Testing SASI Model sensitivity to assumptions

The SASI simulation model was tested for changes in the distribution of adverse effects when three model parameters were changed:

(1) the duration of recovery;
(2) the gear/substrate sensitivity and recovery values; and
(3) the contribution of geological and biological features to the total adverse effect

Conclusions

The SASI model appears to be robust to all three classes of model assumption with one exception. When SASI is run with a re-coded matrix where all scores of 2 are coded as 3, areas of high adverse effects for trawl and scallop dredge gears shift somewhat from Georges Bank to the outer continental shelf. The Gulf of Maine is relatively unaffected, as are hydraulic clam dredge and static gears. Extended recovery durations for biological features in low energy areas may explain the shift. Because this sensitivity model re-codes nearly half of the features evaluated for trawl and scallop dredge gears, it is unsurprising that some change in the spatial distribution of high adverse effects results. <u>Overall, the model appears highly robust to the primary assumptions underlying the vulnerability assessment, matrix values and the relative contribution of geological and biological habitat components to the estimated adverse effects from fishing gears on structure-forming habitat.</u>

Model Sensitivity Test 1: Duration of Recovery

To test model sensitivity to the recovery time steps parameterized in the model, the PDT tested two potential sources of error; specifically that the recovery durations parameterized in the model are either too short (test 1.1) or too long (test 1.2). Sensitivity was tested by changing parameters as follows:

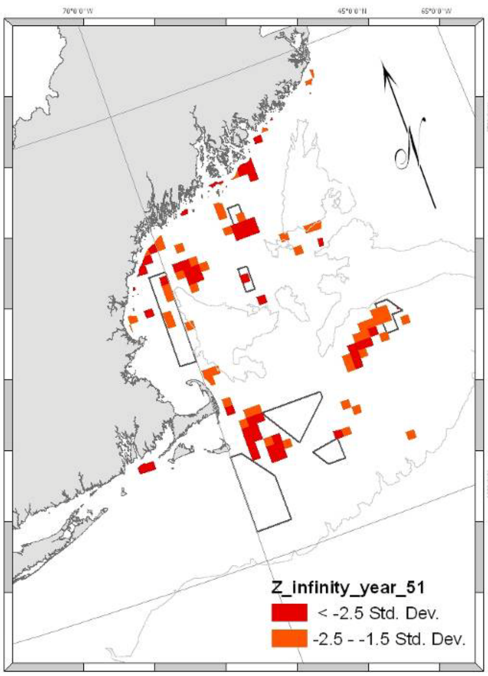
Recovery sensitivity test 1.1 (extended recovery duration):

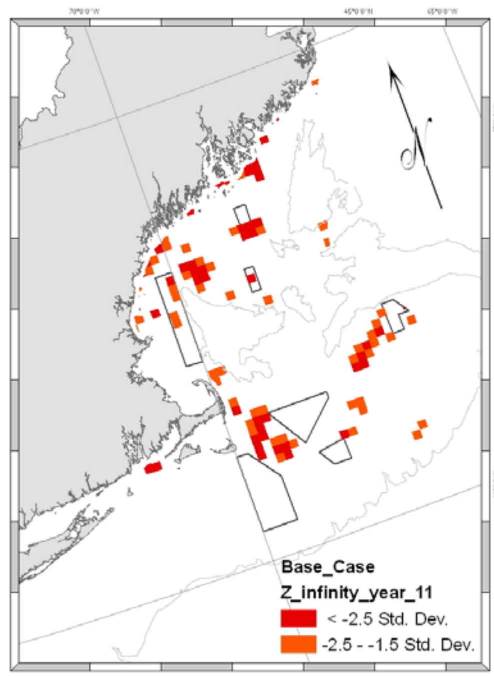
R	Definition	Model Parameter	Sensitivity Definition	Sensitivity Parameter
0	1 year	1	1 year	1
1	1-2 years	1 + round(ranuni(0))	2-3 years	2 + round(ranuni(0))
2	2-5 years	2 + round(3*(ranuni(0)))	3-20 years	3 + round(17*(ranuni(0)))
3	5-10 years	5 + round(5*(ranuni(0)))	20-50 years	20 + round(30*(ranuni(0)))

Test 1.1 results (trawl gear shown):

The left frame (below) shows the spatial distribution of adverse effect (Z infinity) binned by standard deviations from the mean value domain-wide for this sensitivity test. The highlighted areas represent roughly the top 3% of the distribution, or approximately 80-100 cells out of roughly 2,550 cells in the domain. The right frame (below) shows the spatial distribution of adverse effects under the base case scenario, as SASI is currently parameterized.

Extending the duration of recovery time steps does not fundamentally alter the spatial distribution of modeled adverse effects. Areas accumulating adverse effects within the bin covered by Z infinity values ranging between 1.5 and 2.5 standard deviations from the mean tended to expand around central core clusters with the longer time steps, and a few isolated grid cells were elevated, particularly in the Gulf of Maine. While trawl gear is the only model output shown here, this conclusion holds across gear types.





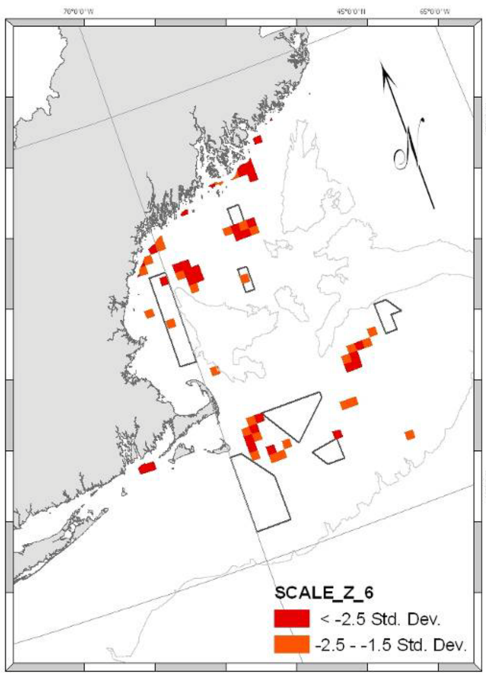
Recovery sensitivity test 1.2 (compressed recovery duration):

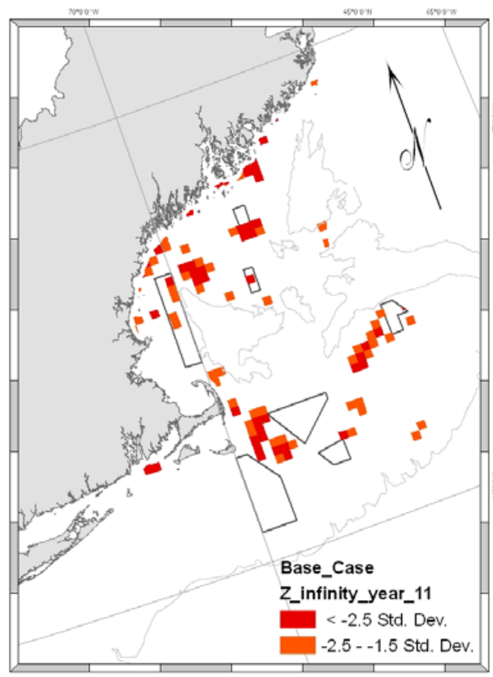
R	Definition	Model Parameter	Sensitivity Test Definition	Sensitivity Test Parameter
0	1 year	1	1 year	1
1	1-2 years	1 + round(ranuni(0))	1 year	1
2	2-5 years	2 + round(3*(ranuni(0)))	1-2 years	1 + round(1*(ranuni(0)))
3	5-10 years	5 + round(5*(ranuni(0)))	2-5 years	2 + round(3*(ranuni(0)))

Test 1.2 results (trawl gear shown):

The left frame (below) shows the spatial distribution of adverse effect (Z infinity) binned by standard deviations from the mean value domain-wide for this sensitivity test. The highlighted areas represent roughly the top 3% of the distribution, or approximately 80-100 cells out of roughly 2,550 cells in the domain. The right frame (below) shows the spatial distribution of adverse effects under the base case scenario, as SASI is currently parameterized.

Compressing the recovery durations does not fundamentally alter the spatial distribution of modeled adverse effects. Areas accumulating adverse effects within the bin covered by Z infinity values ranging between 1.5 and 2.5 standard deviations from the mean tended to contract around central core clusters with the shorter time steps, and a few isolated grid cells dropped out of this bin, particularly on George's Bank. While trawl gear is the only model output shown here, this conclusion holds across gear types.





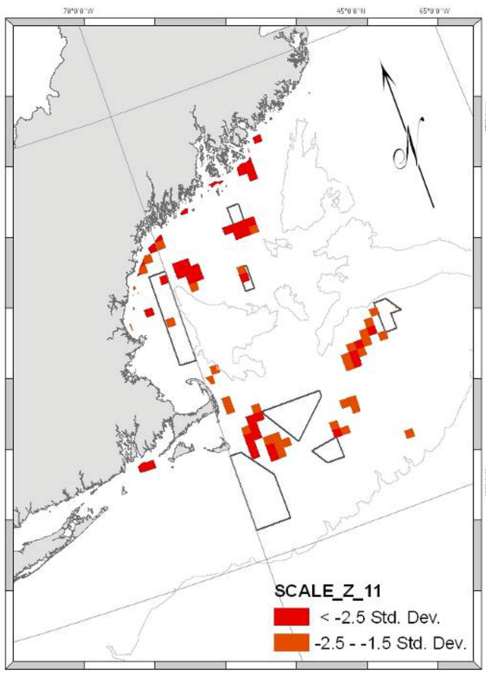
Model Sensitivity Test 2: Susceptibility and Recovery Scoring

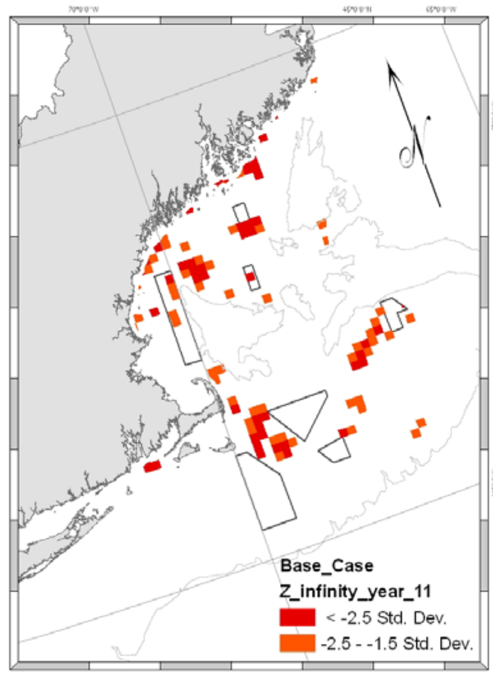
The PDT notes that the most difficult interpretations of the published gear effects literature came when estimating susceptibility and recovery scores at the outer extremes of the zero, one, two and three scale. To test model sensitivity to these parameters, the team conducted model runs after converting all one (1) scores for both sensitivity and recovery to scores of zero (0) (test 2.1), and again after converting all scores of two (2) to scores of three (3) (test 2.2).

Scoring sensitivity test 2.1 results (trawl gear shown):

The left frame (below) shows the spatial distribution of adverse effect (Z infinity) binned by standard deviations from the mean value domain-wide for this sensitivity test. The highlighted areas represent roughly the top 3% of the distribution, or approximately 80-100 cells out of roughly 2,550 cells in the domain. The right frame (below) shows the spatial distribution of adverse effects under the base case scenario, as SASI is currently parameterized.

Shifting the parameter value for all features coded 1 to a code of 0 reduces slightly the number of cells that fall into the bins greater than 1.5 standard deviations from the mean adverse effect value. The fundamental distribution and clustering of areas likely to accumulate adverse effects is relatively unchanged. While trawl gear is the only model output shown here, this conclusion holds across gear types.





Scoring sensitivity test 2.2 results (trawl gear shown):
The top left frame (page 6) shows the spatial distribution of adverse effect (Z infinity) binned by standard deviations from the mean value domain-wide for this sensitivity test. The highlighted areas represent roughly the top 3% of the distribution, or approximately 80-100 cells out of roughly 2,550 cells in the domain. The top right frame (next page) shows the spatial distribution of adverse effects under the base case scenario, as SASI is currently parameterized.

Shifting the parameter value for all features coded 2 to a code of 3 has a significant impact on the distribution of estimated adverse effects for trawl and scallop dredge gears, shifting high adverse effect areas from the northern flank of George's Bank to the edge of the continental shelf and a deepwater area just north of George's Bank. Adverse effect accumulation in the Gulf of Maine remains similar to the base case.

For these two gears, there are 116 individual class/feature/energy/substrate combinations evaluated in the model. Of these, only 14 were evaluated with a score of 3 for either susceptibility or recovery, while 85 are evaluated with a score of two or higher, resulting in a six-fold increase in the maximum values assigned in the matrix.

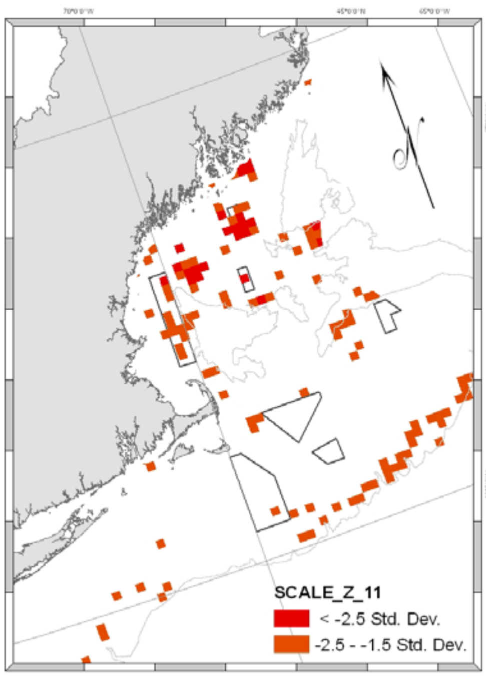
The change in distribution of adverse effects that results from this six-fold increase in maximum-value scores is dominated by biological habitat components.

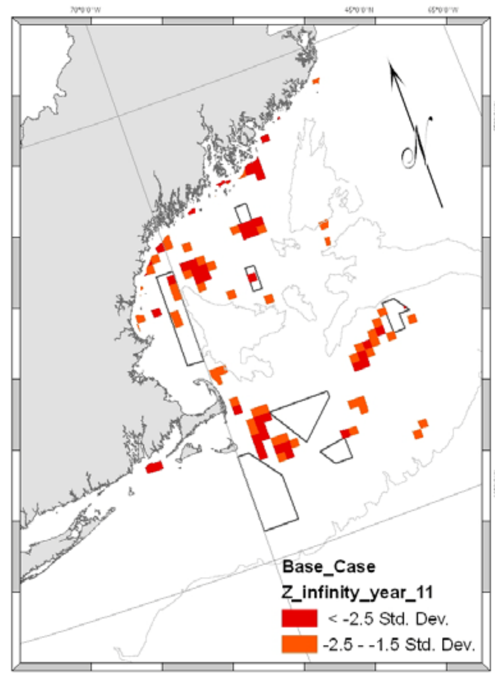
This sensitivity model run changes values for 71 features in total. 15 of these are geological habitat features with high recovery rates—their mean recovery score is less than 1 (0.4). 56

biological habitat components have their scores increased, and the mean recovery score for these features is 1.9. The features are roughly evenly distributed amongst the five dominant substrate categories, but low energy features see the highest change in susceptibility and recovery values. All of this implies that the primary driver in the change in the distribution of areas estimated to have high adverse effects under the sensitivity model test is the relatively long recovery duration for biological features in low energy habitats.

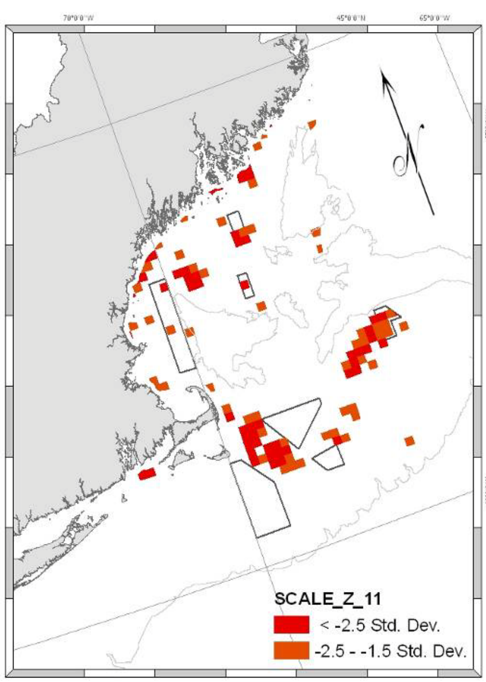
Unlike other sensitivity model tests performed by the PDT, the SASI model is much more sensitive to extreme S and R values for trawl and scallop dredge gears than hydraulic dredge and static gears. For hydraulic clam dredge gears, this is due to the fact that very few features are evaluated with a sensitivity score of two (most features for this gear type are evaluated with either a three or zero). 27 features do have their recovery score increased from a two to a three under this test, but this serves only to compound the adverse effects in areas already estimated to have high values. For static gears, the lack of sensitivity to this assumption results because the static gears have zero features coded with a two or higher for susceptibility and only 26 of 102 features similarly coded for recovery. Similar to the hydraulic clam dredge case, the net effect of this is to compound the degree of adverse effect in locations already estimated to be high. The spatial distribution of high adverse effect accumulation areas therefore changes imperceptibly for these gears. The bottom left frame on the following page shows the sensitivity model output for gillnet and longline gear, while the bottom right frame shows the base case model output for these gears.

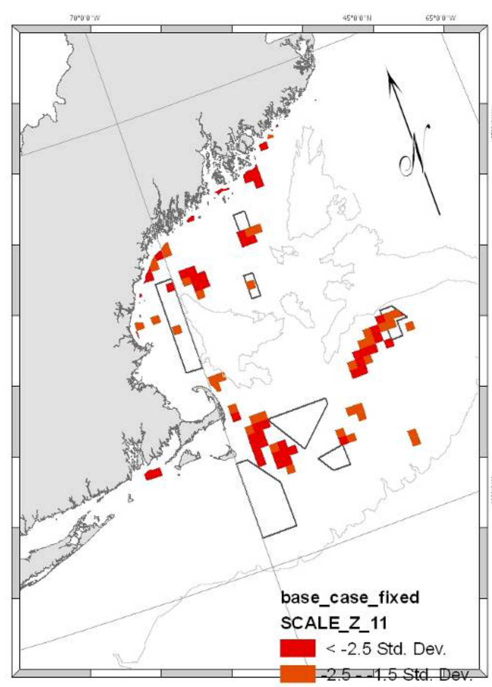
Sensitivity model and base case model outputs for trawl gear, all scores of 2 re-scored 3





Sensitivity model and base case model outputs for gillnet and longline gear, all scores of 2 re-scored 3



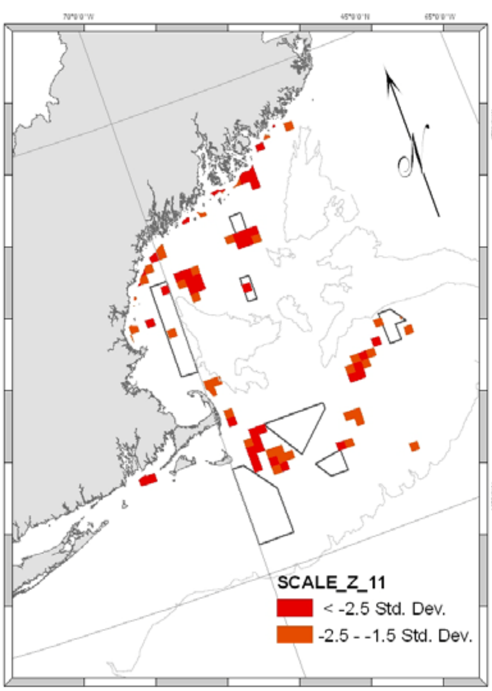


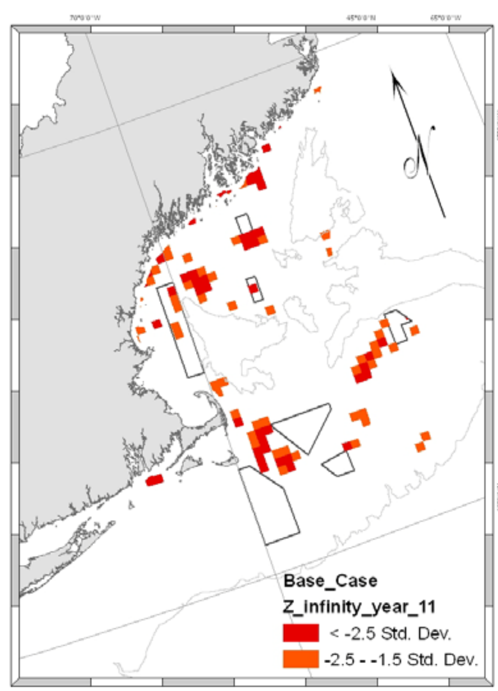
Model Sensitivity Test 3: Geological and Biological Feature Weighting

Absent empirical data on the relative abundance of the various features assigned sensitivity and recovery scores in the vulnerability assessment, the PDT assumed that features specific to these two components of structural habitat would be weighted equally, and therefore contribute equally to the resulting estimated adverse effect. The PDT tested the sensitivity of the model to this equal-weighting assumption by re-weighting in favor of geological habitat features and biological habitat features. Specifically, the sensitivity models altered the weighting from 50/50 (equal weighting) to 90/10 (highly skewed). Test 3.1 skewed the weighting in favor of geological habitat features, and test 3.2 skewed the weighting in favor of biological habitat features.

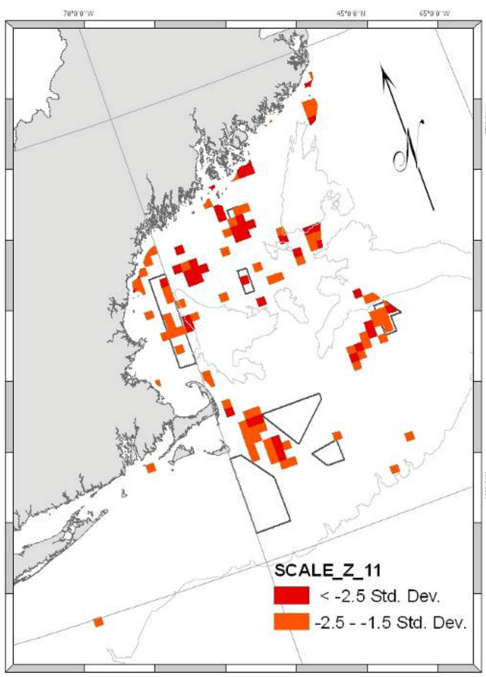
Feature weighting sensitivity test 3.1 results (trawl gear shown):

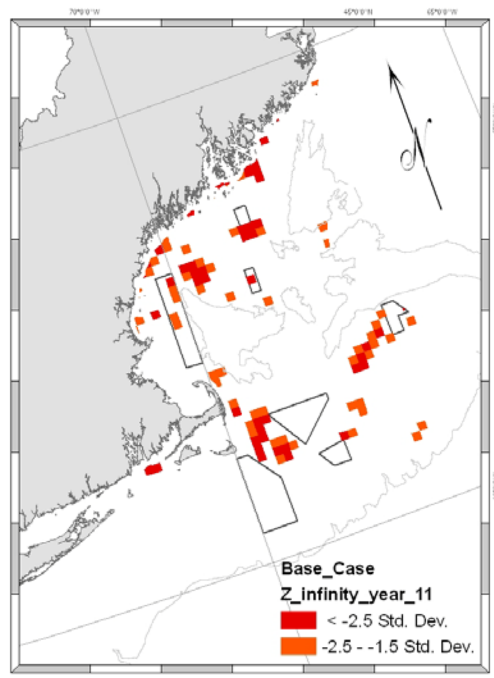
The left frame (below) shows the spatial distribution of adverse effect (Z infinity) binned by standard deviations from the mean value domain-wide for this sensitivity test. The highlighted areas represent roughly the top 3% of the distribution, or approximately 80-100 cells out of roughly 2,550 cells in the domain. The right frame (below) shows the spatial distribution of adverse effects under the base case scenario, as SASI is currently parameterized. Skewing the feature weighting in favor of geological habitat components reduces slightly the number of cells that fall into the bins greater than 1.5 standard deviations from the mean adverse effect value. Isolated cells in the Gulf of Maine also fall out of these bins in the distribution. The fundamental distribution and clustering of areas likely to accumulate adverse effects is relatively unchanged. While trawl gear is the only model output shown here, this conclusion holds across gear types.





Feature weighting sensitivity test 3.2 results (trawl gear shown):
The left frame (below) shows the spatial distribution of adverse effect (Z infinity) binned by standard deviations from the mean value domain-wide for this sensitivity test. The highlighted areas represent roughly the top 3% of the distribution, or approximately 80-100 cells out of roughly 2,550 cells in the domain. The right frame (below) shows the spatial distribution of adverse effects under the base case scenario, as SASI is currently parameterized.





Skewing the feature weighting in favor of biological habitat components increases the number of cells that fall into the bin between 1.5 and 2.5 standard deviations from the mean adverse effect value. Spatially, many of these additional cells expand smaller clusters of high adverse effect areas in the Gulf of Maine that are not necessarily highlighted in other model runs or in the base case. This implies that, conditioned on all other assumptions in the SASI model, if biological components of structural habitat are on the order of nine times more susceptible to the adverse effects from fishing on habitat, adverse effects in a few areas in the Gulf of Maine may be underrepresented in the base case model. In particular, the center of the Western Gulf of Maine closed area and the offshore portions of the Gulf are highlighted. The PDT notes that substrate sampling in the deepwater portions of the Gulf of Maine is significantly less dense than in other areas of the domain, and that a few isolated samples of granule/pebble are likely influencing the results in these areas. The area in the center of the Western Gulf of Maine, however, is well sampled. The PDT notes that this is most likely area where the model may underestimate adverse effects if indeed the sensitivity assumption of biology-skewed feature weighting is more correct than the SASI assumption of equal weighting. While trawl gear is the only model output shown here, this conclusion holds across gear types.