MEDAC - Registered Office Via XX Settembre, 20 - c/o MIPAAF - 00187 Rome (Italy) - Tax identification number 97534810581 - Association registered with the Prefecture of Rome as a legal entity n.1224/2017

Ref.:70/2021 Rome, 30 March 2021

MEDAC ADVICE ON CLIMATE CHANGE

The MEDAC,

having deepened the topic of climate change, through the collaboration of researchers who presented at the MEDAC meetings of 28 September 2020 and 30 October 2020 the main scientific knowledge regarding the impact on fisheries.

whereas:

GENERAL PREMISES

Recent accelerated climate change has exacerbated existing environmental problems in the Mediterranean basin caused by the combination of changes in land use, increasing pollution and declining biodiversity (MedECC, 2019[1]) – George Triantaphyllidis[2];

Climate changes affects the productivity of stocks through changes in recruitment and interactions with trophic web. Therefore, assessment and management should consider effects of climate and sea change on the resources – Fabio Fiorentino[3];
It seems that climate change is affecting the Mediterranean Basin more than ever and that climate change impacts fisheries through multiple path-ways; (Shelton, 2014[4]) - George Triantaphyllidis[5];
Scientific literature shows several evidences that climate changes are negative on fisheries (Free et al., 2019; Gaines et al., 2018; Moullec et al., 2014) although some works based on global ocean models suggest future primary production increase in some higher latitude areas with potential benefits for fisheries (Barange et al., 2014) – Simone Libralato[6];

CAUSES AND EFFECTS OF CLIMATE CHANGES: 1. TEMPERATURE

Scientists observed Earth's surface warming and many of the warmest years have been recorded in the past 20 years[7] - George Triantaphyllidis[8].

[1] Risks associated to climate and environmental changes in the Mediterranean region. A preliminary assessment by the MedECC Network. Science-policy interface – 2019. https://ufmsecretariat.org/wp-content/uploads/2019/10/MedECC-Booklet_EN_WEB.pdf
[2] Slide 4 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf
[3] Slide 15 http://en.med-ac.eu/files/documentazione_eventi/2020/10/5_fiorentino_managing_small_pelagics-1.pdf
[4] Shelton, C. 2014. Climate change adaptation in fisheries and aquaculture – compilation of initial examples. FAO Fisheries and Aquaculture Circular No. 1088. Rome, FAO. 34 pp.
[5] Slide 17 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf
[6] http://en.med-ac.eu/files/documentazione_eventi/2020/10/2020_climatechangefisheries_medac_libralato_vdef.pdf
[7] See: https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
[8] Slide 2 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf

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For the Mediterranean region, average annual air temperatures now range approximately 1.5°C higher than during the preindustrial period (1880-1899) and well above current global warming trends (+1.1°C). (Cramer et al., 2018[9]) - George Triantaphyllidis[10];

Warming of the Mediterranean Sea surface is currently estimated at 0.4°C per decade for the period between 1985 and 2006 (+0.3°C per decade for the western basin and +0.5°C per decade for the eastern basin). The projections for 2100 vary between +1.8°C and +3.5°C in average compared to the period between 1961 and 1990. The Balearic Islands, the northwest Ionian, the Aegean and Levantine Seas have been identified as the regions with maximum increase of sea surface Temperature (Adloff et al. 2015[11]) - George Triantaphyllidis[10];

Similar to worldwide trends caused by warming and loss of glacial ice, sea level in the Mediterranean has risen between 1945 and 2000 at a rate of 0.7mm per year [Calafat & Gomis - 2009[12]) and between 1970 and 2006 at the level of 1.1 mm per year (Meyssignac et al. - 2010[13]) - George Triantaphyllidis[10];

Meeting the Paris Agreement global warming target of 1.5°C will have large benefits to Fisheries: for every degree Celsius decrease in global warming, potential fish catches could increase by more than three million tonnes per year[14] - George Triantaphyllidis[10];

Scientists compared the Paris Agreement 1.5°C warming scenario to the currently pledged 3.5°C by using computer models to simulate changes in global fisheries and quantify losses or gains. Due to the migration of fish towards cooler waters, climate change would also cause more species turnover, altering the composition of species within the stocks. This would have impacts on fishers and make fisheries management more difficult. (Cheung et al., 2016[15]) - George Triantaphyllidis[10];

Increasing water temperatures in Mediterranean lead to changes in species composition and abundance: in general, coldwater species become less abundant or extinct and warm-water species become more abundant, leading to homogenization of the Mediterranean biota with warm-water species. (Moullec et al., 2016[16]) George Triantaphyllidis[17];

Due to the warming of the Mediterranean, warm-water species, like the blue runner, the Mediterranean parrotfish, the common dolphinfish, the grey triggerfish and the barracuda are moving northwards (Azzurro E, Moschella P, Maynou F - 2011)[18] - George Triantaphyllidis[17];

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[9] Cramer Wolfgang, Joel Guiot, Marianela Fader, Joaquim Garrabou, Jean-Pierre Gattuso, et al. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. Nature Climate Change, Nature Publishing Group, 8 (11), pp.972 - 980. ff10.1038/s41558-018-0299-2ff. ffhal-01911390

[10] Slide 7-8-9-15-16 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf

[11] Mediterranean Sea response to climate change in an ensemble of twenty first century scenarios. Climate Dynamics, 45(9-10), 2775-28].

[12] Reconstruction of Mediterranean sea level fields for the period 1945-2000. Global and Planetary Change, 66(3-4), 225-234.

[13] Two-dimensional reconstruction of the Mediterranean sea level over 1970– 2006 from tide gage data and regional ocean circulation model outputs. Global and Planetary Change, 77(1-2), 49-61.

[14] (Nippon Foundation-Nereus Program study published in Science: http://archives.nereusprogram.org/1-5c-paris-agreement-target-could-net-six-million-tonnes-of-fish-annually/).

[15] Cheung, William W. L.; Reygondeau, Gabriel; Frölicher, Thomas L. (2016). Large benefits to marine fisheries of meeting the 1.5°C global warming target. Science, 354(6319), 1591–1594. doi:10.1126/science.aag2331

[16] Moullec Fabien , Frida Ben Rais Lasram, Marta Coll, François Guilhaumon, François Le Loc'H et Yunne-Jai Shin (2016). Sub-chapter 2.1.4. Climate change and fisheries. In : The Mediterranean region under climate change : A scientific update [en ligne]. Marseille : IRD Éditions, 2016 (généré le 04 février 2021). Disponible sur Internet : <http://books.openedition.org/irdeditions/23439>. ISBN : 9782709922203. DOI : https://doi.org/10.4000/books.irdeditions.23439.

[17] Slide 11-18-22 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf

[18] Tracking signals of change in Mediterranean fish diversity based on local ecological knowledge. PLoS ONE, 6(9), e24885

Also, seagrass meadows (which represent an important habitat but also a carbon sink) are vulnerable to seawater warming (Licandro et al. - 2010)[19] - George Triantaphyllidis[17];
The effects of global change are particularly serious in areas where range shifts of species are physically constrained such as in the Ligurian Sea, one of the coldest sectors of the Mediterranean (Parravicini et al. - 2015)[20] - George Triantaphyllidis[17];
However, climate-induced changes may also offer new opportunities to some Mediterranean fisheries, with increased landings of warmwater species, some of which of high commercial interest (e.g., the mahi-mahi C. hippurus). (Moullec et al., 2016[21]) - George Triantaphyllidis[17];
There is a different ecological optimal temperature of sardine (SST range 12 - 14 °C) and anchovy (SST range 17– 19°C) (by Palomera et al., 2007): increasing water temperature, pin particular in winter, when sardines reproduce, may decrease breeding performances and cause population decline; warming, on the other hand, may result in a n improvement of the spawning success for anchovy - Fabio Fiorentino[22];

CAUSES AND EFFECTS OF CLIMATE CHANGES: 2. ACIDIFICATION

In the Mediterranean Sea, all waters have been acidified by values ranging from −0.156 to −0.055 pH units since the beginning of the industrial era, which is clearly higher than elsewhere in the open ocean (Touratier and Goyet, 2011; Hassoun et al., 2015) - George Triantaphyllidis[17];

Ocean acidification is already impacting many ocean species, especially organisms like oysters and corals that make hard shells and skeletons by combining calcium and carbonate from seawater. However, as ocean acidification increases, available carbonate ions bond with excess hydrogen, resulting in fewer carbonate ions available for calcifying organisms to build and maintain their shells, skeletons, and other calcium carbonate structures. If the pH gets too low, shells and skeletons can even begin to dissolve. (NOOA)[23] - George Triantaphyllidis[24];

CAUSES AND EFFECTS OF CLIMATE CHANGES: 1. CO_2 INCREASE

In the last two centuries the concentration of carbon dioxide (CO_2) in the atmosphere has increased due to human actions: during this time, the pH of surface ocean waters has fallen by 0.1 pH units. This change represents approximately a 30 % increase in acidity. [Source: NOOA, cit.] - George Triantaphyllidis[24];

[19] A blooming jellyfish in the northeast Atlantic and Mediterranean. Biology Letters, 6(5), 688-691]
[20] Climate change and warm-water species at the north-western boundary of the Mediterranean Sea. Marine Ecology, 36(4), 897-909]
[21] Moullec Fabien , Frida Ben Rais Lasram, Marta Coll, François Guilhaumon, François Le Loc'H et Yunne-Jai Shin (2016). Sub-chapter 2.1.4. Climate change and fisheries. In : The Mediterranean region under climate change : A scientific update [en ligne]. Marseille : IRD Éditions, 2016 (généré le 04 février 2021). Disponible sur Internet : <http://books.openedition.org/irdeditions/23439>. ISBN : 9782709922203. DOI : https://doi.org/10.4000/books.irdeditions.23439.
[22] Slide 15 http://en.med-ac.eu/files/documentazione_eventi/2020/10/5_fiorentino_managing_small_pelagics-1.pdf
[23] See: https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification
[24] Slide 10-11-15-18 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf

Changes in ocean conditions that affect fishing catch potential, such as temperature and oxygen concentration, are strongly related to atmospheric warming and therefore also carbon emissions. For every metric ton of CO_2 emitted into the atmosphere, the maximum catch potential decreases by a significant amount (Cheung et al., 2016, Science) - George Triantaphyllidis[24];

CAUSES AND EFFECTS OF CLIMATE CHANGES: 1. SALINITY CHANGE

For Mediterranean coasts, regional changes in river runoff, provoking salinity changes and also significant land movements in the eastern parts of the basin needs to be considered. In addition to the impacts of global sea level change, circulation patterns in the Mediterranean may also be modified and generate changing regional sea level patterns, with local differences in sea surface height of up to 10 cm. (Aucelli PPC et al. - 2017)[25] - George Triantaphyllidis[24];

CAUSES AND EFFECTS OF CLIMATE CHANGES: 1. ALIEN SPECIES

Most species from warmer regions enter the Mediterranean from the Red Sea through the recently widened Suez Canal (they are referred to as Lessepsian species), others are transported accidentally through ballast water from ships. More than 700 non-indigenous marine plant and animal species have been recorded so far in the Mediterranean, many of them are favored by the warmer conditions (Marbà, Jorda, Agustí, Girard, Duarte (2015)[26]; Azzurro, Moschella, Maynou - 2011[27]) - George Triantaphyllidis[24];

The eastern Mediterranean is the area displaying the most severe environmental effects of invasive species. Some tropical invasive species create heavy disturbances in ecosystems, like tropical rabbit fish, which devastate algal forests. (Vergés et al. - 2014)[28] - Tria 18; Moreover, the western Mediterranean it is being affected by invasive species, in smaller numbers but not to a lesser extent, such as the alga *Rugulopterix okamurae*.

Movements of species and introduction of alien species represent in some cases a compensation of criticalities (e.g. bluefish; blue crab) - Accounting for thermal, alien and competition effects result in negative future effects even including some adaptation of fisheries to new species. (Libralato S., Caccin A. and Pranovi F., 2015[29]; Gaines, S. D., Costello, C., Owashi, B., Mangin, T., Bone, J., Molinos, J. G., ... & Ovando, D., 2018[30]; Cheung, W. W., Pinnegar, J., Merino, G., Jones, M. C., & Barange, M., 2012[31]) - Simone Libralato[32].

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[25] *Coastal inundation risk assessment due to subsidence and sea level rise in a Mediterranean alluvial plain (Volturno coastal plain–southern Italy). Estuarine, Coastal and Shelf Sciences, 198, Part B, 597-609.]*

[26] Footprints of climate change on Mediterranean Sea biota. Frontiers in Marine Science, 2, 00056

[27] Tracking signals of change in Mediterranean fish diversity based on local ecological knowledge. PLoS ONE, 6(9), e24885]

[28] Tropical rabbitfish and the deforestation of a warming temperate sea. Journal of Ecology, 102, 1518-1527

[29] Modelling species invasions using thermal and trophic niche dynamics under climate change. Frontiers in Marine Science, 2: 29. doi: 10.3389/fmars.2015.00029

[30] Improved fisheries management could offset many negative effects of climate change. *Science advances*, *4*(8), eaao1378.

[31] Review of climate change impacts on marine fisheries in the UK and Ireland. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *22*(3), 368-388.

[32] http://en.med-ac.eu/files/documentazione_eventi/2020/10/2020_climatechangefisheries_medac_libralato_vdef.pdf

CAUSES AND EFFECTS OF CLIMATE CHANGES: 1. WINNERS AND LOSERS

The bulk of increase in catch and biomass would be located in the southeastern part of the basin while total catch could decrease by up to 23% in the western part. Winner species would mainly belong to the pelagic group, thermophilic and/or exotic, of smaller size and of low trophic level while loser species are generally large-sized, some of them of great commercial interest, and could suffer from a spatial mismatch with potential prey subsequent to a contraction or shift of their geographic range. (Moullec, F., Barrier, N., Drira, S., Guilhaumon, F., Marsaleix, P., Somot, S., Shin, Y.-J., 2019)[33] - George Triantaphyllidis[34];

Future changes in biomass are expected to slightly differ depending on the vertical distribution of species in the water column. By the middle of the century, the biomass of demersal species could increase by 3% whereas benthic biomass could decrease by 2%. Pelagic species, with an increase in biomass of 7%, could benefit the most from the increase in plankton productivity. Despite the global increase, the biomass of some species of high commercial interest is expected to decline, for instance, hake (*Merluccius merluccius*) and Atlantic mackerel biomass could decrease by 26 and 15%, respectively. On the other hand, the biomass of other species of commercial interest, mainly pelagic species such as anchovy (*Engraulis encrasicolus*), mahi mahi (*Coryphaena hippurus*), blue fin tuna (*Thunnus thynnus*), or sardine (*Sardina pilchardus*), are expected to increase by 35, 34, 9, and 6%, respectively. (Moullec, F., Barrier, N., Drira, S., Guilhaumon, F., Marsaleix, P., Somot, S., ... Shin, Y.-J. ,2019)[35] - George Triantaphyllidis[34];

The main studied effect is the increased temperature and SOME of its direct effects on population growth/metabolism/reproduction success. In this context the impacts of increased temperatures determine winners and losers even among resident local species. (Libralato, Caccin and Pranovi, 2015[36] ; Albouy, C., Leprieur, F., Le Loc'h, F., Mouquet, N., Meynard, C. N., Douzery, E. J., & Mouillot, 2015[37]; Tzanatos, E., Raitsos, D. E., Triantafyllou, G., Somarakis, S., & Tsonis, A. , 2014[38]) – Simone Libralato[39].

CAUSES AND EFFECTS OF CLIMATE CHANGES: OTHER FACTORS

Climate change is only one component of global change. In the Mediterranean Sea, perhaps more than elsewhere, climate change is likely to act in synergy with other increasing anthropogenic disturbances such as pollution, eutrophication, overexploitation of resources and habitat

[33] An End-to-End Model Reveals Losers and Winners in a Warming Mediterranean Sea. Frontiers in Marine Science, 6. doi:10.3389/fmars.2019.00345

[34] Slide 21-22 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf

[35] An End-to-End Model Reveals Losers and Winners in a Warming Mediterranean Sea. Frontiers in Marine Science, 6. doi:10.3389/fmars.2019.00345

[36] Modeling species invasions using thermal and trophic niche dynamics under climate change. Frontiers in Marine Science, 2: 29. doi: 10.3389/fmars.2015.00029

[37] Projected impacts of climate warming on the functional and phylogenetic components of coastal Mediterranean fish biodiversity. *Ecography*, *38*(7), 681-689.

[38] Indications of a climate effect on Mediterranean fisheries. *Climatic Change*, *122*(1), 41-54.

[39] http://en.med-ac.eu/files/documentazione_eventi/2020/10/2020_climatechangefisheries_medac_libralato_vdef.pdf

modification and destruction, [and others] all of which playing a major role in altering the structure and functioning of ecosystems. (Moullec Fabien, Frida Ben Rais Lasram, Marta Coll, François Guilhaumon, François Le Loc'H et Yunne-Jai Shin 2016[40]) - George Triantaphyllidis[41];

Other effects might be considered relevant however, such as increase pH and especially future changes in primary production: climatic effects (less mixing, higher SST etc) are resulting in decrease in PP (because of nutrient limitation and higher metabolism) with overwhelming general effects on marine food web (Behrenfeld, M. J., O'Malley, R. T., Siegel, D. A., McClain, C. R., Sarmiento, J. L., Feldman, G. C., ... & Boss, E. S., 2006[42]; Barange, M., Merino, G., Blanchard, J. L., Scholtens, J., Harle, J., Allison, E. H., ... & Jennings, S., 2014[43]) – Simone Libralato[44].

PROJECTS AND STUDIES ON CLIMATE CHANGES IN FISHERIES

The network of Mediterranean Experts on Climate and Environmental Change (MedECC), involving 400 scientific experts supported by government agencies, Union for the Mediterranean and Plan Bleu (UNEP/MAP Regional Activity Center) and other partners, produced a full synthesis of risks and presented it to decision makers for debate and approval (MedECC 2019) - George Triantaphyllidis[41];
The Climefish project in Western Mediterranean run the Vulnerability assessment of various impacts belonging to 4 main groups (community and livelihoods, fisheries resources, fishing operations and wider society and economy implications) (Climefish.eu) - George Triantaphyllidis[41];
Climate change adaptation was studied by FAO[45] providing a portfolio of climate adaptation tools and methods recommended such as 1) Institutional and management, 2) livelihoods, and 3) risk reduction and management for resilience - George Triantaphyllidis[46];
Important trends observed over the twenty-first century show a decrease of anchovy and sardine stocks, the expansion of other thermophilic species (round sardinella) and the contraction in distribution of cold-water species (sprat). The strong dependence of pelagic species upon river runoff variability and the very likely decrease in precipitation in the Mediterranean will have negative implications for pelagic species. (FAO, 2018) – Fabio Grati[47];
The composition of the demersal communities has changed in the Mediterranean region in recent decades with a higher contribution of warmwater species, which are progressively colonizing northern areas concomitant with a regression of cold-water species. (Lloret et al., 2015) – Fabio Grati[47];

[40] Sub-chapter 2.1.4. Climate change and fisheries. In : The Mediterranean region under climate change : A scientific update [en ligne]. Marseille : IRD Éditions, 2016 (généré le 04 février 2021). Disponible sur Internet : http://books.openedition.org/irdeditions/23439>. ISBN : 9782709922203. DOI : https://doi.org/10.4000/books.irdeditions.23439).
[41] Slide 6-22 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf
[42] Climate-driven trends in contemporary ocean productivity. *Nature*, *444*(7120), 752-755.
[43] Impacts of climate change on marine ecosystem production in societies dependent on fisheries. *Nature Climate Change*, *4*(3), 211-216
[44] http://en.med-ac.eu/files/documentazione_eventi/2020/10/2020_climatechangefisheries_medac_libralato_vdef.pdf
[45] (Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. 2018. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp)
[46] Slide 22 http://en.med-ac.eu/files/documentazione_eventi/2020/09/6_triantaphyllidis_scientificaspectsoftheimpactonthesector.pdf
[47] http://en.med-ac.eu/files/documentazione_eventi/2020/10/4_grati_climate_change.pdf

MANAGEMENT PROPOSALS FROM SCIENTIFIC RESEARCH

Improved fisheries and ecosystems management in an overexploited Mediterranean Sea could have the potential to offset many negative effects of climate change. Given the already poor conditions of some exploited resources, these results suggest the need for fisheries management to adapt to future changes and to incorporate climate change impacts in future management strategy evaluation. (Triantaphyllidis G., Medac, 2020) - George Triantaphyllidis[46];

The MEDAC considers that

- (FUTURE MAP) the effects of climate change on fish stocks, in particular those related to rising water temperature and salinity changes, should be taken into account in future multi-annual fisheries plans.
- (MITIGATION AND ADAPTATION STUDIES) with regard to the current and future effects of climate change and the threats it poses, adaptation and mitigation measures should start with a good understanding of each fishing or aquaculture system and an accurate assessment of climate variability and likely future impacts on the environment, people and biodiversity, in order to strengthen productive and resilient aquatic ecosystems and maintain benefits for consumers and animal health.
- (MITIGATION AND ADAPTATION INVESTMENTS) it is urgent, in order to prevent, prepare for and mitigate the impact of extreme events and disasters on fisheries and aquaculture, to invest heavily in risk detection and reduction through mitigation and adaptation measures for the environment and the fishing economy.
- (MITIGATION AND ADAPTATION SUPPORT) the EU institutions, in agreement with the Member States, should pay the outmost attention to the study, development and activation of detection, mitigation and adaptation actions, including, where possible, also financial support for the damaged fishing communities.
- (SUPPORT) the fisheries sector should be shielded and supported, as it is one of the main traditional human activities conducted in the marine environment, making it a key component of integrated maritime policy and maritime spatial planning. as well as the maintenance of the economic and social activity of a large part of the Mediterranean coast.
- (THREATS REDUCTION AND OPPORTUNITIES SEIZING) On the one hand, the threats arising from climate change should be reduced or contrasted and, on the other hand, should be seized any opportunities arising from the same climatic changes, such as the introduction of new species into marketing, even if they come from outside the Mediterranean.
- (RESEARCH) It's very important the strengthening and development of international scientific programs to monitor the temperature, salinity and heat absorption of the oceans and the seas in order to better predict the impact of climate change on their functioning, carbon absorption and management of living marine resources. The program should be focused not just only on sea water parameters but also on fisheries and indirect factors that can accentuate climate change such as changes in land use and pollution for example.
- (MS INFORMATION NETWORK) Within an alert program, an information network must be developed among the MS that can quickly indicate any changes in fishing conditions and resources following the climate change, to quickly grasp the problems and implement measures to combat and, in the long term, to manage the problems.

Calls

- for a transition from reactive management, in the wake of disasters, to proactive management and measures to reduce risk and further climate-related threats.
- for a proactive management of extreme events, considering it a matter of urgency to invest in adaptation measures for climate resilience (such as safety at sea, climate-resilient infrastructure, etc.), risk reduction and climate disaster prevention, while safeguarding the health of the aquatic ecosystem and providing for specific measures in the future EMFF to support affected sectors.
- on the Commission to take these requests into account and to respond to them in its new climate change adaptation strategy (New Green Deal), which it plans to submit by the end of 2021, and in all its forthcoming legislative proposal.

Invites

- The Commission and the Member States to provide for appropriate support measures, such as insurance regimes and social protection systems for the groups that are the most exposed to climate change.
- The Commission and the Member States to deepen knowledge: 1. on the impacts of climate change, now and in the future, to anticipate measures to adapt to change, as well as 2. on the adaptation of fisheries,
- The Commission and the Member States to incorporate flexibility and adaptation in fisheries laws, regulation, and enforcement to allow fishing sector to adapt,
- The Commission and the Member States to support the adaptation of the downstream sector, including consumers, to promote new species favoured by climate change.

Recommends

- To enforce effective monitoring, control and surveillance

  Ultimately, sustainability comes down to optimal resource management – if fishery regulations are absent or ignored, controlling what goes on there is impossible. Permits, seasonal closures, fishing opportunities, protected areas – all can contribute to sustainable management. Control bodies should be reinforced with tools and resources they need, and the culture of compliance should be endorsed and promoted by the fishers themselves.

- Adaptive management

  By definition, climate change implies a situation that is constantly evolving, and fisheries management needs to keep pace to ensure adaptive measures remain appropriate and effective. Therefore, it is necessary to:

  - Promote greater consideration of adaptation to climate change in the guidelines and integrated community policies (in particular the Common Fisheries Policy),
  - Consider alternative management approaches (e.g., changing from effort limits to catch limits to adjust exploitation rates when catch potential is unstable),
  - Promote innovation and the adaptation of fishing vessels (safety, habitability and respect of the environment) considering the need of the fishing fleets to explore new fishing grounds

adapting to movements and migrations of certain species in response to climate change (often towards offshore areas) balancing fishing capacity with the status of target stocks.

- To take into account the distribution of fish stock in response to climate change in managing marine resources.

- Co-management

  Fishers rightly place great importance on participatory management structures, which could be implemented via multi-stakeholder management committees at fishery and regional levels. As well as making the active support of local fishers much more likely, such structures benefit from their unique knowledge and observations of what's really going on in the water – this perspective is an invaluable complement to the fine-grained scientific projections and analysis.

- Precautionary targets and an ecosystem-based approach

  The increasing risks that climate change determine, can be mitigated with an ecosystem-based approach to fisheries management that supports a broader ecosystem resilience. Selectivity is, for example, a tool to reduce unwanted catches.

- Research development

  Some effects have been highlighted such as for example the changes in species composition and abundance, emergence of invasive species, food web modifications or impact on water resources. However, effects of complex climate changes on fish stocks and their consequences on fisheries need to be deepened.

  About fisheries adaptation, planning based on alternative scenarios that integrates knowledge from all stakeholders is needed – and the range of potential outcomes to plan for, must integrate social factors as well as climatic and fishery science. This is another area where the role of women should be highlighted, as a driver of efficiency and sustainability.