Spatio-temporal ecosystem drivers of Eastern Scotian Shelf shrimp (Pandalus borealis)

The distribution of the eastern Scotian Shelf (ESS) stock of Northern Shrimp (Pandalus borealis) located in Atlantic Canada vary spatially and temporally in response to suitable habitat. Given that the shrimp from this stock inhabit very small swathes of suitable habitat along the ESS, this population is vulnerable to local overfishing and changing environmental conditions. Surplus production models estimate changes in exploitable portions of available stock biomass; however, explicitly incorporating spatio-temporal processes and appropriately describing variability is key to fish population science and stock assessments. To predict biomass as a function of spatially varying ecosystem variables, we applied a spatially explicit lag-1 autoregressive surplus production model to the ESS stock of Northern Shrimp. We demonstrate the application of Hierarchical Generalized Additive Models (Wood 2017; Pedersen et al. 2019) to model the spatial variance of shrimp productivity as a function of ecosystem predictor variables such as predation intensity. We further demonstrate the use of Markov Random Fields to model spatially structured variation in demographic parameters such as intrinsic growth rates.