Modeling hydrodynamic connectivity in the USVI and Eastern PR MPAs

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Introduction

The motivation of this study is to explore the main oceanographic pathways leading to the dispersal patterns of eggs and early larvae from marine protected areas (MPAs) in the US Virgin Islands and off the Eastern Puerto Rico shelf, and then quantify the hydrodynamic connectivity these MPAs for commercially important fish species such as the red hind (*Epinephelus guttatus*), yellowfin grouper (*Mycteroperca venenosa*), and mutton snapper (*Lutjanus analis*). A finite volume unstructured-grid 3D community ocean model (FVCOM) has been implemented in PRVI by CARICOOS and validated to be a reliable and indispensable 3D ocean modeling tool. A Lagrangian particle-tracking model (PTM) compatible to FVCOM was utilized to numerically investigate the characteristics of the flow fields and particle transport dynamics. The vertical movements due to species-specific particle behavior were adopted into the tracking algorithm to particularly simulate biotic particle transports and to a great extent to identify potential settlement sites of fish larvae after spawning. The findings presented here will be useful to guide decisions regarding fishery regulations and MPA delimitation in the Eastern US Caribbean.

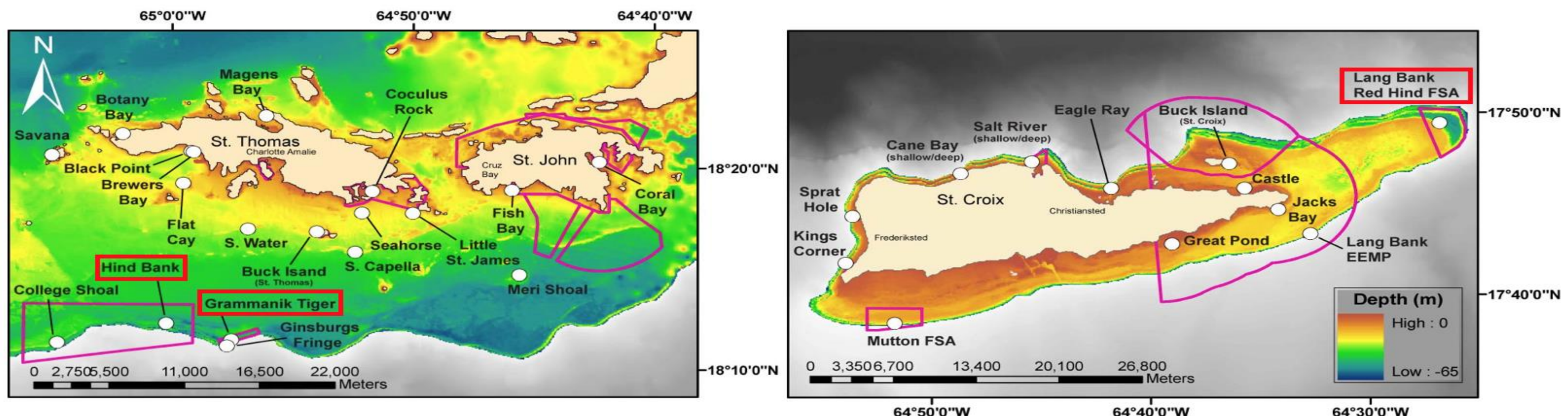


Figure 1. Marine protected areas in the US Virgin Islands (from NOAA).

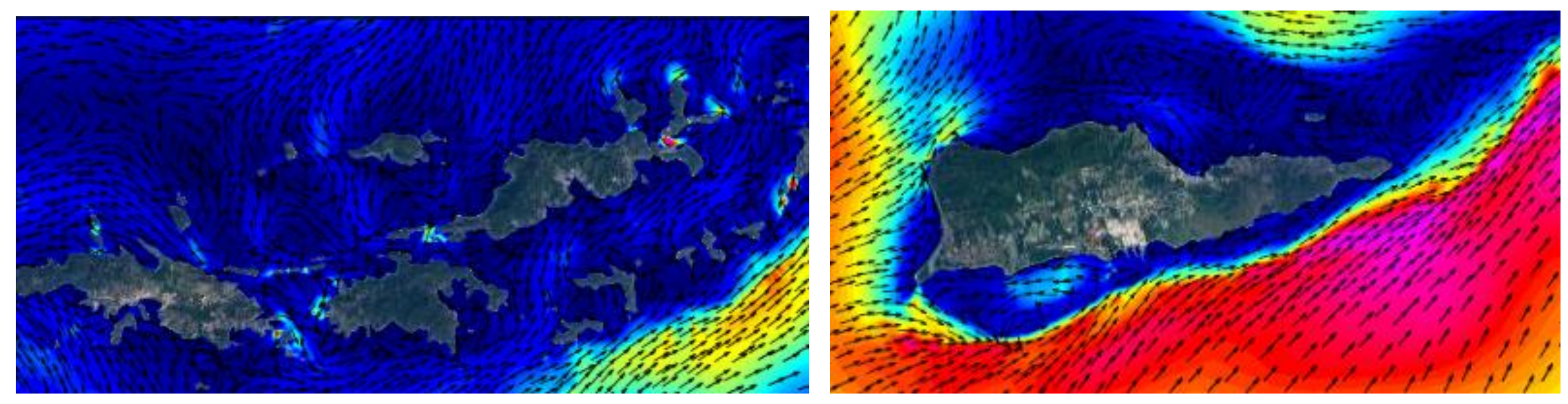
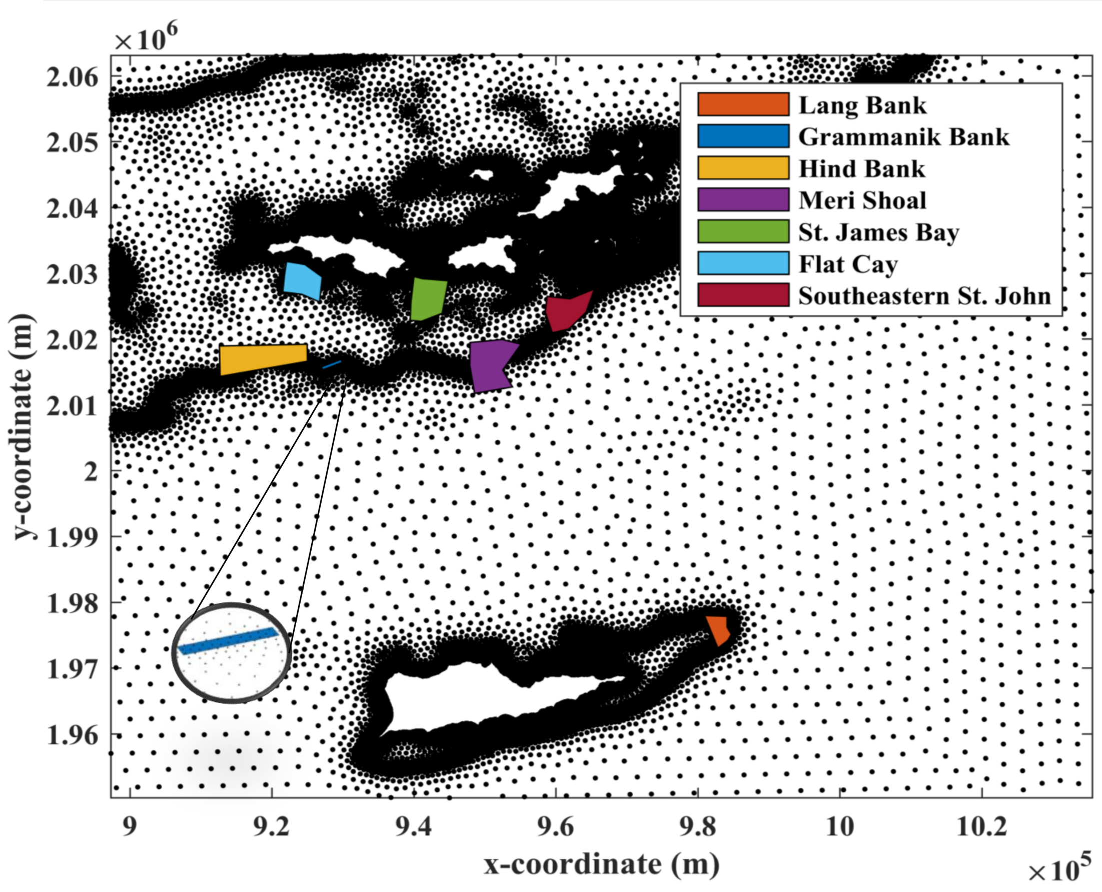


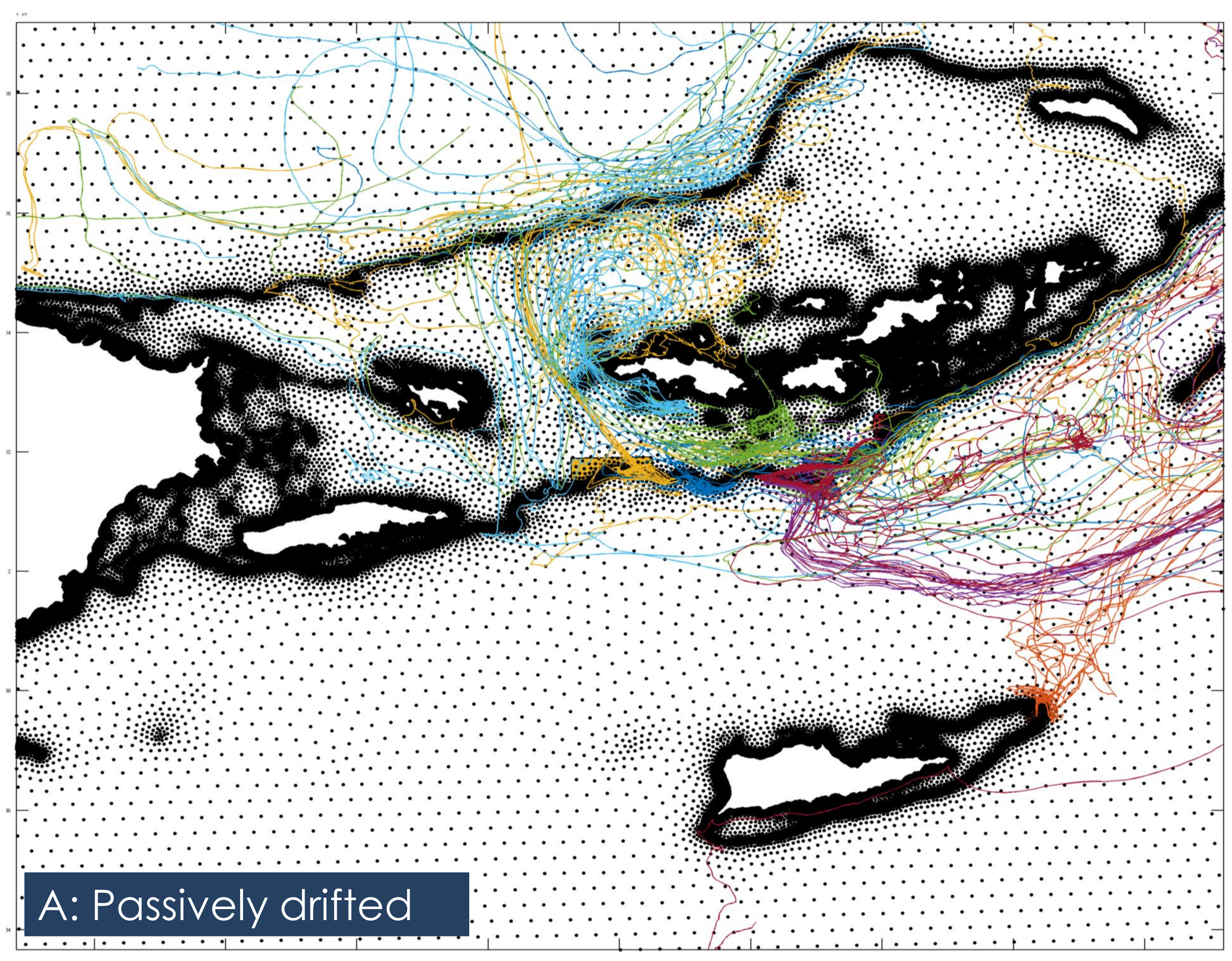
Figure 2. Example output from a high-resolution FVCOM model at the Virgin Island and St. Croix.

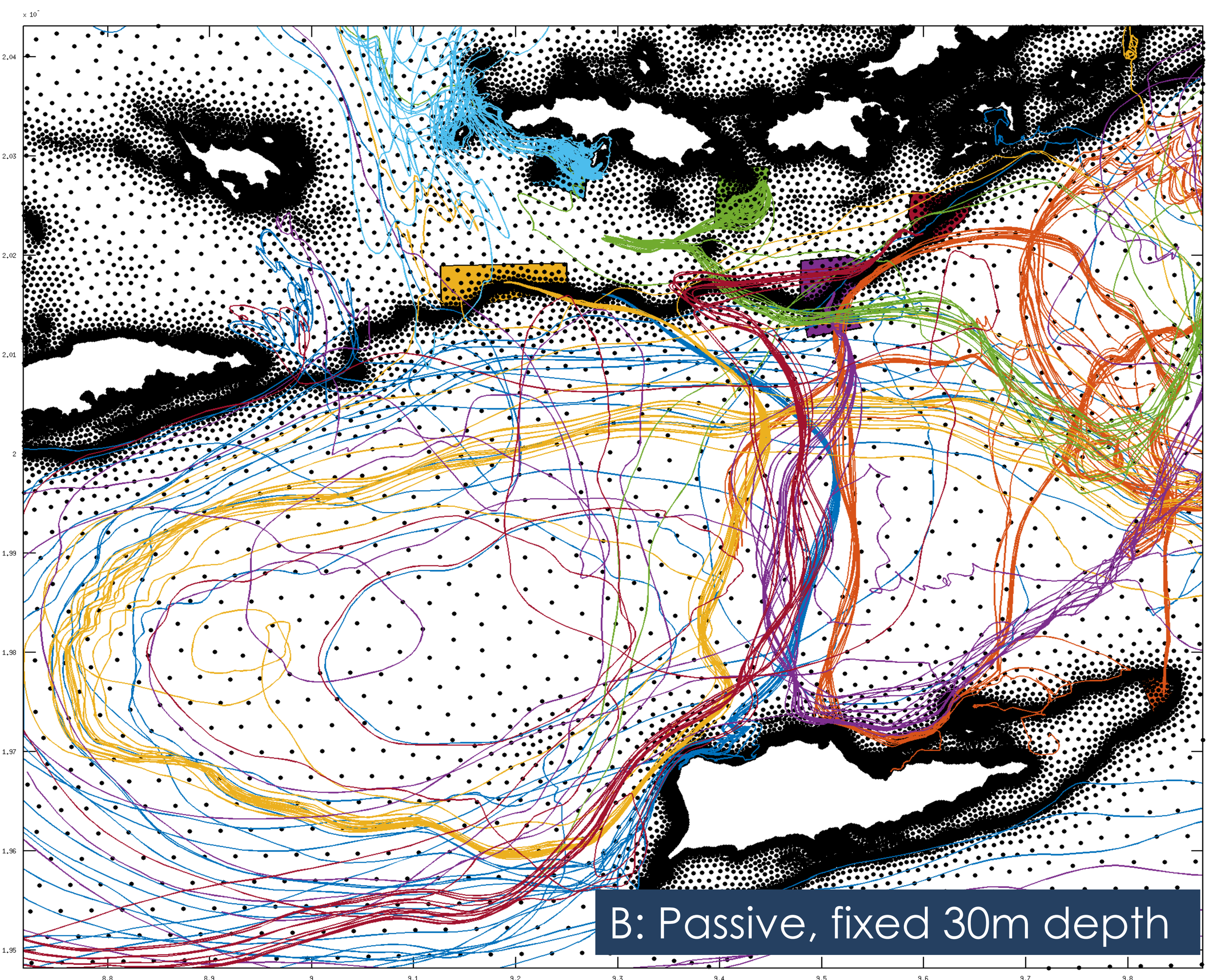
Particle Tracking Simulation

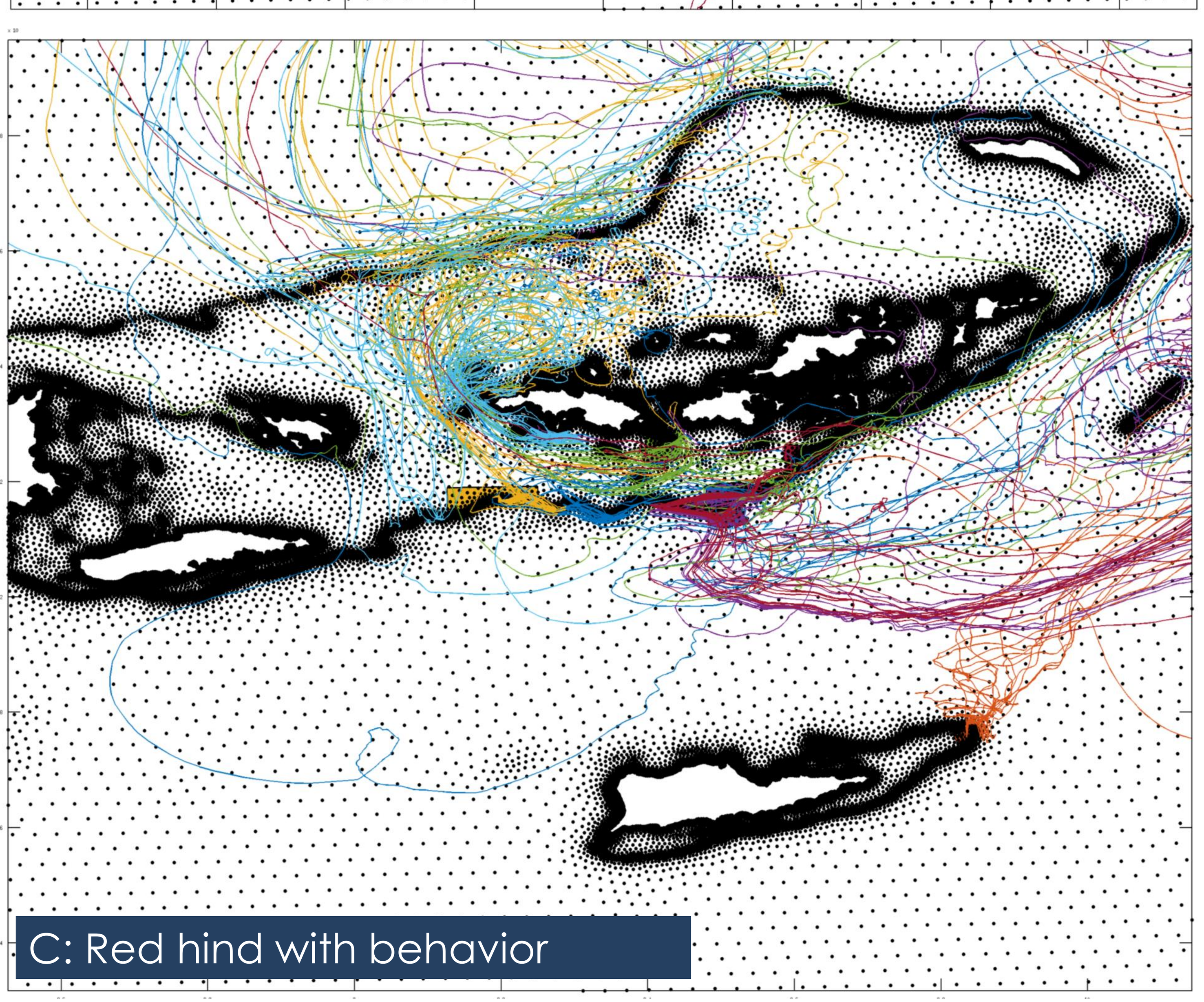


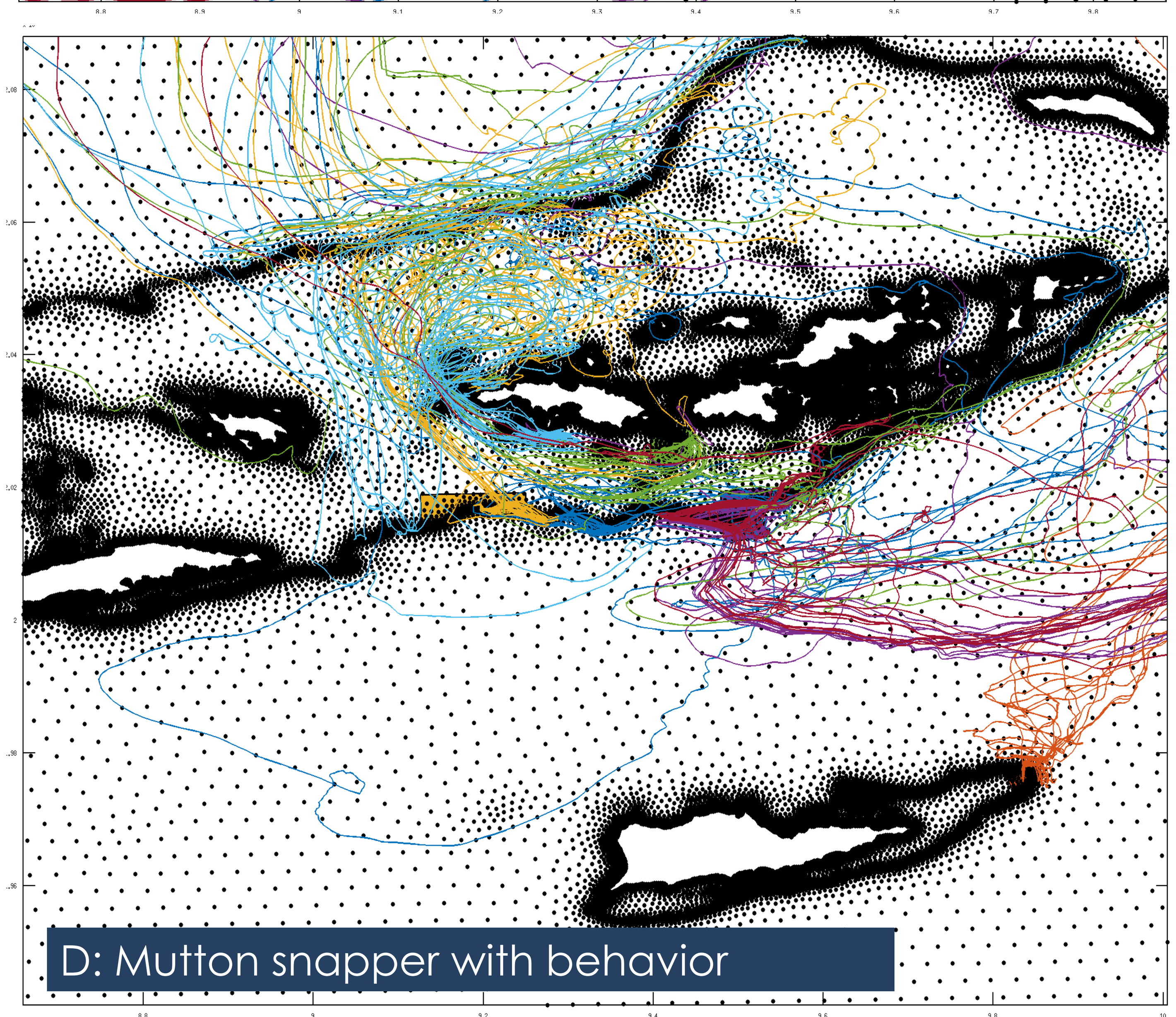
A total of 15 particles were released at 30m depth (average of most coral fish spawning depths) at each MPA (represented by polygons in left panel) and then transported for more than a month under different conditions from A to D. A: drifted passively (no biological model is applied). B: drifted passively and kept the depth (30m). C: activate red hind bio-behavior. D: activate mutton snapper bio-behavior. The bio-particles drafted buoyantly for a specific hours before reached post-flexion stage where larvae were capable to swim and underwent ontogenetic vertical migration (Table). The larvae particles started settlement process once they completed pelagic larval duration (PLD).

Fish egg and larvae	Spawning depth (m)	Timing of flexion	Pelagic Larval Duration (PLD)
Red hind	~30m	~18 days	~41.6 days
Mutton snapper	~35m	~17 days	~30 days









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