FINAL PROJECT REPORT
NOAA MARINE DEBRIS PROGRAM

PROJECT TITLE: Derelict Traps and Casita Debris in the Florida Keys National Marine Sanctuary: Distribution, Habitat Impacts, and Bycatch Mortality

DATE: July 22, 2008

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(1) PROJECT TITLE: Derelict Traps and Casita Debris in the Florida Keys National Marine Sanctuary: Distribution, Habitat Impacts, and Bycatch Mortality

(2) REPORTING PERIOD: March 1, 2008 – May 31, 2008

(3) PROJECT OVERVIEW:

Spiny lobster and stone crab trap debris and casitas (artificial structures illegally deployed by divers to attract lobsters for subsequent harvest) are common features along shorelines and in nearshore waters of the Florida Keys. Tens of thousands of traps are lost annually during routine fishing and hundreds of thousands of traps are lost during hurricanes. The number of casitas is unknown but a recent cleanup effort removed 66 tons of debris. In addition to presenting a hazard to navigation and public health and safety, derelict traps and casitas may both have an impact on Essential Fish Habitat (EFH) as they rest directly on top of habitat features and move during storms. Traps may also continue to actively fish, causing mortality of confined animals. Little data exists on the impact of traps and casitas on EFH or the extent of lobster, crab, and bycatch mortality from derelict traps. This project uses towed-diver surveys throughout the Florida Keys National Marine Sanctuary (FKNMS) to document the distribution of derelict trap debris and casita structures and the extent of habitat damage from both. The proposed surveys will provide critical data on the distribution of trap and casita debris, the impact of this debris on EFH, and lobster and bycatch mortality. Specifically, this project will result in a distribution map of primary habitats in the FKNMS affected by debris, estimates of habitat damage from both derelict traps and casitas, and observations of the potential for lobster and other confined animal mortality due to derelict traps. In combination, these key pieces of information will help more effectively manage the trap fisheries in the Florida Keys by providing quantitative information on the existence and extent of the debris problem and identification of specific targets for remedial action.

(4) PROGRESS TO DATE:

METHODS

Site Selection

The nearshore waters of the Florida Keys National Marine Sanctuary were divided into eight use-zones of the commercial spiny lobster fishery including the Upper, Middle, and Lower Keys on both the Atlantic Ocean and Florida Bay sides of the island chain and the Gulf and Ocean sides of the Marquesas Keys (Figure 1). These zones are based upon historic differences in density of trap use (Florida Wildlife Conservation Commission, unpublished data). The zones were subdivided into one minute latitude x one minute longitude grids. Within each zone, 15 grid squares were randomly selected for surveys. The Marquesas zones were not included for surveys due to lower trap densities (FWC, unpublished data) and difficult access to this remote area.

Manta Tow Surveys

Towed-diver debris surveys were initiated in May 2007 and were completed in December 2007. The center point of each randomly selected square was navigated to using a Garmin GPS unit. Care was taken such that the boat rarely drifted more than 50 m from the original coordinate. Once towing commenced, a second coordinate was recorded, to mark the exact starting point. Tow direction was determined based upon random selection of a bearing (0 - 360°). Tow direction was altered when necessary to exclude land and other navigational hazards.

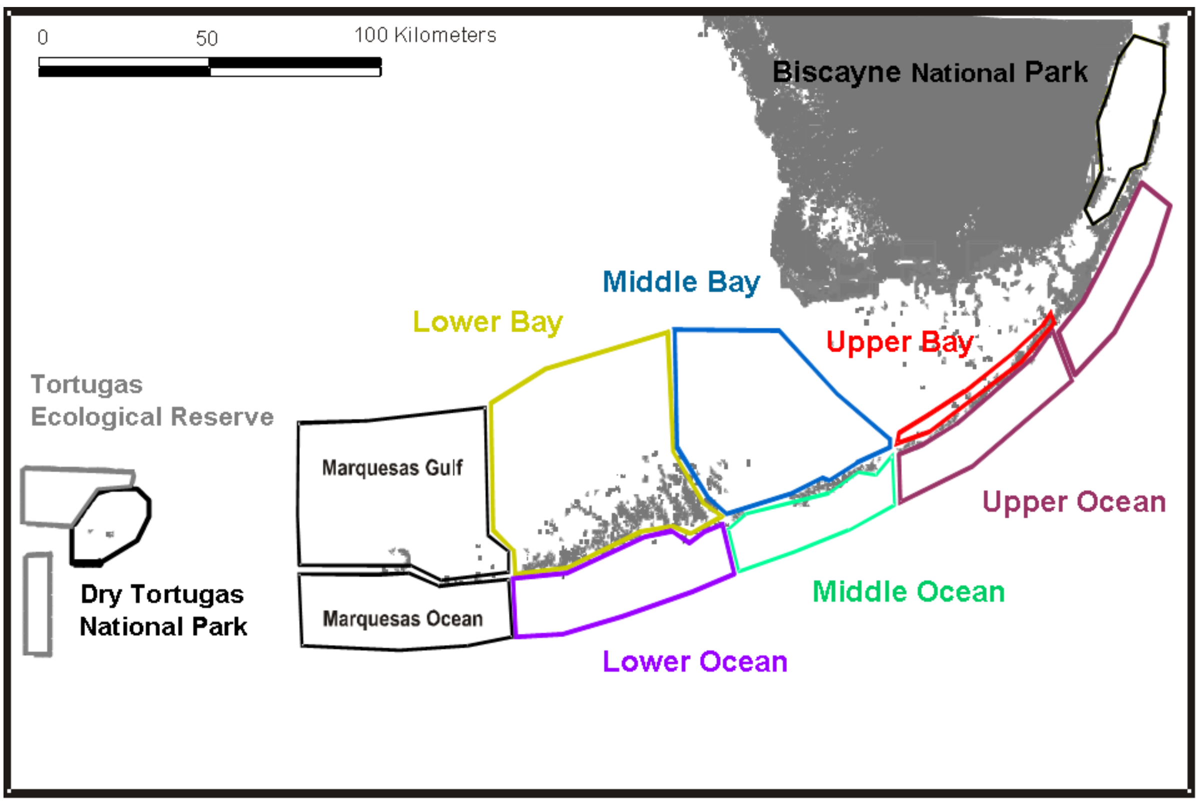


Figure 1. Historic trap use zones of the commercial spiny lobster fishery in FKNMS.

Marine debris surveys were conducted by paired SCUBA divers towed 30 m behind a small boat for a total distance of 1 km. Boat speed was held constant at 1.6 kts. Divers utilized tethered manta boards to steer themselves underwater (Figure 2). Since the 1970s, the manta tow technique has been used extensively in broad scale surveys on the Great Barrier Reef, particularly to assess the distribution of crown-of-thorns starfish (Moran et al. 1988). It is a versatile method that has been adapted to other census-specific benthic targets including derelict fishing gear (Donahue et al. 2001). Each tow board was equipped with a re-usable data sheet and timer (Figures 2 and 3). The tow bridles allowed for diver separation of 4 m. Divers recorded debris found within 2 m on either side of their respective tow-line, yielding an effective transect swath of 8 m x 1000 m (8000 m^2, or 0.8 hectares). In addition, divers recorded the habitat type that the debris was residing on. Divers timed the duration of the tow, and recorded the type of habitat encountered "on-the-fly" at one-minute intervals.

Trap Debris Impacts & Bycatch

The identification of damage caused by trap debris and casitas was difficult to measure from debris located during towing. Both trap debris and casitas occur in multiple habitat types and both types of debris were often seen in sand patches or areas

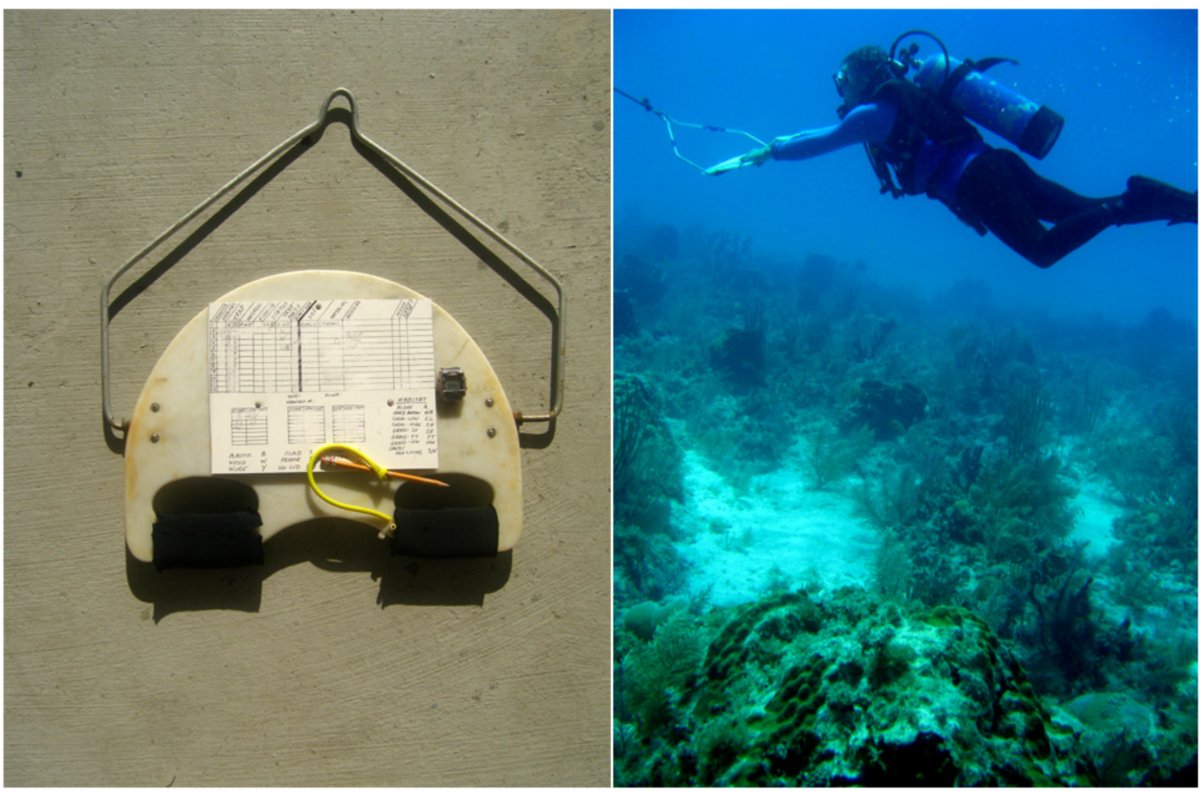
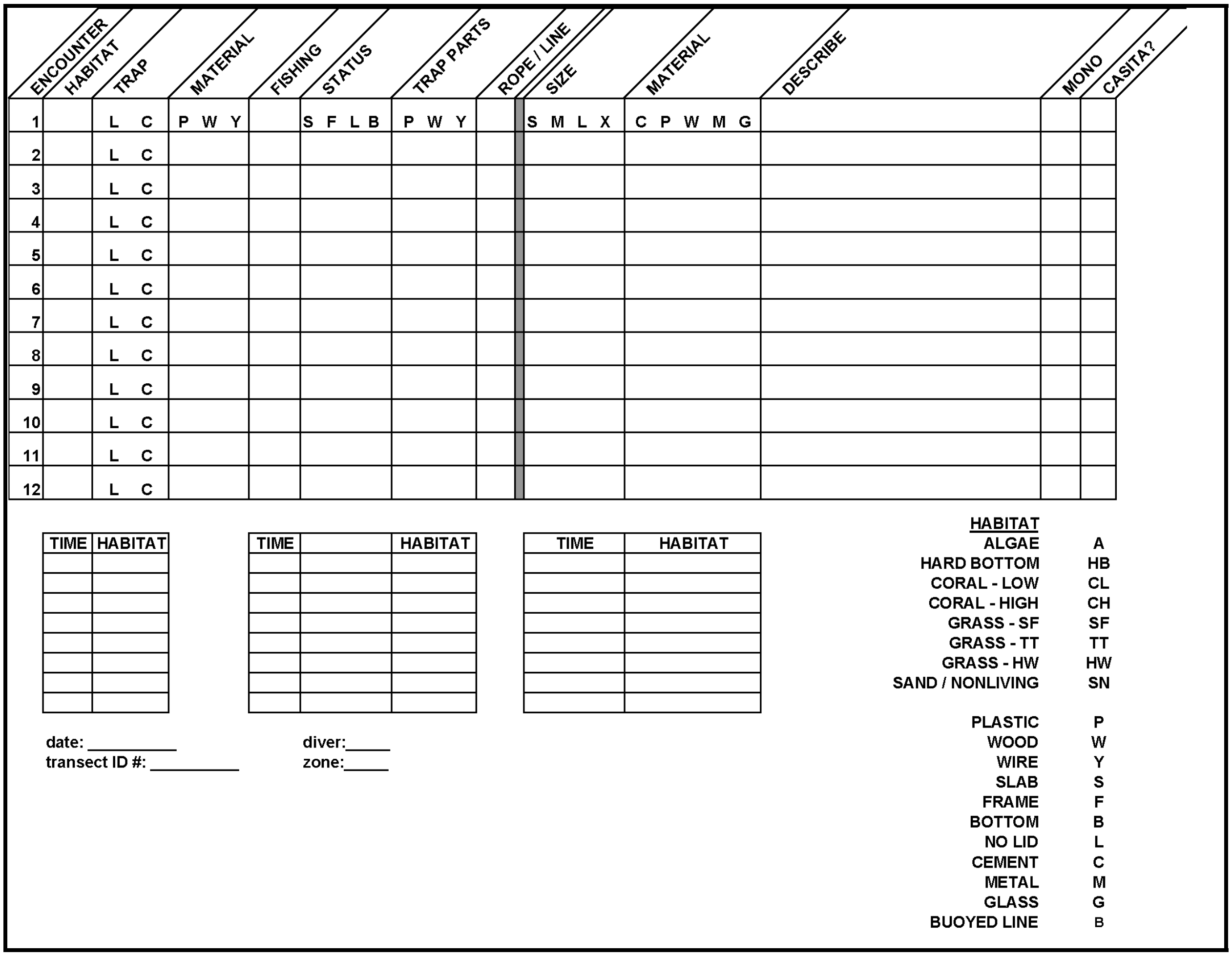


Figure 2. The manta tow board (left) and a diver towing across reef habitat in the FKNMS.



ENCOUNTER	HABITAT	TRAP	MATERIAL	FISHING	STATUS	TRAP PARTS	ROPE / LINE	SIZE	MATERIAL	DESCRIBE	MONO	CASITA?
1		L C	P W Y		S F L B	P W Y		S M L X	C P W M G			
2		L C										
3		L C										
4		L C										
5		L C										
6		L C										
7		L C										
8		L C										
9		L C										
10		L C										
11		L C										
12		L C										

TIME	HABITAT

TIME		HABITAT

TIME	HABITAT

date: __________
transect ID #: __________
diver:_____
zone:_____

HABITAT	
ALGAE	A
HARD BOTTOM	HB
CORAL - LOW	CL
CORAL - HIGH	CH
GRASS - SF	SF
GRASS - TT	TT
GRASS - HW	HW
SAND / NONLIVING	SN
PLASTIC	P
WOOD	W
WIRE	Y
SLAB	S
FRAME	F
BOTTOM	B
NO LID	L
CEMENT	C
METAL	M
GLASS	G
BUOYED LINE	B

Figure 3. The underwater data sheet as attached to the manta board.

with reduced live benthic cover. It is difficult to deduce if the debris created the sand patch or reduced live cover, or if those conditions existed before trap or casita placement. Previous experimental placement of traps has definitively identified loss of seagrass from shading or crushing by traps (Uhrin et al. 2005) and loss of live coral and hardbottom cover when traps move during storms (Lewis et al. in review). Thus, it was determined that the long-term effects of trap debris were better measured using an experimental approach.

The following experimental design allowed for the simultaneous examination of the amount of time lost traps remain intact and the potential for lobster and other species bycatch, in addition to the measurement of ghost trap movement for one year or until the traps decayed to a condition that movement was no longer likely. In April 2007, we placed traps in three areas where spiny lobster traps are commonly fished and where we had previously observed trap debris. A combination of new and 1-year old traps was used at each site. Nine traps (4 new and 5, 1-year old) were place in 8 m deep coral habitat at the main reef tract (Atlantic Ocean), nine traps (5 new and 4, 1-

year old) were placed in 4 m depth in a nearshore hardbottom habitat (Atlantic Ocean), and six traps (5 new and 1, 1-year old) were placed in 3 m deep hardbottom habitat in Florida Bay. Ropes and buoys were removed from all traps to simulate ghost-fishing, that is, traps that are lost but remain intact. The 1-year old traps had been used for eight months of the previous lobster season, removed from the water, re-nailed, and returned to the water as is typical practice in Florida's spiny lobster fishery. Experimental traps were monitored quarterly for: 1) percent cover of live habitat (i.e., hard coral, gorgonian, sponge, fire coral, and algae) in each trap footprint and in paired control quadrats at a distance of 5 m from each trap; 2) distance (meters) the trap had moved and area of impact until such time as the trap decayed or it was apparent that the trap was unlikely to continue to move (i.e., wedged into substrate); 3) percent cover in each trap footprint before and after movement; and 4) number of confined or dead lobster and other species bycatch in each trap.

(5) IMPORTANT MEETINGS:
Project co-PI, Tom Matthews, attended the NOAA Marine Debris Forum held April 1-3, 2008 in Bethesda, MD where he presented a poster on said project.

Project PI, Amy Uhrin, will attend the 61st Annual Gulf and Caribbean Fisheries Institute conference to be held November 10-14, 2008 in Guadeloupe, French West Indies where she will present either a poster or oral presentation on said project.

(6) PROBLEMS ENCOUNTERED AND/OR ANTICIPATED CHALLENGES:
After one year of monitoring, a number of experimental traps remain intact. Therefore, results presented herein reflect trap impacts after only one year. We will continue to monitor trap movement and animal confinement until the traps decay sufficiently such that continued impact on these resources ends.

(7) MEDIA/OUTREACH ACTIVITIES:

(8) SUPPORTING MATERIAL:

(9) FUNDS SPENT: All funds were spent by October 1, 2007

(10) Include a discussion of conclusions, recommendations and 1-2 sentences that describe the significance and main accomplishment of this project:

RESULTS

Manta Tow Surveys

A total of 96 marine debris surveys were completed, covering a total of 768,000 m^2 (76.8 hectares) of the seafloor in FKNMS (Table 1). These surveys represent random locations, as originally proposed, selected from within six historic trap fishery zones. Of 802 individual sightings of marine debris, 451 were trap-related (spiny lobster + stone crab, 56.2%), a rate of 5.9 trap debris sightings per hectare of seafloor. Spiny lobster trap debris dominated, accounting for 91.8% (414 sightings) of all trap-related debris and yielding a rate of 5.4 sightings of lobster trap debris per hectare of seafloor. The most common forms of trap debris included wood slats (38.1% of trap debris sightings), followed by cement slabs from trap bottoms (18.9%), and intact traps (15.4%; Figure 4). Much of the rope debris encountered (152 sightings) could not be definitively identified as originating from traps. Although this rope can have other uses (i.e., anchor line), given the preponderance of trap debris in FKNMS we suspect that a large portion of the miscellaneous rope sightings are indeed of trap origin.

More trap-related debris (68.3% of total) was found per survey area on Atlantic Ocean habitats (7.4 sightings per hectare) versus Florida Bay (4.1 sightings / ha). The highest amount of trap debris was recorded from the Middle Keys on the Atlantic Ocean side (9.4 sightings / ha; Table 1, Figure 5) while the least amount of trap debris occurred in the Middle Keys of Florida Bay (1.4 sightings / ha; Table 1, Figure 5). The distribution of trap-debris forms by fishing zones is depicted in Figure 6.

The majority of tows were conducted over seagrass with 39.2 hectares surveyed (Table 2), which is indicative of the prevalence of this habitat Sanctuary-wide. Seagrass dominated surveys in both the Atlantic Ocean and Florida Bay (Figure 7). Hardbottom habitats were surveyed nearly equally on both the Atlantic Ocean and Florida Bay (Figure 7). The low encounter rate for reef habitat in the Atlantic Ocean highlights the small contribution of this habitat on a per area basis compared to seagrass, hardbottom,

Table 1. Total hectares of seafloor surveyed in each fishing zone, by habitat type.

Location / Zone	# Tows	Total ha	Seagrass (ha)	Sand (ha)	Hardbottom (ha)	Reef (ha)	Algae (ha)
Upper Bay	14	11.2	8.0	0.8	1.6	0	0.8
Middle Bay	9	7.2	6.8	0	0	0	0.4
Lower Bay	21	16.8	9.4	3.6	2.8	0	1.0
Upper Ocean	19	15.2	6.6	4.0	3.0	1.6	0.04
Middle Ocean	18	14.4	4.6	6.4	1.8	0.8	0.8
Lower Ocean	15	12.0	3.8	3.8	2.0	1.6	0.8
Grand Total	**96**	**76.8**	**39.2**	**18.6**	**11.2**	**4.0**	**3.8**

Table 2. Trap debris sightings (spiny lobster + stone crab) in each fishing zone, by habitat type.

Location / Zone	Total Debris	Seagrass	Sand	Hardbottom	Reef	Algae
Upper Bay	66	34	8	23	0	1
Middle Bay	10	7	0	0	0	3
Lower Bay	67	8	27	24	0	8
Upper Ocean	119	56	18	27	18	0
Middle Ocean	135	20	76	30	7	2
Lower Ocean	54	7	25	4	17	1
Grand Total	**451**	**132**	**154**	**108**	**42**	**15**

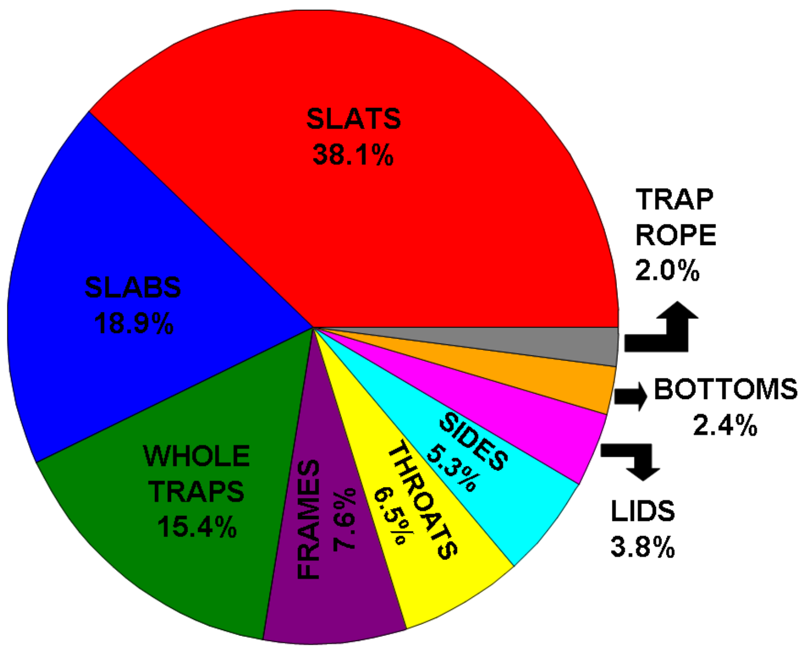


Figure 4. Frequency of trap-related debris across all random tows. Unattached rope is reported as miscellaneous rope as its identification is not definitive.

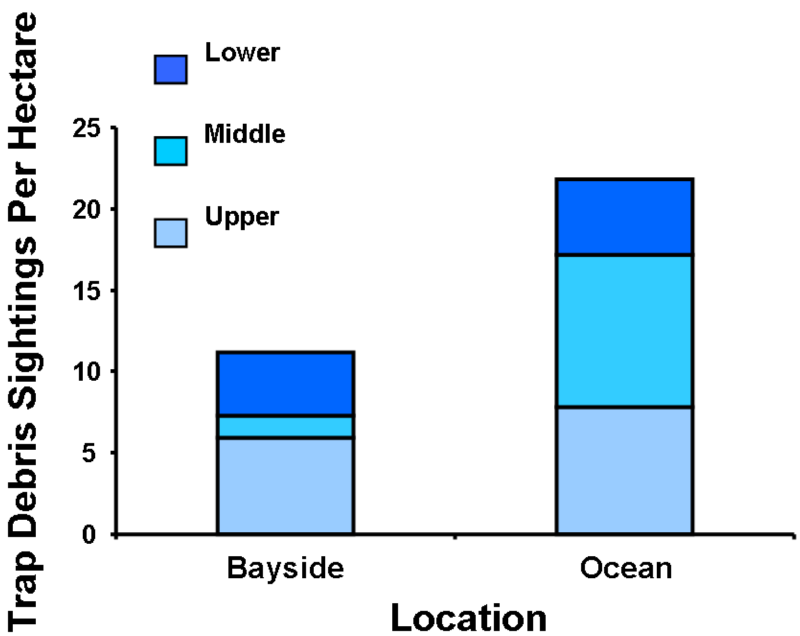


Figure 5. Trap-related debris sightings per hectare, by fishery use zone.

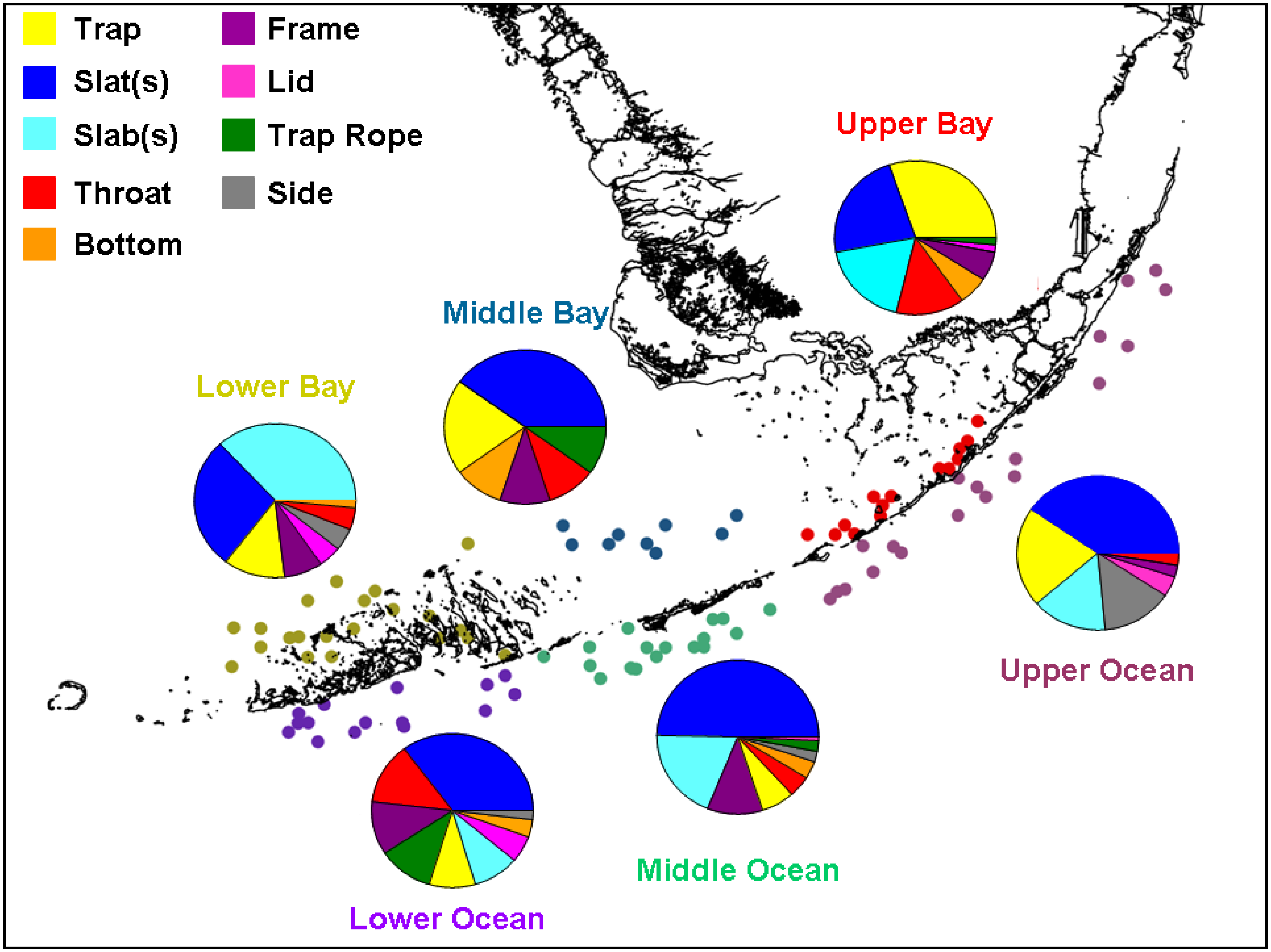


Figure 6. Distribution of trap-related debris within each fishing zone. Pie charts represent proportion of each debris type encountered. Small circles indicate starting coordinates for each tow.

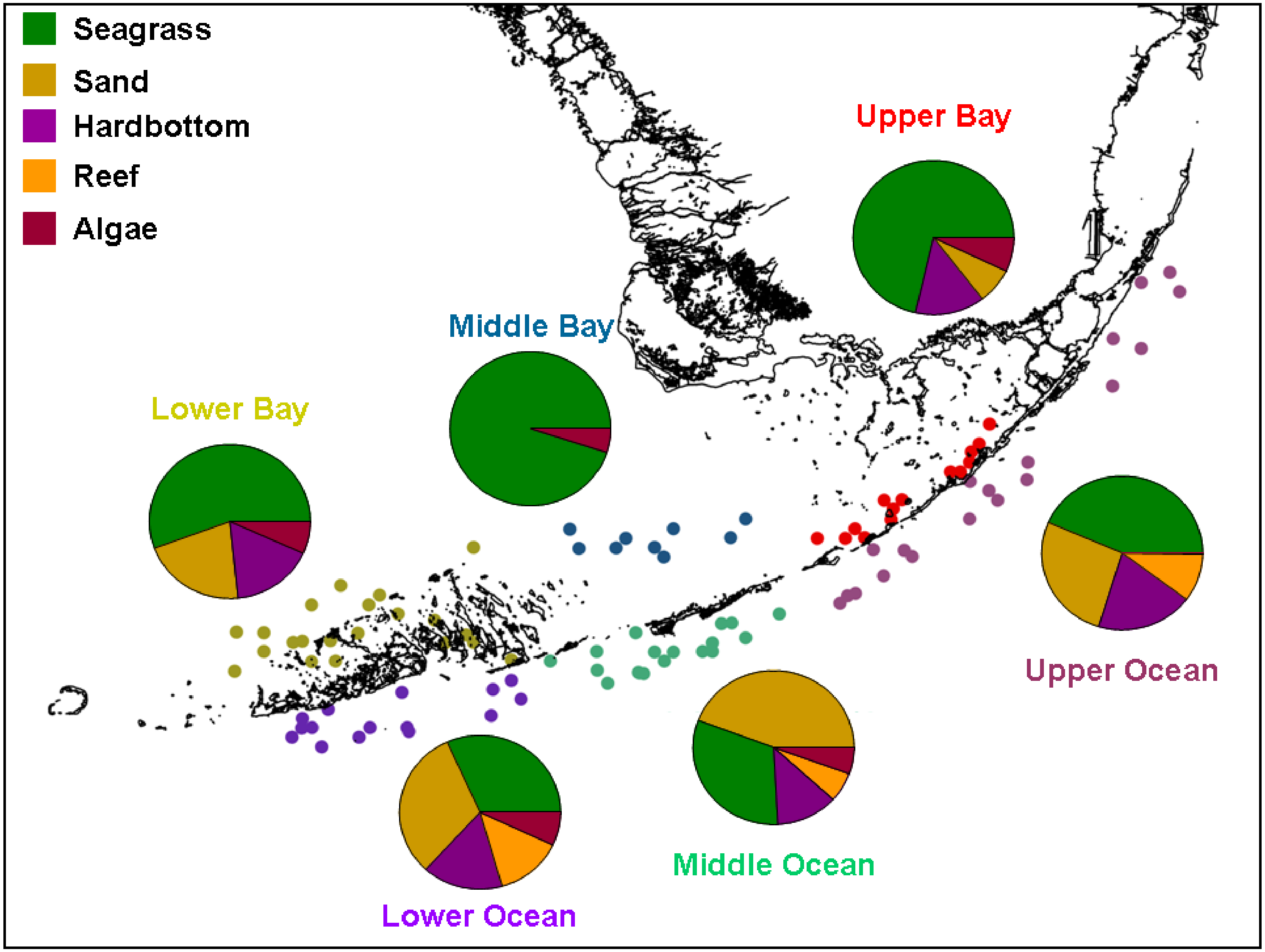


Figure 7. Distribution of habitat within each fishing zone. Pie charts represent proportion of each habitat type encountered. Small circles indicate starting coordinates for each tow.

and sand (Figure 7).

Standardizing by the amount of area surveyed per habitat, reefs had the highest accumulation of trap debris per hectare (10.5 sightings / ha; Table 3), followed closely by hardbottom (9.6 sightings / ha; Table 3). The least amount of trap debris was encountered in seagrass (3.4 sightings / ha; Table 3).

Of 802 individual sightings of marine debris, 351 (43.8%; Figure 8) were not related to trap fisheries. Non-trap debris was dominated by miscellaneous rope (43.1%). Much of the rope debris encountered could not be definitively identified as originating from traps, unless it was directly attached to trap debris. However, given the preponderance of trap debris in FKNMS we suspect that a large portion of the rope sightings are indeed of trap origin. Metal and plastic debris, accounting for 13.3% each, were the second most common types of non-trap marine debris (Figure 8).

At the onset of the surveys, it was apparent that although intact casita structures could be readily identified (Figure 9), it was not possible to definitively identify cement blocks and metal sheeting, pipes, and drums as casita debris. Although there is anecdotal evidence that appliances and other objects have been discarded to serve as casitas, there is no way to prove that these types of debris, when encountered, were purposefully deployed to act as such. Two intact casita structures were reported from the random tows, both from the Lower Bay, suggesting that this practice is more prevalent in this area of FKNMS. After consultation with local fishermen, an additional 23 tows were conducted in an area of Lower Florida Bay known for its preponderance of illegal casita structures (Figure 10). These tows resulted in a total survey area of 184,000 m^2 (18.4 hectares). If we consider any cement blocks and metal sheeting, pipes, and drums encountered to be derived from a former casita, then of 217 sightings of debris, 53 (24.4%) were cement and metal structures potentially of casita origin (including two intact casitas; Figure 11).

Table 3. Trap debris sightings in each fishing zone, by habitat type, standardized to per hectare values.

	Trap Debris Sightings Per Hectare Sampled					
Location / Zone	**Total Debris**	**Seagrass**	**Sand**	**Hardbottom**	**Reef**	**Algae**
Upper Bay	5.9	4.2	10	14.3	0	1.2
Middle Bay	1.4	1.0	0	0	0	7.5
Lower Bay	4.0	0.8	7.5	8.6	0	8.0
Upper Ocean	7.8	8.5	4.5	9.0	11.2	0
Middle Ocean	9.4	4.3	11.8	16.6	8.7	2.5
Lower Ocean	4.5	1.8	6.5	2.0	10.6	1.2
Grand Total	**5.9**	**3.4**	**8.3**	**9.6**	**10.5**	**3.9**

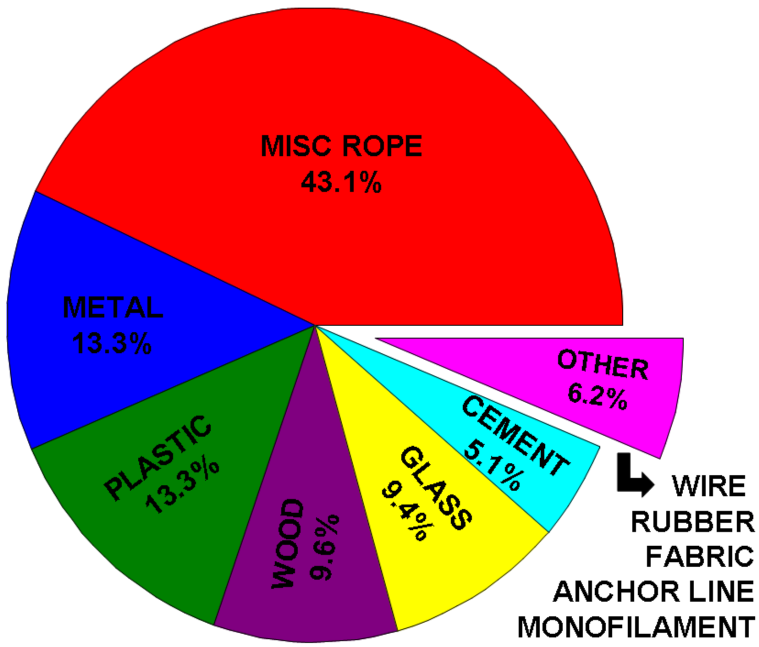


Figure 8. Frequency of non-trap debris across all random tows. Miscellaneous rope category lacks a definitive source.

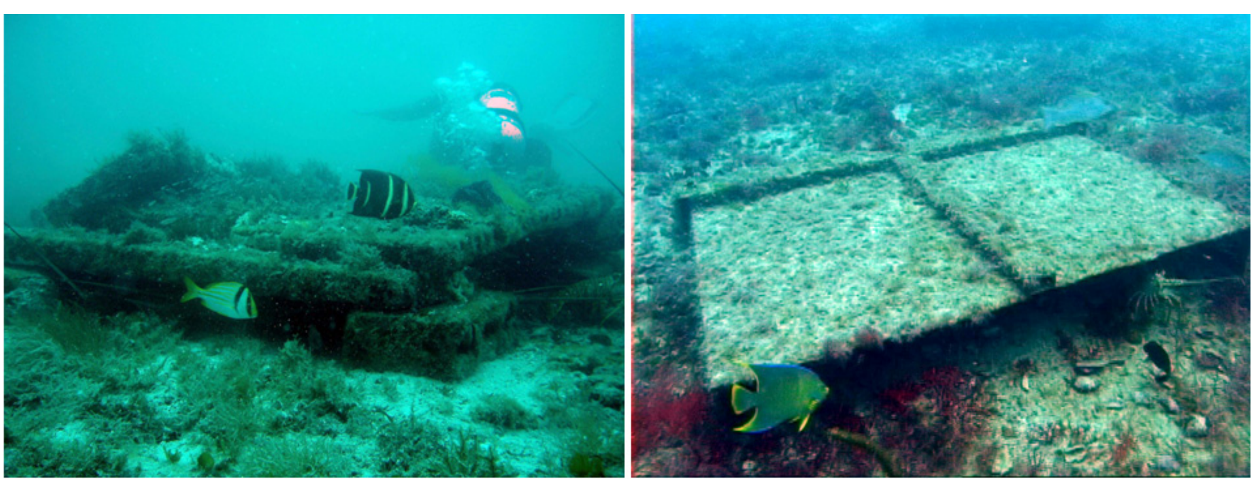


Figure 9. Examples of typical cement (left) and metal casita structures.

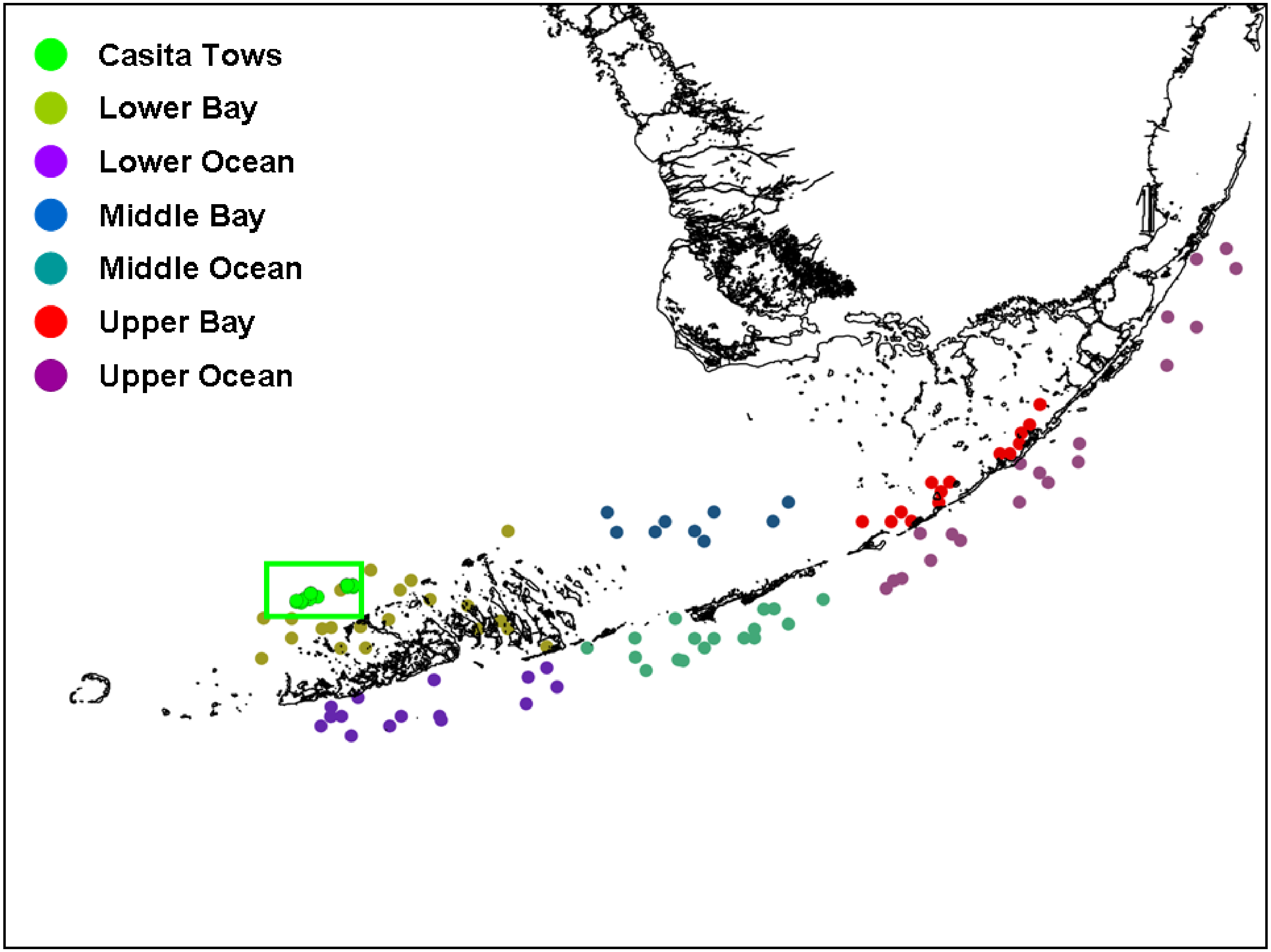


Figure 10. Location of casita-specific surveys in relation to random surveys.

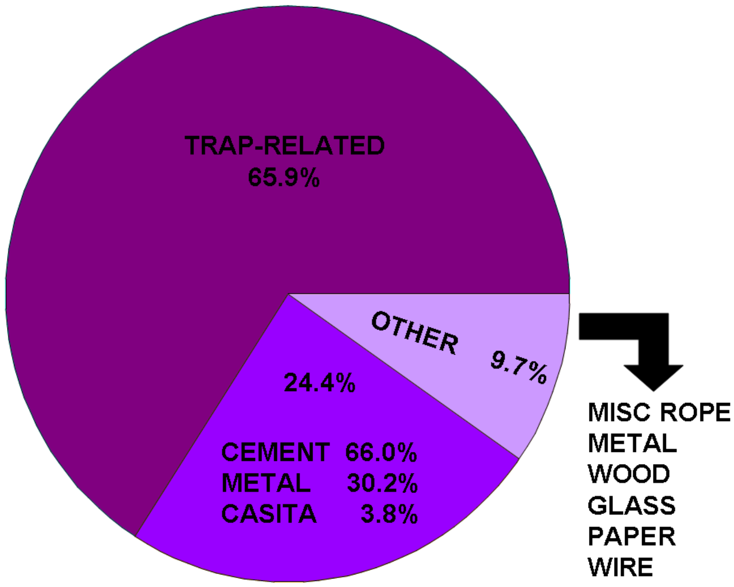


Figure 11. Frequency of all debris across casita-specific tows.

Trap Debris Impacts & Bycatch

Initial results of the movement of non-buoyed ghost traps during winter storms indicate that traps moved considerably less distance than previous experiments with buoyed traps (Figure 12). Traps at 4 and 8 m depth moved less than 0.5 m per winter storm. Traps in Florida Bay generally only shifted in place. Observations of cumulative trap movement after one year indicate that 14 of the 24 experimental traps appear likely to continue to move and impact habitat. During the first year, traps deployed in 8 m of water at the reef impacted an average of 4.3 m^2 of habitat. Traps on nearshore hardbottom habitat impacted a total of 31.5 m^2 of habitat, while traps in Florida Bay impacted less than 1m^2. Traps at the reef moved gradually in response to each storm until they broke apart, became wedged in the structure of the reef, or settled in sand areas. Traps at the nearshore hardbottom site

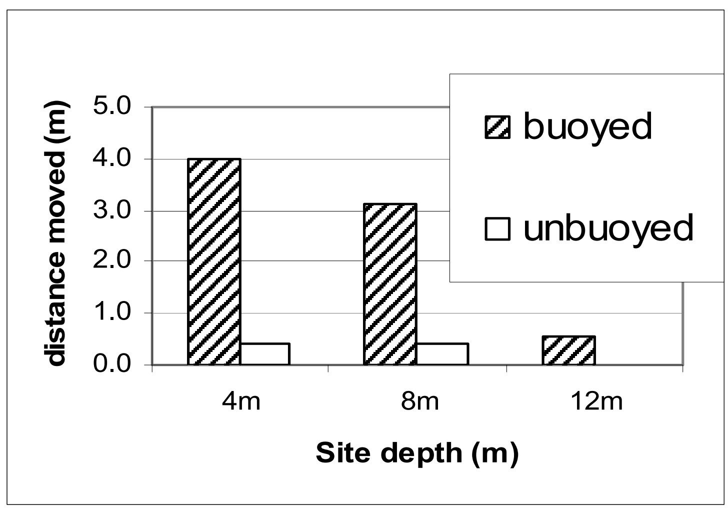


Figure 12. Trap movement and habitat impact during winter storms at three sites. Mean trap movement of buoyed traps (19 storms; 292 total trap observations) and unbuoyed traps (7 storms; 126 total trap observations).

moved regularly during strong winds, but most of the movement occurred during non-tropical storm force winds associated with Tropical Storm Barry that passed 290 miles west of the research site in June 2007 and a storm with 25 kt southerly winds in April 2008.

Six of the 14 new traps continued to ghost fish after one year. All one-year old traps that were reused became non-fishing (i.e., degraded to a point where animals could enter and exit freely) after one year. Ghost traps continue to catch lobsters intermittently. More lobsters appear to be trapped during the summer closed fishing season when all legal traps have been removed from the water. Dead lobsters were observed in traps on two occasions and after one year of abandonment, three traps were observed with a total of nine lobsters. Our observations of traps were limited to once every three months which prohibited comprehensive assessment of the number of lobster killed and confined in traps over the course of the year. Our observations are sufficient to confirm that lost traps can continue to catch and kill lobsters after one year of loss. No mortality has been observed among other bycatch. Bycatch species include angel fish, highhats, white grunts, trunkfish, and porcupine fish. Only the porcupine fish and trunkfish appeared unable to freely enter and exit the trap through the spaces between slats or the trap throat. Numerous small grunts (< 5 cm) and other juvenile fish including high hats, porkfish, damsel fish, and gobies were routinely observed in and around the traps, apparently attracted to the structure (Figure 13).

Prior to trap placement, total percent cover at the reef site (8 m) averaged 49% in the controls and 48% in the trap footprints. By June 2007, total percent cover where traps had moved declined to 33% while control sites remained stable at 53%. Because trap impact areas were selected randomly, the actual percent cover varied and the relative difference between controls and impact areas is a more definitive measure of site degradation and recovery. By February 2008, the difference in percent cover at control and impact sites was 9% and by May the trap impact site had recovered to 8% less cover than control sites. At the 4 m depth site prior to trap placement, control percent cover was 43% and percent cover at the future trap footprint was 41%. In June, after trap movement, percent cover was reduced to 25% and the difference in percent cover between controls and trap impact sites remained 25% through May 2008. Several newly recruited hard corals (*Siderastrea* spp. and *Porites* spp.) and gorgonians (soft corals) were present at the trap impact sites and we anticipate measurable recovery of the trap impact sites during the summer of 2008. At the 3 m depth site in Florida Bay, control percent cover (16%) did not differ from future trap footprint sites (15%). All traps shifted in place and routinely reoccupied their original trap foot print. Measurements of percent cover are therefore limited to the areas surrounding the trap that have been impacted. Habitat loss was not measured in June due to the limited impact area of each trap, but by February 2008, partially bare halos began to appear around each trap and percent cover in this halo was 18% lower than controls and was 13% lower by May 2008. The change in percent cover of hard coral and hardbottom habitat from trap movement is consistent with the movement of buoyed traps observed by Lewis et al. (in review; Figure 14). Results from the current study remain preliminary given that many of our experimental traps remain intact after one year. We will continue to observe and measure the experimental traps over the next year.

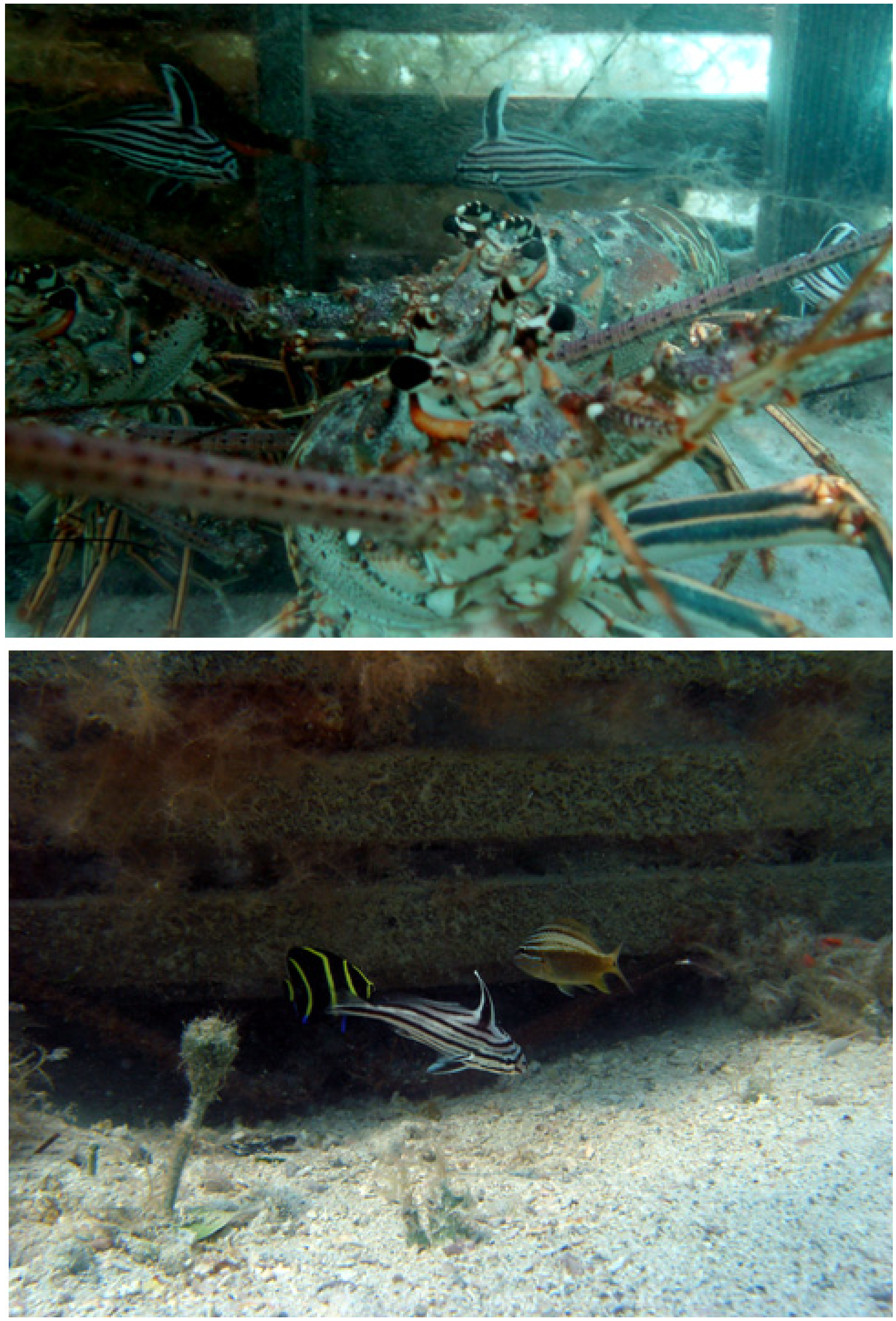


Figure 13. Juvenile highhats share space with spiny lobsters inside a derelict trap (top). A juvenile gray angelfish, highhat, and white grunt swim next to a derelict trap.

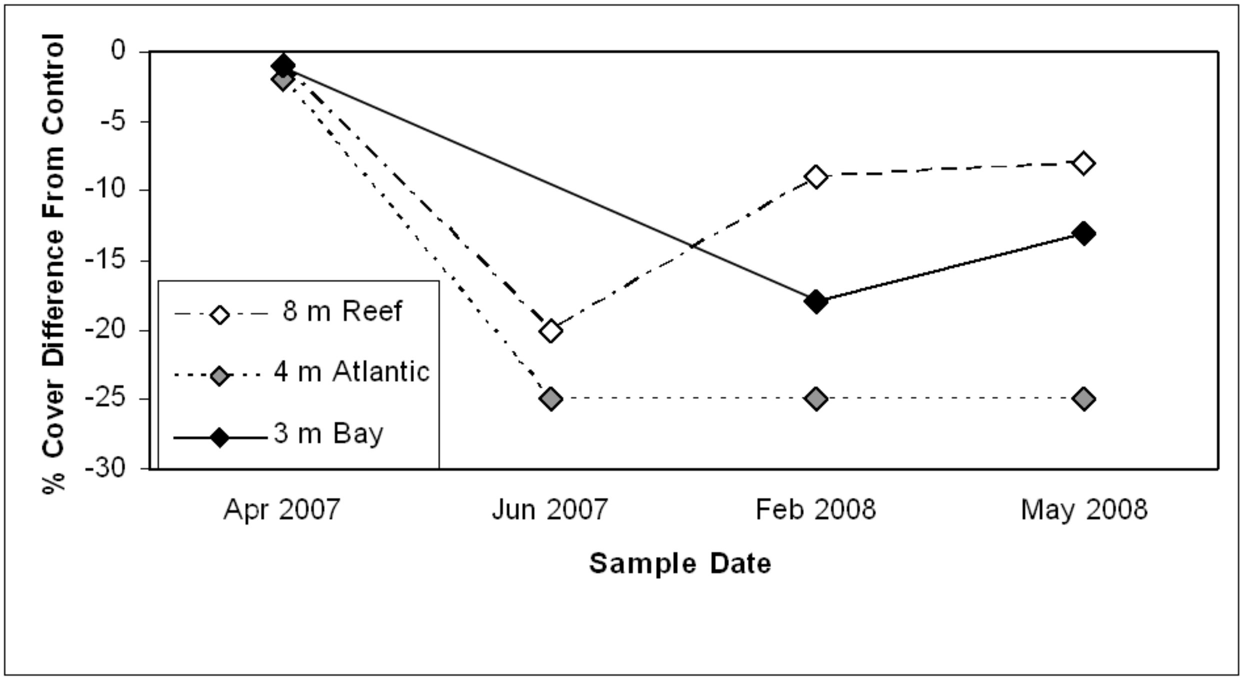


Figure 14. Difference in percent cover of coral, octocoral, sponge, and fire coral at control sites and sites where unbuoyed, ghost traps slid across the habitat. Observations in April 2007 were prior to trap placement. Observations in June 2007 were after initial trap movement and subsequent dates measure potential recovery at the impact sites. Traps at the 3 m Bay site did not move prior to the June sample, therefore precluding measurement of percent cover.

DISCUSSION

Distribution of Trap Debris

The proportion of spiny lobster trap-related debris observed from the current study greatly exceeds that reported elsewhere (Chiappone et al. 2004). Chiappone et al. (2004) surveyed 2.5 hectares of seafloor and reported 10.1% of all instances of debris (30 of 298 observations) to be related to the spiny lobster trap fishery. In the current study, 76.8 hectares of seafloor were surveyed with 56.2% of all debris originating from trap fisheries. Chiappone et al. (2004) did not explore Florida Bay and limited debris surveys to hardbottom and reef habitat. When data from the present study is restricted to the hardbottom and reef habitats of the Atlantic Ocean, and only spiny lobster trap-related debris is considered (i.e., no stone crab trap debris), per-area-sampled estimates of trap debris are similar (Chiappone et al. - 12.0 / ha; present study - 9.5 / ha). The trap debris categories used by Chiappone et al. (2004) do not reflect the various stages of trap deterioration used herein and were limited to ropes and buoys, slats, and wire grating. Interestingly, no whole intact traps, portions of framing, cement slabs, nor throats were encountered by these authors.

Given the rugose, complex nature of reef habitat which may act to entrap debris, it is not surprising that more trap-related debris per unit area surveyed was encountered on reef compared to other habitats. Most notable is the high prevalence of trap parts on reef versus intact traps. Hard coral surfaces may facilitate abrasion and breakage when traps come into contact. Additionally, the reefs of FKNMS are high diver-use areas and divers may molest derelict traps in an attempt to release confined animals. More intact traps were observed in Florida Bay, an area of high trap and boat use (i.e., buoy cutoffs that render traps lost) compared to the Atlantic Ocean.

It was surprising that the least amount of trap-related debris was recorded from the fishing zone that typically experiences the most intense fishing pressure (Middle Bay). Surveys in this region were completely dominated by deeper softbottom habitats, further from shore, which perhaps are unable to entrap debris as well as reef or hardbottom. Less offshore boat traffic is observed here as well. When some level of rugosity is introduced, debris sightings rise. This is evidenced by increased debris sightings in the Upper and Lower Bay where hardbottom was surveyed. It is also possible that heavier trap parts (i.e., slabs) sink into the soft sediments and become buried or overgrown with time (Figure 15). Interestingly, no trap slabs were recorded from the Middle Bay. Additionally, fewer surveys were conducted in the Middle Bay, resulting in a lack of inshore tows, where hardbottom is typically encountered.

At the onset of the surveys, it was apparent that although intact casita structures could be readily identified, it was next to impossible to link random sightings of cement blocks and metal sheeting, pipes, and drums to a former casita structure. Additionally, although there is anecdotal evidence that appliances and other objects have been discarded to serve as casitas, there is no way to prove that these types of debris, when encountered, were purposefully deployed to act as such. In 96 random tows, only two intact casita structures were encountered, both from the Lower Bay, suggesting that this practice is more prevalent in this area of FKNMS. The proportion of casita-related debris recorded in the casita-specific surveys is comparable to that of the random tows of the Lower Bay where assumed casita-related debris accounted for 33.9% of total non-trap debris.

Figure 15. Two cement slabs (left) and the bottom slats of a spiny lobster trap nearly overgrown in a *Thalassia testudinum* (turtle grass) bed.

Trap Debris Impacts & Bycatch

Simulated derelict traps (i.e., without ropes and buoys), moved consistently less per storm event than typical traps with intact buoys and ropes. However, traps lost during the first or second year of use persist either functionally intact or at least structurally intact for over one year. During this year, derelict traps continue to move with each passing storm. In the current study, movement of derelict traps over one year was similar to movement of buoyed traps during one storm (Figure 16). Appropriate modeling of the number and impact of derelict traps can now be conducted to ascertain the impact of derelict traps on habitat using the data available herein.

Wind speed and duration are known to affect trap movement (Lewis et al. in review). Storms during our study were of typical wind speed and duration to those of the past 10 years. Two particularly high trap movement events were observed for traps at the 4 m depth site in the nearshore hardbottom. Both of the summer storms had winds from the south which are atypical for the winter storms that had been previously associated with trap movement. These summer storms, which are occasionally of tropical storm or hurricane force, can occur during the fishing season which begins in August, and potentially would result in very high trap movement.

Although several of our traps continued to confine and kill lobsters, most traps were empty during our quarterly observations. Empty traps become covered with algae and other encrusting organisms and look distinctly unused. When lobsters enter these traps, the encrusting organisms are removed and the trap often appears 'clean' and is indistinguishable from other actively fished traps. The condition of lobsters in traps varied considerably from dead to lethargic with many epizoons (attached algae and/or external parasites) to vibrantly colored and active. Our observations indicate that lost traps continue to catch and kill lobsters, but we were not able to estimate mortality rates for lobsters confined in derelict traps. Bycatch species appeared healthy and also appeared to use lost traps as shelter particularly in the low structure hardbottom habitat where little other vertical relief exists. Traps do not appear to be a significant source of structure in reef habitat that is already structurally complex. Although lost traps cause a loss of benthic habitat in all habitats tested, traps may be associated with increased abundance of fish in areas devoid of alternative natural structure. It remains to be tested, as with all artificial reefs, if the increased structure of trap debris might enhance fish populations. The high number of lost traps observed in this study suggests that cumulative impacts of lost traps on living habitat need to be considered when managing marine resources. Fishing practices that can reduce trap loss or reduce the intentional disposal of old traps would be beneficial to fishermen and resource protection.

SIGNIFICANT ACCOMPLISHMENTS

To our knowledge, this study is the first comprehensive Sanctuary-wide survey of marine debris in the Florida Keys, spanning the entire island chain in both Florida Bay and the Atlantic Ocean and including all habitat types found in FKNMS.

Marine debris estimates from this study identify spiny lobster trap debris as the primary form of marine debris in FKNMS. The high abundance of trap debris on coral habitat, relative to the actual amount of coral habitat found in FKNMS, suggests that this habitat may act as a sink for trap debris.

When traps deteriorate, the smaller pieces may become colonized by algae, seagrass, and corals and eventually become incorporated into the surrounding habitat. Intact derelict traps have the potential to move across the seafloor during storm events causing abrasion and breakage of habitat structural components and significantly reducing live cover, up to 25% in some instances, over a one year period.

Derelict traps continue to catch and kill lobster. Additional research is needed to determine lobster mortality estimates due to confinement in derelict traps. Non-lobster bycatch in derelict traps is minimal, with some fauna utilizing the traps as refuge.

The prevalence of spiny lobster trap debris in FKNMS identifies a specific user group and activity to be targeted for education, debris prevention programs, or management action. The widespread distribution of trap debris throughout FKNMS would impede retrieval in any type of debris removal program. Instead, efforts to reduce the amount of trap debris through better fishing practices or reductions in the number of traps used in the fishery may be more suitable. Florida's spiny lobster fishery has been identified as overcapitalized (i.e., too many traps) by both economic and catch per effort criteria. A reduction in the number of traps used would meet economic, catch, and debris reduction goals.

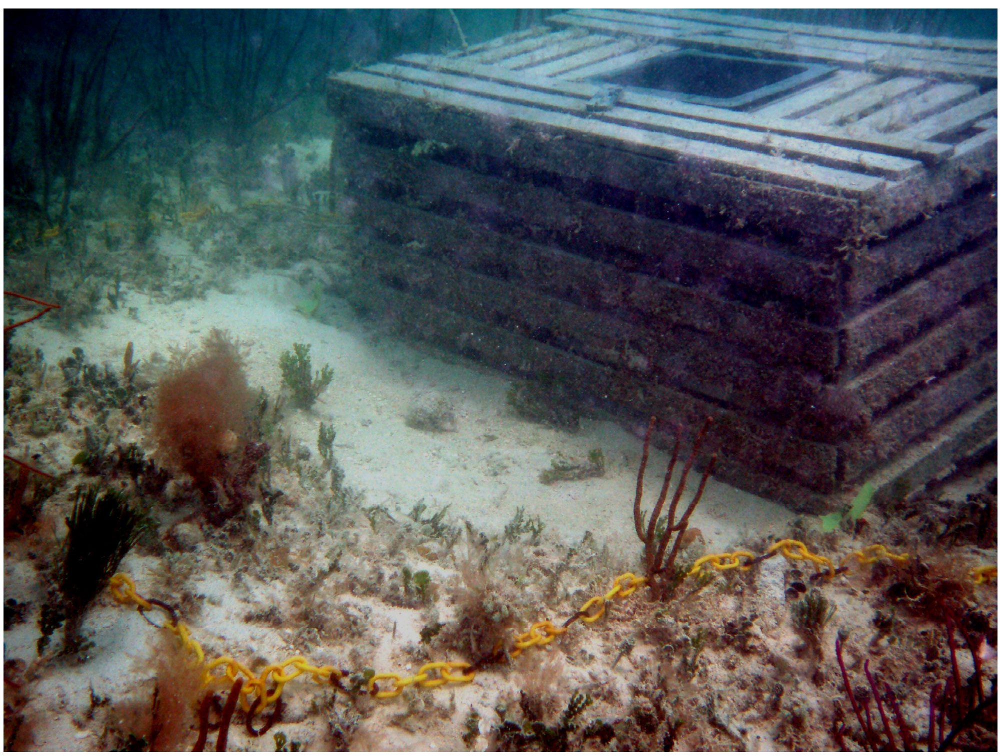


Figure 16. The beginning of an impact halo is evident around one of the experimental lobster traps.

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