Oil on Water Time Series Analysis Method for Assessment of Injury to *Sargassum* and *Sargassum*-Dependent Fauna
DWH NRDA Water Column Technical Working Group Report

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This technical report details the development of cumulative oiling polygons used in the assessment of Deepwater Horizon (DWH) oil exposure to *Sargassum* and *Sargassum*-dependent fauna. The analysis of the exposure and injury to *Sargassum* relied on two key inputs: the percent cover of *Sargassum* and the total area of oiling in the northern Gulf of Mexico. This report focuses on the determination of the latter; the former is detailed in Hu et al. (2015). This assessment used the National Oceanic and Atmospheric Administration's Oil-on-Water Product (Graettinger et al. 2015) to determine the total area of the northern Gulf of Mexico with surface oil coverage following the DWH spill.

The NOAA Oil-on-Water Product used numerous remote sensing data sources to develop a GIS product with daily surface oil coverage polygons that showed the location and extent of the DWH oil. This GIS-based product divided the northern Gulf of Mexico into 25 km^2 grid cells. For each cell, the product provides the percent of "thin" and "thick" surface oiling categories. "Thin" refers to oil sheen to rainbow in appearance and "thick" oil refers to dark colored and/or highly emulsified oil (see Graettinger et al., 2015 for further details). This analysis used the "thick" category, because exposing *Sargassum* to this degree of oiling likely led to the destruction of *Sargassum* habitat for dependent fauna (Sean Powers, personal communication).

This analysis calculated cumulative oiling polygons using GIS data containing information on the coverage of oil for most days from 4/23/2010 through 7/28/2010.[1] The daily feature class files are contained in a geodatabase named DailyIntegratedGrids_020415.gdb. All files were exported out of the geodatabase to individual polygon files, and all fields were deleted with the exception of the "Prior_Thick" field, which indicates the percentage of thick oil coverage in each 25 km^2 grid cell. The Prior Thick field is reported as a decimal in Double format, so a new field was added to convert the field to an integer for conversion to a raster image grid file. The field was multiplied by 1000 to retain one decimal place (e.g. a value of "81" is derived from the Prior Thick value of 0.081, or 8.1% covered in thick oil).

The shapefiles were each converted to grid files with the same extent and resolution of the grid cells as in the polygon files. The values of the cells in the grid file were based on the new Prior Thick integer field. The grid files were then reclassified into five bins based on ranges of percentages of thick oil:

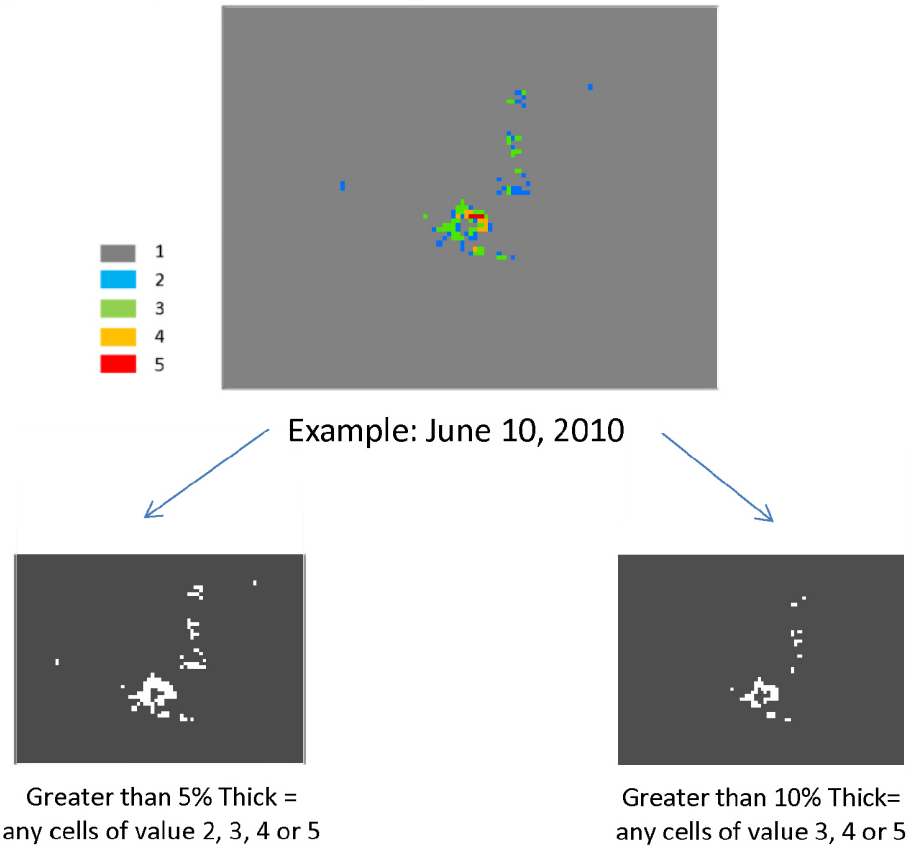
1. 0-5% (new cell value of 1)
2. >5%-10% (new cell value of 2)
3. >10%-50% (new cell value of 3)
4. >50%-75% (new cell value of 4)
5. >75-100% (new cell value of 5)

[1] Several days did not have remote sensing data available.

The grid files were then each split into multiple files based on how much oil was present on a given day (see Figure 1). For the purposes of the *Sargassum* analysis, we were interested in areas with greater than 5% thick oil and greater than 10% thick oil:

- Greater than 5% thick oil = any cells of value 2, 3, 4 or 5
- Greater than 10% thick oil = any cells of value 3, 4 or 5

Figure 1. Example of cumulative oiling polygons



These grid files were then summed with each other for various date ranges using the Cell Statistics tool in ArcGIS. This gives the number of days that had some percent coverage of oil. Grid cells were included in the cumulative oiling polygons if they had at least one day of oiling coverage, as defined below[2]:

- First six weeks (4/25/2010 through 6/5/2010)

[2] *Sargassum* doubles approximately every six weeks (Sean Powers, personal communication). Exposed *Sargassum* was either in the path of the oil during the spill or moved via currents and winds into the spill area. To account for this doubling rate and for this movement, two sets of cumulative areas were used in this assessment. *Sargassum* present at the beginning of the spill was assumed to be oiled and injured as it moved through the spill area for six weeks and then it would be replaced by additional *Sargassum* over the following six weeks. The total amount of *Sargassum* injured by the spill is the sum of these two areas.

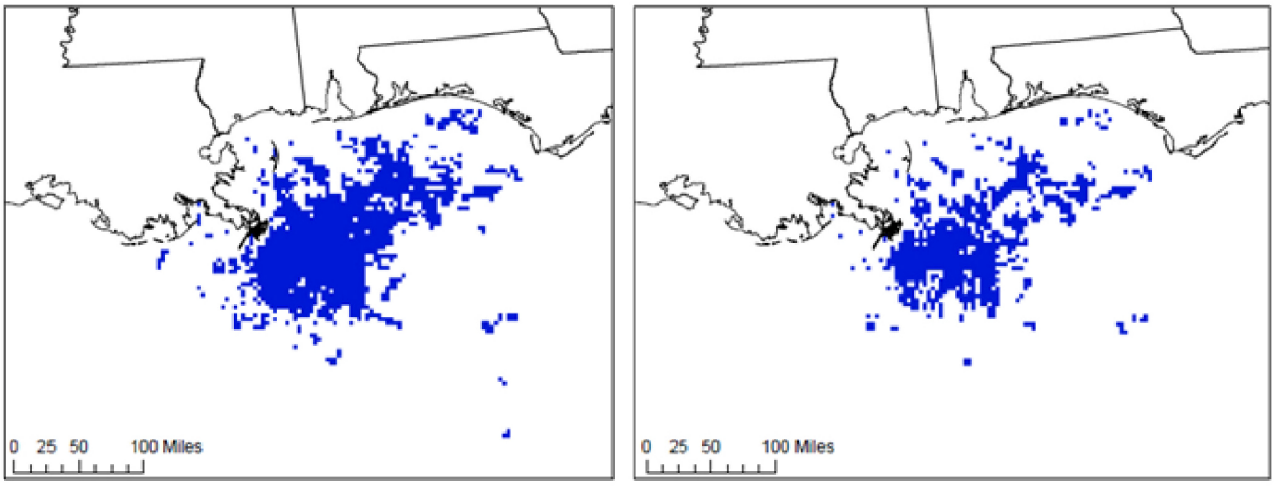
- Second six weeks (6/6/2010 through 7/17/2010)[3]

This resulted in four different analysis products (i.e., combinations of two date ranges and two oil presence percentage types). Area was calculated for each of these products for the number of days that oil was found in any particular grid cell, given a grid cell size of 5 km by 5 km. The areas of these polygons are displayed in Table 1. Figure 2 shows the geographic extent of all gridcells for both the >5% and >10% thick oil coverage.

Table 1. Total Cumulative Oiling Polygon Areas (km^2)

Polygon	First 6 weeks	Second 6 weeks
>5% thick oil	23,225	22,600
>10% thick oil	13,275	12,750

Figure 2. Total Cumulative Areas for >5% and >10% Thick Oil Coverage



Sum of all greater than 5% thick oil grid files

Sum of all greater than 10% thick oil grid files

This analysis determined the extent of "thick" oil coverage in the northern Gulf of Mexico following the DWH well blow out and resulting oil spill. As demonstrated in Figure 2, this thick oil covered extensive portions of the Gulf for several months following the spill. The calculation of areas of thick oil exposure was a key step in the injury assessment for *Sargassum* and *Sargassum*-dependent fauna.

[3] We initially calculated the areas for the second ~eight weeks (6/6/2010 through 7/28/2010), but the results were the same as for the second six weeks polygons.

Sources Cited:

Graettinger, G., J. Holmes, O. Garcia-Pineda, M. Hess, C. Hu, I. Leifer, I. MacDonald, F. Muller-Karger, J. Svejkovsky, and G. Swayze. 2015. Integrating Data from Multiple Satellite Sensors to Estimate Daily Oiling in the Northern Gulf of Mexico during the Deepwater Horizon Oil Spill. DWH NRDA Technical Report.

Hu, C. 2015. Sargassum Injury Assessment Plan: Mapping using remote sensing. DWH NRDA Water Column Technical Working Group Report