Model and Data Based Hydrodynamic Connectivity Study for the Marine Protected Area Network off Western Puerto Rico:

HFR Random-Flight PTM Update

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Introduction

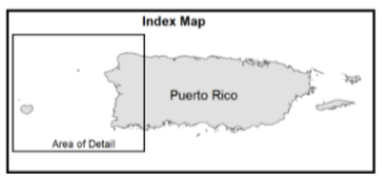
Connectivity Sites

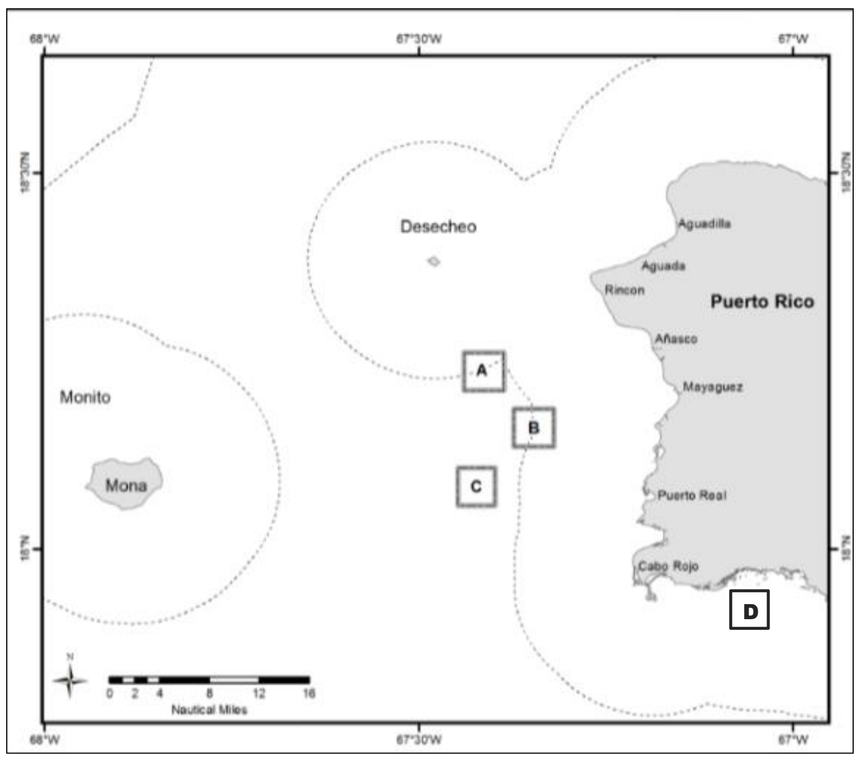
Source - Recruitment

Bajo de Sico [A]	BdS
Tourmaline Bank [B]	TBa
Abrir La Sierra [C]	ALS
La Parguera [D]	LPa

Recruitment

Los Rabos - Aguadilla	LRa
Pichincho	Pin
Desecheo	Des
Mona	LMo
Cabo Rojo	CRo
Guanica	Gca
Guayanilla	Gya

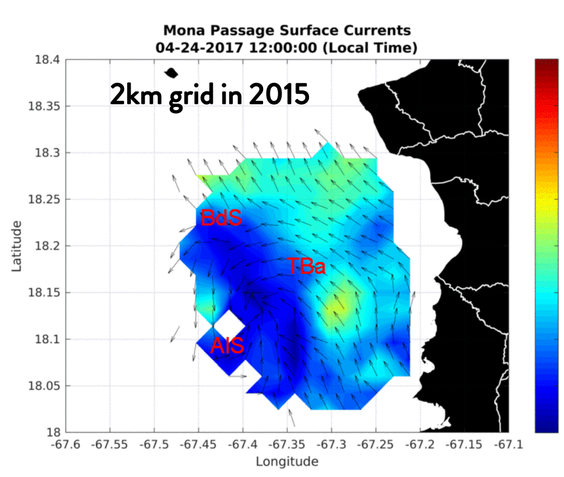


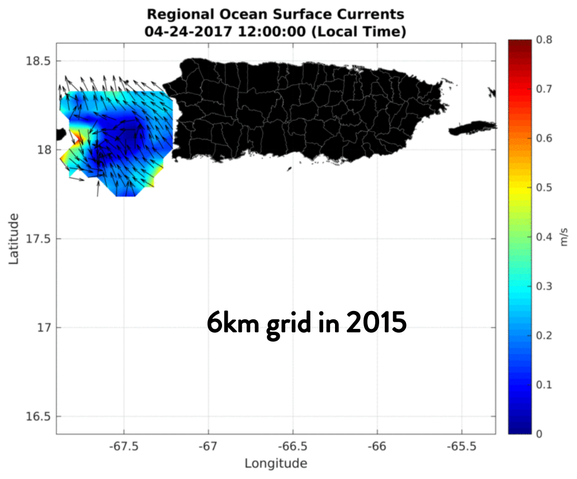


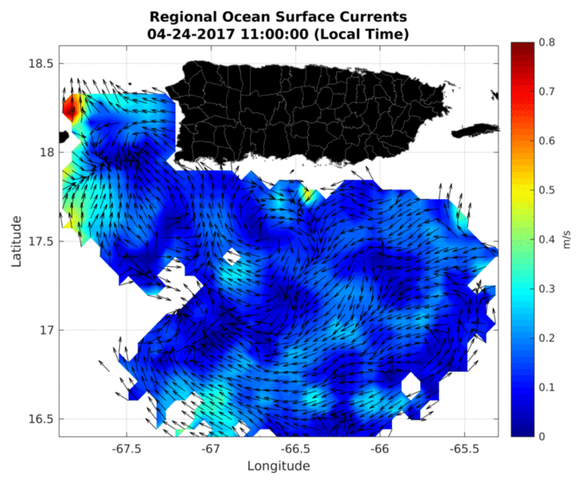
The Random-Flight PTM algorithm (MATLAB code) developed by Donglai Gong (see Gong et al., 2009) and based on the theoretical framework of Ullman et al. (2006) was utilized in this study. The code was provided by the HFR group at Rutgers and locally modified to fit our experimental setup. It performs particle trajectory prediction using HF radar surface currents and incorporates Monte Carlo simulations of prediction uncertainties. In our implementation we allow for hourly virtual particle releases, each release consisting of 10 replicates differing by small random (Monte Carlo type) spatial variability. So, 10 randomly tweaked virtual particles are released every hour (plus the average trajectory) over a 6 month period, at three sites and tracked over a 14-day period at an hourly time step. Our initial HFR PTM test runs clocked at three months per site which is unacceptable as multiple runs are needed for testing and debugging purposes. We rewrote several of the Random-Flight scripts and brought execution times down to approximately 5 days per site .

Virtual Particle Trajectories and Connectivity Matrices

Lets not forget our goals, which are: 1) to determine the path of dispersal (or particle trajectories) of large numbers of virtual eggs and early larvae from the three marine protected areas (MPA) off the west coast of Puerto Rico, and from the spawning aggregation region at La Parguera from December 1, 2014 to May 31, 205, which covers the spawning season for many commercially important snapper and grouper species including the red hind (*Epinephelus guttatus*) and the mutton snapper (*Lutjanus analis*); 2) generate connectivity matrices to identify the potential of the four source sites towards larval recruitment at several known fishery sites (herein referred to as recruitment sites); and 3) to provide the CFMC with a tool to augment the Council's MPA placement and decision-making information suite.



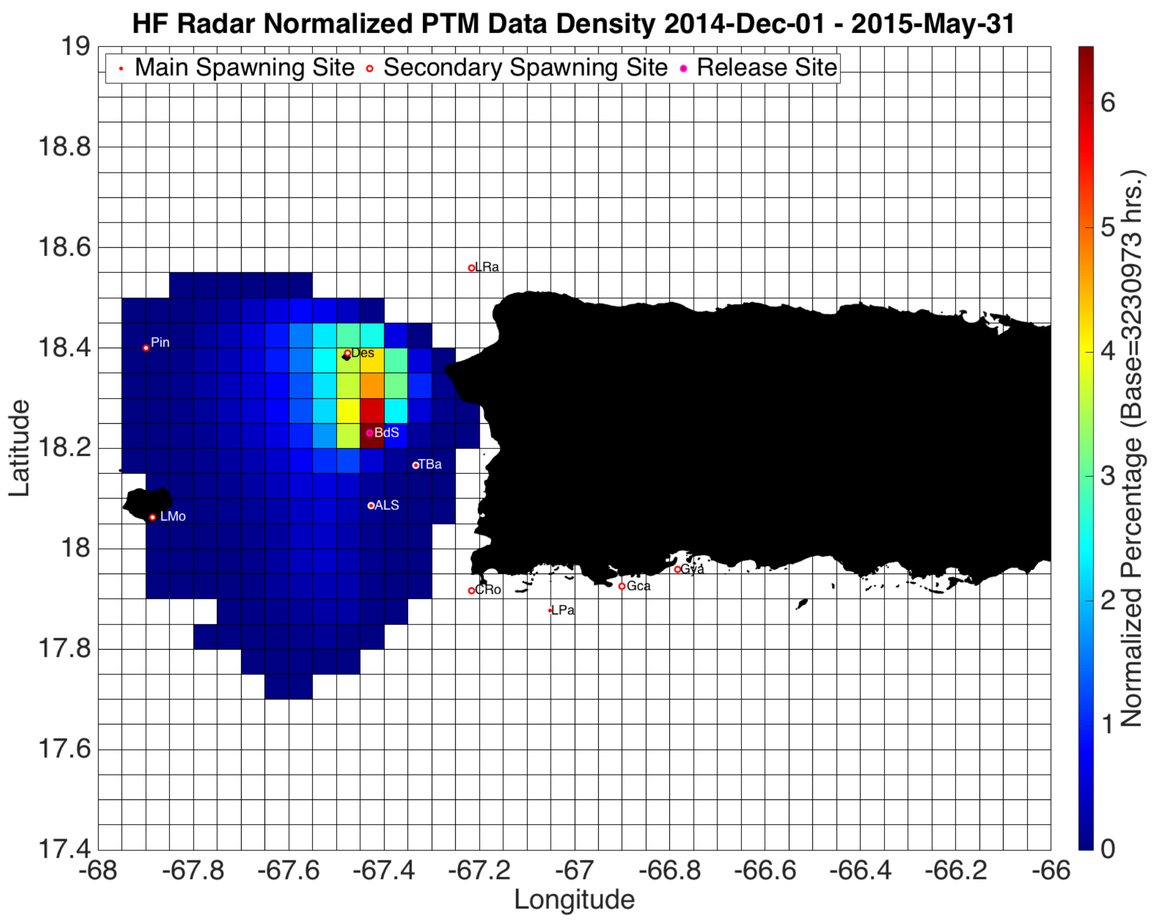


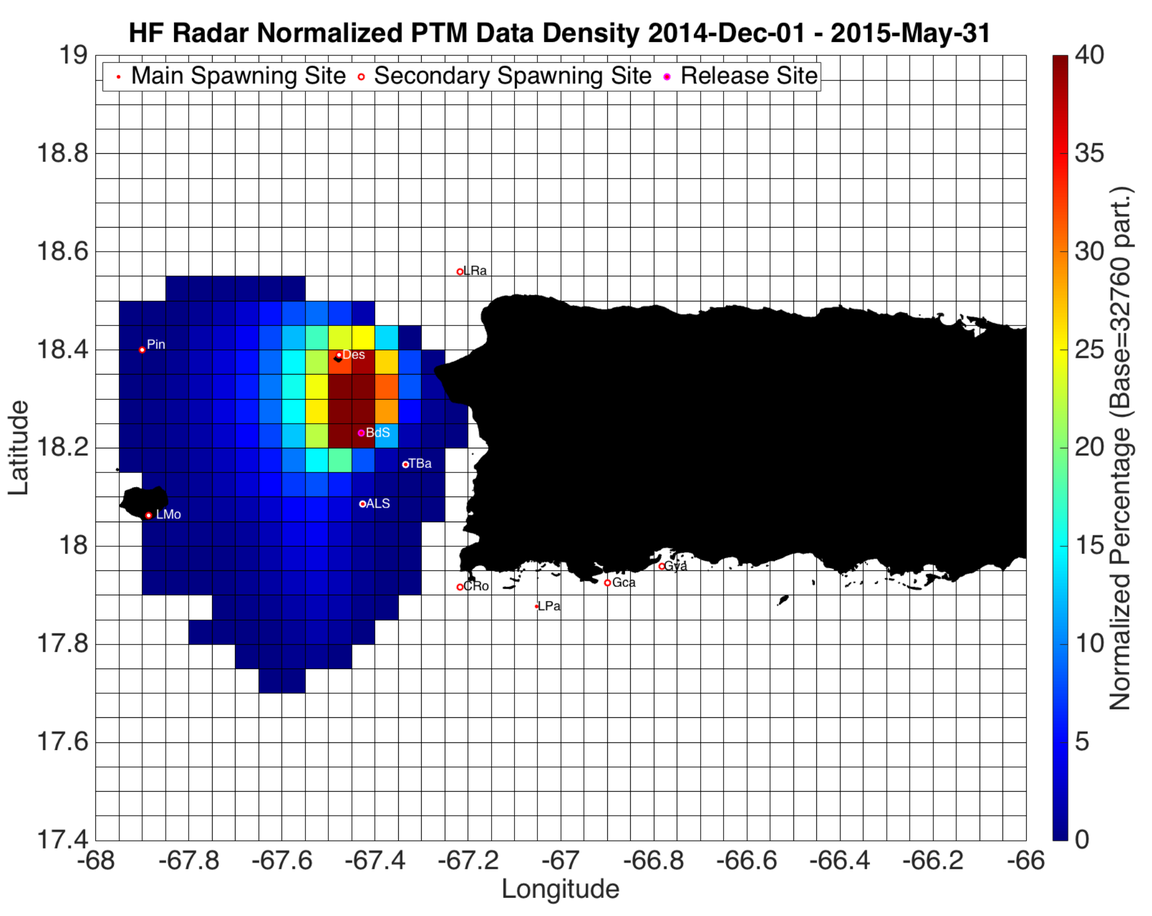


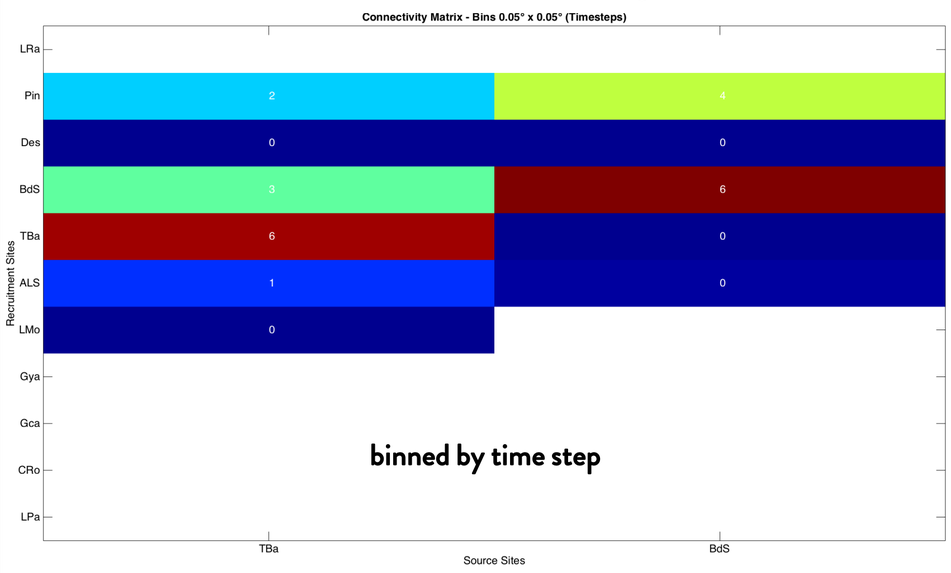
6km grid NOW

Evolution of the CariCOOS HFR surface velocity vector grid. West coast MPA locations have been overlaid on the 2014-2015 2km grid. Note that Bajo de Sico and Abrir la Sierra are located close to the grid boundary whereas Tourmaline Bank is located towards the center, and La Parguera is not covered. The HFR PTM uses a hybrid grid.

HFR Random-Flight PTM Plots for Bajo de Sico and Connectivity Matrices



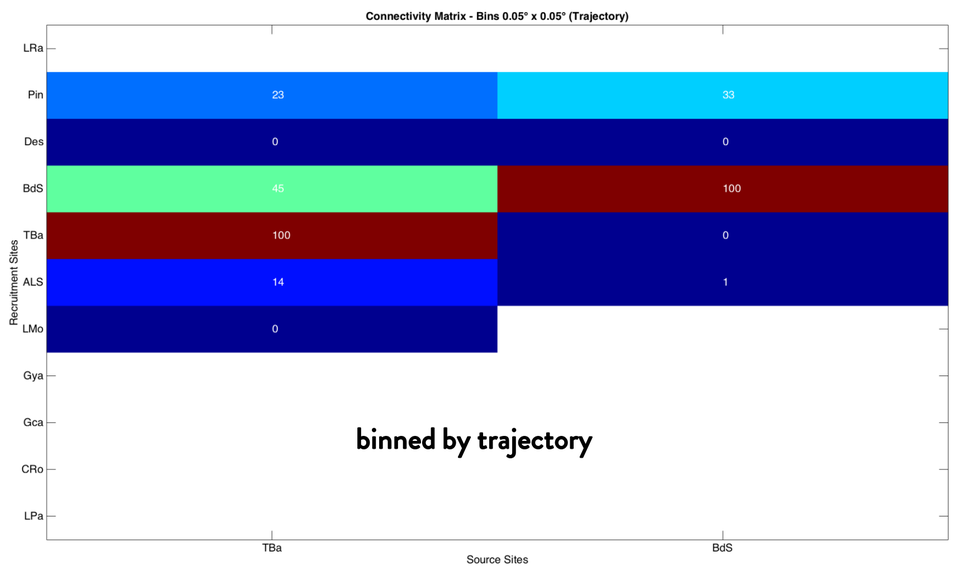




binned by time step

The connectivity matrices address MPA's management issues such as optimal locations and spatial distributions, as well as the relative contribution of MPA's to local vs. far-field recruitment.

Gridded trajectory summaries for BdS and TBa are shown above.



binned by trajectory