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Incentivizing More Effective Marine Protected Areas with the Global Ocean Refuge System (GLORES)

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Healthy oceans are essential to human survival and prosperity, yet oceans are severely impacted worldwide by anthropogenic threats including overfishing, climate change, industrialization, pollution, and habitat destruction. Marine protected areas (MPAs) have been implemented around the world and are effective conservation tools that can mitigate some of these threats and build resilience when designed and managed well. However, despite a rich scientific literature on MPA effectiveness, science is not the main driver behind the design and implementation of many MPAs, leading to variable MPA effectiveness and bias in global MPA representativity. As a result, the marine conservation community focuses on promoting the creation of more MPAs as well as more effective ones, however no structure to improve or accelerate effective MPA implementation currently exists. To safeguard marine ecosystems on a global scale and better monitor progress toward ecosystem protection, robust science-based criteria are needed for evaluating MPAs and synthesizing the extensive and interdisciplinary science on MPA effectiveness. This paper presents a strategic initiative led by Marine Conservation Institute called the Global Ocean Refuge System (GLORES). GLORES aims to set standards to improve the quality of MPAs and catalyze strong protection for at least 30% of the ocean by 2030. Such substantial increase in marine protection is needed to maintain the resilience of marine ecosystems and restore their benefits to people. GLORES provides a comprehensive strategy that employs the rich body of MPA science to scale up existing marine conservation efforts.

Keywords: marine protected areas, marine reserves, conservation targets, biodiversity, ecosystem-based management

PROBLEM: HUMAN ACTIVITIES THREATEN MARINE BIODIVERSITY

Life on Earth came from the oceans and our lives and our future are inexorably linked to them. Oceans include about 97% of Earth's water, offer 99% of the living space on our planet, and provide more than half the oxygen we breathe. With about 40% of the global population living within 100 km of the coast (UNEP, 2008), oceans play a major role in the global economy and support the livelihoods of billions of people around the world. Coastal and marine ecosystems also play important roles by buffering anthropogenic climate change through carbon sequestration

and coastal zone protection, and filtering water via estuaries. Moreover, the exquisite and diverse wildlife in the oceans has inspired us throughout human history.

The increasing impacts of a growing global population are degrading the oceans at a rapid pace (Halpern et al., 2008). The cumulative impacts of climate change, overexploitation of marine life, and habitat degradation are threatening marine ecosystems and populations, as well as the human economies that rely on them (Worm et al., 2006; Kildow and McIlgorm, 2010). In an attempt to better protect oceans, marine scientists, conservation groups, governments, and the United Nations have called for ecosystem-based protections for marine wildlife (UNEP, 2006).

TOO LITTLE OF THE OCEAN IS STRONGLY PROTECTED

Intact ecosystems are more resilient to natural and anthropogenic disturbances (Halpern and Warner, 2003; Hughes, 2003). In this context, ecosystem level protections in the form of marine protected areas (MPAs) may be the most effective strategy to minimize the risk of population collapse, community disruption, and biodiversity loss (Micheli et al., 2012; Mellin et al., 2016). The scientific evidence for MPA effectiveness is robust and growing. MPAs were shown to be effective when they are well-designed (e.g., large enough, encompassing whole habitats surrounded by natural buffers, part of an MPA network that sustains metapopulations), well-managed, and strictly regulated (Claudet et al., 2008; Lester and Halpern, 2008; Gaines et al., 2010; Fox et al., 2012; Edgar et al., 2014; Gill et al., 2017).

Despite the efficacy and efficiency of MPAs, ocean ecosystem protections are not keeping pace with ocean degradation and the loss of marine biodiversity (Lubchenco and Grorud-Colvert, 2015; O'Leary et al., 2016). Although, interest in establishing MPAs has grown in past decades, driven in part by the Convention on Biological Diversity's Aichi Target 11 and UN Sustainable Development Goal 14, the global ocean remains minimally protected (Wells et al., 2016b). As of September 2016, there were ~10,000 MPAs in the world, totaling roughly 2.6% of the ocean (**Figure 1**, MPAtlas.org), and this total is expected to be close to 6% in the coming year once commitments such as the Ross Sea Marine Protected Area are fully in place. Although, the total continues to increase as governments commit to protecting more areas, these efforts need to scale up dramatically to reach international conservation targets, and no structure currently exists to coordinate and accelerate these MPA implementation efforts around the world. Additionally, most existing MPAs offer little protection for marine life because they often do not strictly regulate high impact activities, are not properly managed or enforced, or are located in areas with low biological value (Devillers et al., 2014; Edgar et al., 2014; Lubchenco and Grorud-Colvert, 2015; Worm, 2017). These so-called "paper parks" do little to safeguard marine biodiversity and the myriad of ecosystem services humans derive from intact ecosystems. Strongly protected areas large enough to adequately protect ecosystems and placed in important locations are needed to more effectively conserve marine biodiversity.
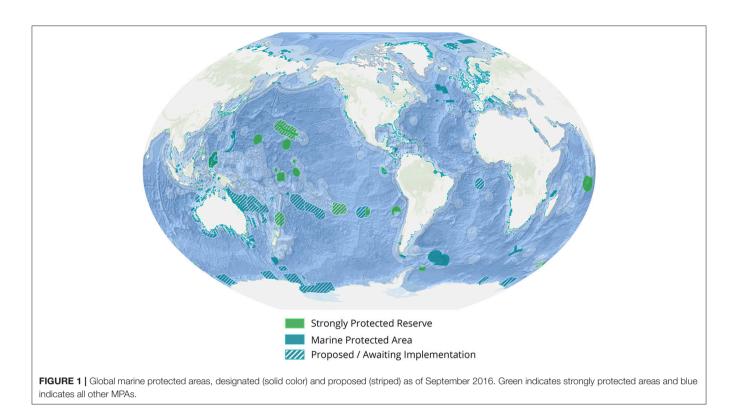
SOLUTION: INCENTIVIZE SCIENCE-BASED MARINE PROTECTED AREAS

Governments and non-governmental organizations (NGOs) are ramping up efforts to implement MPAs in light of the threats to marine biodiversity. The International Union for Conservation of Nature World Conservation Congress recently passed Resolution WCC-2016-Res-050, calling on nations to protect at least 30% of the ocean in strict MPAs, to protect marine biodiversity and ecosystem services (IUCN, 2016). It is an ambitious goal, but it is one that reflects the growing scientific literature that meaningful protection of at least 30% of the most important places in our oceans is needed to safeguard marine ecosystems (O'Leary et al., 2016) and sustain fisheries (Gaines et al., 2010). In light of a rapid erosion of marine life, efforts to implement new MPAs need to be accelerated in order to achieve this goal. New MPAs need to be better informed by science to be more effective and ensure that the ecological benefits of MPAs are being realized.

The Global Ocean Refuge System (GLORES) is an initiative of Marine Conservation Institute designed to incentivize the implementation of stronger MPAs by awarding MPAs that meet or exceed science-based standards. By developing science-based MPA standards and using them as the basis for these prestigious awards, GLORES aims to improve both the quality and the quantity of MPAs around the world. MPAs awarded Global Ocean Refuge status will form a strategic network of effective MPAs. By establishing clear science-based criteria, GLORES will play a key role in safeguarding the world's diversity of marine life.

Marine conservation and MPA science have become rich interdisciplinary fields in the past two decades. In addition to documenting the effects of single MPAs and MPA networks, scientists have analyzed data from MPAs around the world to identify the design, regulation, and management attributes that lead to effective MPAs (Lester and Halpern, 2008; Gaines et al., 2010; Edgar et al., 2014; Gill et al., 2017). To make this growing wealth of information meaningful for on-the-ground marine conservation, GLORES aims to bridge MPA science and MPA implementation. GLORES award criteria are being developed from the scientific literature and vetted by international academic, government, and NGO scientists. Marine Conservation Institute has hosted four focused workshops over the past 3 years to ensure that these criteria reflect the most up-to-date MPA science and rely on information that is typically available for MPAs. GLORES award criteria will be continually reviewed and updated as research reveals new insights regarding MPA efficacy, so that GLORES awards advance strong protections for marine ecosystems and marine wildlife.

One lesson from MPA science that informs GLORES criteria is that the conservation value of a MPA depends, in part, on its spatial relationship to other MPAs (McLeod et al., 2009; Gaines et al., 2010). GLORES evaluation criteria incorporate a geographic framework with an assessment of ecosystem representation and population connectivity to effectively protect marine biodiversity and promote ecosystem resilience, with

FIGURE 1 | Global marine protected areas, designated (solid color) and proposed (striped) as of September 2016. Green indicates strongly protected areas and blue indicates all other MPAs.
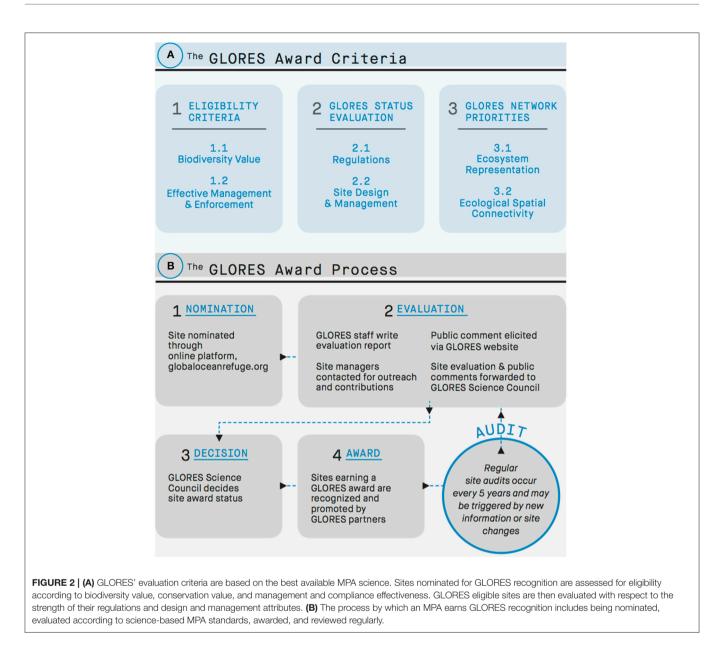
a goal of 30% protection for each ecosystem within each biogeographic region. A new three-dimensional visualization tool of ecological marine units (Sayre et al., 2017) provides a framework for gap analyses on a global scale. Using gap analyses for ecosystems, endangered species, and biological connectivity in each region, the GLORES initiative will identify priority conservation targets that will be used to galvanize support and funding leverage for new MPAs that will contribute most significantly to the conservation of marine biodiversity.

There are three parts to the GLORES science-based evaluation (**Figure 2A**). First, to qualify as a Global Ocean Refuge, candidate sites must meet GLORES standards for: (1.1) biodiversity value and (1.2) effective management and compliance. These criteria will set the standard for implementing MPAs in places that matter for conserving biodiversity with effective management plans and resources. Meeting these standards qualifies a site for a GLORES award, but does not guarantee it. Sites determined to be eligible will be subsequently evaluated according to (2.1) the strength of the site's regulations, and (2.2) design and management characteristics. Third, sites that contribute to the (3.1) ecosystem representation or (3.2) ecological spatial connectivity of the existing GLORES network will be prioritized for GLORES awards. Depending on the outcome of the three-part evaluation and the expert opinion of the GLORES Science Council, sites will earn GLORES awards and join the GLORES network of effective MPAs.

Becoming a Global Ocean Refuge is a four-step process (**Figure 2B**). First, sites can be nominated to the Global Ocean Refuge System through an online nomination platform that solicits information and documentation needed to evaluate the site. GLORES staff members will then complete an evaluation

report for each nominated site after compiling, verifying, and reviewing site information. The evaluation report will include an assessment of the current status of the site in relation to GLORES criteria (**Figure 2A**) as well as recommendations to improve the efficacy of the site with respect to protecting marine biodiversity. Evaluations will then be published on the GLORES website (www.globaloceanrefuge.org), and interested parties may submit additional documentation or evidence to correct or refine the evaluation report. The evaluation report and all public comments will then be forwarded to the GLORES Science Council, a group of MPA and marine science experts that will make the decision regarding the GLORES award status of each site, based on the GLORES criteria and the best available information about the site. Sites that earn a GLORES award will be recognized at a GLORES award event and promoted by GLORES Alliance partners. All GLORES sites are subject to a review audit every 5 years. An out-of-cycle audit can be triggered by significant changes to a site that could reduce or improve the status of the MPA.

Global Ocean Refuge awards are one means of providing incentives to governments to strongly protect 30% of the ocean by 2030. NGO-led frameworks such as the International Olympic Committee, United Nations Educational, Scientific and Cultural Organization World Heritage Sites, and Leadership in Energy and Environmental Design building certification show that individuals and governments can devote significant financial and human resources to gain prestige and economic benefits from having "the world's best." GLORES will incentivize countries and international governmental organizations to garner the prestige and economic benefits of earning Global Ocean Refuge status. Existing and new MPAs will be eligible to receive

FIGURE 2 | (A) GLORES' evaluation criteria are based on the best available MPA science. Sites nominated for GLORES recognition are assessed for eligibility according to biodiversity value, conservation value, and management and compliance effectiveness. GLORES eligible sites are then evaluated with respect to the strength of their regulations and design and management attributes. **(B)** The process by which an MPA earns GLORES recognition includes being nominated, evaluated according to science-based MPA standards, awarded, and reviewed regularly.

GLORES designation and accrue the benefits of being a Global Ocean Refuge: international prestige, funding leverage, and boosted tourism. GLORES' success, in terms of advancing marine conservation, will rely on rigorous science that sets high standards for effective MPAs.

GLORES aims to fill a significant gap within the world of marine conservation. There are many organizations working to implement single MPAs around the world; however, there is currently no structure to coordinate, support, or dramatically scale up these efforts. Furthermore, there is no comprehensive science-based incentive structure for increasing the quality of MPAs (though see Wells et al., 2016a). GLORES accomplishes both of these goals. GLORES will connect the scattered MPA implementation efforts around the world, and with GLORES recognition, governments, international organizations, and their local collaborators should find fundraising easier, encouraging them to scale-up effective MPA implementation.

GLORES' strategic science-based approach will leverage the work of marine scientists, conservation practitioners, and conservation NGOs around the world, making MPA science meaningful for on-the-ground conservation. GLORES has the capacity to improve the quality of MPAs around the world, provide strong incentives for accelerating MPA designations, build a broad coalition of marine conservation NGOs, and identify priority areas for conservation. With the support of key partners, GLORES aims to support the creation of a network of strongly protected marine areas that cover enough of every region in the ocean to provide safe havens for the full diversity of marine life for future generations.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and development of this work. SH drafted the manuscript, which was then reviewed and edited by all authors. All authors approve the submission of this manuscript.

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REFERENCES

Claudet, J., Osenberg, C. W., Benedetti-Cecchi, L., Domenici, P., García-Charton, J.-A., Pérez-Ruzafa, Á., et al. (2008). Marine reserves: size and age do matter. *Ecol. Lett.* 11, 481–489. doi: 10.1111/j.1461-0248.2008.01166.x

Devillers, R., Pressey, R. L., Grech, A., Kittinger, J. N., Edgar, G. J., Ward, T., et al. (2014). Reinventing residual reserves in the sea: are we favouring ease of establishment over need for protection? *Aquat. Conserv. Mar. Freshw. Ecosyst.* 25, 480–504. doi: 10.1002/aqc.2445

Edgar, G. J., Stuart-Smith, R. D., Willis, T. J., Kininmonth, S., Baker, S. C., Banks, S., et al. (2014). Global conservation outcomes depend on marine protected areas with five key features. *Nature* 506, 216–220. doi: 10.1038/nature13022

Fox, H. E., Mascia, M. B., Basurto, X., Costa, A., Glew, L., Heinemann, D., et al. (2012). Reexamining the science of marine protected areas: linking knowledge to action. *Conserv. Lett.* 5, 1–10. doi: 10.1111/j.1755-263X.2011.00207.x

Gaines, S. D., White, C., Carr, M. H., and Palumbi, S. R. (2010). Designing marine reserve networks for both conservation and fisheries management. *Proc. Natl. Acad. Sci. U.S.A.* 107, 18286–18293. doi: 10.1073/pnas.0906473107

Gill, D. A., Mascia, M. B., Ahmadia, G. N., Glew, L., Lester, S. E., Barnes, M., et al. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature* 543, 665–669. doi: 10.1038/nature21708

Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C., et al. (2008). A global map of human impact on marine ecosystems. *Science* 319, 948–952. doi: 10.1126/science.1149345

Halpern, B. S., and Warner, R. R. (2003). Matching marine reserve design to reserve objectives. *Proc. R. Soc. B* 270, 1871–1878. doi: 10.1098/rspb.2003.2405

Hughes, T. P. (2003). Climate change, human impacts, and the resilience of coral reefs. *Science* 301, 929–933. doi: 10.1126/science.1085046

IUCN (2016). *IUCN Resolutions, Recommendations and other Decisions*. Gland: IUCN.

Kildow, J. T., and McIlgorm, A. (2010). The importance of estimating the contribution of the oceans to national economies. *Mar. Policy* 34, 367–374. doi: 10.1016/j.marpol.2009.08.006

Lester, S. E., and Halpern, B. S. (2008). Biological responses in marine no-take reserves versus partially protected areas. *Mar. Ecol. Prog. Ser.* 367, 49–56. doi: 10.3354/meps07599

Lubchenco, J., and Grorud-Colvert, K. (2015). Making waves: the science and politics of ocean protection. *Science* 350, 382–383. doi: 10.1126/science.aad5443

McLeod, E., Salm, R., Green, A., and Almany, J. (2009). Designing marine protected area networks to address the impacts of climate change. *Front. Ecol. Environ.* 7, 362–370. doi: 10.1890/070211

Mellin, C., MacNeil, M. A., Cheal, A. J., Emslie, M. J., and Caley, M. J. (2016). Marine protected areas increase resilience among coral reef communities. *Ecol. Lett.* 19, 629–637. doi: 10.1111/ele.12598

Micheli, F., Saenz-Arroyo, A., Greenley, A., Vazquez, L., Montes, J. A. E., Rossetto, M., et al. (2012). Evidence that marine reserves enhance resilience to climatic impacts. *PLoS ONE* 7:e40832–e40838. doi: 10.1371/journal.pone.0040832

O'Leary, B. C., Winther-Janson, M., Bainbridge, J. M., Aitken, J., Hawkins, J. P., and Roberts, C. M. (2016). Effective coverage targets for ocean protection. *Conserv. Lett.* 9, 398–404. doi: 10.1111/conl.12247

Sayre, R. G., Wright, D. J., Breyer, S. P., Butler, K. A., Van Graafeiland, K., Costello, M. J., et al. (2017). A three-dimensional mapping of the ocean based on environmental data. *Oceanography* 30, 90–103, doi: 10.5670/oceanog.2017.116

UNEP (2006). *Marine and Coastal Ecosystems and Human Well-Being: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment*. Nairobi: United Nations Environment Programme.

UNEP (2008). *Percentage of Total Population Living in Coastal Areas*.

Wells, S., Addison, P. F. E., Bueno, P. A., Costantini, M., Fontaine, A., Germain, L., et al. (2016a). Using the IUCN green list of protected and conserved areas to promote conservation impact through marine protected areas. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 26, 24–44. doi: 10.1002/aqc.2679

Wells, S., Ray, G. C., Gjerde, K. M., White, A. T., Muthiga, N., Bezaury Creel, J. E., et al. (2016b). Building the future of MPAs - lessons from history. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 26, 101–125. doi: 10.1002/aqc.2680

Worm, B. (2017). Marine conservation: how to heal an ocean. *Nature* 312, 1806–1802. doi: 10.1038/nature21895

Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., et al. (2006). Impacts of biodiversity loss on ocean ecosystem services. *Science* 314, 787–790. doi: 10.1126/science.1132294