MPA Impacts Globally

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Introduction:

BOPP's core principles guiding the development of Bermuda's Marine Spatial Plan (MSP) include, among others, using the best-available science to inform proposed activities and developments in marine spaces, and managing the environment to conserve biodiversity and maintain ecosystem function.

These principles are supported by the goals and objectives of the MSP, and also provide transparency in the decision-making process by clearly demonstrating how the development and implementation of a zoned, managed, and well-enforced network of MPAs can protect Bermuda's marine environments, preserve its cultural heritage, and build resilience in the island's blue economies.

The following annotated bibliography is intended as a resource for decision-makers and ocean users, as well as members of the general public, who are interested in learning more about how MPAs have been developed and implemented in countries around the world.

The resources herein represent decades of accumulated knowledge about the lessons learned from the application of MPAs—partially protected, fully protected, and a mixture of both—for fisheries management, biodiversity conservation, species protection, and to protect cultural resources.

Significant endeavours have been undertaken to identify and incorporate literature that is either specific to Bermuda or locations similar to Bermuda (e.g., island, subtropical, and including seagrass and coral reef environments) so that: 1) parallels can be drawn between experiences, and/or 2) data can be used to clarify the decision-making process involved in the creation of Bermuda's MSP.

That said, this bibliography represents only part of the best-available science utilised in the development of Bermuda's MSP, as multiple other data sets—including feedback from the public Ocean Use Survey—have been incorporated.

Introduction:

For the purposes of this document, BOPP would like to draw particular attention to the ecological benefits that appear most frequently in the peer-reviewed literature, and which are most likely to manifest in Bermuda under a well-managed and well-enforced network of MPAs:

- Increased biomass of fish species, particularly among target fish species, within MPA boundaries, especially within designated no take zones.[1]

- Protection of ecologically valuable nursery habitats (e.g., mangrove stands and seagrass beds), for commercially and recreationally fished species, as well as legally protected species. Priority protection of these areas supports the export of adult fishes to offshore populations, which directly benefits local fisheries, and is critical in an ecosystems based management approach that protects vital ecosystem services.

- Preservation of the migration corridors and spawning areas for highly mobile and highly migratory pelagic fish species.[3] This ensures habitat connectivity throughout the lifespan of individual organisms, as well as genetic connectivity for species whose populations may require additional protection for replenishment or to prevent future losses.[2]

- Maintenance of marine habitat biodiversity and ecological function, with priority given to plans that protect both underwater cultural heritage and 20% of each marine habitat type, as well as help restore degraded marine habitats.

- Resilience of Bermuda's marine habitats to global climate change, protecting valuable marine economic resources for future generations.

References:

1. Turnbull, et al (2021), Cooney, et al (2019), McClure, et al (2020), Rojo, et al (2021)
2. Kopp, D., Bouchon-Navaro, Y., Louis, M., Mouillot, D. & Bouchon, C. (2010) Juvenile Fish Assemblages in Caribbean Seagrass Beds: Does Nearby Habitat Matter? *Journal of Coastal Research*, 26(6),1133-1141.

3 Boerder, et al (2019); Gilman et al (2019)

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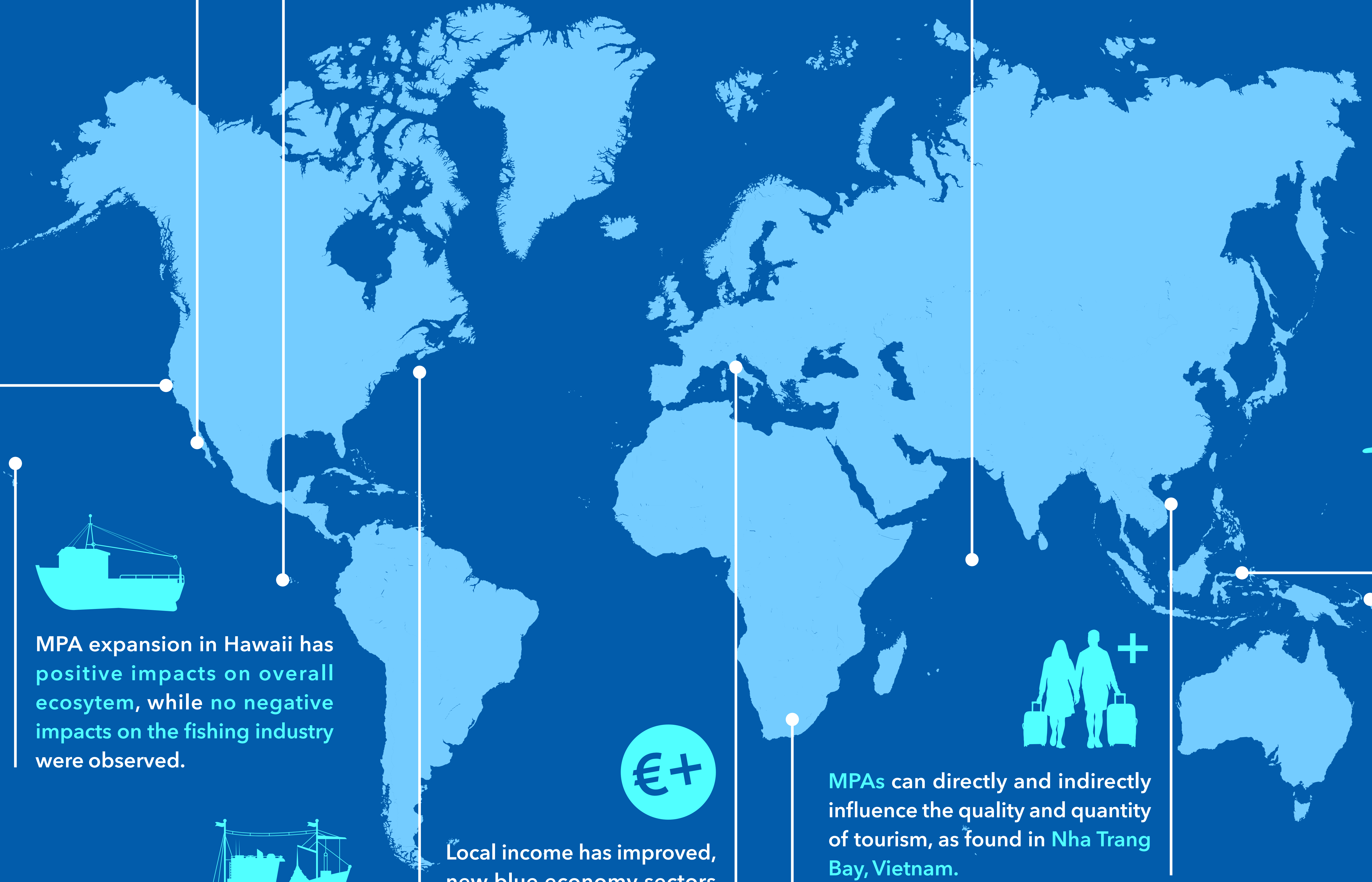
A four year closure of Mexico's EEZ increased the abundance of Striped Marlin.

The Galapagos Marine Reserve, which protects tuna spawning and breeding grounds, has had a positive impact on the industrial tuna purse-seine fishery.

The British Indian Ocean Territory MPA offers protection to a variety of species with a range of ecologies.

On average, fish biomass in no-take MPAs is significantly higher than in unprotected areas

MPAs created near the Channel Islands, California, led to an increase in the total catch of spiny lobster, despite a reduction in the total fishing area.



50%
(7,500,000)
of all yearly dives take place within MPAs such as Wakatobi, Indonesia.

Key Findings:

MPAs can benefit fisheries and tourism, preserve culture, history, and heritage, and are used for education and research.

People have a willingness to pay for environmental restoration, even if the habitat in question is remote and has little or no commercial value.

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

MPA expansion in Hawaii has positive impacts on overall ecosytem, while no negative impacts on the fishing industry were observed.

Fisheries found no decline in catch or any additional travel time following the closure of the Northeast Canyons and Seamounts Marine National Monument in New England, USA.

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Local income has improved, new blue economy sectors and jobs were created, and scientific research and tourist visits in off-peak seasons increased after creating MPAs in France, Spain, Sweden and Italy.

MPAs can directly and indirectly influence the quality and quantity of tourism, as found in Nha Trang Bay, Vietnam.

The adjacent Roman Seabream fishery benefitted from establishment of the Goukamma Marine Protected Area.

Periodic closure areas such as those established in the Indo-Pacific have above average biomass and fish size.

In Fiji, species closures led to large increases in clam numbers inside closed areas and in nearby fishing areas.

General Information:

- Marine reserves have rapid and lasting effects.
- Periodic closure areas have above average biomass and fish size.
- No-take MPAs have positive effects on the biomass, numerical density, species richness, and size of organisms within reserve boundaries.
- MPAs are defensible instruments for pelagic conservation.
- No-take marine reserves are the most effective type of MPA.

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2000 — 2020

2002

Finding:
Marine reserves have rapid and lasting effects.

Evidence:
Biological responses (Higher average values of density, biomass, average organism size, and diversity) inside marine reserves appear to develop quickly and last through time.

Source:
Halpern, B. S., & Warner, R. R. (2002). Marine reserves have rapid and lasting effects. Ecology letters, 5(3), 361-366.

2006

Finding:
Above average biomass and fish size were documented inside periodic closure areas. Both long-lived and short-lived species benefited from periodic closures.

Evidence:
Biomass and the average size of fishes commonly caught in Indo-Pacific subsistence fisheries were greater inside areas subject to periodic closures compared to sites with year round open access.

Source:
Cinner, J., Marnane, M. J., McClanahan, T. R., & Almany, G. R. (2006). Periodic Closures as Adaptive Coral Reef Management in the Indo-Pacific. Ecology and Society, 11(1).

2009

Finding:
Positive effects on the biomass, numerical density, species richness, and size of organisms were observed within reserve boundaries. Even small reserves can produce positive effects, and positive effects are far more common than no difference or negative effects. Reserves in temperate environments have as large or larger than documented positive effects as tropical reserves.

Evidence:
Global synthesis of research into no-take marine reserves showing an average positive impact on the ecosystem.

Source:
Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J and others (2009) Biological effects within no-take marine reserves: a global synthesis. Mar Ecol Prog Ser 384:33-46.

2009

Finding:
MPAs are defensible instruments for pelagic conservation.

Evidence:
Recent advances across conservation, oceanography, and fisheries science provide the evidence, tools, and information to address critics on the ecological, logistical, and economic feasibility of place-based management.

Source:
Game, E. T., Grantham, H. S., Hobday, A. J., Pressey, R. L., Lombard, A. T., Beckley, L. E., ... & Richardson, A. J. (2009). Pelagic protected areas: the missing dimension in ocean conservation. Trends in ecology & evolution, 24(7), 360-369.

2018

Finding:
No-take marine reserves are the most effective type of MPA.

Evidence:
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.

Source:
Sala, E., & Giakoumi, S. (2018). No-take marine reserves are the most effective protected areas in the ocean. ICES Journal of Marine Science, 75(3), 1166-1168.

Key Learnings for Tourism:

- MPAs can yield significant increases in biological productivity.
- In the context of diving, the total value of a reserve may become greater than pre-reserve value within five years of protection and may increase further as biomass and diversity increase.
- MPAs can directly and indirectly influence the quality and quantity of tourism by increasing visitor numbers, length of stays, business opportunities, and revenue, creating eco-tourism sectors, and extending peak tourist seasons.

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Key Learnings for Tourism:

- MPA designation and implementation can improve local income, create previously non-existent blue economy sectors and jobs, and increase scientific research and tourist visits in off-peak seasons.
- Tourism benefits households both directly and indirectly involved in the tourism sector through production and income linkages. Tourism operators hire local people and buy local goods; households spend wages or businesses spend profits earned through the tourism sector.
- MPAs are preferred destinations providing more cultural ecosystem services than other adjacent coastal areas.

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2000 — 2022

2003

Finding:
Small community-based protected areas can yield significant increases in biological productivity, and associated biodiversity also seems to increase in undisturbed (protected) areas.

Additional Benefits:
Socioeconomic benefits from locally managed marine areas in the Pacific region have been observed: one area reported a significant increase in household income and catch rates, with others noting the mutual benefits of the tourism industry being closely involved in these community-based conservation efforts.

Source:
Aalbersberg, W.G.L. (2003). The role of locally managed marine areas (LMMAs) in the development of eco-tourism in Fiji. Institute of Applied Science, Faculty of Islands and Oceans, University of the South Pacific, Suva, Fiji.

2013

Finding:
In the context of diving, the total value of a reserve may become greater than the pre-reserve value, with economic benefits offsetting costs within five years of MPA establishment.

Evidence:
In the wider Caribbean and Pacific coast of Central America, 50% of all dives take place within MPAs, even though only 4% of Caribbean coral reefs are in MPAs rated as "good" or "partially effective." There is a clear preference for diving in MPAs because of the expectation of encountering more abundant marine life within their boundaries.

Source:
Sala E, Costello C, Dougherty D, Heal G, Kelleher K, Murray JH, et al. (2013). A General Business Model for Marine Reserves. PLoS ONE 8(4): e58799.

2018

Finding:
MPAs can directly and indirectly influence the quality and quantity of tourism by increasing visitor numbers, length of stays, business opportunities, and revenue, creating eco-tourism sectors, and extending peak tourist seasons.

Additional Benefits:
MPAs can support other activities within the blue economy, including research, biotechnology, aquaculture, development of MPA-related technologies, ecological restoration and mitigation, and corporate social responsibility activities.

Source:
European Commission, Executive Agency for Small and Medium-sized Enterprises, Hattam, C., Russi, D., Haines, R. (2018). Study on the economic benefits of MPAs : final report, Publications Office.

2018

Finding:
MPA implementation improved local income, created previously non-existent blue economy sectors and jobs, and increased tourist visits in off-peak seasons.

Evidence:
Several MPAs around the world have been successfully implemented, positively impacting marine environments, tourism industries, fisheries, and livelihoods.

Source:
European Commission, Executive Agency for Small and Medium-sized Enterprises, Peri, I., Pantzar, M., Haines, R. (2018). Study on the economic benefits of marine protected areas : task 5 case studies : final report, Publications Office.

2021

Finding:
Tourism benefits households directly and indirectly involved in the tourism sector through production and income linkages. Tourism operators hire local people and buy local goods; households spend wages or businesses spend profits earned through the tourism sector.

Additional Benefits:
Recreation and tourism improvements caused by MPA implementation will spill over into other sectors, such as hotels, restaurants, real estate, and community infrastructure, providing a boost to all parts of local economies.

Source:
World Bank. (2021). Banking on Protected Areas: Promoting Sustainable Protected Area Tourism to Benefit Local Economies.

2021

Finding:
MPAs are preferred tourist destinations, providing more cultural ecosystem services than other adjacent non MPA coastal areas.

Evidence:
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.

Source:
Erskine, E., Baillie, R., & Lusseau, D. (2021). Marine Protected Areas provide more cultural ecosystem services than other adjacent coastal areas. One Earth, 4(8), 1175-1185.

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Key Learnings for Fisheries:

- Species closures led to large increases in clam numbers inside closed areas and in nearby fishing areas; catch per unit effort increased in the area adjacent to a closed area; certain species that had disappeared locally returned to the closed areas; and habitat health improved within the closed areas.
- Reserves can benefit fisheries, even those targeting species that are expensive to harvest.
- Catch and catch per unit effort are higher among the Hawaii longline fleet since the expansion of two of the world's largest MPAs.

Key Learnings for Fisheries:

- Establishment of the Galápagos Marine Reserve supported local industrial tuna fisheries, and free schools of tuna were more abundant along reserve boundaries.
- With specific regard to fisheries, the optimal area for reserve size is 30% protection. A network of smaller MPAs across all marine habitats will better meet fisheries and conservation goals.
- Reserves are more effective at sustaining fish stocks than rebuiling them after a collapse.

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2000 — 2018

2002

Finding:
Marine reserves are an effective fisheries management tool; however, they are most effective when used in conjunction with other measures, such as limits on fishing effort. Reserves are also more effective at sustaining stocks than rebuilding them after a collapse.

Evidence:
Synthesis of published evidence, coupled with case studies, shows that reserves are effective for a wide variety of species targeted by fishers, and that increases of 2-3x biomass are often achieved within a few years of reserve establishment. Many studies show local enhancement of fish catch close to reserve boundaries.

Source:
Gell, F. R., & Roberts, C. (2003). The fishery effects of marine reserves and fishery closures.

2008

Finding:
Reserves can benefit fisheries, even those targeting species that are expensive to harvest. 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:
Bioeconomic model using reserve-based management strategies and a range of profit levels for fished species.

Source:
White, C., Kendall, B. E., Gaines, S., Siegel, D. A., & Costello, C. (2008). Marine reserve effects on fishery profit. Ecology Letters, 11(4), 370-379.

2010

Finding:
With specific regard to fisheries, the optimal area for reserves is moderately large (~30%). A network of smaller MPAs across all major marine habitats will better meet fisheries and conservation goals than one large MPA because it provides additional resilience.

Evidence:
A comprehensive synthesis of over 100 conservation and bioeconomic studies resulted in a set of guidelines for the development of MPA network designs.

Source:
Gaines, S. D., White, C., Carr, M. H., & Palumbi, S. R. (2010). Designing marine reserve networks for both conservation and fisheries management. Proceedings of the National Academy of Sciences, 107(43), 18286-18293.

2013

Finding:
The establishment of the Goukamma Marine Protected area benefitted the adjacent roman (seabream) fishery.

Evidence:
Roman catch per unit effort (CPUE) in the vicinity of the new MPA immediately increased, contradicting trends across this species' distribution. The increase continued after five years, the time lag expected for larval export, effectively doubling the pre-MPA CPUE after 10 years.

Source:
Kerwath, S. E., Winker, H., Götz, A., & Attwood, C. G. (2013). Marine protected area improves yield without disadvantaging fishers. Nature communications, 4(1), 1-6.

2016

Finding:
MPAs can provide conservation benefits to fisheries via spillover; however, there is "ecological" spillover (export of fish biomass across MPA borders due to population recovery within the protected area) and "fishery" spillover (the passive export of larvae and eggs across MPA borders).

Evidence:
Literature review to better define the terminology and characterise the mechanisms necessary for spillover to occur, and what methods should be used to measure each type of spillover.

Source:
Di Lorenzo, M., Claudet, J., & Guidetti, P. (2016). Spillover from marine protected areas to adjacent fisheries has an ecological and a fishery component. Journal for Nature Conservation, 32, 62-66.

2017

Finding:
Establishment of the Galápagos Marine Reserve supports local industrial tuna fisheries, and free schools of tuna were more abundant along the reserve boundary, which meant that fishermen could reduce their reliance on FADs.

Evidence:
Using FAD, AIS, and IATTC observer data, the study found higher catch, effort, and catch per unit effort in a hotspot along the reserve border since reserve implementation.

Source:
Boerder, K., Bryndum-Buchholz, A., & Worm, B. (2017). Interactions of tuna fisheries with the Galápagos marine reserve. Marine Ecology Progress Series, 585, 1-15.

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2018

2020

Finding:
Catch and catch per unit effort are higher among the Hawaii industrial longline fleet since the expansions of two of the world's largest MPAs.

Evidence:
The MPA expansions had little, if any, negative impacts on the fishing industry, corroborating models that predicted minimal impacts from closing large parts of the Pacific Ocean to fishing.

Source:
Lynham, J., Nikolaev, A., Raynor, J., Vilela, T., & Villaseñor-Derbez, J. C. (2020). Impact of two of the world's largest protected areas on longline fishery catch rates. Nature communications, 11(1), 1-9.

2020

Finding:
Higher fish abundance and biomass were found near the borders of fully protected areas, indicating the general occurrence of spillover. Spillover was observed more often in fully protected areas surrounded or next to a partially protected area.

Evidence:
Meta-analysis of existing data from 23 fully protected MPAs in 12 countries, combined with a literature review and data gathered from underwater visual census samplings carried out in the field.

Source:
Di Lorenzo, M., Guidetti, P., Di Franco, A., Calò, A., & Claudet, J. (2020). Assessing spillover from marine protected areas and its drivers: A meta-analytical approach. Fish and Fisheries, 21(5), 906-915.

2021

Finding:
Greater build-up of lobsters and greater increases in total catch, but not catch per unit effort, in zones containing MPAs versus those without MPAs.

Evidence:
A 35% reduction in fishing area resulting from MPA designation was compensated for by a 225% increase in total catch after six years, indicating the trade-off for loss of fishing zones ultimately benefitted the fishery.

Source:
Lenihan, H. S., Gallagher, J. P., Peters, J. R., Stier, A. C., Hofmeister, J. K., & Reed, D. C. (2021). Evidence that spillover from Marine Protected Areas benefits the spiny lobster (Panulirus interruptus) fishery in southern California. Scientific Reports, 11(1), 1-9.

2022

Finding:
Closure of two commerially important fishing grounds off the east coast of the United States for a period of 16 months had little to no negative economic impact on any of the three fisheries.

Evidence:
Using a combination of catch reports, vessel tracks, and historical trends, the re-opening of the protected area did not result in an increase in catch, a reduction in distance traveled, or an increase in relative effort (impacts raised used to challenge MPA designations).

Source:
Lynham, J. (2022). Fishing activity before closure, during closure, and after reopening of the Northeast Canyons and Seamounts Marine National Monument. Scientific Reports, 12(1), 1-21.

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Key Learnings for Migratory Species:

- Temporary closures of Mexico's EEZ to long-lining from 1977–1980 and 1984–1985 had a rapid effect on local abundance of striped marlin.
- The Western Indian Ocean MPA had an important impact on skipjack tuna fishing mortality and succeeded in stabilising the spawning population.
- By preserving key habitat for juvenile yellowfin tuna, the Galápagos Marine Reserve protected the fish during a critical life stage and had a positive impact on the industrial tuna purse-seine fishery.

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Key Learnings for Migratory Species:

- MPAs can protect migratory species, particularly those with predictable behaviors that are protected within MPAs.
- The British Indian Ocean Territory MPA likely offers protection to a variety of pelagic and reef species with a range of spatial ecologies.
- Catch rates of tuna close to the reserve grew, alongside increased yellowfin and skipjack productivity in and around reserve areas in large-scale MPAs such as the Galápagos.
- Increased biomass and diversity of large pelagic fishes were found at various MPAs.

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2010

Finding:
Temporary closures of Mexico's EEZ to long-lining had a rapid effect on local abundance of striped marlin.

Evidence:
Commercial and recreational catch per unit effort time-series from recreational and commercial billfish fisheries in a stock reduction analysis model.

Source:
Jensen, O. P., Ortega-Garcia, S., Martell, S. J., Ahrens, R. N., Domeier, M. L., Walters, C. J., & Kitchell, J. F. (2010). Local management of a "highly migratory species": the effects of long-line closures and recreational catch-and-release for Baja California striped marlin fisheries. Progress in Oceanography, 86(1-2), 176-186.

2013

Finding:
The Western Indian Ocean MPA had an important impact on skipjack tuna fishing mortality and succeeded in stabilizing the spawning population.

Evidence:
Modeling experiments combining different trends in fishing effort, environmental variables, and technological development with population dynamics (early 1980s-2030).

Source:
Dueri, S., & Maury, O. (2013). Modelling the effect of marine protected areas on the population of skipjack tuna in the Indian Ocean. Aquatic Living Resources, 26(2), 171-178.

2017

Finding:
Marine reserves can act as an insurance policy against target-based management gone awry, and large marine reserves better act as a tool for the conservation of large pelagic fishes.

Evidence:
Simulations of individual processes (birth, death, movement) in a spatial model that combined population and evolutionary dynamics. This traced a single-gene variation among fish in their movement distances.

Source:
Mee, J. A., Otto, S. P., & Pauly, D. (2017). Evolution of movement rate increases the effectiveness of marine reserves for the conservation of pelagic fishes. Evolutionary Applications, 10(5), 444-461.

2018

Finding:
By preserving key habitat for juvenile yellowfin tuna, the Galapagos Marine Reserve protected the fish from harvest during a critical life stage. In this manner, the reserve has a positive impact on the yellowfin tuna fishing industry.

Evidence:
Analysis of a 20 year time-series of catch and effort data gathered by an observer program.

Source:
Bucaram, S. J., Hearn, A., Trujillo, A. M., Rentería, W., Bustamante, R. H., Morán, G., ... & García, J. L. (2018).

2022

2018

Finding:
Palmyra Atoll National Wildlife Refuge is an important refuge and long-term habitat for green turtles.

Evidence:
Residency patterns of turtles were investigated using satellite telemetry and flipper tagging studies conducted between 2008 and 2013 .

Source:
Naro-Maciel, E., Arengo, F., Galante, P., Vintinner, E., Holmes, K. E., Balazs, G., & Sterling, E. J. (2018). Marine protected areas and migratory species: residency of green turtles at Palmyra Atoll, Central Pacific. Endangered Species Research, 37, 165-182.

2019

Finding:
The British Indian Ocean Territory MPA likely offers protection to a variety of pelagic and reef species with a range of spatial ecologies.

Evidence:
147 satellite and acoustic tags on 7 pelagic and reef fish species, tracked over 3 years.

Source:
Carlisle, A. B., Tickler, D., Dale, J. J., Ferretti, F., Curnick, D. J., Chapple, T. K., ... & Block, B. A. (2019). Estimating space use of mobile fishes in a large marine protected area with methodological considerations in acoustic array design. Frontiers in Marine Science, 6, 256.

2019

Finding:
The Phoenix Islands Protected Area (PIPA) is a stable spawning area for skipjack, bigeye, and yellowfin tunas and is protecting viable tuna spawning habitat.

Evidence:
Tuna larvae collected in the field, combined with model simulations to estimate spawning locations.

Source:
Hernández, C. M., Witting, J., Willis, C., Thorrold, S. R., Llopiz, J. K., & Rotjan, R. D. (2019). Evidence and patterns of tuna spawning inside a large no-take Marine Protected Area. Scientific reports, 9(1), 1-11.

2019

Finding:
MPAs can protect highly migratory fish species, particularly those with predictable behaviors (e.g., migration routes, aggregating behavior, site fidelity). Spatial protection should be combined with other fisheries management measures.

Source:
Boerder, K., Schiller, L., & Worm, B. (2019). Not all who wander are lost: Improving spatial protection for large pelagic fishes. Marine Policy, 105, 80-90.