology, doi:10.1016

28. Acknowledge that urgent action is needed as evidence suggests that the extent of marine ecosystem recovery increases with the age and size of the protected zone and benefits of MPAs build over time.

29. Review the state of national and European MPAs planning to identify gaps in habitats, species and biogeographical coverage; formulate corrective actions to address those insufficiencies both at designation and management level.

30. Note the slow progress in establishing MPAs in areas beyond national jurisdictions, especially in the Mediterranean Sea's high-seas, and take appropriate actions to promote international cooperation in that regard

31. Prioritise the retention of remaining fragments of unaltered or semi-natural marine habitats as interlinks between protected areas.

32. Give special attention to endangered and vulnerable migratory species pursuant to Chapter IV of the Convention; rigorously account for changes in their migratory routes due to climate change in MPA networks developments.

33. Pay special attention to maintaining or restoring large-scale connectivity between MPAs and networks, to increase permeability, aid population and gene flow. Take restoration measures outside of MPAs, such as enhancing functional ecological habitats 'stepping stones', to increase the chances that species can adjust successfully their distributions in response to climate change.

34. Encourage the creation of sufficiently large no-take zones within MPAs, where exploitation is strictly prohibited and human activities are severely limited in order to protect the most critical ecosystems; and consider defining buffer zones around, to provide protection from activities with far-reaching effects

35. Involve stakeholders and relevant organizations, including Regional Fisheries Management Organizations, non-governmental organizations and local communities, in designation, management and enforcement processes for MPAs, to ensure understanding, cooperation and ownership. Build management and conservation capacity within all appropriate management levels of MPAs networks.

36. Develop and implement robust management plans for MPAs, with strict enforcement mechanisms, which fully integrate climate change concerns and achieve protection of existing habitats, restoration of degraded habitats and sustainable management of activities likely to impact marine protected areas.

37. Take a long-term view in MPAs management plans, and include actions for climate change adaptation (for periods up to 20 to 50 years, depending on the speed with which ecosystem changes are expected). Develop adaptive management strategies and flexible conservation measures and prevent the maintenance of ill-adapted habitats (e.g. mobile boundaries, temporal or seasonal protection, etc.). Consider the varying nature and extent of stressors over time, in response to climate and other drivers of change.

38. Develop special financial mechanisms to sustain marine biodiversity conservation efforts, through specific funding directed to MPA management and research, to ensure availability of appropriate means.

39. Ensure existing MPAs are adequately monitored and assessed so that they are in a state as healthy as possible before climatic and other change intensifies. Make sure monitoring covers climate change impacts on protected sites, at both site and network levels.

40. Increase awareness of the benefits that marine biodiversity provides to society and its role in adaptation strategies across all sectors. Communicate best management measures, successful adaptation strategies, and engage the wider public.

d) Minimise threats and pressure to marine biodiversity

Facilitating climate change adaptation also involves reducing "conventional" pressures on biodiversity such as intensification of land-use, fragmentation of habitats, overexploitation, invasive alien species and pollution. The impacts of human activities on marine biodiversity are multiple and require an integrated approach aiming to reduce and mitigate their negative impacts and restore the health and functions of marine ecosystems.

Reducing direct pressure from anthropogenic sources is urgently needed to stop the degradation and loss of ecologically important marine habitats, in particular on sensitive habitats such as hatchery and nursery areas, sanctuaries, areas with endemic and autochthonous species. Exploitation particularly may further exacerbate the effects of oceanic warming on fish population often by disproportionately threatening larger marine species[28].

Changes in sectoral policies can significantly reduce environmental externalities as in the case of harmful subsidies. Systematic application of robust environmental impact assessments and spatial planning tools within national strategies may also help improving marine and coastal planning, thus reducing the overall pressure from human activities on marine biodiversity.

Proposed actions:

41. Minimise all threats from human activities directly interacting with climate change to impact marine biodiversity and reduce its adaptive capacity, including extractive activities and in particular fisheries and aquaculture, dredging and mining, tourism and urbanisation, infrastructure and energy developments, maritime transport, military activities, agriculture and land based pollutions.

42. Incorporate fisheries management measures into other climate change mitigation and adaptation strategies (e.g. mathematical fisheries models with chemistry and temperature-driven climate change and acidification figures, based on species specific observational studies, to help determine appropriate harvest levels for many fisheries).

43. End all form of public subsidies and tax exemptions that have detrimental environmental impacts on oceans, in particular for the fishing sector (e.g. investment in vessels and fuel aid) in order to counter overexploitation of fisheries resources, destruction of marine ecosystems, and greenhouse gas emissions from the industry. Redirect aid to support transition towards truly sustainable marine and coastal activities which will result in long-term beneficial economic and social outcomes. Promote and invest in environmentally sounds marine renewable energy projects, as credible and viable solutions to decarbonize energy policies in the long-term.

44. Recognise the interconnections between human activities, ecosystem health, and ecosystem services. Design and implement integrated ecosystem-based approaches to the management of human activities which impact the wider marine environment, in order to reduce the overall anthropogenic pressures on biodiversity.

45. Ensure thorough and systematic environmental impact assessments (EIAs) and strategic environmental assessments (SEAs) to further minimise specific and cumulative impacts of projects and activities on coastal and marine biodiversity. Pay special attention to ocean noise and underwater disturbances.

46. Develop and encourage the use of specific marine spatial planning strategies to guide human activities development in a sustainable manner and take into account ecological principles.

47. Cooperate at regional level to improve and enhance coordination (e.g. common approaches, harmonized procedures, actions or trainings) in particular with regards to the transboundary aspects of many of the marine climate impacts.

e) Prevent and control the introduction of invasive alien marine species

Proposed actions:

48. Fully implement Recommendation No. 91 (2002) the European Strategy on Invasive Species endorsed in Recommendation No. 99 (2003) which requests Contracting Parties to draw up and implement national strategies on invasive alien species.

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[28] Planque, B. & Frédou, T. 1999. *Temperature and the recruitment of Atlantic cod (Gadus morhua)*. Can. J. Fish. Aquat. Sci. 56, 2069-2077.

49. Prevent the introduction and establishment of human-induced marine invasive species, through understanding vectors and pathways, risk assessment, early warning systems and control strategies. Improve detection, eradication and control mechanism, with a particular focus on sensitive marine ecosystems such as the Arctic, the Macaronesian or the Eastern Mediterranean basins because of their high rates of endemism.

50. Improve information on the biology of invasive species, how their populations respond to climate change, and how native marine ecosystems are likely to react to invasions under climate change impacts.

51. Monitor the effects of natural invasions of species in European waters and consider the need for measures to conserve and protect threatened species and habitats that may enter European waters as a result of climate-driven shifts in distribution. Identify and implement appropriate management measures to reduce risks associated with these shifts in distribution and ranges.

52. Work in key maritime sectors (e.g. fishing, aquaculture, shipping, tourism, trade) to raise awareness of invasive alien species threats, develop effective management approaches and share best practices.

Annex A. – Species/Habitats protected under other international agreements and not in listed under the Bern Convention

SPECIES	Barcelona Convention	Habitats Directive	OSPAR	HELCOM (2005)
Abramis ballerus				Vulnerable, VU
Acipenseridae		Annex V		
Alopias vulpinus	Annex III			Critically Endangered, CR
Alosa spp		Annex II and V		
Amblyraja radiata				Endangered, EN
Ammodytes marinus				Data Deficient, DD
Ammodytes tobianus				Vulnerable, VU
Anarhichas lupus				Endangered, EN
Anguilla anguilla	Annex III		All	Critically Endangered, CR
Aplysina sp plur	Annex II			
Arctica islandica			II	
Aspius aspius				Vulnerable, VU
Axinella cannabina	Annex II			
Balaena mysticetus			All	
Barbus Barbus				Endangered, EN
Boops boops				Endangered, EN
Carcharhinus plumbeus	Annex III			
Carcharias taurus	Annex II			
Centrophorus granulosus	Annex III		All	
Centrophorus squamosus			All	
Centroscymnus coelolepis			All	
Cerastobyssum hauniense				Threatened/declining
Chimaera monstrosa				Vulnerable, VU
Clupea harengus, subsp.				Endangered, EN
Cobitis taenia				Vulnerable, VU
Cottus gobio				Vulnerable, VU
Cottus poecilopus				Vulnerable, VU
Cyclopterus lumpus				Vulnerable, VU
Cystoseira abies-marina	Annex II			
Cystoseira mauritanica	Annex II			
Cystoseira spp	Annex II			
Dasyatis pastinaca				Threatened migrant, TM
Dicentrarchus labrax				Threatened migrant, TM
Dipturus batis	Annex II		All	Critically Endangered, CR
Entelurus aequoreus				Vulnerable, VU
Etmopterus spinax				Vulnerable, VU
Etmopterus spinax				Vulnerable, VU
Fucus virsoides	Annex II			
Gadus morhua			II, III	Endangered, EN
Galeorhinus galeus	Annex III			Endangered, EN
Galeus melanostomus				Endangered, EN
Geodia cydonium	Annex II			
Gibbula nivosa		Annex II, IV		
Gobio gobio				Near Threatened, NT
Gymnogongrus crenulatus	Annex II			

Gymnura altavela	Annex II			
Heptranchias perlo	Annex III			
Hexanchus griseus				Critically Endangered, CR
Hippocampus guttulatus			All	
Hippocampus hippocampus			All	
Hippoglossus hippoglossus				Endangered, EN
Hoplostethus atlanticus			All	
Hornera lichenoides	Annex II			
Kallymenia spathulata	Annex II			
Labrus bergylta				Endangered, EN
Labrus mixtus				Endangered, EN
Lagenodelphis hosei		Annex IV		
Leiopathes glaberrima	Annex III			
Leucoraja circularis	Annex III			
Leucoraja fullonica				Threatened migrant, TM
Leucoraja melitensis	Annex III			
Liparis liparis				Endangered, EN
Liparis montagui				Endangered, EN
Lophius budegassa				Vulnerable, VU
Lumpenus lampretaeformis				Critically Endangered, CR
Macroplea sp.				Threatened/declining
Megabalanus azoricus			All	
Melanogrammus aeglefinus				Vulnerable, VU
Mesoplodon europeaus		Annex IV		
Monoporeia affinis				Threatened/declining
Mustelus asterias	Annex III			
Mustelus mustelus	Annex III			
Mustelus punctulatus	Annex III			
Mya truncata				Threatened/declining
Myoxocephalus scorpius				Vulnerable, VU
Nerophis lumbriciformis				Vulnerable, VU
Nerophis ophidion				Vulnerable, VU
Nucella lapillus			II, III, IV	
Odontaspis ferox	Annex II			
Osmerus eperlanomarinus				Vulnerable, VU
Oxynotus centrina	Annex II			
Patella ulyssiponensis aspera			All	
Pelectus cultratus				Vulnerable, VU
Phoxinus phoxinus				Vulnerable, VU
Pinna nobilis	Annex II	Annex IV		
Pollachius pollachius				Endangered, EN
Pomatoschistus pictus				Vulnerable, VU
Pontoporeia femorata				Threatened/declining
Prionace glauca				Threatened migrant, TM
Pristis pectinata	Annex II			
Pristis pristis	Annex II			
Raja clavata			II	Endangered, EN
Raja montagui			All	Endangered, EN
Rhinobatos cemiculus	Annex III			

Rhinobatos rhinobatos	Annex III			
Rostroraja alba			All	
Saduria entomon				Threatened/declining
Salmo trutta				Vulnerable, VU
Sarcotragus foetidus	Annex II			
Sarcotragus pipetta	Annex II			
Sargassum acinarium	Annex II			
Sargassum flavifolium	Annex II			
Sargassum hornschuchii	Annex II			
Sargassum trichocarpum	Annex II			
Scomber scombrus				Vulnerable, VU
Scyliorhinus canicula				Endangered, EN
Sebastes marinus				Endangered, EN
Sebastes viviparus				Endangered, EN
Somniosus microcephalus				Vulnerable, VU
Sphaerococcus rhizophylloides	Annex II			
Sphyrna lewini	Annex III			
Sphyrna mokarran	Annex III			
Sphyrna zygaena	Annex III			
Spinachia spinachia				Vulnerable, VU
Squalus acanthias	Annex III		All	Endangered, EN
Squatina aculeata	Annex II			
Squatina oculata	Annex II			
Symphodus melops				Vulnerable, VU
Syngnathus acus				Endangered, EN
Syngnathus typhle				Vulnerable, VU
Taurulus bubalis				Vulnerable, VU
Tethya sp plur	Annex II			
Thunnus thynnus	Annex III		All	Critically Endangered, CR
Titanoderma ramosissimum	Annex II			
Titanoderma trochanter	Annex II			
Torpedo marmorata				Threatened migrant, TM
Trachinus draco				Vulnerable, VU
Triglopsis quadricornis				Vulnerable, VU
Tursiops truncatus		Annex II, IV		
Vimba vimba				Vulnerable, VU
Xiphias gladius	Annex III			Threatened migrant, TM
Zeus faber				Endangered, EN
HABITATS / FLORA	**Barcelona Convention**	**Habitats Directive**	**OSPAR**	**HELCOM (2005)**
Alisma wahlenbergii				Threatened/declining
Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation				C, D, E, F, K
Boreal Baltic narrow inlets (Fjords)				D-F, H, I, K
Carbonate mounds			V	
Chara sp				Threatened/declining
Coastal lagoons		Annex I		All
Coral Gardens			All	
Cymodocea meadows			All	

Deep-sea sponge aggregations			All	
Estuaries		Annex I		G,J,K,M,N
Fucus sp.				Threatened/declining
Furcellaria lumbricalis				Threatened/declining
Gravel bottoms with Ophelia species				All
Hippuris tetraphylla				Threatened/declining
Intertidal mudflats			All	
Intertidal Mytilus edulis beds on mixed and sandy sediments			All	
Lamprothamnium papulosum				Threatened/declining
Large shallow inlets and bays		Annex I		J,K,L,M,N
Littoral chalk communities			All	
Lophelia pertusa reefs			All	
Macrophyte meadows and beds		Annex I		All
Maerl beds			III	R
Modiolus modiolus beds			All	
Mudflats and sandflats not covered by seawater at low tide		Annex I		A,B,C,D,H,I,J,K,L,M,N,P,Q,R
Oceanic ridges with hydrothermal vents/fields			V	
Offshore (deep) waters below the halocline				All
Ostrea edulis beds			All	
Reefs		Annex I		M,N,R
Sabellaria spinulosa reefs			II, III	
Sandbanks		Annex I		K,L,M,N
Seamounts			All	
Sea-pen and burrowing megafauna communities			II, III	R
Shell gravel bottoms				All
Submarine structures made by leaking gases		Annex I		R
Submerged or partially submerged sea caves		Annex I		
Zostera marina			All	Threatened, /declining
Zostera noltii	Annex II		All	Threatened, /declining