Marine Protected Areas Connectivity in the Israeli Mediterranean Waters -a biophysical modeling approach*Igal Berenshteina\* , Claire B. Parisa, Nir Sternb, Erick Fredjc, Eliyahu Bitonb*

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AbstractThe marine environment of the Israeli Mediterranean, which harbors a diverse wealth of marine
fauna, is a highly valuable asset from environmental, economic, and social aspects. Yet, this asset is under growing threat due to anthropogenic stress such as petroleum activities, desalination plants, commercial fishing, and invasive species from the Suez Canal. Networks of Marine Protected Areas (MPAs) are effective tools in protecting marine environments and conserving their biodiversity. Currently, less than 1% of the Israeli territorial waters are declared as MPAs, however six new MPAs, which will encompass more than 20% of the Israeli territorial waters, are planned. A central component in the effectiveness of MPAs is the degree to which the protected populations are connected, i.e. the exchange of individuals between populations via migration. For most benthic marine organisms, dispersal occurs during the larval phase, in which newly hatched larvae set out to the open sea for a few days to a few weeks, at the end of which they undergo metamorphosis, and settle to a suitable habitat. The larval stage is of great demographic and ecological importance governing population dynamics and gene flow. The purpose of the current project is perform a comprehensive connectivity analysis for the existing and the proposed Israeli MPAs. The commonly used approach for demographic connectivity analysis is biophysical modeling, which computes virtual larval dispersal trajectories combining currents data with biological species-specific traits. It has been repeatedly demonstrated that passive dispersal cannot realistically reconstruct larval connectivity patterns since marine larvae are often active organisms with substantial capacity to control their horizontal and/or vertical positions. For the current proposal, we adopt a 3-pronged approach focusing on: (1) Physical oceanography, which includes running a high-resolution Regional Ocean Modeling System (ROMS) producing 3D current fields for 4 years of data, which will be validated with in-situ observations and a High Frequency Radar system. (2) Biological component, which includes a sampling scheme of benthic habitats and ichthyoplankton, as well as an extensive literature review; this will provide the best available data regarding target key species in the MPAs, and their biologically relevant traits: e.g. Pelagic Larval Duration (PLD), spawning times and locations, and larval vertical migration. (3) Bio-physical simulations will combine the biological and the physical components, and produce 3D larval trajectories. These trajectories will be then used to analyze the connectivity patterns of the existing and proposed MPAs. Given the physical and biological variation in the system, a robust sensitivity analysis will be performed, covering the meaningful ranges of parameter values representing the range of realistic connectivity patterns. The end product will include a user-friendly interface, which will display output such as graph-theory dispersal pathways and a probability connectivity matrix between MPAs, given the chosen species and range of parameters.