Key Scientific Literature in Support of 30x30 and MPAs

Below is a list of key scientific literature underpinning: 1) the goal to protect 30% of our ocean and land by 2030 and 2) the benefits of marine protected areas for people, biodiversity, and climate resilience.

For additional scientific literature underpinning the importance of highly and fully protected areas, please see Marine Conservation Institute's website here: https://marine-conservation.org/scientific-support/

The Science Supporting 30x30

The scientific publications below demonstrate the necessity and value of protecting 30% of land, water, and oceans in order to: 1) prevent mass extinctions and promote global biodiversity; 2) defend against climate change impacts by keeping areas like forests, mangroves, wetlands and grasslands that sequester large quantities of carbon intact; 3) facilitate climate adaptation by providing safe havens where wildlife can thrive without other pressures; and 4) ensure that the natural systems on which we depend for food, oxygen and other essential services are sustained.

There are two foundational pieces of scientific literature supporting 30x30:

- The Global Assessment Report on Biodiversity and Ecosystem Services: Summary for policymakers

  S.Diaz, et al. (2019) *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES).

  A critical assessment of the status and trends of the natural world that finds that a million species are threatened with extinction, many within decades, and outlines the social implications of these trends given how dependent we are on thriving and abundant biodiversity and ecosystems. The Report identifies the largest drivers of extinction: changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasion of alien species, and the actions that can be taken to temper nature's collapse. The Report concludes that expanding and effectively managing protected areas, including terrestrial, freshwater and marine areas, is critical for safeguarding biodiversity and the natural systems we depend on for abundant food, clean water, and other services. Protected areas must be ecologically representative networks of interconnected areas covering key biodiversity hotspots that are safeguarded into the future by enhanced monitoring, enforcement, and stakeholder collaboration.

- A Global Deal for Nature: Guiding principles, milestones, and targets

  E. Dinerstein, et al. (2019) *Science Advances* 5: 4.

  The Global Deal for Nature (GDN) calls for 30% of the Earth to be formally protected—and an additional 20% designated as climate stabilization areas—by 2030 in order to save the Earth's biodiversity and conserve the native ecosystems required to remain below a 1.5°C rise in average global temperature. The paper highlights 67% of terrestrial ecoregions that can help meet the land-specific 30% protection goal, identifies

protecting and restoring 30% of the world's freshwater ecoregions as a "vital milestone," and calls for protection of at least 30% of the ocean. The paper makes the case for the GDN as a companion pact to the Paris Climate Agreement, solving "the two major challenges facing the biosphere and all the species within it and result[ing] in a return to safe operating space for humanity."

Additional literature supporting protecting 30% of our planet's lands and waters, and 30% of our oceans in protected areas includes:

General

- A review of evidence for area-based conservation targets for the post-2020 global biodiversity framework
  S. Woodley, et al. (2019) *PARKS* 25.2: 31-46.

  The paper reviews scientific evidence on large-scale percentage-area conservation targets and concludes that current targets are not adequate to conserve biodiversity; protected areas need to be high-quality, well governed, and effectively managed; and that global protection of a minimum of 30% and up to 70% or higher of the land, inland waters and sea on Earth is well supported in scientific literature.

- Protecting 30% of the planet for nature: costs, benefits and economic implications, Waldron, A., Adams, V., Allan, J., Arnell, A., Asner, G., Atkinson, S., . . . Austin Beau, J. (2020).

  The current report is based on the work of over 100 economists/scientists, analyzing the global economic implications of a 30% PA target for agriculture, forestry, fisheries, and the PA/nature sector itself. Our *financial* analysis showed that expanding PAs to 30% would generate higher overall output (revenues) than non-expansion (an extra $64 billion-$454 billion per year by 2050). In the *economic* analysis, only a partial assessment was possible, focusing on forests and mangroves. For those biomes alone, the 30% target had an avoided-loss value of $170-$534 billion per year by 2050, largely reflecting the benefit of avoiding the flooding, climate change, soil loss and coastal storm-surge damage that occur when natural vegetation is removed. The value for all biomes would be higher.

Land

- 30% land conservation and climate action reduced tropical extinction risk by more than 50%
  L. Hannah, et al. (2020) *Ecography* 43: 1-11.

  The authors assess the combined impact on extinction risk of species from limiting climate change and increasing the extent of protected areas in the tropics. They conclude that by limiting climate change to 2°C and protecting 30% of terrestrial areas, we can reduce the aggregate extinction risk for nearly 300,000 species by more than 50% compared with uncontrolled climate change and no increases in protected areas.

- Conservation attention necessary across at least 44% of Earth's terrestrial area to safeguard biodiversity
  J. Allan, et al. (2019) *bioRxiv* 339977.

  The authors estimate the minimum amount of land needed to secure important sites for biodiversity, remaining wild areas, and representative areas of species distribution and ecosystems. They conclude that at least 43.6% of terrestrial areas require conservation attention via protected area designations or responsive land-use policies. The authors note that nearly 2% of these critical areas are slated to be lost to intensive land-use by 2030 and thus require immediate protection.

- Targeted expansion of Protected Areas to maximize the persistence of terrestrial mammals
  S. Mogg, et al. (2019)*bioRxiv* 608992.

  The authors find that the global community's existing targets for protection (17% of land and 10% of ocean) have limited ecological impact because they are too small and poorly enforced. To assess what is necessary in the future, they focus on terrestrial mammals and reverse-engineer the IUCN Red List criteria to generate area-based conservation targets and spatial conservation priorities for minimizing extinction risk. They conclude that approximately 60% of the Earth's non-Antarctic land surface requires some form of protection and that targets short of this will be inadequate to secure the persistence of the current populations of terrestrial mammals.

Water

- Theory and practice to conserve freshwater biodiversity in the Anthropocene
  R. Flitcroft, et al. (2019) *Aquatic Conservation: Marine and Freshwater Ecosystems* 29: 1013– 1021. Fresh waters are hotspots of both biodiversity and endangerment.

  Freshwater ecosystems occupy less than 1% of the Earth's surface but contain as much as 12% of all known species, including a third of all vertebrate species. Populations of monitored freshwater species have declined 83% between 1970 and 2014. Freshwater species are particularly vulnerable to stressors including diversions, dams, pollution, and changes in temperature and habitat expected from climate change. Simply relying on protection of land areas has been ineffective, and immediate action directed specifically at fresh waters is necessary to prevent extinction and further degradation.

- Protected areas and freshwater biodiversity: A novel systematic review distills eight lessons for effective conservation
  M. Acreman, et al. (2020) *Conservation Letters*. 13: e12684.

  A systematic review of 75 case studies regarding the effectiveness of terrestrial protected areas in conserving or restoring freshwater biodiversity found that the absence of measures to specifically address freshwater biodiversity stressors, such as dams, abstractions, habitat degradation, and invasive species was associated with lack of effectiveness. Among the tools for enhancing the effectiveness of protected areas include expanding protected areas to ensure connectivity, including measures

specifically targeted at freshwater biodiversity protection in areas designed to protect terrestrial ecosystems, and protecting hydrological regimes, water quality, and riparian vegetation.

- Ecosystem services of wetlands
  W. Mitsch, et al. (2015) *International Journal of Biodiversity Science, Ecosystem Services & Management* 11: 1-4.

  Wetlands are recognized as among the most valuable ecosystems on the planet. They stabilize water supplies, mitigating floods and droughts. Wetlands support an extensive foodchain and rich biodiversity, and play a major role in the landscape by providing unique habitats for a wide variety of flora and fauna. Likewise, they are some of the most important carbon sinks and climate stabilizers on a global scale.

Ocean

- Designing marine reserve networks for both conservation and fisheries management.
  Gaines, S.D., White, C., Carr, M.H., and Palumbi, S.R. (2010) Proc. Natl. Acad. Sci. 107, 18286–18293.

  This study assessed the size, spacing, location, and configuration guidelines for designing networks of marine reserves that simultaneously enhance biological conservation and reduce fishery costs, or even increase fishery yields and profits. In some settings, a well-designed MPA network is critical to the optimal harvest strategy. When reserves benefit fisheries, the optimal area in reserves is moderately large (mode ≈30%).

- Effective Coverage Targets for Ocean Protection: Effective Targets for Ocean Protection
  B. C. O'Leary, et al. (2016) *Conservation Letters* 9: 398-404.

  This meta analysis finds that existing scientific literature strongly supports placing at least 30% of the ocean in highly protected MPAs. Highly protected MPAs provide more benefits per area covered than partially protected MPAs, including greater benefits for habitats and species of conservation concern. MPAs must also be designated in areas with high biodiversity value and have effective management and enforcement.

- Area requirements to safeguard Earth's marine species.
  Jones, K. R., Klein, C., Grantham, H. S., Possingham, H. P., Halpern, B. S., Burgess, N. D., . . . Watson, J. E. M. (2019). *bioRxiv*, 808790.

  This analysis shows 26-41% of the ocean (depending on targets used for species representation) needs to be effectively conserved through a combination of site-based actions and wider policy responses to achieve global conservation and sustainable development agendas.

- Climate change mitigation and nature conservation both require higher protected area targets.

Roberts, C. M., O'Leary, B. C., and Hawkins, J. P. (2020). Philos. Trans. R. Soc. B Biol. Sci. 375, 20190121.

Nations of the world have, to date, pursued nature protection and climate change mitigation and adaptation policies separately. Both efforts have failed to achieve the scale of action needed to halt biodiversity loss or mitigate climate change. This article argues that success can be achieved by aligning targets for biodiversity protection with the habitat protection and restoration necessary to bring down greenhouse gas concentrations and promote natural and societal adaptation to climate change. Higher targets, like the new target of protecting 30% of the sea by 2030, would make the transition to a warmer world slower and less damaging for nature and people.

The Science Underpinning the Value of MPAs

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

  This global synthesis of research into no-take marine reserves shows, on average, positive effects of reserve protection on the biomass, numerical density, species richness, and size of organisms within reserve boundaries. Reserve characteristics and context, particular the intensity of fishing outside the reserve and inside the reserve before implementation, play key roles in determining the direction and magnitude of the reserve response and protection.

- Marine Protected Areas provide more cultural ecosystem services than other adjacent coastal areas
  Erskine, E., Baillie, R., and Lusseau, D. (2021) First published: August 20, 2021 DOI:https://doi.org/10.1016/j.oneear.2021.07.014

  This study of MPAs worldwide found that people preferentially visit MPAs over other adjacent areas to experience nature and wildlife, and that MPAs are associated with positive cultural ecosystem services like mental and physical health, sense of place, and identity formation.

- Marine reserves have rapid and lasting effects
  Halpern, B. S. and Warner, R. R. (2002) Ecology Letters, 5: 361–366. doi: 10.1046/j.1461-0248.2002.00326.x

  The higher average values of density, biomass, average organism size, and diversity inside reserves (relative to controls) reach mean levels within a short (1–3 y) period of time and that the values are subsequently consistent across reserves of all ages (up to 40 y). Therefore, biological responses inside marine reserves appear to develop quickly and last through time.

- Marine reserve effects on fishery profit
  White C, Kendall, B. E., Gaines, S., Siegel, D. A. and Costello C (2008) Ecology Letters 11(4): 370-379 doi: 10.11111/j.1461-0248.2007.01151.x

  The results of this study indicate that reserves can benefit fisheries, even those targeting species that are expensive to harvest. Furthermore, reserve area and harvest intensity can be traded off with little impact on profits, allowing for management flexibility while still providing higher profit than attainable under conventional management.

- Evidence that spillover from Marine Protected Areas benefits the spiny lobster (Panulirus interruptus) fishery in southern California
  H. S. Lenihan, et al. (2021) *Scientific Reports* 11, 2663.

  This assessment of Southern California MPAs found a greater build-up of lobsters within MPAs relative to unprotected areas, and greater increase in total lobster catch in fishing zones containing MPAs vs. those without MPAs. The results show that a 35% reduction in fishing area resulting from MPA designation was compensated for by a 225% increase in total catch after 6 years, thus indicating at a local scale that the trade-off of fishing ground for no-fishing zones benefitted the fishery.

- No-Take Marine Reserves Are the Most Effective Protected Areas in the Ocean
  E. Sala and S. Giakoumi (2018) *ICES Journal of Marine Science* 75: 1166-1168.

  This study illuminates evidence that no-take marine reserves are the most effective type of MPA. Fish biomass in no-take MPAs is 670% higher than in unprotected areas and 343% higher than in partially-protected MPAs. No-take MPAs help restore the entire ecosystem through a chain of positive effects resulting from animal recovery. Effective MPAs also create benefits outside of their boundaries and provide ecotourism, job, and fisheries benefits.

- Evaluating the social and ecological effectiveness of partially protected marine areas
  Turnbull, J.W., Johnston, E.L., and Clark, G.F. (2021) Conservation Biology. First published: 14 January 2021 https://doi.org/10.1111/cobi.13677

  This study assessed the social perceptions and ecological effectiveness of partially and fully protected areas compared with open areas along the coast of southern Australia. It found that partially protected areas had no more fish, invertebrates, or algae than open areas; were poorly understood by coastal users; were not more attractive than open areas; and were not perceived to have better marine life than open areas. Fully protected areas were not only more effective ecologically, but were perceived more positively by local communities and visitors and assigned a higher value by local communities and visitors.

- Recovery trajectories of kelp forest animals are rapid yet spatially variable across a network of temperate marine protected areas
  Caselle, J. E., Rassweiler, A., Hamilton, S.L. & Warner R.R. (2015) Scientific Reports 5, Article number: 14102

This study found that the biomass of targeted (i.e. fished) species has increased consistently inside a network of MPAs in the northern Channel Islands, California, with an effect of geography on the strength of the response. More interesting, biomass of targeted fish species also increased outside MPAs, although only 27% as rapidly as in the protected areas, indicating that redistribution of fishing effort has not severely affected unprotected populations.

- The central importance of ecological spatial connectivity to effective coastal marine protected areas and to meeting the challenges of climate change in the marine environment
  Carr, M. et al. (2017) Aquatic Conserv: Mar Freshw Ecosyst. 27(S1):6–29.

  Connectivity-informed MPAs and MPA networks – designed and managed to foster the ecological spatial connectivity processes important to local populations, species, communities, and ecosystems – can best address ecological changes induced by climate change. Also, the protections afforded by MPAs from direct, local human impacts may ameliorate climate change impacts in coastal ecosystems inside MPAs and, indirectly, in ecosystems outside MPAs.

- Protecting the global ocean for biodiversity, food and climate
  Sala, E., Mayorga, J., Bradley, D. et al. Protecting the global ocean for biodiversity, food and climate. Nature 592, 397–402 (2021). doi./10.1038/s41586-021-03371-z

  This study developed a conservation planning framework to prioritize highly protected MPAs in places that would result in multiple benefits today and in the future. The authors find that a substantial increase in ocean protection could have triple benefits, by protecting biodiversity, boosting the yield of fisheries and securing marine carbon stocks that are at risk from human activities.