Listen to the scientists, use protection - Marine Protected Areas

Human activities such as excessive use of fossil fuels, plastic production and overfishing are now negatively affecting the oceans. Human interference are causing changes in the biodiversity and the ecosystems found in marine areas. Areas with a high density of species are especially at risk [1]. Here, many organisms depend on each other, and if one is missing an entire food web could potentially collapse [1]. A marine protected area (MPA) is an area designated to the maintenance and protection of marine ecosystems, processes, habitats and species. This includes shipwrecks, reefs, lagoons, mangroves and more.

One such important type of area are coral reefs. Coral reefs are hotspots for biodiversity and hold one quarter of all marine life [2]. Therefore, many species are dependent on the coral reefs for food and protection [3]. Coral loss has a cascading effect on the reef ecosystems and could eventually lead to consequent changes in the population dynamics and reef biodiversity [2]. Due to overfishing and other human activities, this ecosystem type is under severe threat [4]. Marine protected areas have been relatively successful in restoring populations of over-harvested fish and invertebrates by protecting important habitats [4]. Here we will discuss the importance of biodiversity and the positive and negative sides of MPAs. Furthermore, the effects and the benefits of MPAs and the economics behind it will be debated. Lastly, the MPAs will be linked to terrestrial nature conservation.

Biodiversity is important for maintenance of goods and resources

Biodiversity is the variety of life and refers collectively to variation at all levels of biological organization. Because the variety of life can be expressed in profound ways, there is no single overall measure of biodiversity, rather multiple measurements of different factors. Measures of biodiversity are used as bases for making decisions about conservation action [5]. Marine biodiversity has always been linked closely to our livelihood and plays a crucial role in maintaining marine ecosystem services and supply of crucial goods to human society [6]. This includes the transformation, detoxification and sequestration of waste, and moderation of climate [7]. The production of plant biomass from sunlight and nutrients is the primary food source for all living organisms in the natural environment, and ultimately for humans. The decline of marine biodiversity is also leading to fluctuating and unpredictable changes to the ecosystem services and goods from the ocean, reducing the resilience and resistance of marine environment to changes [8]. Moreover, the complementarity effect, where two forms of life live together without depriving the other also shows the importance of biodiversity. For instance, some algae species grow better with intense light while others prefer less light, when growing together one will grow towards the light and block the light for the other [9]. These examples show that rich biodiversity is not only good for the sustainability of the marine environment, but that we as humans also benefit from it.

Marine protected areas are meant to maintain biodiversity

MPAs are created for the purpose of protecting biodiversity, habitats, and to restore productivity and avoid further degradation of the ocean [10]. The aim of restoring and conserving biodiversity is especially important, but 94% of all MPAs are only “partially protected MPAs”. Meaning that fishing, aquaculture and tourism activities are permitted, but restrictions such as fishing quotas are imposed [11]. Any fishing can have an ecological impact and thus alter the level of biodiversity, from genes to ecosystems. For example, fishing on a top predator could alter the population size of the predator itself, causing a trophic cascade and changing the whole ecosystem. Hence MPAs that allow fishing will not maintain all levels of biodiversity in its natural condition [11]. In 2017, 1.6% of all MPAs were no-take MPAs; areas that prohibit extractive activities, such as fishing, archaeological digging, hunting and diving [16]. A meta-analysis of scientific studies showed, on average, no-take MPAs had 670% greater fish biomass than unprotected areas and 343% greater than in partially protected MPAs [12]. Partially protected MPAs had 183% greater fish biomass than unprotected areas. After protection, fish biomass was restored in no-take MPAs, but not in partially protected MPAs or unprotected [12]. Therefore, more no-take MPAs are needed to restore fish biomass and ecosystems and for the conservation of biodiversity. If fish biomass increases, more fish is likely to migrate to surrounded unprotected areas (spillover effect) where fishing can occur [13]. If fished in a sustainable way, increased fish biomass can help to meet the increasing food demand and thereby SDG 2: Zero Hunger. Global MPA coverage continues to grow about 8% a year [14], and this, along with other conservation and restoration initiatives, has led to a reduced risk of extinction for many marine mammals as well as increased recovery of many of the scientifically assessed and depleted fish stocks [14]. Besides, many of the benefits associated with MPAs have yet to be realized as they increase with the age of the reserve, and most MPAs are still less than ten years old [15].

Marine protected areas are still considered a controversial conservation tool

When implementing marine protected areas, there are numerous potential pitfalls. Negative consequences may be a displacement of coastal communities, harvesting and fishing moving to other areas causing illegal harvesting and increasing conflict. These consequences are a stark contrast to SDG 16, which aims to reduce conflict and violence. Traditionally, marine protected areas have mainly been designed to optimize and protect biodiversity, with little consideration for potential costs to the recreational and commercial fisheries that are affected [16]. Failing to accommodate these socioeconomic interests often strains the success of established marine protected areas because support and compliance from the local community is lacking [17]. Unless MPAs are implemented with proper consultation with local communities in coastal and marine areas, they are unlikely to meet their social, ecological and economic objectives [18]. However, well-manage MPAs can benefit local communities, leading to increased number of jobs in the fishing- and tourism industry, providing a link with SDG 1 and 8 [19].

Creating marine protected areas is costly, but could be worth it

The ocean is finite, and therefore the resources need to be protected. Establishing and operating MPAs can be expensive. An estimation of the operation cost can be around 7-26 billion USD annually for 20%-30% of the ocean conserved through MPAs [20]. The area we aim to reach is at least 10% by 2020 (SDG 14.5). This is a question of priority. For comparison: the world's biggest cruise ship, The Symphony of the Seas, cost $1.35 billion to build, with the expense of five of these ships we are within reaching SDG 14.5.Active conservation of MPAs could potentially create up to 1 000 000 new jobs [20]. In order to fulfill SDG 1 and SDG 8, jobs like these will be vital in growing economies. Similar measurements are being taken to create sustainable jobs on land. For example, Pakistan is committed to planting 10 billion trees by 2023, and this planting project will employ 60 000 workers [21]. If marine protected areas are managed well, they could create job opportunities (SDG1), sustainable fishing regiments (SDG8, SDG14), as well as preserving biodiversity in our oceans.

There is a link between terrestrial and marine nature conservation

Protected areas are not only important for conservation of oceans and marine areas, but also for terrestrial nature conservation (SDG 15). The area which is protected on land is, in comparison, larger (14.9%) than the marine protected areas (7.3%) [22]. There is a strong link between marine and terrestrial ecosystems [23]. Ecological processes like the flow of water and the movement of organisms between terrestrial, freshwater, and marine ecosystems are crucial for biodiversity below water and on land [24]. For instance, many birds feed on marine organisms and therefore, depend on the nutrition delivered by marine food webs. Hence, threats on marine organisms influence terrestrial ecosystems and vice versa. The nutrient input from agriculture in the water cycle causes eutrophication, toxic phytoplankton blooms and hypoxia in coastal ecosystems [25, 26]. Additionally, the use of pesticides causes diebacks in species-rich habitats like coral reefs [27]. On the other hand, excessive fishing of salmon in the ocean can cause reduced nutrition input in rivers [28] and lead to less food for terrestrial predators [29]. Thus, the cooperation of marine and terrestrial nature conservation is needed to preserve biodiversity on land and below water.

Final thoughts

MPAs will be important tools for conserving marine ecosystems and working towards sustainable development. Especially for marine areas with a high level of biodiversity, this protection is required. However, there are different types of MPAs. Many marine areas are only partly protected, and not substantially efficient for marine conservation. Thus, we need more no-take MPAs to reach the targets of SDG 14, as well as several other SDGs. The connections between the MPAs and the sustainable development goals are complex, as use of MPAs can work both for and against different SDG targets. Establishing marine protected areas can be very expensive, but could on the other hand, contribute with more jobs and thereby increase employment (SDG 2 and 8), through responsible use of marine resources (SDG 12) Because marine and terrestrial processes are closely linked, the success of marine conservation depends on the success of conservation on land (SDG 15). In conclusion, successful MPAs will not only protect marine ecosystems, but also important resources, and should still be considered as a plausible tool for working towards sustainable development.

References

[1] Worm, B., et al. (2006). Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science*, 314(5800), pp.787-790. https://doi.org/10.1126/science.1132294

[2] UN Environment. (2020). *UNEP Launches Glowing Glowing Gone Campaign On Loss Of Coral Due To Climate Change*. [online] Available at: <https://www.unenvironment.org/news-and-stories/story/unep-launches-glowing-glowing-gone-campaign-loss-coral-due-climate-change> [Accessed: 2 May 2020].

[3] Mouillot, D., et al. (2011). Protected and Threatened Components of Fish Biodiversity in the Mediterranean Sea. *Current Biology*, 21(12), pp.1044-1050. https://doi.org/10.1016/j.cub.2011.05.005

[4] Selig, E. & Bruno, J. (2010). A Global Analysis of the Effectiveness of Marine Protected Areas in Preventing Coral Loss. *PLoS ONE*, 5(2), p.e9278. https://dx.doi.org/10.1371%2Fjournal.pone.0009278

[5] Kevin J. Gaston & John I. Spicer (2013). Biodiversity: An Introduction, chapter 1: What is biodiversity. [online] Available at: <https://books.google.no/books?hl=da&lr=&id=0Bjp2o5CVnQC&oi=fnd&pg=PT6&dq=biodiversity&ots=Y02c_LjfEA&sig=ZghghXalCzWS-XdEbxEvJ2HxqE4o&redir_esc=y#v=onepage&q=biodiversity&f=false> [Accessed: 2 May 2020]

[6] Palumbi, S., et al. (2009). Managing for ocean biodiversity to sustain marine ecosystem services. *Frontiers in Ecology and the Environment*, 7(4), 204-211. https://doi.org/10.1890/070135

[7] Pharo, E. (1998). Nature's Services: Societal Dependence on Natural Ecosystems. *The Bryologist*, 101(3), 475. https://doi.org/10.2307/3244191

[8] Beaumont, N.J., et al.(2008). Economic valuation for the conservation of marine biodiversity. *Marine Pollution Bulletin*, 56(3), 386-396. https://doi.org/10.1016/j.marpolbul.2007.11.013

[9] Lehmkoster, J. (2010). Living with the oceans. A report on the state of the world's ocean. [online] Available at: <https://worldoceanreview.com/en/wor-1/marine-ecosystem/biodiversity/> [Accessed 1 May 2020]

[10] Kenchingtin R., et al. (2003). The benefits of MARINE PROTECTED AREAS <https://www.environment.gov.au/system/files/resources/5ead4f9-e8e0-45d1-b889-83648c7b2ceb/files/benefits-mpas.pdf> [Accessed: 2 May 2020]

[11] Costello, M. & Ballantine, B. (2015) Biodiversity conservation should focus on no-take Marine Reserves: 94% of Marine Protected Areas allow fishing. *Science and society* 30(9), *507-509 https://doi.org/10.1016/j.tree.2015.06.011*

[12] Sala, E., et al. (2018) No-take marine reserves are the most effective protected areas in the ocean. *ICES Journal of Marine Science* 75(3), 1166-1168 https://doi.org/10.1093/icesjms/fsx059

[13] Forcada, A., et al. (2009). Effects of habitat on spillover from marineprotected areas to artisanal fisheries. *Marine ecology progress series* 379, 197-211. https://doi.org/10.3354/meps07892

[14] Worm, B. (2017). Marine conservation: How to heal an ocean. *Nature*, 543(7647), 630-631. https://doi.org/10.1038/nature21895

[15] Duarte, C., et al. (2020). Rebuilding marine life. Nature, 580(7801), 39-51. https://doi.org/10.1038/s41586-020-2146-7

[16] Stewart, R.R. & Possingham, H.P. (2005). Efficiency, costs and trade-offs in marine reserve system design. Environmental Modeling and Assessment, 10(3), 203–213. https://doi.org/10.1007/s10666-005-9001-y

[17] Klein, C.J., et al. (2008). Striking a Balance between Biodiversity Conservation and Socioeconomic Viability in the Design of Marine Protected Areas. Conservation Biology, 22(3), 691–700. https://doi.org/10.1111/j.1523-1739.2008.00896.x

[18] Spalding, M., et al. (2016). Building towards the marine conservation end-game: consolidating the role of MPAs in a future ocean. *Aquatic Conserv: Marine and freshwater ecosystems* 26(2), 185-199https://doi.org/10.1002/aqc.2686

[19]Le Blanc, D., et al. (2017). Mapping the linkages between oceans and other Sustainable Development Goals: A preliminary exploration. *Department of Economic & Social Affairs* [online] available at: https://sustainabledevelopment.un.org/content/documents/12468DESA_WP149_E.pdf [Accessed: 8 May 2020]

[20] Balmford, A., et al. (2004). The worldwide costs of marine protected areas. *Proceedings Of The National Academy Of Sciences*, 101(26), 9694-9697. https://doi.org/10.1073/pnas.0403239101

[21] Aljazeera Pakistan. (2020). Pakistan's virus-idled workers hired to plant trees. [online] Available at: https://www.aljazeera.com/news/2020/04/pakistan-virus-idled-workers-hired-plant-trees-200429070109237.html [Accessed: 3 May 2020]

[22] Protected Planet Report (2018). Tracking progress towards global targets for protected areas. UN Environment Programme. https://livereport.protectedplanet.net/ [Accessed 28 April 2020]

[23] A´ lvarez-Romero J.G. et al.(2011). Integrated Land-Sea Conservation Planning: The Missing Links. *Annu. Rev. Ecol. Evol. Syst*. 42: 381-409 https://doi.org/10.1146/annurev-ecolsys-102209-144702

[24] Beger, M., et al. (2010). Conservation planning for connectivity across marine, freshwater, and terrestrial realms. *Biol. Conserv*. 143:565–75 https://doi.org/10.1016/j.biocon.2009.11.006

[25] Diaz, R.J., et al. (2008). Spreading dead zones and consequences for marine ecosystems. *Science* 321:926-29 https://doi.org/10.1126/science.1156401

[26] Howarth, R.W. (2008). Coastal nitrogen pollution: a review of sources and trends globally and regionally. *Harmful Algae* 8:14-20 https://doi.org/10.1016/j.hal.2008.08.015

[27] Haynes, D., et al. (2007). Assessment of the water quality and ecosystem health of the Great Barrier Reef (Australia): conceptual models. *Environ.Manag*. 40: 993-1003 https://doi.org/10.1007/s00267-007-9009-y

[28] Gresh, T., et al. (2000). An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. *Fisheries* 25:15–21 https://doi.org/10.1577/1548-8446(2000)025%3C0015:AEOHAC%3E2.0.CO;2

[29] Helfield, J.M. & Naiman, R.J. (2006). Keystone interactions: salmon and bear in riparian forests of Alaska. *Ecosystems* 9, 167–180 https://doi.org/10.1007/s10021-004-0063-5