MPA Science Brief: What Does the Science Say?

DO FISH SWIM OUT OF MARINE PROTECTED AREAS?

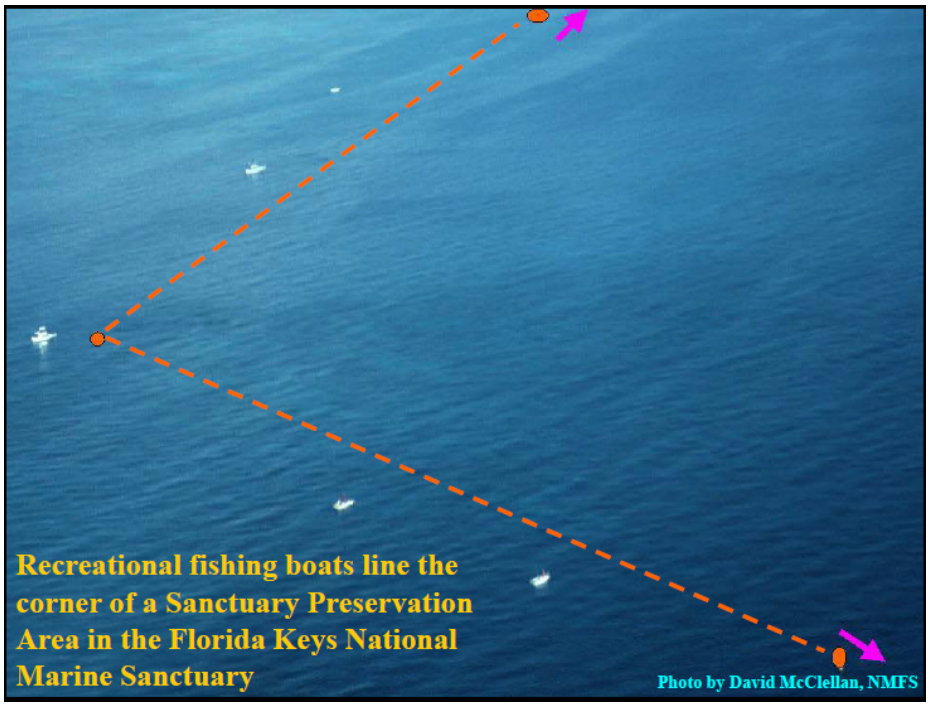
Benefits of "no-take" MPAs: What happens inside and outside these areas?

Over the past decade, many environmental groups, politicians, and scientists have called for large-scale implementation of marine protected areas (MPAs) in which fishing is restricted or prohibited altogether (e.g., "no-take" or fully protected MPAs). Globally, the abundance of fish has continued to decline despite using conventional fishery management tools like changes in gear used, use of short-term closures, and the reduction in fishing effort and catch of non-targeted species. It is thought that by removing fishing pressure completely from key areas, such as spawning or nursery habitats, targeted fish stocks will be able to rebound (NRC 2001). Monitoring results from 89 no-take MPAs around the world where fishing is prohibited has been assessed and it was found that, on average, fish density, biomass, size, and diversity all increased within no-take MPAs (Halpern 2003). However, fishermen often ask "what good is it if the abundance and size of fish increases inside a no-take MPA if these fish are off limits?" MPA proponents note that MPAs can create "win-win" situations where an increase in the number of fish inside a no-take MPA results in better fishing in areas adjacent to the no-take MPA, as fish are free to move back and forth across the boundary. But, how do we know if fish from inside any MPA really do swim out to adjacent areas?

How can fish movements be tracked?

Various methods are currently used to track the movements of fish. Small external tags are attached to fish so that they can be visually identified when they are caught by fishermen or seen during SCUBA or snorkeling surveys. Transmitters are placed on or surgically implanted in fish that put out an acoustic signal that can be detected by stationary receivers (e.g., hydrophones) or by someone actively following the fish either from a boat or by SCUBA diving. Large pelagic fish such as sharks, billfish (e.g., swordfish, marlin), and tunas are given individually identifiable electronic tags and tracked via satellite telemetry (Lowe and Bray 2006). Understanding where, when, and why fish move is important in choosing locations for MPAs to meet specific conservation goals such as protecting critical habitats and fish stocks from overfishing.

Do fish "spill over" into unprotected areas?



Recreational fishing boats line the corner of a Sanctuary Preservation Area in the Florida Keys National Marine Sanctuary

Photo by David McClellan, NMFS

Fish spillover is defined as the active movement of fish swimming out of MPAs into adjacent areas. There are many examples of fish that have been tracked moving out of MPAs and what happened in adjacent areas. In tropical coastal habitats in Cuba, the establishment of no-take MPAs resulted in twice as many fish swimming to neighboring areas as swam into the MPA (Amargós et al. 2010). This likely occurred because fish left the no-take MPA as it became too crowded and competition for food and shelter increased. In the Philippines, there was a 3 to 4.5-fold increase in fish biomass in no-take MPAs in the 18 years after they were established (Alcala 2005). In areas outside the no-take MPA, trap and gillnet catches increased by about 27% over this same time period, suggesting that spillover of fish out of the MPA was probably occurring. Elsewhere in the Philippines, the biomass of surgeonfish tripled inside a no-take MPA (Russ et al. 2003). Just outside the no-take MPA (within 200m), biomass of surgeonfish increased by a factor of 40. The number of fish caught (expressed

as # of fish per hour or day) was 45 times higher than before, clearly suggesting that the MPA was providing fish to adjacent areas. In colder waters, year-round and seasonal fishery closures in the Gulf of Maine resulted in average revenue per hour trawled about twice as high within 4 km of the closed area boundary than for catches further away (Murawski et al. 2000). This certainly suggests spillover of commercially valuable species such as cod, haddock, and flounder from the closed area to the adjacent fished area was occurring or fishing effort would not have concentrated near the boundary of the MPA. Recreational boats have been observed "fishing the line" just outside the no-take boundary areas within the Florida Keys National Marine Sanctuary (see photo on page 1). If fish were not swimming out of the reserve, why would the anglers be there?

How much time are fish spending inside or outside an MPA?

Whether fish movement is known due to tagging information reported by fishermen or by following the fish acoustically, a variety of studies have shown that fish do swim in and out of MPAs. If the goal of the MPA is to protect fish, it is important to know how much time fish spend inside versus outside the MPA. The degree of protection provided by no-take MPAs normally declines as fish mobility increases as fish are more vulnerable when they are outside the protection of the MPA. Some fish may be faithful to specific habitats (e.g., coral reefs, kelp forests, rocky outcrops) and do not venture very far away from these habitats. If the MPA was created to protect these habitats, they may be effective in protecting fish that are closely tied to these habitats as well. Acoustically tracked kelp bass in Southern California were found to remain inside the MPA most of the time, with only one individual spending about 5% of its time outside the MPA (Lowe et al. 2003). The protection offered from MPAs to such a species is great as they rarely venture outside the MPA. In this instance, perceived benefits to fishermen outside the MPA may be small because spillover is small.

The kelp bass (Paralabrax clathratus) is a popular sport fishing species. Photo credit: Steve Lonhart / SIMoN NOAA

Highly mobile fish that are not as closely tied to specific habitats routinely venture outside MPAs to feed or spawn. Acoustically tagged snappers and groupers in MPAs around the Dry Tortugas, Florida, made repeated migratory trips to adjacent unprotected areas of up to 50km in order to spawn (Feeley et al. 2010). These prized species are vulnerable to being caught by anglers along the way. Fish that spend time in MPAs at different times in their life cycle (e.g., juvenile stage or spawning adult) receive protection when they are most vulnerable. This can help prevent overfishing, thus maintaining populations. Even migratory fish can benefit from MPAs that safeguard habitat quality, improve feeding opportunities, offer better survival chances for the young, and protect areas where adults gather to spawn. Fishermen receive fishery benefits over the long term from these safeguards.

Summary

Do fish swim in and out of MPAs? As expected, the answer is yes. How do we know? A variety of tracking techniques (e.g., tags attached to fish, acoustic tags implanted in fish) allow us to follow the movements of fish. From this information, we can document where and when fish move in and out of MPAs, the amount of time spent inside versus outside an MPA, and assess how effective an MPA may be in protecting fish (if that is the objective of the MPA). Do adjacent areas benefit from spillover? For some species, spillover appears to play a role in increased fisheries yield in adjacent unprotected areas. A win-win situation for fishermen and conservationists can be realized when fish become so big and abundant inside an MPA that some move out of the MPA where they become available to recreational and commercial fishermen. When this happens, all may be pleased with the MPAs effectiveness. Improving sonar and acoustic technology that allows for the tracking of fish movements over wide distances will help us better design and site MPAs to enhance fisheries benefits both inside the MPA (e.g., increase in size and abundance) as well as fished areas outside the MPA (e.g., increase in yield).

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