VIMS Nantucket Lightship SHMW Analysis

September 22, 2020

Methods

Shell height meat weight relationships (SHMW) were estimated for the Nantucket Lightship (NL) survey by SAMS Area with VIMS survey data. SHMW relationships were developed using a combined dataset from 2016 - 2020. Surveys from 2016 - 2019 occurred in June or July of a given year. The 2020 survey was delayed due to COVID-19 travel restrictions and was completed in late September of 2020.

Station-level data from the 2016 - 2019 surveys were reassigned to 2020 SAMS Areas for analysis. VIMS' protocols dictate that at every station with scallop catch, 15 scallop that encompass the length distribution of scallops at a given station are sampled to collect data on meat weight, gonad weight, meat quality, sex, maturity stage, and disease prevalence. The shell height is taken for each scallop assessed, and then the adductor muscle and gonad are carefully removed. The adductor muscle and gonad are weighed with a Marel M200 motion compensating scale. Maturity stage is assessed by visual examination of the gonad. VIMS classifies maturity into six stages: rebuilding, mature, spent, spawning, resting, and unknown.

SHMW mixed effect models were developed with forward selection and variables were retained in the model if the AIC was reduced three or more units. SAMS area was included in all models to estimate the SAMS area effect. The model with the lowest AIC was selected as the preferred model and used to predict SHMW relationships by SAMS area. If models were within three units of each other, a likelihood ratio test was used to test for significant differences between model. If there was no significant difference between the models, the more parsimonious model was selected as the preferred model. Variables considered were: ln shell height, ln depth (average depth for a station), SAMS Area (retained in all models), latitude (beginning latitude of a station), an interaction term of shell height and depth, year, and maturity stage. Maturity stage was included to account for the delay of the 2020 survey. Models with and without maturity stage were compared to assess the need to include this variable. Post-hoc multiple pairwise comparisons for the levels of maturity stage were also completed. The interaction term was not considered in model development if the term was not significant in the individual model. Year was included to test for a year effect, and was not significant. Tables provided below include the SHMW models with parameters and AIC by SAMS area. Parameter estimates for the preferred model and predicted SHMW relationships are also provided.

A sensitivity analysis was also completed to assess the impact of removing stations located in the 2020 NL Triangle Closed Area. This area is closed to fishing effort in 2020 and located in the NL_South_Deep SAMS Area. Seventeen stations were completed in this area from 2016 - 2020. All station SHMW data from these stations were removed and model predictions were compared to the preferred model including all data from 2016 - 2020.

Results

Maturity stage was not considered in final model development based on a comparison of predicted SHMW curves with and without maturity stage, as well as a lack of significance between maturity factor levels in the preferred model, and post-hoc pairwise comparisons between maturity stage levels. The preferred model included shell height, SAMS Area, latitude, and depth as fixed effects (Table 1). All

variables were significant (Table 2). The NL_South_Deep and NLS_West SAMS Areas were significantly different from the reference SAMS Area, the NLS_North SAMS Area. Predicted SHMW curves indicate the NLS_South_Deep continues to have lower meat weights across all lengths compared to the other three SAMS Areas (Figure 1). Exclusion of stations from 2016 - 2020 located in the NL Triangle Closed Area did not change variables in the preferred model, predicted SHMW curves or coefficient estimates (Figure 2, Table 3). All parameter estimates and the predicted SHMW curves for the preferred model in Figure 1 and Table 2 include all data from all stations within the VIMS NL survey domain for 2016 - 2020.

Table 1. SHMW models for the 2016 - 2020 VIMS NL survey data. Bold variables indicate significance. Model in red was selected as the preferred model. The number of parameters (K), AIC, Delta_AIC, AIC weight (AICWt), and Deviance explained are also included.

Modnames	Parameters	K	AIC	Delta_AIC	AICWt	Deviance
m4	**~1 + Shell Height + SAMS Area + Depth + Latitude**	9	44,086.29	0	0.76	74.23
m1	~1 + **Shell Height*Depth + SAMS Area + Latitude**	10	44,088.80	2.51	0.22	74.22
m3	~1 + **Shell Height + SAMS Area + Depth**	8	44,094.13	7.83	0.02	74.22
m2	~1 + **Shell Height*Depth + SAMS Area**	9	44,097.46	11.17	0	74.2
m5	~1 + **Shell Height + SAMS Area + Latitude**	8	44,097.62	11.32	0	74.24
null	~1	3	58,821.82	10,734.82	0	

Table 2. Parameter estimates for model m4 from Table 1.

Parameter	Parameter Estimate
Intercept	-24.04
log Shell Height	2.87
SAMS_AreasNLS_South_Deep	-0.27
SAMS_AreasNLS_West	-0.08
SAMS_AreasVIMS_45	0.02
log Depth	-0.25
Latitude	0.37

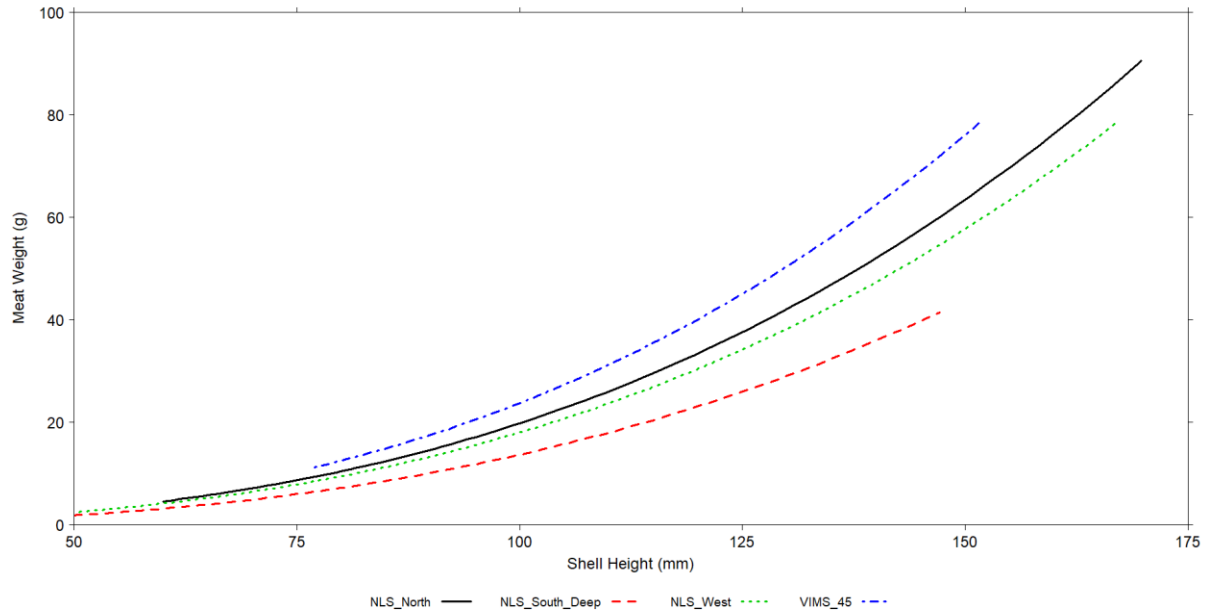

Figure 1. Predicted SHMW relationships by SAMS Area for the NL using model m4 from Table2.

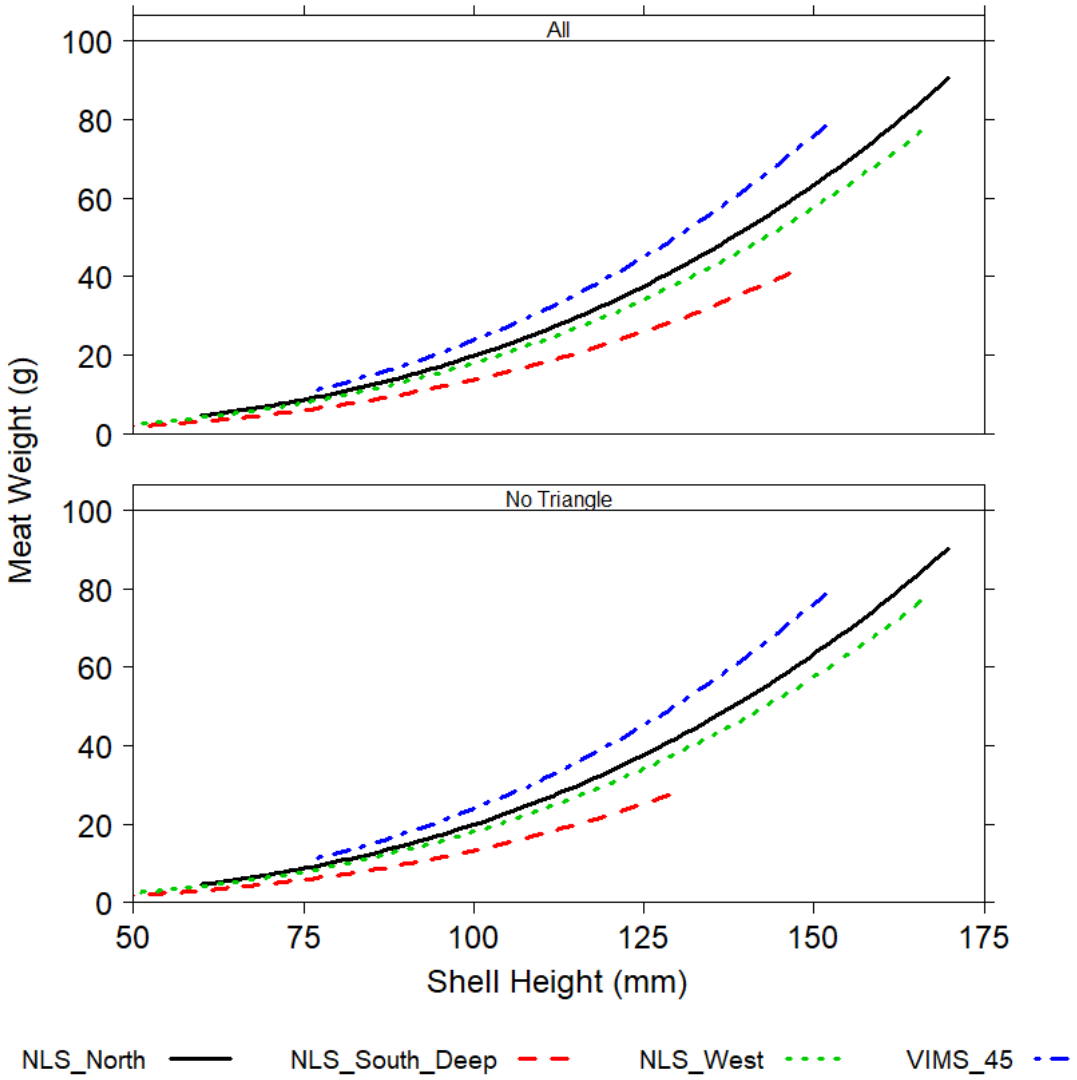

Figure 2. Predicted SHMW relationships by SAMS Area for the NL excluding stations in the NL Triangle Closed Area (No Triangle panel – bottom) and with all data (All panel – top).

Table 3. Parameter estimates for the sensitivity analysis excluding stations in the NL Triangle Closed Area.

Parameter	Parameter Estimate
Intercept	-31.97
log Shell Height	2.86
SAMS_AreasNLS_South_Deep	-0.25
SAMS_AreasNLS_West	-0.07
SAMS_AreasVIMS_45	-0.01
log Depth	-0.25
Latitude	0.56

Discussion

SHMW relationships in the NL continue to show a similar trend across years. The South_Deep SAMS Area continues to have a lower meat weight at shell height compared to the other SAMS areas. This SAMS Area is significantly different from the reference case, NLS_North SAMS Area, for the 2020 analysis (not included) and the combined analysis for this year. Biomass estimates for the VIMS NL Survey domain have not been calculated yet, but the assumption of reduced dredge efficiency in the high density area in the South_Deep SAMS area is believed to persist.