Key Findings from *Fisheries Research*: Marine Protected Areas as a Fisheries Management Tool

National Marine Protected Areas Center

The Nation's Hub for Building Innovative Partnerships and Tools to Protect Special Ocean Places

Background

Fishery managers are charged with managing fish stocks for optimum yield, ensuring that adequate spawning biomass is available for future recruitment success and minimizing the risk of overfishing, all while attempting to preserve jobs and recreational opportunities in the community. Marine protected areas (MPAs) have been increasingly proposed, evaluated and implemented as management tools for achieving both fisheries and conservation objectives in aquatic ecosystems. However, as the role MPAs in fisheries management has increased in importance, it has also been subject to increased scrutiny and debate.

For fishery decision-makers and managers, key questions include:

- What are some of the ecological responses observed inside MPAs?
- Can MPAs also provide fishery benefits to adjacent areas?
- Can arctic/temperate MPAs also provide perceived fishery benefits to adjacent areas even though these species tend to have lower site fidelity and greater movement compared to their tropical counterparts?

Photo Credit: Florida Keys National Marine Sanctuary

To address these questions, a special symposium was held at the American Fisheries Society Annual Meeting in Seattle in 2011. Twelve manuscripts and twenty-one abstracts were published in the peer-reviewed journal *Fisheries Research* (Brock, R.J., D. Hart and S. McDermott (eds.). 2013. Marine Protected Areas as a Fisheries Management Tool. Volume 144, 116pp. http://www.sciencedirect.com/science/journal/01657836/144).

Traditional fisheries management actions have primarily focused on input (e.g., restrictions on fishing effort) and output (e.g., limitations on the amount of fish available to be caught) controls. Area and seasonal closures have been the norm for decades. While MPAs have gained much acceptance globally as an effective marine conservation tool (e.g., protecting marine habitats and biodiversity), most MPAs allow some sort of extraction. The global rarity of no-take MPAs means that there is not always a great deal of scientific information available for different ecosystems and habitats where benefits to an adjacent fishery have been well documented. As such, uncertainty about the benefits of MPAs in fisheries management remains.

Can fishery benefits realized within MPAs be transferred to adjacent areas? This summary cites key findings from manuscripts and/or abstracts published in this special issue. Consult the journal at http://www.sciencedirect.com/science/journal/01657836/144) for specific details about manuscript, abstracts and authors. Key findings include but not limited to:

About U.S. MPAs

- The United States has over 1600 MPAs, most of which primarily focus on natural heritage (e.g., biodiversity) conservation (70%), with 24% focusing on sustainable fisheries {Wenzel et al.}.
- Over 92% of the MPAs in the United States are classified as multiple use, meaning some extractive activities are allowed {Wenzel et al.}.
- MPAs managed by the NOAA Fisheries Service account for 87% of the total MPA area in U.S. waters, of which < 1% of this total area is "no-take" {Wenzel et al.}.

General Observations on Implementing MPAs

- MPAs in the Bering Sea (AK) reduced red king crab bycatch but increased bycatch of halibut in adjacent waters from displaced fishermen, thus creating a situation where a closure intended to protect one vulnerable species (e.g., red king crab) may increase unintended fishing pressure on another (e.g., halibut) {Abbott and Haynie}.
- Monitoring annual length frequency inside and outside of no-take MPAs in the Channel Islands (CA) can provide useful information on the size and abundance of fishes under fished and relatively unfished conditions {Babcock}.


Photo Credit: NOAA Northeast Fisheries Science Center

- Synthesizing datasets from the Caribbean, Brazil, the Eastern Pacific and Fiji, researchers using models found that at sufficiently large scales, fish assemblage structure (piscivore and non-piscivore) across reef systems is more influenced by ecosystem processes than by management of fishing activities {Shank et al.}.
- Assessing NOAA's long-term visual census reef fish monitoring program from the past 30 years in the Florida Keys, researchers concluded that different factors drive patterns for different species. Loss of coral cover results in the decline of some habitat-dependent species while MPAs likely resulted in the slight recovery of heavily targeted fish species {Ruttenberg et al.}.

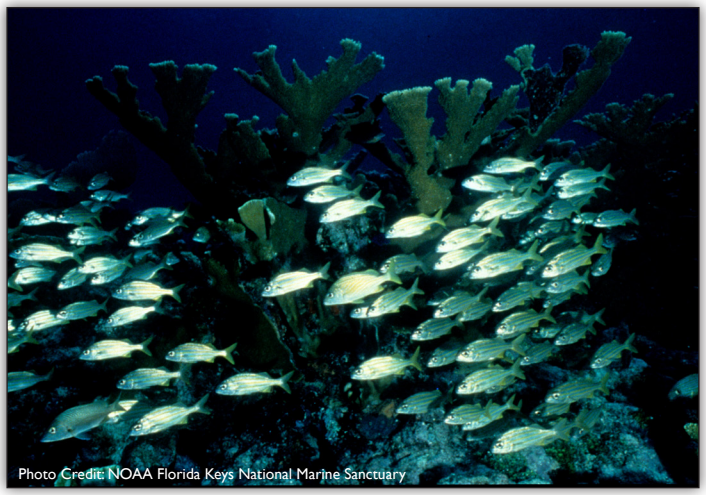


Photo Credit: NOAA Florida Keys National Marine Sanctuary

- Between 2004-2006, six hurricanes impacted the Tortugas region (FL), resulting in fishery and non-target species experiencing declines in density and abundance during this period, highlighting that environmental and climatic conditions can affect the effectiveness of MPAs {Ault et al.}.
- MPAs assisted in rebuilding the Georges Bank sea scallop fishery west of Cape Cod (MA) and the rotational reopening of these areas contributed to the high scallop landings during the past decade or more {Hart and Jacobson}.
- Although an estimated 20-fold increase in Georges Bank sea scallop biomass in the closed areas was observed between 1994 and 2004, there is no evidence that recruitment of sea scallops increased outside the closed areas during 1995-2006, indicating that environmental conditions rather than larval supply were likely the main driver of variability in recruitment in this area {Hart and Jacobson}.

Spillover of Adults

- Acoustic studies of Caribbean spiny lobster (*Panulirus argus)* indicate that nomadic movements (e.g., more than a day to complete and covering several kilometers) were observed during all seasons of the year in the Florida Keys, resulting in the replenishment of marine life to the surrounding areas, a stated management objective of the MPA {Bertelsen}.
- Acoustic telemetry tagging studies around Dry Tortugas National Park (FL) found that the principal fishery species occasionally moved between the no-take Research Natural Area and the adjacent open areas {Ault et al.}.
- Underwater visual surveys for a no-take MPA north of Oahu, Hawai'i found that fish abundance and biomass were correlated with distance from the MPA boundary, showing a decreasing gradient from inside to outside, indicating a spillover of adult fish {Tissot et al.}.

Export/Replenishment of Larvae

- Direct evidence from Hawai'i has shown successful larval dispersal from an MPA to an unprotected site {Christie et al}.
- Larval dispersal distances for the popular aquarium coral-reef fish yellow tang (*Zebrasoma flavescens*) in Hawai'i ranged from 15 to 184 km. All offspring settled at sites to the north of where they were spawned {Christie et al.}.
- The no-take Tortugas North Ecological Reserve and Research Natural Area of Dry Tortugas National Park (FL) are major source points of recruits to populations of principal reef fishery species in the Florida Keys {Ault et al.}.

Changes in Abundance, Biomass, Size, Age and/or Fecundity

- A 5-year study conducted in a 400 km^2 no-take MPA in South Africa revealed that relative abundance, mean length and catch-per-unit-effort for 4 slow-growing, high trophic level sparids were significantly greater in a no-take zone compared to adjacent exploited areas {Maggs et al.}.
- The Pupukea Marine Life Conservation District located on the north shore of Oahu, Hawai'i shows a strong effect of this no-take area, with significantly higher species richness, numerical density, and biomass (four-fold difference) compared to the adjacent open area {Stamoulis and Friedlander}.
- Georges Bank sea scallop biomass increased an estimated 20-fold in the closed areas between 1994 and 2004 {Hart and Jacobson}.
- Ninety percent of Caribbean spiny lobster in fished areas were younger than 1.9 years, compared to 50% in the adjacent no-take Western Sambo Ecological Reserve within the Florida Keys National Marine Sanctuary, resulting in increased egg production of female lobsters inside the no-take area {Maxwell et al.}.
- Male and female Caribbean spiny lobsters from the no-take Western Sambo Ecological Reserve within the Florida Keys National Marine Sanctuary were significantly larger than those from the fished areas of the Florida Keys {Maxwell et al.}.
- Recent studies have indicated that the viability of larvae for species such as Pacific rockfish (*Sebastes sp.*) and Atlantic cod (*Gadus morhua*) may depend upon spawner age, as older fish would be expected to contribute disproportionately to the viable offspring {Spencer et al.}.


Photo Credit: NOAA Alaska Fisheries Science Center

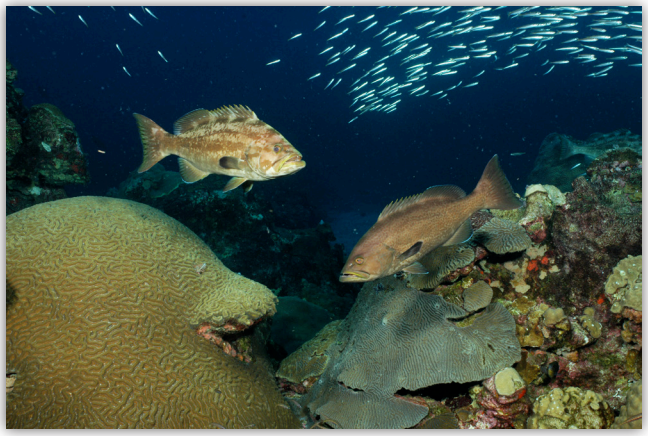
- Between 2003-2010, monitoring showed that areas outside the mostly non-extractive Virgin Islands Coral Reef National Monument (VICRNM) had significantly more scleractinian corals, greater habitat complexity, and greater species richness and abundance of reef fishes than areas within the VICRNM. The VICRNM boundaries were primarily defined based on the legal parameters of the Antiquities Act and not delineated by integrative ecological design {Monaco}.

Modeling MPA Response

- An age-based dynamic model developed for the common snook showed that MPA networks were more beneficial to the sustainability of the recreational snook fishery than fully fished scenarios, resulting in higher spawning potential ratio (60% vs. 25%) and stock abundance, indicating that certain recreational fisheries may benefit from designation of no-take areas in a network of spatially distinct but biologically connected coastal systems {Ley and Allen}.
- Stock assessment models that assess single stocks without accounting for no-take MPAs result in severe underestimation of biomass {McGilliard et al.}.
- Simulation modeling results show that undertaking separate stock assessments for fished and no-take MPAs leads to improved regional biomass estimates {McGilliard et al.}.
- Modeling studies along the California coast suggest that changes in biomass and yield in the long term are dependent upon the level of fishing outside MPAs, as well as larval dispersal distances and movement of juvenile and adult fish {Botsford et al.}.

MPAs, Socio-economics and Public Participation

- An MPA network established along the Kona-Kohala coast of the Island of Hawai'i led to increased profits to aquarium fishers as fishers adjusted to this spatial management by expanding their operating range {Tissot et al.}.
- Socio-economic studies have indicated that divers around the Kona-Kohala coast of the Island of Hawai'i felt that MPAs were more effective at enhancing fish populations than fisheries management (e.g., than changing fishing regulations or behavior) {Tissot et al.}.
- The public review process for establishing a no-fishing, no-anchor zone in Dry Tortugas National Park (FL) indicated a strong desire to develop quantitative targets for performance measures. This stakeholder-driven process has resulted in regular three- and five-year monitoring assessment reports developed and available to the public {Hallac et al.}.
- For complete papers containing these findings, see *Fisheries Research* (Brock, R.J., D. Hart and S. McDermott (eds.). 2013. Marine Protected Areas as a Fisheries Management Tool. Volume 144, 116pp. http://www.sciencedirect.com/science/journal/01657836/144).



The National Marine Protected Areas Center is located within NOAA's Office of National Marine Sanctuaries and works with the Department of the Interior to serve as a resource to all federal, state, territorial and tribal programs responsible for the health of the oceans.

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