Untrawlable Bottom in Shrimp Statistical Zones of the Northwest Gulf of Mexico

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Introduction

The shrimping industry in the Gulf of Mexico has criticized the bycatch reduction plans of the Gulf of Mexico Fishery Management Council (GMFMC). A predominant issue the industry has raised is a potential lack of recognition for bycatch reductions that may have already occurred. A specific example of this is that an increase in the untrawlable bottom in shrimping areas could reduce bycatch by the shrimp fishery.

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ABSTRACT—The Gulf of Mexico Fisheries Management Council tasked the National Marine Fisheries Service with determining the extent, if any, of loss of trawlable bottom in the Gulf of Mexico based upon fishing industry concerns. There are approximately 31 million hectares in the 21 shrimp statistical zones in the Gulf, approximately 23 million hectares of waters that are <35 fathoms (where most shrimp trawling effort occurs), and approximately 11 million hectares in zones 10–21, <35 fathoms, which were examined. There are 31,338 known hangs, snags, artificial reefs, hazards to navigation, oil rigs, and similar obstructions which cause trawling to be unfeasible in these zones. There are several refuge (i.e. untrawlable) areas associated with the Alabama Artificial Reefs. Conservatively assuming 1 hectare for each known obstruction, coupled with the known area of each refuge, the estimate of total untrawlable bottom in zones 10–21 less than 35 fathoms in the Gulf is 185,953 hectares, or roughly 1.7% of this total trawlable area. Sensitivity analysis demonstrated the robustness of this assumption, with a range of 0.3–4.3% possible. In specific shrimp zones, untrawlable area is much less than 1% except in zones 10 (26%) and 11 (2.5%), both of which possess a refuge. Other than the implementation periods of these refugia, no temporal trends were detectable with respect to the amount of untrawlable bottom.

Questions of specific concern are: 1) has there been an increase in the amount of untrawlable bottom in the Gulf and 2) if so, when did these changes occur? Thus, the GMFMC asked NOAA's National Marine Fisheries Service (NMFS) to determine the extent, if any, of loss of trawlable bottom in the Gulf based upon shrimp fishing industry concerns.

To address the primary questions raised above, other questions arise. They are: how much area is there in the Gulf Shrimp Statistical Zones (zones); what is the scale of spatial resolution (i.e. amount of change in area) needed to detect a difference within zones; what is the current status of untrawlable bottom in the Gulf zones (specifically, what data sources are there to ascertain this); and what are the temporal trends, if any, and are there data to ascertain this issue?

To assess the bottom condition of the Gulf zones, I assembled data from multiple sources, and then summarized this information by zone to determine the extent of untrawlable phenomena. In addition to addressing the trawlable bottom issue, these data should serve as a baseline for similar fisheries and oceanographic studies.

Materials and Methods

Bottom Area

I used Patella's (1975) estimates for the known amount of area in the Gulf zones (Fig. 1). The total for all zones is 30,901,394.3 ha or, more simply, about 31 million ha. Patella's estimates are commonly available and widely used. Since most shrimp trawling occurs in the shallower portions of these zones, I only assessed bottom area for depths 35 fathoms and shallower, with a Gulf total of 23,431,293 ha, or about 23 million ha.

Zones 1 through 9 were omitted from this analysis. Sparse data at best were available for this region. Relatively little effort has been attempted to assess artificial obstructions in the Florida region, and this is compounded by the underwater topography of this region. Thus, the total area in zones 10–21 in waters less than 35 fathoms is 11,290,485 ha.

Polygonal Areas

There are known areas in the Gulf that are neither amenable, feasible, nor legal for trawling operations. I obtained parameters of these areas (preserves or refugia) to estimate the area that is untrawlable within their bounds. Data collected were simply latitude and longitude corresponding to the corners of these refugia. These were obtained from the following sources.

The Alabama Department of Natural Resources maintains the Artificial Reef General Permit Areas.[1] Although estimated at approximately 900 n.mi.^{2}, after doing the appropriate splitting by zones and removing those portions outside of any zones, the total area from these three areas is slightly greater than 150,000 ha, predominately in zone 10.

The Florida Middle Grounds comprise an area of 153,600 ha, all in zone 6. These coordinates are obtainable

[1] The primary contact is Ralph Havard at 334-861-2882.

from any pertinent navigational chart, but they can be explicitly obtained in Smith et al. (1975). The Florida Keys and Dry Tortugas National Park (NPS and NOS) also comprise assorted polygons, with a combined area of 41,648 ha, predominately in zone 2.[2] However, both of these are only partial estimates of the Florida region. Because I have limited this analysis to zones 10 through 21, these areas were omitted. Also excluded is the Eglin bombing range south of Fort Walton to Panama City, Fla. It is known that trawling is feasible there except during military operations, and it is also beyond the scope of this analysis.

An area purposely omitted from this analysis is the Texas Flower Gardens. Although these areas would qualify, they are all outside (predominately south) of the boundaries of the statistical zones. I assumed that the area associated with these polygons used in this analysis was entirely included in the areas of these zones and shallower than 35 fathoms.

Specific Points

I obtained data to be used as untrawlable point estimates. These data were compiled and source, year, depth, latitude, and longitude (both lat. and long. were in both decimal and minute-degree-second format) were the primary parameters examined. These were obtained from MMS, NOS, GSMFC, ALSG, and TXSG.

The Minerals Management Service (MMS) produced oil rig data on the World Wide Web.[3] This information was downloaded in ASCII format for the analysis.

The National Ocean Service (NOS) produced information on hazards to navigation, commonly known as the AWOIS (NOS, 1994).

The Gulf States Marine Fisheries Commission (GSMFC) produced a listing of artificial reef development in the Gulf (Lukens, 1993).

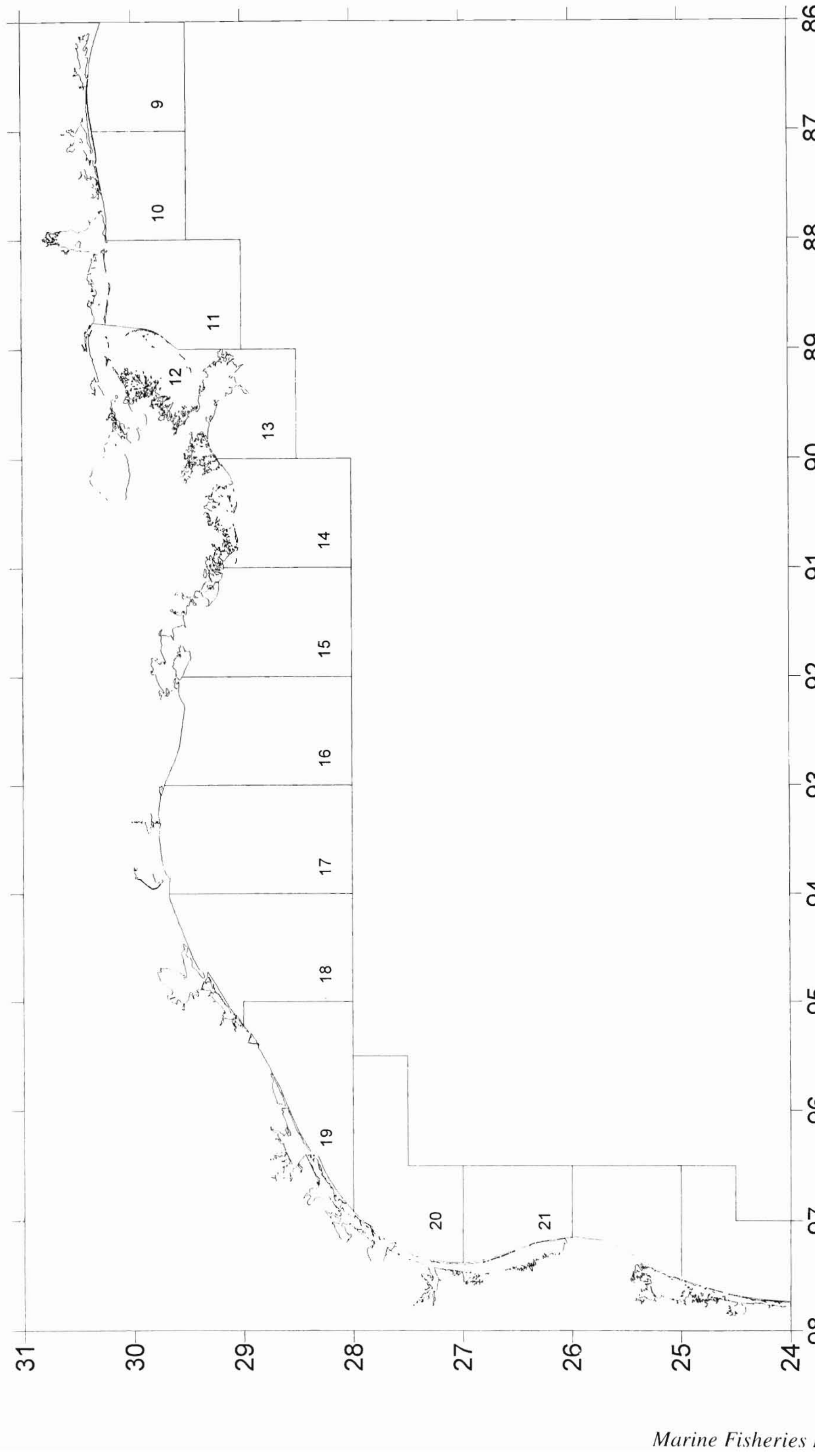

Figure 1.— Shrimp statistical zones in the Northwest Gulf of Mexico.

[2] A contact for this is Ben Haskell at 305-743-2437.

[3] Oct. 1996. http://www.mms.gov/omm/gomr/homepg/pubinfo/freeasci/platform/freeplat.html. A contact for this data is Norman Froomer at 504-736-2782.

Table 1. — Obstructions, polygons, and areas for each (assuming 1 ha per obstruction) by statistical zone relative to trawlable bottom.[1]

Zone	Area (Patella)	Hzd hang (NOS)	Art. reefs (GSMFC)	Hangs (ALSG)	Oil Rigs (MMS)	Hangs (TXSG)	Summary	Area total	Polygons area	Total untrawl.	Trawl. (Patella)	Total untrawable/ trawlable
10	643,145	272	48	86	9		415	415	133,835	134,250	508,896	0.26381
11	915,633	282	29	1,486	241		2,038	2,038	20,118	22,156	893,476	0.02480
12	101,238	57	2	436	26	1	522	522		522	100,716	0.00518
13	324,658	36	3	1,261	324	315	1,939	1,939		1,939	322,719	0.00601
14	791,626	45	3	1,192	602	1,213	3,055	3,055		3,055	788,571	0.00387
15	1,139,186	14	8	1,676	708	1,732	4,138	4,138		4,138	1,135,048	0.00365
16	1,430,383	7	2	2,371	540	1,970	4,890	4,890		4,890	1,425,493	0.00343
17	1,637,564	171	15	1,731	373	1,301	3,591	3,591		3,591	1,633,973	0.00220
18	1,530,259	420	28	1,227	139	1,131	2,945	2,945		2,945	1,527,314	0.00193
19	1,194,823	646	19	1,227	137	1,904	3,933	3,933		3,933	1,190,890	0.00330
20	891,486	603	12	457	66	1,476	2,614	2,614		2,614	888,872	0.00294
21	690,485	55	4	231	7	961	1,258	1,258		1,258	689,227	0.00183
Total	11,290,486	2,608	173	13,381	3,172	12,004	31,338	31,338	153,953	185,291	11,105,195	0.01668

[1] Totals may not add owing to rounding of data

The Alabama Sea Grant Program (ALSG) provided a listing of hangs, snags, and other trawling obstructions (Hosking et al., 1987).

The Texas Sea Grant Program (TXSG) provided an updated listing of similar obstructions (Graham, 1996a, b).

Contacts with state Departments of Natural Resources, Bureaus of Marine Resources, Departments of Conservation, Departments of Wildlife and Fish, and similar institutions revealed only minimal point data (i.e. <100), and these were not explicitly included in the analysis since most were already included in the Sea Grant or GSMFC data sets.

Once all of these data were placed in digital format (ASCII txt and Dbase dbf files), they were debugged and compiled. This compiled data set is housed at the NMFS Mississippi Laboratories facility of the Southeast Fisheries Science Center.[4] The sort procedure in SAS (Statistical Analysis System, v. 6.10) was used to delete all duplicates based upon decimal latitude and longitude coordinates. That is, an obstruction noted from two or more sources to be located at the same place was not counted twice. However, due to slightly different methods of estimating digital latitude and longitude it is possible that there may be some duplication between the two Sea Grant data sets.

Those data (i.e. oil rigs) from the MMS data set known to have been removed were also deleted from further analysis. The total number of rigs from 1990 to 1994 has remained relatively constant (Froomer[5]). During 1983–96, there was an average of about 125 removals per year and an average of about 110 additions per year. This assumes that a site formerly occupied by an oil rig is entirely devoid of bottom obstructions.

After sorting and removals, each obstruction was assigned to the appropriate zone using SAS. I assumed that all of these obstructions were in waters shallower than 35 fathoms.

A conservative assumption is that each of these points represents the center of a circle with an area of 1 ha that is untrawlable. Scanning the hangs, reefs, and similar data sets, I noted the radius of such obstructions (if provided) and none approached that magnitude of area. This assumption is also entirely reasonable for oil rigs (Dyhrkopp[6]). The largest oil rigs in the Gulf are on the order of 300 ft^2, smaller than 1 ha (about 328 ft^2). Conversations with personnel at other agencies (NMFS, Sea Grant, state agencies) affirm this assumption.

Results and Discussion

Untrawlable Bottom

The total area for the refugia is 153,953 ha (Table 1). Without these polygons, <1% (0.3%) of the Gulf in these zones within these depths is untrawlable (Table 2). Accounting for the various removals and duplications, the total number of points from each source were: GSMFC, 173; MMS, 3,172; NOS, 2,608; ALSG, 13,381; and TXSG, 12,004 (Table 1). These obstructions are concentrated in the shelf off Texas and Louisiana from zones 14 to 20. All of these zones examined, except zones 10, 12, and 21, have roughly 2,000 or more obstructions each.

Table 2. — Sensitivity analysis of the area per obstruction relative to the trawlable bottom in zones 10–21 less than 35 fathoms.

Area per point (ha)	Total untrawlable	Total trawlable	Untrawable/ trawlable
Standard (1)	185,291	11,105,194	0.01669
0.1	157,087	11,133,398	0.01411
0.25	161,787	11,128,697	0.01454
0.5	169,622	11,120,863	0.01525
2	216,629	11,073,856	0.01956
4	279,305	11,011,180	0.02537
10	467,333	10,823,152	0.04318
No polygons	31,338	11,259,147	0.00278

Given the assumptions of 1 ha and that all these points are shallower than 35 fathoms, the amount of untrawlable bottom from these point data is estimated at 31,338 ha (Table 1). Sensitivity analysis showed that by assuming each point variably represents 1, 0.1, 0.25, 0.5, 2, 4, or 10 ha, the relative ratio of the changes in these ranges from 1.2 to 4.3% (Table 2). Thus, a robust and reasonable conclusion is that untrawlable bottom tallied from the data sources above constitute about 2% of potential shrimping grounds.

By adding the number of points that are known obstructions, assuming an area for each (in this case, 1 ha), adding this total to the amount of area set aside as refugia, this sum (185,953 ha; Table 1) can be subtracted from the known area of these shrimp zones shallower than 35 fathoms to estimate the

[4] P.O. Drawer 1207, Pascagoula, MS 39568.

[5] Froomer, N. MMS, 1201 Elmwood Park Blvd., New Orleans, LA 70123. Personal commun. Nov. 20, 1996.

[6] Dyhrkopp, F. MMS, 1201 Elmwood Park Blvd., New Orleans, LA 70123. Personal commun. Nov. 20, 1996.

area in zones 10 through 21 that is still trawlable (over 11,300,000 ha). By examining the ratio of total untrawlable bottom to total area, only 1.7% of these zones is untrawlable.

Examining this same ratio by zone unsurprisingly shows that zones 10 (26%) and 11 (2.5%) have a relatively high percentage of their bottoms that are untrawlable. All other zones are much less than 1% untrawlable. The reason the preceding zones have such a high percentage is due to the presence of refugia in these zones. Without these refugia they too would be well below 1% untrawlable.

Changes in Untrawlable Bottom

To address the temporal aspect of this issue, each datum would need an associated year. This information is not available. Simply put, the temporal resolution to address this question does not exist. I could have artificially assigned a year to each obstruction based upon the year the source of each was published, but that did not seem reasonable and is potentially misleading. I examined the data that had known years before and after several cut-off points, and no pattern was observable. Additionally, even if a year was given for when an obstruction was observed, assuming it was placed there in the same year may also not be a reasonable assumption. The predominant type of obstruction expected to change and also amenable to quantification would be oil rigs. Again, conversations with MMS personnel (Froomer[5]) noted the total number of rigs has remained relatively constant, with about 125 removals and 110 additions on average per year during 1983–96.

Given the areas of all Gulf zones, to detect a 1% change in the entire Gulf trawlable bottom, an increase or decrease in 300,000 ha would have to occur Gulfwide. Carried further, a change in 30,000 ha would only be a 0.1% change in the entire Gulf. For areas less than 35 fathoms, 230,000 ha and 23,000 ha would have to be removed to detect a 1% and 0.1% change, respectively. Removing 23,000 ha from all but the smallest zones (12 and 13) produces a 1–4% change within a zone. A change on the order of 23,000 ha would require an interesting and noteworthy event or series of events. Similarly, to observe a 1% change in zones 10 through 21 less than 35 fathoms, 110,000 ha would have to be altered (Table 1).

On an absolute basis, all obstructions should be (and will likely continue to be) tracked and may indeed change. The perception when graphically presenting these data is often extreme and gives an inflated sense of untrawlable bottom due to the scale of representing an obstruction relative to the scale of the map (Fig. 1). However, when weighted by the spatial scale of these zones, at least 110,000 removals or additions would have to occur to detect a 1% change in zones 10 through 21 less than 35 fathoms. This is much greater than the total that have been recorded during the entire period that this information has been tracked.

The implementation periods for the refugia have been the biggest change in trawlable bottom of these zones. Before 1986, zones 10 through 21 less than 35 fathoms had an untrawlable area of 0.27% (Table 2), but after 1989 that rose to 1.67%. Once fully implemented, these reefs added 1.4% to the total untrawlable bottom area in these zones. This largest single change in trawlable bottom is predominately in zone 10. Approximately one-quarter of that zone was untrawlable after these reefs were established. When considered across all zones from 10 to 21 and less than 35 fathoms, the untrawlable area including these refugia is still only 1.7%.

Initial expectations of changes in untrawlable area when this analysis was initiated were on the order of 5–10% of the entire Gulf. The order of magnitude required for this to have occurred seems unlikely. More importantly, this suggests that to detect any change is likely rather difficult due to the spatial scale involved. Thus, although the data do not exist to explicitly ascertain temporal changes in the amount of untrawlable bottom in these Gulf zones, it is highly unlikely that, other than setting aside known areas of extremely substantial size, will there be nor have there been changes in the area that is considered trawlable bottom in the Gulf of Mexico Shrimp Statistical Zones.

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