Wideband acoustic methods for estimating spillover distance from MPAs: development of a reliable monitoring tool for quantification of biomassand size structure

Jonathan Belmaker 1,2, Ilia Ostrovsky3, Thomas Mehner4

¹School of Zoology, Tel Aviv University

² The Steinhardt Museum of Natural History, Tel Aviv University

3 Israel Oceanographic and Limnological Research, Kinneret Limnological Laboratory

4 Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) Berlin, Germany

Contact details: Jonathan Belmaker, jbelmaker@post.tau.ac.il Tel: 052-48264452

**Abstract**

Brief background: Marine Protected Areas (MPAs) reduce mortality due to habitat destruction and harvesting, with increased abundance, biomass and diversity often following protection. However, the relevance of these MPAs to larger-scale benefits such as increased fishing revenue, ecosystem health and ecological stability will critically depend on “spillover” distance: the distance over which gain in biomass associated with the MPA can be seem outside of it. Spillover is expected to have a discernable effect on the size structure of the community, with a faster decrease in the abundance of large and harvested species away from MPAs. Nevertheless, spillover distance is hard to estimate and is particularly lacking for MPAs in the eastern Mediterranean. Modern acoustic methods for surveying natural fish populations have important advantages over traditional catch-based methods and visual surveys as they cover the entire water column, are less size selective, and are non-lethal. However, the application of such methods to MPA management is scarce**.** Here, we propose to develop and adapt acoustic methods to estimate the biomass and size structure of fishes (as well as other nekton and plankton) at increasing distances from MPAs to estimate spillover distance, its seasonality and its relationship to bottom characteristic.This data is essential for understanding impacts of MPAs on surrounding habitats, prioritizing management scenarios and as a routine monitoring tool.

The knowledge gaps to be addressed: While the beneficial impact of MPAs to fish biomass and abundance is well established, the degree to which these extend outside of MPAs is less understood. Much of the difficulty in assessing spillover lays in the limitations of establishing an efficient and non-destructive methodology for quantifying abundance and size structure. Here, we will implement a novel broadband echo sounder to obtain first estimates of the distance over which MPAs in the eastern Mediterranean exert an ecological impact. This study will provide much-needed ecological information about MPA functioning and will be directly used to understand the degree to which MPAs impact their surroundings areas. In addition, this study will serve as a knowledge infrastructure and an important reference to understand future changes in the functioning of fish communities over the next decades.3

Applicability of the project to Israeli Mediterranean MPAs: Using novel acoustic methodology, we will estimate fish biomass and size structure at various distances from MPAs. The relatively fast data acquisition of hydro acoustic methods is efficient in time and costs compared to alternative survey methods. This information will be used to: (1) Quantify the degree to which already established MPAs augment fish biomass and modify their size structure. (2) Estimate the decline in fish biomass and change in size structure with increasing distances from MPA boundaries (spillover distance). (3) Provide important information on the state of soft bottom fish communities within proposed MPAs which are currently not quantitatively sampled. (4) Provide an efficient and, importantly, non-destructive sampling protocol to estimate fish biomass and size structure to be used as a major future monitoring tool