Documents in support of National Advisory Panel on Marine Protected Area Standards study

Dr Rodolphe Devillers, Memorial University of Newfoundland

Those scientific references, most of them published in international peer-review journals, document evidences of incompatibility between protected areas (MPA and OECMs) and several human activities. In light of the study done by the panel, this document focuses on (1) the fact that MPAs that have stronger protection levels are generally more effective and (2) threats posed by individual activities to marine ecosystems.

Generally, I would say that there is a clear agreement in the scientific community that mobile gears such as trawling and dredging, oil and gas, and seabed mining activities are incompatible with an area set for conservation like an MPA or OECM. There are still discussions about aquaculture and despite documented impacts on ecosystems, some scientists think this activity could be compatible if well regulated. However, our knowledge of those impacts is still fairly new and a precautionary principle may be wise to apply.

<u>Studies showing that MPAs (and OECMs) that have a higher level of protection are more effective</u>

- **Aburto-Oropeza, O., Erisman, B., Galland, G. R., Mascareñas-Osorio, I., Sala, E., & Ezcurra, E. (2011). Large recovery of fish biomass in a no-take marine reserve. *PLoS One*, *6*(8), e23601.**

  Example of study confirming benefits of no-take MPA (= where fisheries is completely banned) to help depleted fish populations recover.

- **Edgar, G. J., Stuart-Smith, R. D., Willis, T. J., Kininmonth, S., Baker, S. C., Banks, S., ... & Buxton, C. D. (2014). Global conservation outcomes depend on marine protected areas with five key features. *Nature*, *506*(7487), 216-220.**

  Global review of 87 MPAs looking at what criteria make MPAs effective, showing that effective MPAs tend to combine several characteristics that include (1) strong protection (no-take), (2) well-enforced, (3) existed for over 10 years, (4) large size (over 1000km^2), and (5) isolated by deep-water or sand.

- **Lester, S. E., Halpern, B. S., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B. I., Gaines, S. D., ... & Warner, R. R. (2009). Biological effects within no-take marine reserves: a global synthesis. *Marine Ecology Progress Series*, *384*, 33-46.**

Global review of 124 MPAs in 29 countries showing benefits of MPAs and mostly no-take ones on many aspects of marine ecosystems (e.g. biomass, size, richness). They also show that such benefit is very clear in temperate waters (not only tropical).

- **Sciberras, M., Jenkins, S. R., Kaiser, M. J., Hawkins, S. J., & Pullin, A. S. (2013). Evaluating the biological effectiveness of fully and partially protected marine areas. *Environmental Evidence*, *2*(1), 4.**

  Review of studies showing that fully protected (no-take) MPAs provide higher benefits than partially protected ones, and that partial protection provides higher benefits than none.

Impacts of oil and gas on marine ecosystems

- **Dalen, J., & Knutsen, G. M. (1987). Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. In Progress in underwater acoustics (pp. 93-102). Springer US.**

  Study showing that seismic activities (e.g. conducted by the oil and gas industry) can kill fish eggs (and hence increase fish mortality).

- **Gates, A. R., & Jones, D. O. (2012). Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380 m depth in the Norwegian Sea). PloS one, 7(10), e44114.**

  Study that found that oil and gas drilling activities can impact benthic ecosystems and habitats for years from tens to hundreds of meters around the wells (= clearly showing that oil and gas drilling activities has an impact much further what the industry claims).

- **McCauley, R., Day, R. D., Swadling, K. M., Fitzgibbon, Q. P., Watson, R. A., & Semmens, J. M. (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution, 1, 1-8.**

  Study suggesting that commercially used airguns used for oil and gas seismic surveys can increase the mortality of zooplankton of 2-3 times up to a kilometers from the ship. Zooplankton being at the base of the food chain, impact on those species are likely to impact many other species.

- **Popper, A., & Hawkins, A. (Eds.). (2011). The effects of noise on aquatic life (Vol. 730). Springer Science & Business Media.**

Study showing diverse impacts of seismic work on marine life, including evidence of permanent damage to fish hearing.

Impact of bottom contact gears (e.g. trawling and dredging) on marine ecosystems

- **Jennings, S., & Kaiser, M. J. (1998). The effects of fishing on marine ecosystems. In Advances in marine biology (Vol. 34, pp. 201-352). Academic Press.**
  Study describing a range of impacts fisheries activities generally have on marine ecosystems.

- **Sciberras, M., Hiddink, J. G., Jennings, S., Szostek, C. L., Hughes, K. M., Kneafsey, B., ... & Hilborn, R. (2018). Response of benthic fauna to experimental bottom fishing: A global meta-analysis. Fish and Fisheries.**

  Global study showing that a bottom contact gear reduces on average 26% of benthic species abundance and 19% of species richness. Some gear types, like dredging, have even much higher impacts due to their higher penetration in the sediments.

- **Watling, L., & Norse, E. A. (1998). Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology, 12(6), 1180-1197.**

  Study comparing the impacts of mobile fishing gear (like trawling and dredging) with clearcutting in terrestrial environments.

Impacts of aquaculture on marine ecosystems

- **Fisheries and Oceans Canada (2006). A scientific review of the potential environmental effects of aquaculture in aquatic ecosystems. Canadian Technical Report of Fisheries and Aquatic Sciences 2450.**

  Government of Canada report documenting a range of environmental impacts caused by aquaculture.

- **Krkošek, M., Lewis, M. A., & Volpe, J. P. (2005). Transmission dynamics of parasitic sea lice from farm to wild salmon. Proceedings of the Royal Society of London B: Biological Sciences, 272(1564), 689-696.**

  Study focusing on the effect of sea lice on marine ecosystems. They state for instance that "infection pressure imposed by the farm was four orders of magnitude greater than ambient levels, resulting in a maximum infection pressure near the farm that was 73 times greater than ambient levels and exceeded ambient levels for

30 km along the two wild salmon migration corridors."

Impacts of seabed mining on marine ecosystems

- **Miller, K. A., Thompson, K. F., Johnston, P., & Santillo, D. (2018). An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps. Frontiers in Marine Science, 4, 418.**

  Recent paper reviewing a range of disturbances that seabed mining activities can cause to the marine ecosystems and environments (e.g. noise, light, sediments plumes). The study states that "Deep-sea mining will inevitably cause loss of biodiversity on a local scale", saying that activities can impact a much larger area, depending on the nature of the activities and ecosystems.

- **Van Dover, C. L., Ardron, J. A., Escobar, E., Gianni, M., Gjerde, K. M., Jaeckel, A., ... & Smith, C. R. (2017). Biodiversity loss from deep-sea mining. Nature Geoscience, 10(7), 464.**

  This short paper discusses impacts of deep-sea mining on biodiversity, saying that "loss of biodiversity will be unavoidable because mining directly destroys habitat and indirectly degrades large volumes of the water column and areas of the seabed due to the generation of sediment plumes that are enriched in bioavailable metals."