VIMS Nantucket Lightship SHMW Analysis

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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 - 2021. Surveys from 2016 - 2019 and 2021 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 2020/2021 SAMS Areas for analysis. VIMS' protocols dictate that at every station with scallop catch, up to 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 and SAMS Area 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. Year was found to have a significant effect on SHMW relationships this year. Models with Year as a fixed and random effect were also developed. Models with Year, either as a fixed or random effect, had lower AIC values than models presented in this report, but are not included. These models can be presented if requested by the PDT. 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.

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). This result is consistent with results from 2020. All predictor 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). Post-hoc pairwise comparisons for SAMS Area indicated the NL_South_Deep SAMS Area was significantly different from all other SAMS Areas. 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 - 2021.

Table 1. SHMW models for the 2016 - 2021 VIMS NL survey data. Bold variables indicate significance. Model in red was selected as the preferred model. The number of parameters (K), AIC, ΔAIC, AIC weight (AICWt), and Deviance explained are also included.

Models	Parameters	K	AIC	ΔAIC	AICWt	Deviance
m4	~1 + **Shell Height + SAMS Area + Depth + Latitude**	9	53,011.38	0	0.81	76.18
m1	~1 + **Shell Height*Depth + SAMS Area + Latitude**	10	53,014.57	3.19	0.17	76.17
m3	~1 + **Shell Height + SAMS Area + Depth**	8	53,020.53	9.15	0.01	76.17
m5	~1 + **Shell Height + SAMS Area + Latitude**	8	53,020.65	9.26	0.01	76.19
m2	~1 + **Shell Height*Depth + SAMS Area**	9	53,021.96	10.58	0	76.17
null	~1	3	66,565.99	13,554.61	0	

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

Parameter	Parameter Estimate
Intercept	-22.64
log Shell Height	2.87
NLS_South_Deep	-0.24
NLS_West	-0.08
VIMS_45	-0.02
log Depth	-0.23
Latitude	0.33

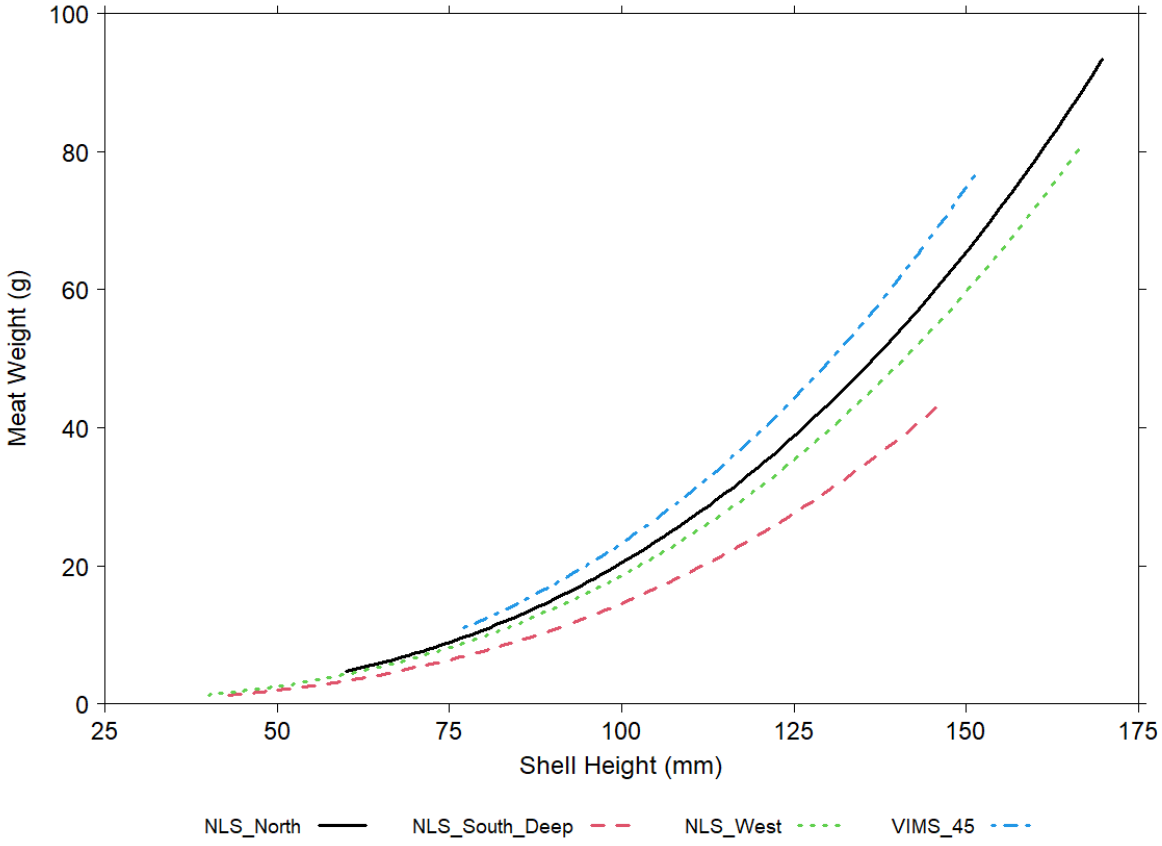

Figure 1. Predicted SHMW relationships by SAMS Area for the NL using model m4 from Table2.

Discussion

SHMW relationships in the NL continue to show a similar trend across years. Results from the 2020 and 2021 SHMW analyses are similar with respect to the preferred model, parameter estimates, and predicted SHMW curves by SAMS Area. 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 and the NL_West SAMS Area. 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 may persist.