Evaluation of Potential Artificial Reef Siting Criteria in the Gulf of Mexico

White Paper

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CHAPTER 1. INTRODUCTION

1.1 Background

The Gulf of Mexico Fishery Management Council is concerned about the rapid removal of petroleum platforms serving as artificial reef habitat and the potential impacts on reef fish in the Gulf of Mexico from this action. This document provides criteria and decision tools for determining locations that are appropriate for placement decommissioned petroleum platforms in the Gulf. However, regulatory permitting requirements for many structures prevent them from remaining in place after decommissioning thus requiring either a suitable alternative location or disposing via some other mechanism (usually on land). The purpose of this project was to evaluate several criteria that affect potential reefing locations including biological, human use, regulatory, and cost considerations. The results aim to inform the decision making process to prioritize potential locations best suited for reefing areas in the Gulf of Mexico. One potential complication is if petroleum platforms are reefed on soft-bottom habitat where shrimping is occurring. This has financial implications for the shrimping industry via reduced trawlable habitat and the potential for gear interactions if the reefed petroleum platform moves after placement.

One possibility is to consolidate decommissioned platforms into artificial reef zones. Assuming the original platform location is restored (as required) to trawlable habitat, a net gain in trawlable habitat could occur while improving the biological function of reefs and providing fishing opportunities. The current project analyzes data examining methods to identify or prioritize areas most suitable for artificial reef siting based on the several criteria including transport time and cost. Moreover, these analyses extend previous work presented to the Joint Ad Hoc Artificial Substrate and Shrimp Advisory Panels (APs) in March 2014 by including additional variables (i.e., shrimp effort, relative distance to shore, and human demographics) and developing analyses on a very fine scale (i.e., 4,000 ft^2 grid cells) throughout the Gulf of Mexico. Ecological criteria were not examined in this study; items such as age 2 red snapper habitat preferences, hypoxic zones and reef value fall under this category and could be useful in future analyses. Given the size of the input database and the fine resolution of the analyses, results were computationally and time intensive.

The following document describes results of the various inputs that could inform the oil and gas industry of the most economically important areas for fisheries in the Gulf of Mexico to reef decommissioned oil and gas petroleum platforms. These analyses can provide the empirical evidence for the greatest benefit for various types of Gulf fishermen while keeping costs to the oil and gas industry in mind. These siting criteria are described in both mapped and descriptive format.

1.2 Center Points of Each Grid

It was recommended by the Ad Hoc Artificial Substrate Advisory Panel at the March 2014 meeting to reduce the grid sizes to 4,000 ft by 4,000 ft because that is the navigational footprint of an artificial reef. To conduct analyses at such a fine scale required steps to reduce computation time. First, a 4,000 ft by 4,000 ft grid was created for the Gulf of Mexico. Second, the center point (centroid) of each grid cell was used for distance calculations (e.g., distance to shore, area surrounding existing platforms).

The fishnet function in ArcMap was used to create a 4,000 x 4,000 ft grid in the Gulf of Mexico; this resulted in some (few) grid cells that were placed on land and in state waters based on the projections of the map. This grid provided the spatial resolution for each mapped variable. The center point of each grid cell was determined as used as the starting location for subsequent distance calculations. The resulting centroid layer is too dense to discern individual points thus, a close-up image of this grid is provided in Figure 1.

A close up of the center point data off of the Louisiana coast.

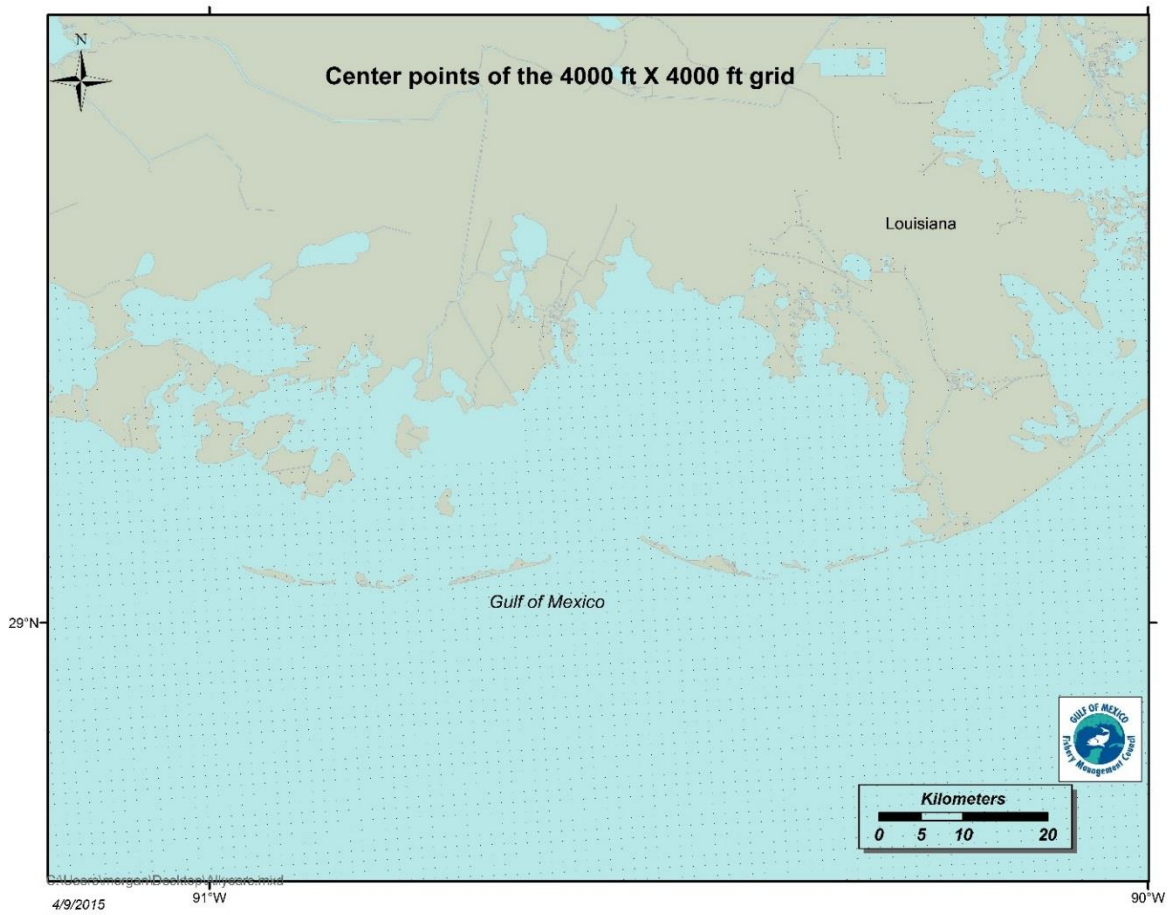

Figure 1. Close up of the center points of each 4,000 ft by 4,000 ft grid cell off of the coast of Louisiana.

1.3 Depth

To facilitate comparisons with the other metrics, a Gulf wide bathymetry layer was used to calculate the depth at the centroid of each grid cell (Figure 3). Depth is among the most important metrics for determining artificial reef placement as it affects biological (e.g., depth zone occupied by shrimp and/or reef fishes), regulatory (e.g., state vs. federal jurisdiction), and logistic/cost considerations (e.g., minimum depth requirements for artificial reefs). For example, placement of an artificial reef should be in water shallow enough to afford anglers with opportunities to fish; deep waters could be prohibitive for fisherman because gear may be too expensive or large to adequately fish in an area. However, shrimping is primarily focused in depths shallower than 360 feet, so there may be user conflicts. The Rigs-to-Reefs depth zone has been defined as between 70 and 350 feet.

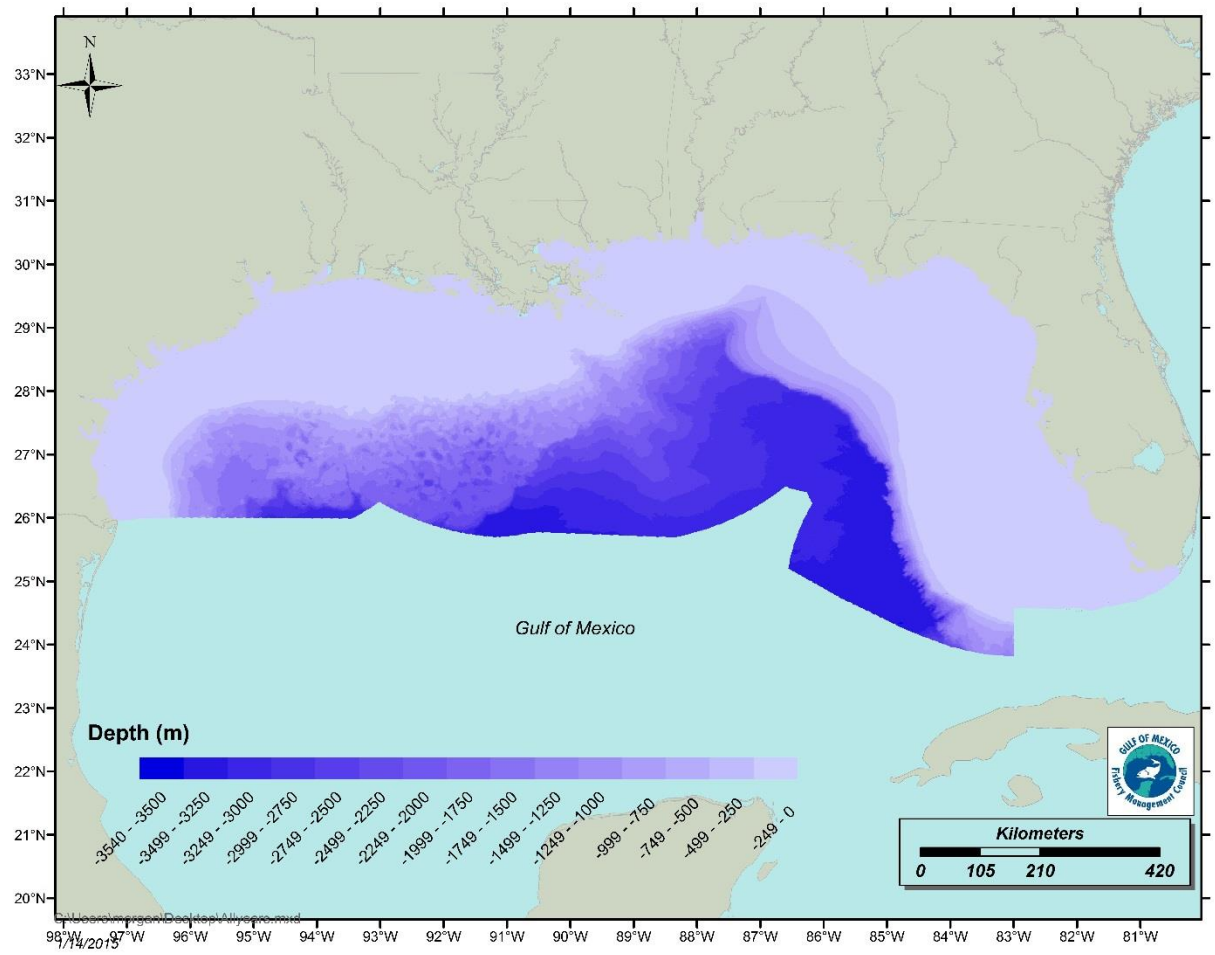

Figure 2. The depth in the center of each 4,000 x 4,000 ft grid was plotted throughout the exclusive economic zone (EEZ) for the Gulf of Mexico. Depth is in meters.

1.4 Distance to Platform

The distance from an existing platform is an important variable to consider when establishing appropriate reef siting. Relocation of a decommissioned platform is expensive. The cost of moving a platform more than 36 miles (31.1 nm) is more than the cost for disassembly and onshore disposal. Therefore, when selecting where to place a decommissioned platform, distance from its current location is one of the most important factors to consider.

To evaluate the area within 35 nm of known oil and gas platforms, a buffer was calculated from each platform and the aggregate area can be considered the footprint that *could* accommodate one or more existing platforms (assuming it satisfactorily met other criteria under consideration; Figure 3). From each platform, a distance to nearest neighbor calculation was used to determine the distance from each platform to the center of each 4,000 ft x 4,000 ft cell.

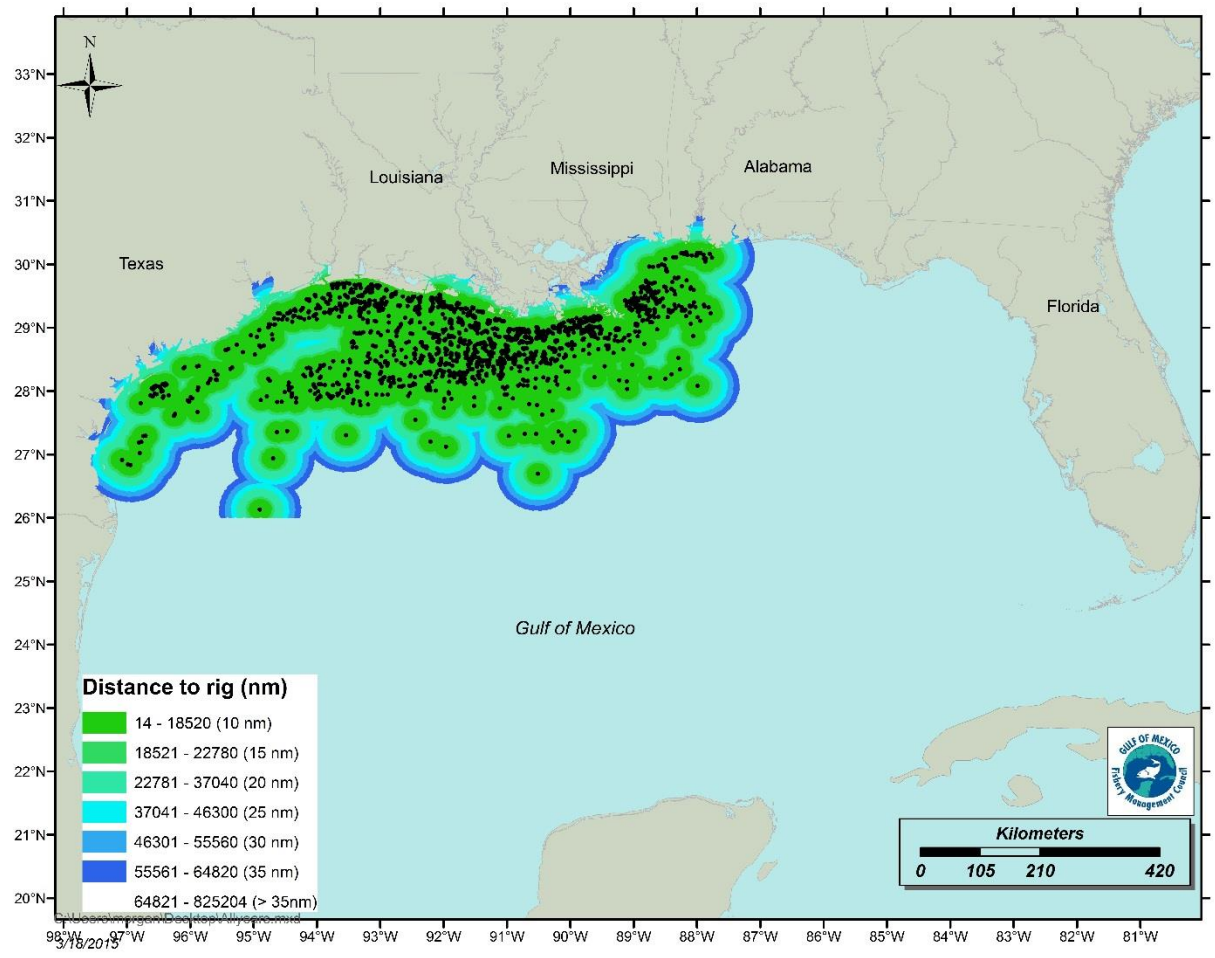

Figure 3. Distance around each oil and gas platform in the Gulf of Mexico EEZ. For analyses, any distance greater than 35 nm should not be considered for an artificial reefing site.

1.5 Distance to Shoreline

The distance to travel from shore is another consideration for establishing artificial reef sites. The major driving force for establishing artificial reefs is to afford recreational anglers opportunities to fish on reef habitats that may otherwise be inaccessible because of distance. Here, we consider several distance strata that might be reasonable for an angler to travel to fish on a reef. Generally, the closer to shore, the shorter the travel time, the more angler opportunities afforded by the reef.

The distance to the shoreline was calculated by finding the nearest neighbor from the center of each grid. These were then categorized by nautical mile bins (Figure 4).

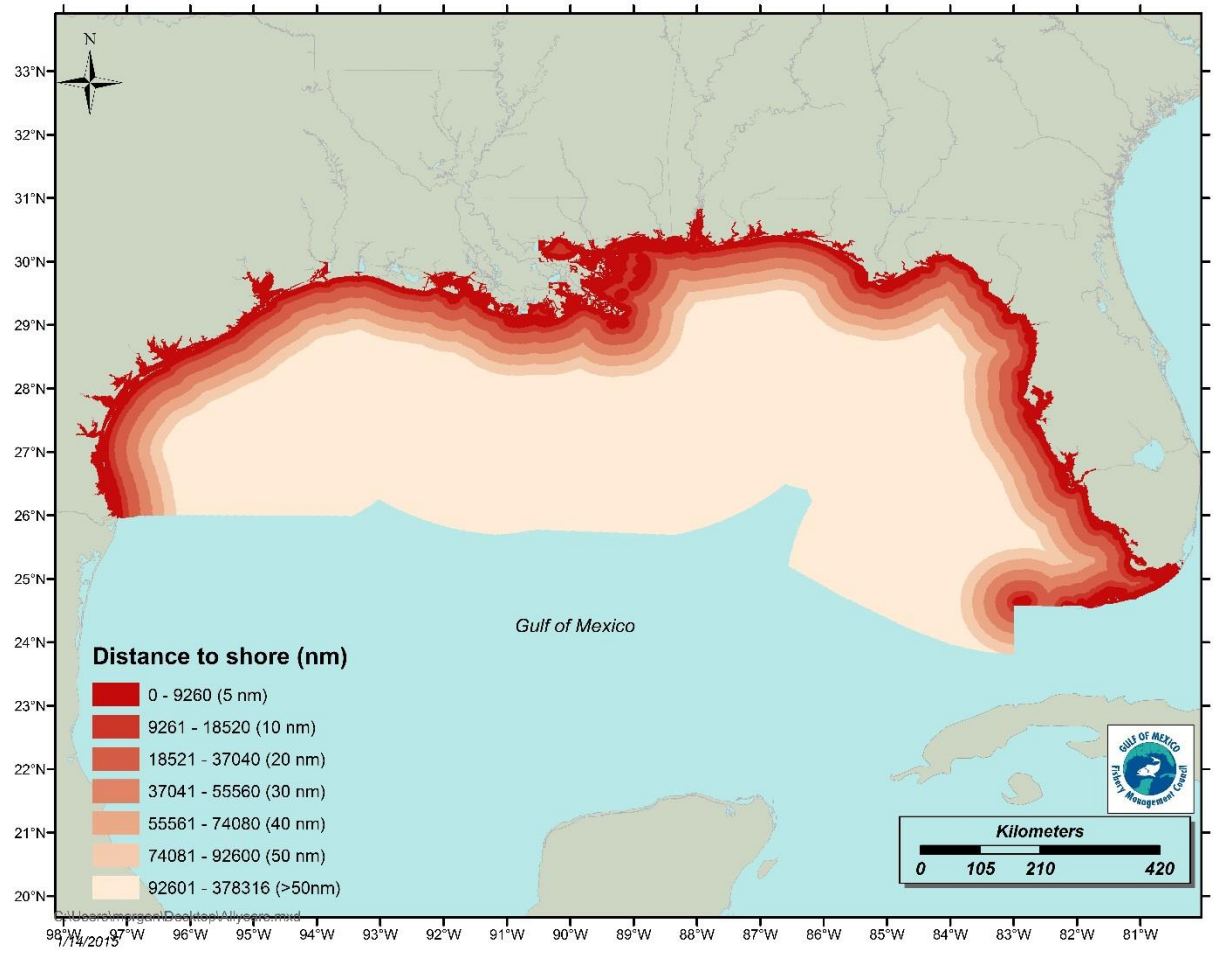

Figure 4. Distance to shoreline in nautical miles from the center of each 4,000 ft x 4,000 ft grid. To maximize fishing opportunities, artificial reef sites should consider areas closer to the shoreline to facilitate angler access.

1.6 Total Number of Artificial Reefs, Platforms, and Wrecks

Currently, there are over 3,000 artificial reefs in the form of wrecks, oil and gas platforms, and artificial reef structures. Using existing designated artificial reef areas would be beneficial for several reasons. First, because anglers already know the artificial reefs exist, it would be helpful to include additional decommissioned oil and gas platforms in these areas. Second, others already know it is a navigational hazard and would avoid bottom trawling and anchoring in that area. Third, it would decrease the footprint of artificial reefs by consolidating platforms in areas where other artificial structure is already present, thereby increasing the three dimensional relief of already existing artificial reefs sites. Coincidentally, many of these sites are nearshore affording anglers more opportunity to fish without traveling long distances.

The total number of reefs, platforms, or wrecks in each 4,000 ft x 4,000 ft cell was also calculated. Following are the full extent of the Gulf of Mexico (Figure 5) as well as two zoomed in versions (Figure 6-7).

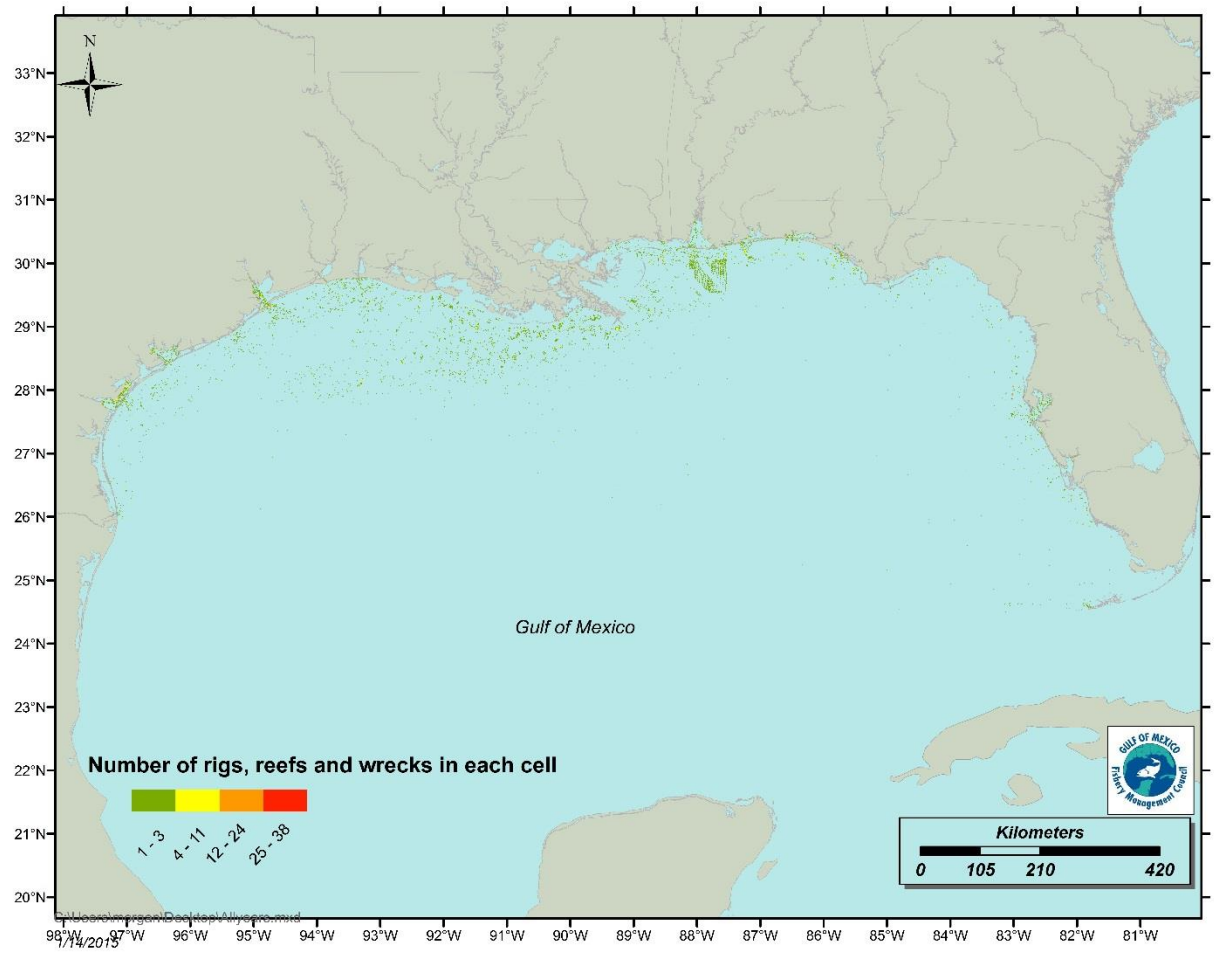

Figure 5. Areas with existing artificial structures in the Gulf of Mexico EEZ.

A close up of the reefs, rigs and wrecks off of the Louisiana Coast

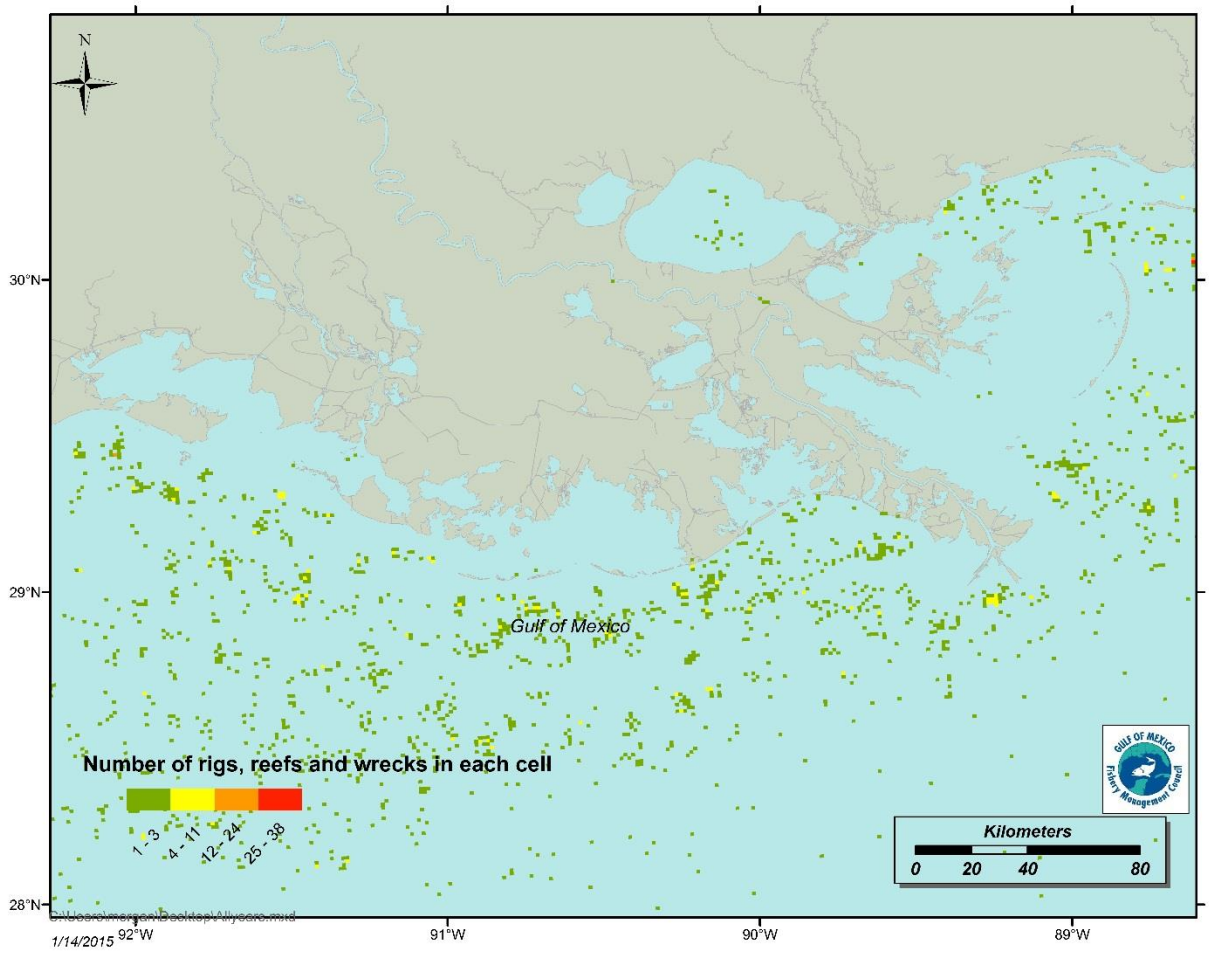

Figure 6. A close up of the artificial structures off of the coast of Louisiana (both state and federal waters).

A close up of the artificial structures and reefs off of the Alabama coast.

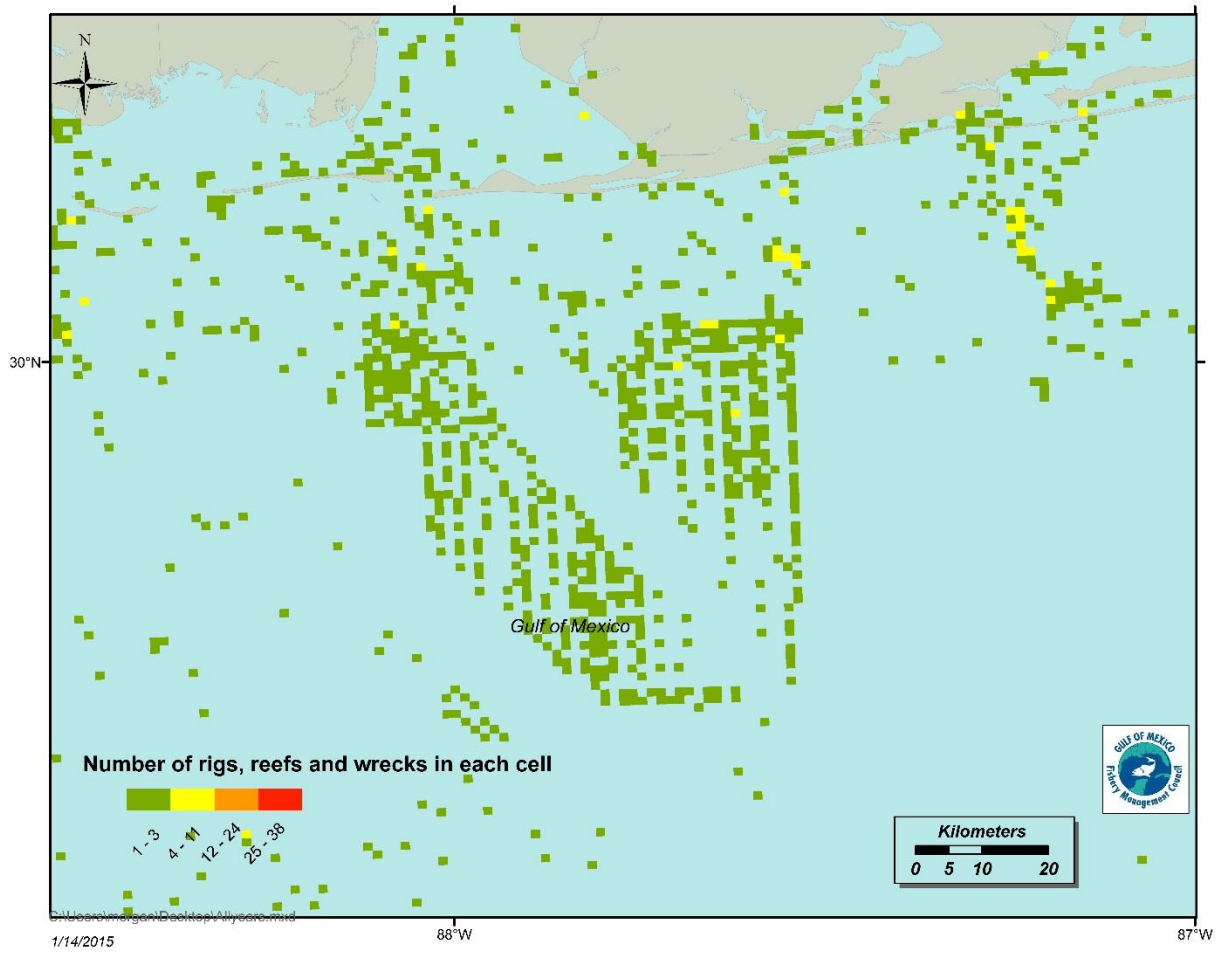

Figure 7. A close up of existing artificial structures off of the coast of Alabama (both state and federal waters).

1.7 Distance to Population Centers

Artificial reefs provide habitat for reef and reef associated fishes and provide anglers additional opportunities for reef fishes. Strategic placement of artificial reefs (including decommissioned oil and gas platforms) could provide social and economic value in terms of fishing opportunities. A reasonable assumption is that reefs placed close to shore and near urban areas will be fished more intensively. To evaluate potential reef placement areas in this framework, distance to the shoreline weighted by the population of the coastal county was calculated to inform this potential decision criteria. If increased angler access is the goal, reefs placed nearshore close to large urban areas provides the greatest benefit. If conservation is the objective, the opposite strategy would be preferred.

For the weighted population distance to city centers, the population was divided by the distance, so that areas with higher populations were assigned a higher relative value to areas with low populations (Figure 8).

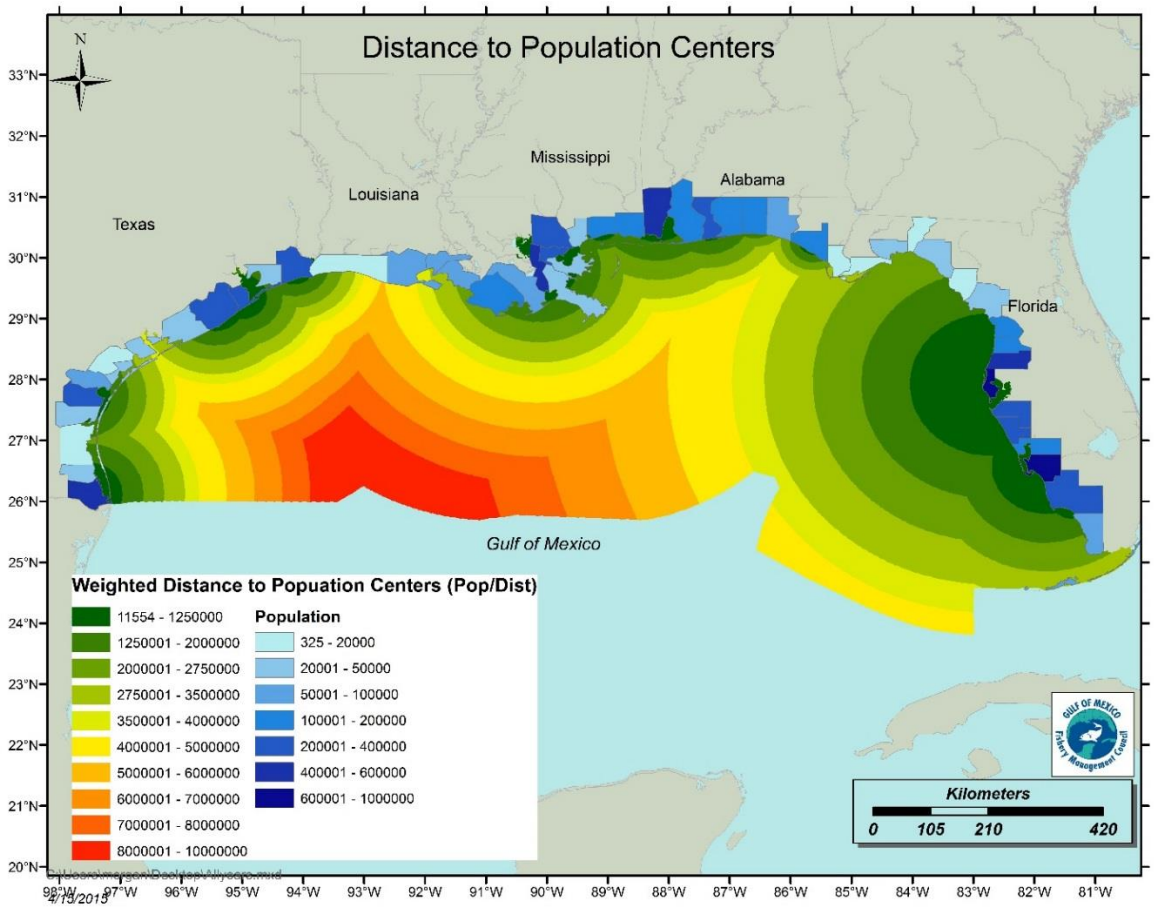

Figure 8. To calculate weighted population distance to coastal counties, the human population (from census data) was divided by the straight-line distance, so that areas with higher populations were assigned a higher value relative to areas with low populations. The human population of coastal counties are indicated via blue shading.

1.8 Number of Shrimp Tows

The placement of artificial reefs may have negative consequences for fisheries that use bottom tending gear (e.g., shrimping). The consideration of where shrimping, the second largest fishery in the Gulf of Mexico, occurs is critical in considering placement of artificial reefs. Reefs should be placed in areas to minimize both potential adverse effects on existing fisheries and disturbance to natural ecosystems. Footprints of artificial reef areas should also be minimized and well documented to prevent entanglement with bottom fishing gear. This reduced footprint may also have biological benefits for the reef and associated fishes as halo effects (i.e., attraction) can be reduced while production is maximized (Pondella et al. 2006).

The total number of shrimp tows from 2004 through 2013 for each 4,000 ft x 4,000 ft grid cell from was calculated by summing up all tow points within a grid cell (Figure 9); it should be noted that these tows are representative of vessels with an electronic logbook. The actual number of tows in these areas is greater when extrapolated for the whole fleet. Currently, only about one third of shrimping vessels have an electronic logbook on board. Tows are calculated by an algorithm which takes into account a vessels speed and interprets whether the vessel is fishing or transiting (Gallaway et al. 2003). Each fishing vessel with an electronic logbook sends off a ping every ten minutes. Therefore, a tow consists of many different pings.

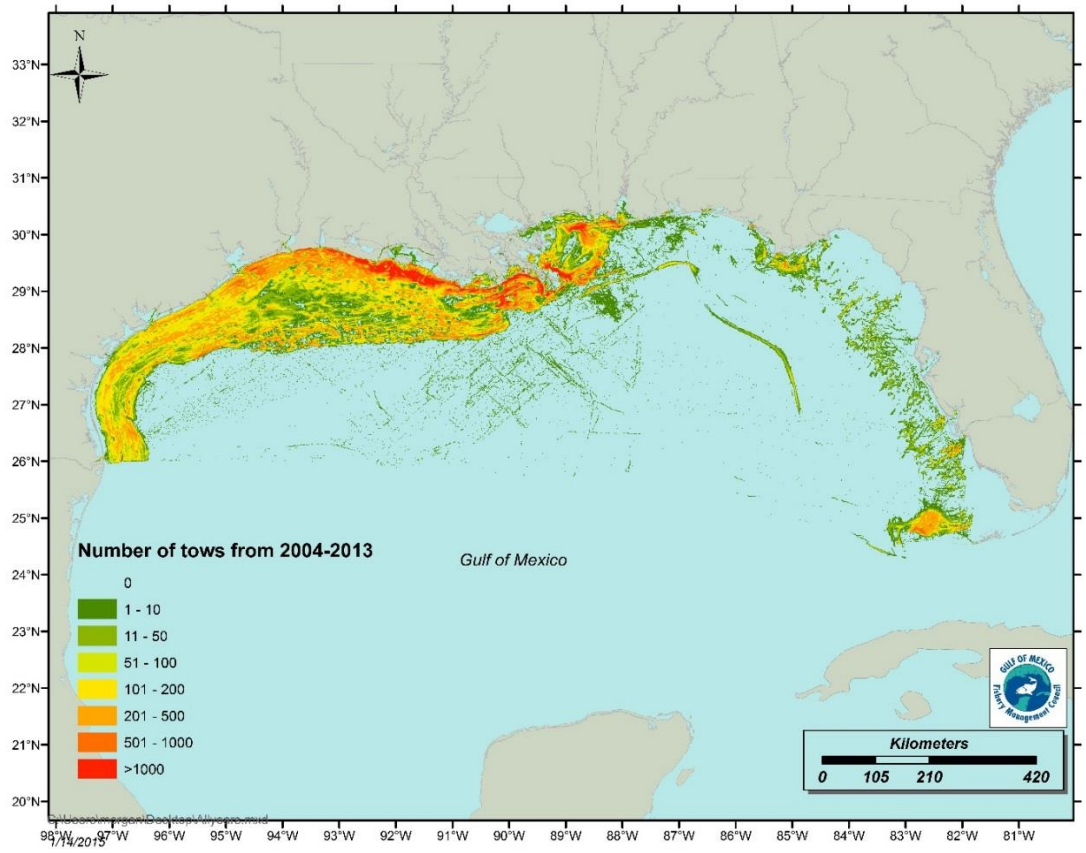

Figure 9. Cumulative shrimp tows in the Gulf of Mexico EEZ from electronic logbook data from 2004-2013.

1.9 Summary

The following criteria were outlined by both the Gulf of Mexico Fishery Management Council's Shrimp AP and members of its Ad Hoc Artificial Reef AP at a meeting in March, 2014. These criteria were listed as critical, but there was some discussion on whether or not weighting of the different variables should be applied. For example, the Shrimp AP did not want any areas that have active shrimping to be considered for artificial reef sites and wanted to consolidate the footprint of existing offshore oil and gas platforms into artificial reef zones that achieve an optimal balance of these criteria. For the oil and gas industry, the distance from platform to the proposed reef site was critical; the shorter the distance, the less industry expense. For placement of decommissioned platforms, it was less important to consider depth or distance from shore. For recreational fisherman, distance from shore and depth of the reef site were more important. When oil and gas platforms are in the process of decommissioning and are examining the transition of a platform for use as artificial reefs, a myriad of factors should be considered and weighed for reef placement.

In summary, we present a spatially explicit decision support tool that can be applied for placement of rigs and platforms scheduled to be reefed. This analysis can be further refined by inclusion of more recent shrimping data, by defining the weighting of the variables and applying these values to each 4,000 ft by 4,000 ft grid. Once specific weighting of each criterion is identified, specific site recommendations could be made for individually decommissioned oil and gas platforms. As it is, the recommendations are to include these criteria when siting locations for decommissioning platforms or creating artificial reefs. Ecological criteria such as hypoxic zone prevalence, habitat preferences of valuable fishery species, and existing sanctuary boundaries may also be considered in future analyses.

A small set of criteria was applied to identify locations that would be appropriate for the placement of decommissioned platforms (Figure 10). None of these criteria were weighted as more important than another. If it is determined that one criterion is more important to consider than others, then a weighting scheme could be applied; however, this should be addressed and documented prior to analysis. Criteria are outlined in the Table 1. Similar tables of criteria can be applied to spatially define appropriate areas, and this is recommended to be informative rather that prescriptive.

Table 1. Criteria used for spatial definition of priority areas in Figure 10. If the value of the grid cell was within the value of the table, the grid was considered a desirable area for artificial reef/platform placement.

Criterion	Values
Depth	Between 70 and 350 ft.
Distance to existing artificial reef structure	Within 35 nm.
Shrimp effort	50 or fewer historical tows

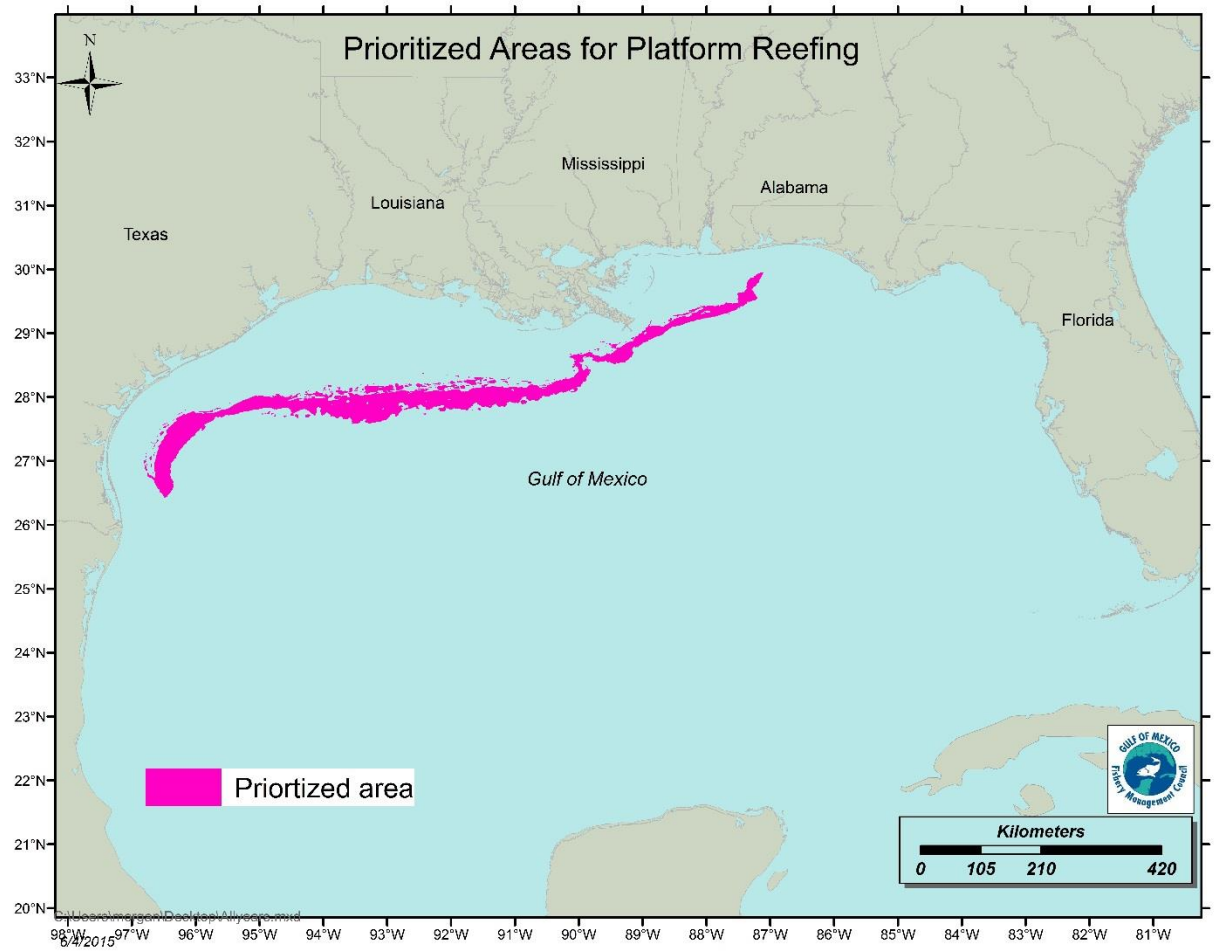

Figure 10. Areas that would be recommended for decommissioned platforms based on 3 criteria: depth, distance to artificial reef structure, and minimal shrimping effort.

2.0 References

Gallaway, B.J., Cole, J.G., Martin, L.R., Nance, J.M., Longnecker, M. 2003. Description of a simple electronic logbook designed to measure effort in the Gulf of Mexico shrimp fishery. North American Journal of Fisheries Management 23: 581-589.

Pondella, II, D.J., Allen, L.G., Craig, M.T., Gintert, B. 2006. Evaluation of eelgrass mitigation and fishery enhancement structures in San Diego Bay, California. Bulletin of Marine Science 78: 115-131.