Preliminary Analysis of Towed Camera Video Data from the eastern Gulf of Mexico for Derelict Fishing Gear Distribution and Concentration

Final Report

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Introduction

Marine debris is a persistent, global problem for marine ecosystems which continues to grow due to increased human populations and coastal development. The term encompasses any solid material that has made its way into the marine environment and ranges from extremely small (e.g. degraded plastic particles) to large items, such as boat wreckages (NOAA, 2020). A significant contributor of marine debris is derelict fishing gear (DFG) which most commonly takes the form of nets, line and traps (NOAA, 2013). This type of marine debris does not discriminate in what it impacts; fishes, crustaceans, mammals, sea turtles, seabirds, coral reefs and benthic habitat are all impacted by DFG (NOAA, 2015). Termed "ghost fishing," lost, abandoned and discarded fishing gear poses a threat to underwater ecology as marine life mortality continues long after the gear is discarded. Derelict fishing gear can also damage important habitat, such as coral reefs and benthic fauna which make up living hard bottom where fishes thrive. This in turn can lead to considerable economic losses (NOAA, 2013). While DFG is harmful, it isn't always littering that is the culprit; the most common reasons for loss of gear are adverse weather, cost of gear retrieval, or other operational fishing factors and gear conflicts (e.g. mobile gear passing through statically positioned gear). Other factors can contribute, such as illegal fishing, vandalism, theft and cost/availability of shoreside collection facilities, but this continues hold a lack of understanding due to failure of proper documentation (Macfadyen et al., 2009). Derelict fishing gear also adds to marine pollution that is quickly continuing to grow. Derelict fishing gear is particularly dangerous due to modern gear being made of synthetic materials and metal (NOAA 2013), known to remain on the seafloor for days to years, with fishes coming and going as they please. It's important to note that ghost fishing only occurs if there is a result of mortality from fishes getting caught in the gear (Lively & Good, 2019).

While most existing information on gear loss is from small scale surveys and underwater census (Macfadyen et al., 2009), it is important to continue to monitor these case-specific areas, even if a more systematic approach is needed. Surveying and monitoring marine protected areas (MPAs) and habitats for targeted or endangered fishes, turtles and other ecologically important species can contribute to preserving the marine life ecosystem, even if on a small scale. The best way to go about this would be with a non-impactful strategy.

The University of South Florida-College of Marine Science (USF-CMS) group, Continental Shelf Characterization, Assessment and Mapping Project (C-SCAMP), previously mapped, classified and characterized 2,350 km^2 of benthic habitat in the eastern Gulf of Mexico in unmapped, targeted areas. Using USF-CMS's custom-built platform, the Camera-Based Assessment Survey System (C-BASS; Lembke et al., 2017), ground truthed over 3,000 km of linear transect from 2016-2019, resulting in over 500 hours of imagery. This included natural and artificial habitats containing a variety of important marine life, including economically important fishes and endangered sea turtle species.

Methods

Trial analysis for evidence of discarded fishing gear and marine debris was accomplished using datasets previously collected by the C-SCAMP team. The purpose of this trial was to assess the potential for the C-BASS platform to provide useable data on the distribution, concentration and composition of marine debris, in particular DFG, for future research and possible remediation measures. Thirteen transects were chosen based off previous analysis of fish density, year and habitat characterization (Table 1) on the Gulfstream Pipeline, Madison-Swanson MPA, the Elbow, Steamboat Lumps MPA, the Florida Middle Grounds HAPC and the SW Florida Middle Grounds (Figure 1).

Table 1: Summary of transects chosen for marine debris analysis based on year, fish & turtle density and habitat. *Analyzed both forward and side cameras

Area	Transect	Year	Total Fish Count	Total Turtle Count	Habitat Type (majority)
Gulfstream Pipeline	GSPLT1*	2016	8,834	7	Anthropogenic structure (pipeline)
Gulfstream Pipeline	GSPLT2*	2016	25,433	18	Anthropogenic structure (pipeline)
Gulfstream Pipeline	GSPLT3	2016	8,502	15	Anthropogenic structure (pipeline)
Madison-Swanson	MST2D10	2014	N/A	N/A	Soft/hard bottom
Madison-Swanson	MST3D11	2013	N/A	N/A	Soft/hard bottom
Florida Middle Grounds	FMGT1D6	2014	N/A	N/A	Mixed hard bottom
The Elbow	ELT3D1	2016	342	1	Soft/hard bottom
The Elbow	ELT3D5	2016	245	0	Soft/hard bottom
Steamboat Lumps	SLT3D7	2013	N/A	N/A	Soft bottom
SW Florida Middle Grounds	SWFMGT4D1	2016	891	0	Soft/hard bottom
SW Florida Middle Grounds	SWFMGT6revD9	2016	21,314	1	Soft/hard bottom

It was important include multiple areas with various habitat types, but the Gulfstream Pipeline was a main focus due to known high densities of fish and sea turtles, the latter of which is30x greater compared to C-BASS observations over natural habitats (Broadbent et al. 2020). Personal communications between C-SCAMP project personnel and local fishermen indicate that there are also high levels of rod and reel activity on the pipeline, making this feature an ideal test-bed for DFG analysis.

The C-BASS has a total of six analog and digital cameras; four in front and one on each side to give a 180° view (Figure 2) and is towed 2-3 meters above the seafloor. Each transect is broken down into 1-minute video segments (1-minute = approx. 110 linear meters of transect) and only the videos with clear visibility of the seafloor were included in analysis. If the visibility was too poor, these segments were also excluded from analysis. Each transect was watched in entirety and all marine debris was identified (otherwise marked as misc. or unknown) and recorded, including possible trawl marks. Of the selected thirteen transects, three were along the pipeline; for two of the pipeline transects, the analysis was repeated using a different camera angle to assess the usefulness of the C-BASS side cameras – these counted as two additional transects (for a total of 5 along the pipeline). Others included two transects in

Madison-Swanson, two in The Elbow, one in the FL Middle Grounds, two in the SW FL Middle Grounds and one in Steamboat Lumps. For each occurrence of marine debris, a screen shot was taken for additional documentation.

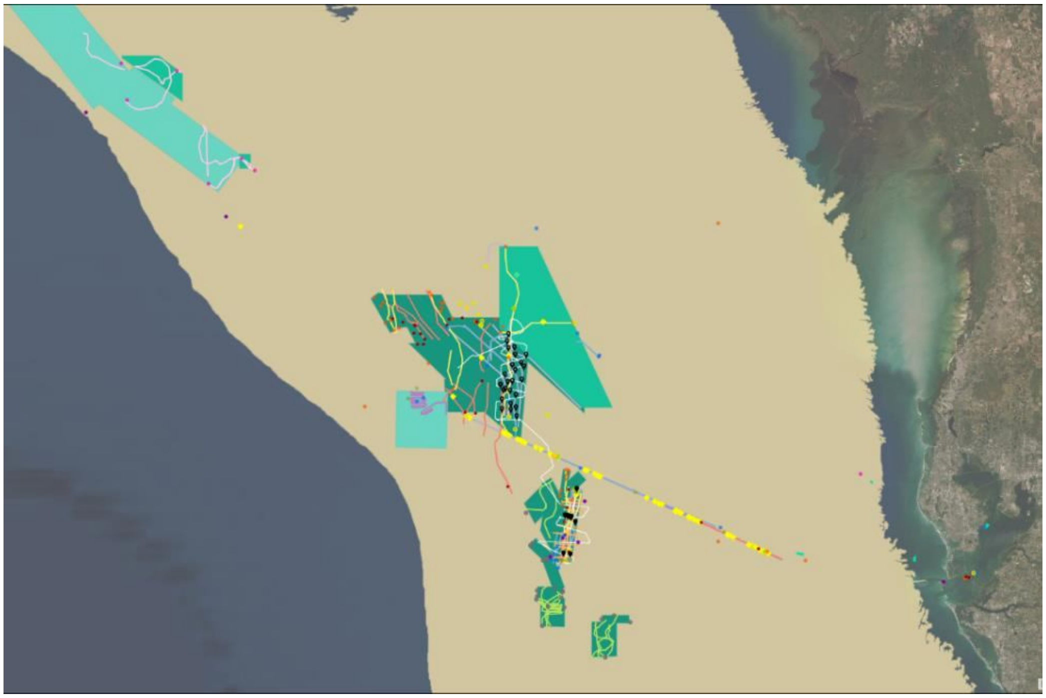

Figure 1: Overview of the areas C-SCAMP mapped and imaged between 2015-2019.

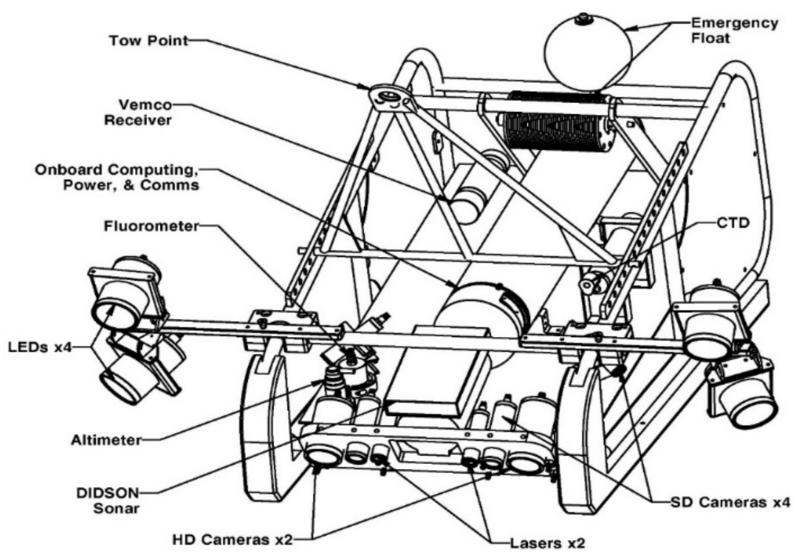

Figure 2: Schematic of the Camera-Based Assessment Survey System (C-BASS).

Results

A total of 50 hours of analysis resulted in the observation of 102 pieces of marine debris within thirteen C-BASS transects which totaled 349.58 km of linear transect observed. This equates to an overall average of 0.207 pieces of litter/km transect. A breakdown of the debris observed along each transect can be found in Table 2. The most common debris observed via the C-BASS was fishing line or nets (DFG), anchors (DFG), tarps, bags and metal sheets (these were only along the GSPL where they exist as buckles around the pipeline at seam points but were only counted if they'd broken and were off the pipeline; Figure 3).

Among the areas where observations were made, most debris were observed on the Gulfstream Pipeline (Table 3). Though most of the analysis effort focused on this artificial habitat, even when standardized the GSPL had the highest amount of observed debris compared to natural bottom transects that were also analyzed. Of the debris observed for all the transects, only 42% could be considered DFG (nets, buoys, line), with the rest as 3% plastic, 18% metal, 9% paper and 28% misc/unk. Though trawl marks were part of this analysis, no observations could confidently be made although possibly man-made impressions were commonly observed throughout analysis.

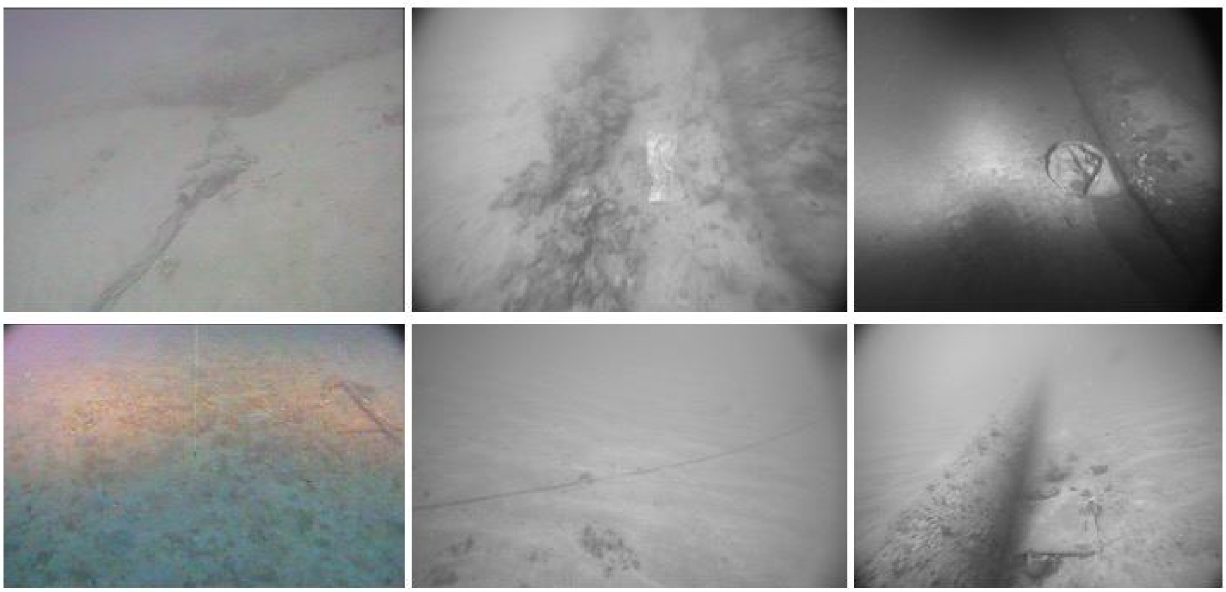

Figure 3: Common debris observed (clockwise from top-left); net (pipeline), bag or tarp (pipeline), bag (pipeline), metal clasp (pipeline), line (SW FL Middle Grounds) and an anchor (Madison-Swanson).

Table 2: Debris observed per transect per survey area. Cameras are in HD (high definition) or SD (standard definition), and were oriented forward-facing, port (left) or starboard (right).

Survey Area	Transect Name	Year	Camera	Length of Transect Surveyed (km)	Plastic (%)	Metal (%)	DFG (%)	Paper (%)	Misc/ Unk (%)	Total # of Debris Observed	Debris/ Linear km
Gulfstream Pipeline	GSPLT1	2016	HD forward	28.16	3%	37%	30%	10%	20%	30	1.07
Gulfstream Pipeline	GSPLT1	2016	SD starboard	28.05	0%	0%	100%	0%	0%	5	0.18
Gulfstream Pipeline	GSPLT2	2016	HD forward	19.58	0%	12%	59%	6%	23%	17	0.87
Gulfstream Pipeline	GSPLT2	2016	SD port	19.47	0%	33%	0%	33%	33%	3	0.15
Gulfstream Pipeline	GSPLT3	2016	HD forward	55.55	6%	10%	23%	13%	48%	31	0.56
Madison-Swanson	MST2D10	2014	SD forward	18.92	0%	0%	80%	0%	20%	5	0.26
Madison-Swanson	MST23D11	2013	SD forward	15.29	0%	50%	50%	0%	0%	2	0.13
Florida Middle Grounds	FMGT1D6	2014	SD forward	38.06	0%	0%	67%	0%	33%	3	0.08
SW Florida Middle Grounds	SWFMGT4D1	2016	HD forward	39.6	0%	0%	0%	0%	100%	1	0.03
SW Florida Middle Grounds	SWFMGT6revD9	2016	HD forward	34.32	0%	0%	100%	0%	0%	2	0.06
The Elbow	ELT3D1	2016	HD forward	24.97	0%	0%	100%	0%	0%	2	0.08
The Elbow	ELT3D5	2016	HD forward	17.93	0%	0%	100%	0%	0%	1	0.06
Steamboat Lumps	SLT3D7	2013	SD forward	9.68	0%	0%	0%	0%	0%	0	0

Table 2: Summary of debris observations for each survey area. *Includes DFG

Area	Number of Debris Items Observed	Number of DFG Observed	Area Surveyed (km^2)	Hectares Surveyed (ha)	Debris* items/km^2	Debris items/ha	DFG items/km^2	DFG items/ha
Pipeline	86	31	1.51	151	56.95	.57	20.53	0.21
Madison-Swanson	7	5	0.34	34	20.59	.21	14.71	0.15
Florida Middle Grounds	3	1	0.38	38	7.89	0.08	2.63	0.03
SW Florida Middle Grounds	3	2	0.74	74	4.05	0.04	2.70	0.03
The Elbow	3	3	0.43	43	6.98	0.07	6.98	0.07
Steamboat Lumps	0	0	0.10	10	0	0	0	0

Discussion

There are little reported data on benthic marine debris in the Gulf of Mexico and no West Florida Shelf-specific (i.e. withing 20-200 meters depth) studies could be found. Compared to other numbers reported in the central/eastern Gulf, it appears that the numbers observed in this study were relatively low. In Wei et al. (2012), trawl surveys were used to evaluate marine debris in the central Gulf of Mexico and two of their sites were near the northern West Florida Shelf break (S35 and S44). These two survey locations are considerably deeper (>250m) than the C-BASS transects studied here (30 - 180 m depth). At S35 and S44, Wei et al. observed debris in concentrations of 0.5 – 2.0 items/hectare (this included a wide range of debris from cotton cloth to metal, monofilament line, paper, and Styrofoam). The highest concentration of marine debris we observed via C-BASS footage in this analysis 0.57 items/hectare and this was even lower when only considering DFG (0.21 items/hectare; Table 3). In the Florida Keys, diver belt transect surveys counted a total of 686 marine debris items within their total area surveyed (0.035 km^2; Miller et al. 2008). Most of the debris was hook-and-line gear (e.g. hooks, monofilament, sinkers) and discarded trapping gear (e.g. pots, cages). This comes out to approximately 20,000 items/km^2 which is substantially higher than the maximum observed by the C-BASS (56.95 items/km^2 [GSPL]; Table 3). What these comparisons appear to capture are the significant differences among sampling platforms in their respective evaluations of marine debris extents and concentrations.

A possible explanation for lower marine debris observed in this analysis, and specifically DFG, could be the areas for which data were available (Madison-Swanson MPA, the Gulfstream Pipeline, Florida Middle Grounds, the Elbow). These data were originally collected for the purposes of habitat assessment and fish density estimation. As such, much of the footage is concentrated over hardbottom. Seeing as these areas of rougher bottom could result in greater chances of gear loss (particularly for trawls and bottom long-lines) and considering they are well-known, it is plausible that fishermen have known for several decades to avoid them to decrease chances of gear loss. Unexpectedly, aside from the GSPL the Madison-Swanson MPA (which is closed to all bottom-contacting gear and only open to surface trolling during select months) had the highest observed density of debris and DFG. This MPA has been closed under these restrictions since the early 2000s but it's difficult to determine whether the DFG was deposited before or after Madison-Swanson's establishment.

Based on this preliminary analysis, it appears that towed camera data can provide helpful information on DFG and other marine debris in the eastern Gulf of Mexico. However, for a comprehensive understanding of the fate and distribution of DFG, additional survey methods would likely be required. There could be great power in coordinated, paired surveys with a towed camera system and an ROV; the former can efficiently cover more area while the latter could be deployed selectively in areas of high relief where the towed system has difficulty navigating steep bathymetric changes. This is important as areas of higher relief may be more likely to trap – and possibly be the cause of – DFG, but a towed system does not have the maneuverability required to effectively sample these portions of seafloor.

Acknowledgements

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