Sea Turtle - Scallop Fishery Interaction Study

Observing Behavior of Loggerhead Sea Turtles, *Carretta carreta,* on Foraging Grounds off the Mid-Atlantic United States Using a Remotely Operated Vehicle (ROV)

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Executive Summary

This project focused on developing the methodologies of using a Remotely Operated Vehicle (ROV) as a research tool for observing behavior of loggerhead sea turtles, *Carretta carreta,* on foraging grounds off the Mid-Atlantic coastline. The project spent 11 days at sea during two research trips. The research trips focused on scallop grounds with water depths of 40-60 meters, during the months of August (2008) and June (2009), when and where turtles are known to be present. Work included: using an ROV to search for turtles and to follow turtles once located; using an ROV to observe behind an actively fishing scallop vessel both in the water column and in the dredge track; deployment of dredge mounted cameras during a commercial scallop trip; and the testing of a vessel mounted multibeam sonar to locate and survey turtles in the water column. Additionally, gear mounted camera and observer work was conducted onboard to two commercial fishing vessels during the same time and area as the two ROV research trips.

During the two research trips we sighted 97 loggerhead sea turtles and 2 leatherback sea turtles. All the turtles were first observed on the surface or within 5 meters of the surface. During the two research trip we were able to follow 23 loggerhead turtles with the ROV for periods of time ranging from 2 minutes to over 2.5 hours with an average of 1 hour per turtle followed. We observed several groups of turtles engaged in social behavior (three separate incidences), we observed one turtle avoid a towed object behind an actively fishing scallop vessel, and observed two turtles swim from the surface to the sea floor (depth of 45 meters). We collected extensive data on the time interval between breaths as well as time at depth and temperature at depth. Gear mounted cameras were deployed on 21 tows during the commercial fish trips done in conjunction with the ROV research trips. A total of 17 hours of video was obtained from these gear mounted cameras, with no turtle/gear interactions observed or recorded.

Key observations regarding loggerheads related to dredge interaction include a) they do frequently dive to the seafloor b) they are often associated in groups of two or more c) they become negatively buoyant at 30 meters, and d) they turn their carapace and dive when encountering a towed object in the water column.

1. INTRODUCTION

1.1 Project Description

The purpose of this project was to collect further information on turtle interactions with sea scallop dredges. This project was a continuation and augmentation of existing work being conducted under 2006 RSA funding and a NMFS contract. In conjunction with the ROV operations we also placed self-contained video cameras and recorders on scallop dredges. The project took place during the known periods and areas of turtle interactions. In addition, vessel mounted multibeam sonar was tested to determine its feasibility as a way to locate and survey turtles in the water column.

Presently it is not understood what interaction, if any, occurs when turtles encounter chain-equipped dredges or whether the noise of the chains is creating an avoidance behavior. Vessels fishing on dense beds of scallops may discard scallop viscera remains concentrated in a relatively small area, which may attract turtles. In short, there are many unanswered questions regarding sea turtle behavior and interactions with scallop dredges equipped with chain mats. It was the intent of this project to continue to investigate the behavior of sea turtles around scallop dredges and in areas where scalloping has recently occurred. This investigation used underwater cameras and a Remotely Operated Vehicle (ROV) to try to visually identify sea turtle behaviors in situ and also around scallop gear.

We chartered with a Benthos Teledyne Stingray ROV system and an onboard sonar provided by American Underwater. We followed the procedures we have developed in 2007. The first strategy is to follow closely behind the towing vessel and observe the activity occurring in the water column in the vessels track. The second strategy is to examine tow paths immediately after the dredges pass.

1.2 Background

In response to increasing numbers of sea turtle interactions observed by the sea scallop industry and subsequently corroborated by NMFS observers, a series of 15 experimental cruises were carried out during the summer and early fall of 2003 on the continental shelf waters of the mid-Atlantic Bight (Dupaul et al, 2004). These cruises demonstrated that a simple modification to the standard sea scallop dredge was effective in eliminating the incidence of sea turtle bycatch without substantial associated reductions in the capture of the target species.

The modification, a chain mat that physically excludes loggerheads, did not catch a loggerhead in over 2400 hauls, while the standard dredge caught seven loggerhead sea turtles. An issue was raised after the study about how the loggerheads interact with the scallop dredge. After the prior study, several proposed the theory that loggerheads are attracted to scallop viscera and lay close to the bottom, while others speculated that the loggerheads are captured while the dredge is being retrieved. In a meeting between Cfarm, VIMS, and NMFS, there was a stated importance of viewing the scallop gear using video with the hope of seeing a turtle(s) interacting with the scallop dredge. It was discussed that with video, NMFS will be better equipped to assess the effectiveness of this gear modification in not only reducing the bycatch of loggerheads, but also in assessing the type of interactions that may be occurring. As an example, we do not know if the noise of the chains is causing the loggerheads to flee from the path of the dredge, if the

loggerheads are getting run-over by the gear, or if the interactions are occurring predominantly during the retrieval of the gear.

Video work with dredge mounted cameras was conducted in 2004 and was successful in devising a methodology to video in front of scallop dredges but was unsuccessful in viewing any turtle behavior. A second study in 2005 utilized the methodology and information gained during the 2004 study, and took more than 70 hours of bottom video in areas where loggerheads were observed on the surface. Surface and bottom water temperatures were also recorded. In 2005, not many loggerheads were observed to interact with the scallop fishery and, during the study, no loggerheads were encountered underwater despite multiple sightings on the surface. Additionally, during the 2005 tests a new turtle excluding dredge frame was fished and data collected on its operation.

In 2007, we introduced an ROV into the RSA project and focused our efforts on trying to observe loggerheads in the water column as well as on the sea floor. We observed over two dozen loggerheads on or near the surface but none on the sea floor. We did not capture any of the turtle sightings on video due to operational difficulties with the ROV. ROVs are designed to observe immobile objects; not to track a moving target or to be towed at scallop dredge towing speeds.

Over the winter 2007-8 we improved our strategy for acquiring and tracking sea loggerheads. On June 16, 2008 we went to sea and applied our ideas with amazing success. We gathered many hours of video following loggerheads and observed what depths they occupied, how often they went to the surface, what they were feeding on and how, behaviors to avoid sharks and vessels, and much more. We even followed one loggerhead to the bottom in 60 m where water temperatures were 7.6° C.

We did have some problems. Just before sailing our long tether failed so we had to conduct the project using a short, 100 m tether. We also found that loggerheads can dive much faster than the ROV. There are also permitting problems. We can not move into and out of the various scallop access areas and utilize a dredge without an EFP. We went on our trip with plans to mount cameras and tow the dredges but the opportunity did not arise in an area where we were allowed to fish.

The short tether made it extremely difficult to stay with a turtle once we acquired it on video. On the first day we lost contact with three loggerheads we acquired on video before any data could be taken. When tracking a turtle the key information recorded was time at depth, temperature at depth, time between breaths, and behavior such as feeding.

2. METHODS

The study took place in the continental shelf waters 40 to 100 kilometers offshore of New Jersey and Delaware along the east coast of the US. Water depths ranged from 50 to 100 m. Loggerhead sea turtles migrate into this area in May, forage for most of the summer and fall, and migrate south, or possibly offshore, during October. Sea surface temperature (SST) ranges around 20 to 23 degrees C during this period and bottom water temperatures increase from about 7 degrees C in June to 12 degrees C in October. The warmer waters of the Gulf Stream lie further offshore to the east.

We conducted two ROV trips; one in August 2008 and one in June 2009. We conducted the study from the scallop vessel F/V Kathy Ann utilizing a Benthos Teledyne Stingray ROV system. During both trips an additional vessel was staffed with an NEFSC trained observer that had extensive experience deploying video equipment on fishing gear during normal commercial operations.

2.1 ROV Operations

The Stingray ROV was rigged with a color video camera. This camera had: an 18 to 1 color zoom camera with 1 lux light capability and a fixed focus color camera with 0.1 lux capability. Full-range dimmable Deep Sea Power and Light halogen fixtures were mounted along with the multibeam sonar and the color zoom camera on a user-adjustable tilt bar on the front of the vehicle. This tilt function allowed the multibeam sonar to be adjusted for the optimum "gazing angle" to represent objects and features in the water column as well as on the seafloor. It also enhanced the ROV pilot's ability to collect detailed video of fish, objects and seafloor features. All video was recorded directly to DVDs using a Sony VRD-MC5 recorder set to HQ mode, putting as much as 1 hour of high quality video on each DVD.

The ROV-mounted multibeam sonar used was a BlueView Technologies ProViewer P450E (http://www.blueviewtech.com) which uses acoustic energy to produce streaming images of objects and features underwater. It weighs about 6 lbs in air and 1.4 lbs in water. The field of view is 45 degrees by 15 degrees with a range of up to 150 meters. The system produces the images with 256 beams of acoustic energy at 450 kHz, giving it the ability to resolve objects as small as 2 inches. The depth rating is 1000 feet. Power consumption is 10 watts at 12 to 48 volts with the Ethernet extender bottle on the vehicle drawing an additional 3 watts. The streaming images are transmitted over a twisted shielded pair of conductors in the tether to the topside via an Ethernet extender bottle at up to 10 frames per second. The actual frame rate we experienced was dependent on the range selected and was in the 4 to 8 FPS range.

All sonar data was recorded on a laptop hard drive. For example, on the September 2007 trip the 30 files occupied about 8 gigs of space. The ProViewer software, supplied with the sonar data files allows it be replayed with the user having the ability to make adjustments to the range, intensity and other parameters to resolve objects of interest more clearly.

The basic procedure for conducting transects was as follows. At approximately 0700 we began a transect holding a straight course based on the best sighting conditions (sea state, wind, glare, etc) at a speed of 4 knots. Three observers were on the lookout for loggerheads. One observer was posted in the masthead crow's nest at an eye height of 14 m above the sea surface. Another observer was posted on the foredeck at an eye height of 4 m above the sea surface. The third observer, usually the Captain, was in the pilot house with an eye height of 4 m above the sea surface. All observers used binoculars for scanning around the vessel. The masthead observer was also equipped with digital cameras, a GPS unit, image stabilized 10x35 binoculars, laser range finder, and VHF radio for communications to the captain and ROV operator.

Visually sighting a turtle from a fishing vessel is made difficult by sea state and glare. The sun needs to be a certain distance above the horizon, even on the best weather days, before you can mount a successful search pattern. During the June through September period we focused our search efforts between 0700 and 1800. Sighting conditions changed throughout the day. We initially tried to maintain a straight transect for searching but found the need to alter the course to maintain the best sighting ahead of the vessel. By far, the masthead position is the most important. Loggerheads are commonly in the top meter just under the surface, surfacing every few minutes to take a breath. Height is needed to view these loggerheads just below the surface when they are at distances beyond 10 meters from the vessel. Usually the mast head observer would spot the turtle first and alert the observer on the foredeck and captain in the wheel house. The vessel would be directed towards the turtle; usually the captain gets the visual and needs no further guidance from the masthead.

2.1.1 Turtle Following Mode

When a turtle is spotted, the vessel is directed to approach by the masthead observer and the ROV team is alerted. Some loggerheads were spotted submerged 2-5 m deep very close to the vessel and others were spotted several hundred meters away on the surface. We stop the vessel for the loggerheads that are close and maneuver to within 50 m for those spotted at a greater distance. Positions are recorded and a continuous GPS track maintained. The ROV operator turns on the vehicle and runs the system checks. The ROV assistant is responsible for getting all DVDs, CDs, and hard drives annotated and operating. The assistant maintains a hand log of all observations during a tracking as well as change out disks as they fill.

Two crew members pick-up the ROV and get it ready to launch from the rail. The captain maneuvers the vessel to get the turtle to windward and 50 meters out in the ideal world. The goal is not to drift over the ROV tether. When all is set the ROV is launched and proceeds towards the turtle's position. Commonly the mast head observer has the best view and communicates via the VHF radio to the ROV assistant which way the ROV should be heading. The ideal approach is to approach the turtle from the front so the turtle would not be startled causing it to dive. We found it best to stop the ROV about 10 meters away and then approach until the turtle is acquired on video. If the turtle approached the ROV we found it best to remain still and let the turtle investigate the vehicle. While the ROV is tracking the turtle the captain must keep maneuvering the vessel to maintain slack in the tether. A crew member on deck handles the tether by paying out or retrieving as needed. When the ROV operator is busy tracking the turtle on the video screen he usually has no idea where the ROV is in relation to the vessel. This means he can not

be given directions relative to the vessel's position if he loses visual. If video contact with the turtle is lost, we use the BlueView sonar to search as well as visual searches from the vessel. If no contact is made we would then proceed to do a bottom search.

Using an ROV in the open ocean to track a sea turtle is not a simple exercise. The ROV is a complicated tool with electronic, electrical, mechanical, and optical systems subject to frequent failure. Even if all systems are functioning well, just the task of maintaining a visual on a moving turtle is no simple achievement. The ROV operator needs to know the location of his vehicle relative to the vessel while knowing the position of the turtle relative to the ROV. Once the turtle is acquired on camera the operator has to monitor the video screen continuously as well as keep an eye on the sonar screen. All data collected has to be recorded and annotated. These procedures and methods were developed during pervious trips and applied on both trips discussed in this report.

2.1.2 Bottom Search Mode

On a number of occasions we would send the ROV vehicle to the bottom in stages. The ROV is equipped with an Onset temperature/depth logger so temperature is continuously recorded on the way down and at the sea floor. Once at the seafloor we would go into a search pattern looking for loggerheads while also observing benthic fauna.

2.2 Towed video system

On several occasions we towed the ROV by marrying the tether to a 13 mm polypro line. The Tether was hung in bights from the line using electricians tape. Extra weights had to be attached to the line to allow the ROV to descend from the surface at towing speeds in access of two knots. This operation was not the most successful but pointed us towards future solutions discussed further on in this report.

2.3 Multibeam Side Scan Sonar

The purpose of this portion of the study was to explore the use of side scan sonar to aid in observing the density of loggerheads during the operations and to assist in ROV operations undertaken when loggerheads are located. The sonar and operator were previously deployed on three successful studies to observe turtle interactions with stationary fishing gear in Chesapeake Bay.

The side scan sonar unit used was a Marine Sonic 900kHz sonar. It was mounted on the bow of the commercial fishing vessel Kathy Ann (see Appendix A figures 1-4). The depth of the tow fish was about 1.3 meters. The sonar is capable of 50 meter range but previous work searching for turtles in Chesapeake Bay suggested an optimum detection range of 30m or less. Often the unit was set at 30 RD (range delayed) and hence searched 30-60m on port and starboard. The tow fish was fixed in position when the vessel was underway. A pin secured the tow fish so that it scanned port and starboard as per a normal side scan sonar operation. The tow fish was mounted on the bow – rather than towed – to better locate suspect targets before the vessel passed by them. When operating in this mode, the speed of the vessel was normally less than

four knots. The intention was to have the sonar augment visual observations of the waters immediately about the vessel. Sonar targets of interest were classified by size, shape and discreteness. This will be explained further in the discussion section.

The tow fish was also able to be rotated when the vessel was in a stationary position when the vessel supported ROV operations. The intent was to assist the ROV operator in determining the relative position of the turtle to the ROV in situations when the ROV lost contact with the turtle. A GPS compass was acquired to assist in determining the direction of any sonar contact. The compass is an electronic compass that relates direction primarily from GPS. It was tested several times for reliability and deemed satisfactory in this deployment. Caution was the rule as it can be compromised by ferrous metal. The sonar records were reviewed for targets in real time (Figures 1 - 11). The records were also reviewed again after the survey and acquired targets generated from the post-survey review are listed (Appendix A).

3.0 RESULTS

3.1 Behavior to ROV and Vessel

The sea turtles exhibited five different behaviors when approached by the ROV, including: immediate indifference/acceptance, gradual acceptance, total avoidance, and aggressive. An immediate acceptance of the ROV was observed with different loggerheads. When this occurred, the turtle would not exhibit any avoidance or seem nervous of the ROV's approach. These cooperative loggerheads were followed for the longest period of times. A few loggerheads even sought and returned to the ROV when the turtle was accidentally lost by the ROV pilot. Other loggerheads became indifferent to the ROV and continued behave in what appeared to be a natural way while swimming, feeding, socializing, resting, breathing, and, diving.

Sometimes the turtle would accept the ROV after initially trying to completely avoid or being weary of it. The amount of time that the turtle took to become comfortable with the ROV could depend on several variables including: the turtle's individual "personality", the turtle's behavior when approached (feeding, socializing, resting, etc), weather/visibility conditions, and the ROV approach technique. If a turtle tried to evade the ROV, it did so with a rapid dive down at least several meters. Sometimes this initial dive was within 10 meters of the surface, a depth where the masthead spotter could still acquire the turtle. Other times the dive was of a short enough duration that the observer could re-sight the turtle, since the turtle was caught off guard and not prepared for an extended dive. Some loggerheads that initially tried to evade the ROV would often become accustomed to the ROV after a few minutes, if the ROV pilot was able to stay with the turtle after its initial escape dive. Only in one case did a turtle allow the ROV to follow it, but never seemed comfortable with its presence and did not seem to behavior naturally.

One turtle displayed a more aggressive behavior than other loggerheads towards the ROV. Turtle 3 of trip Kathyann-2008-3, was sighted at 09:11 floating on the surface in 4-6 foot seas with sunny skies. The turtle was located in the Open Area between the southwest side of the Hudson Canyon Access Area and the Northern boundary of the Elephant Trunk Access Area. Jellies or

other food were not observed in the water, nor was there any floating objects (trash, debris, Sargassum) observed within visual range of the turtle.

This turtle was well within the size range of a juvenile loggerhead. The turtle was observed for a total of 23 minutes. A large chunk missing out of its left fore flipper appeared to be an old healed wound. The carapace had a dense patch of barnacles in the center of it's as well as on its soft tissue around the neck and head. This turtle was first spotted from the mast head floating with its carapace out of the water, slowing moving its fore flippers and taking breaths. The turtle took several long breaths every 10 – 20 seconds while looking directly at the vessel as it approached. Besides one brief dive to less than 1 meter did show any change in behavior during the 5 minutes that ROV was being prepared for deployment. The masthead observer made a video recording of the turtle's behavior while technical difficulties with the ROV were overcome.

The ROV was deployed and directed towards the turtle, the turtle seemed to see the ROV around the same time that the pilot acquired visual. Upon gaining first visual with the ROV, the turtle briefly turned broadside toward the ROV while remaining just below the surface. The turtle then continued swimming directly towards the ROV, while the ROV moved in reverse. Three more similar brief broadside turns were observed during the first 2 minutes of ROV observation. One of these seemed to be instigated when the turtle first made physical contact with the ROV. The turtle's behavior did not seem to be effected by the backwash of the ROV's propellers going in reverse. Turtle was never observed diving more than 1 meter.

The turtle swam just under the surface towards the ROV for 3 minutes taking breaths approximately every 1 minute in a range 1-2 meters behind the ROV before catching up and making extended physical contact. At this point the ROV was almost hard against the port side of the vessel and could no longer go in reverse away from the turtle. On several occasions, the turtle's beak touched the ROV's camera lens. It was theorized by the crew that the turtle could see its reflection in the camera lens. For approximately 3 minutes the turtle maneuvered itself underneath the ROV while pushing the ROV around and rubbing its carapace against the ROV's frame. This behavior was assumed to be aggressive in nature because turtle was deliberately and relentlessly ramming the ROV from all sides. The ROV had limited maneuverability, since it was hard against the side of the vessel and the turtle was underneath pushing it upwards. Except for brief glimpses of the turtle's flipper, the ROV did not have visual of the turtle while it was underneath the ROV. Video footage of this behavior was captured directly above from the masthead.

Maneuvering the vessel was difficult at this point due to increasing winds and the ROV position near the port beam. Visual of the turtle was lost and never reacquired after an attempt to reposition the vessel and ROV. Three hours after this interaction with Turtle 3, Turtles 7 & 8 were observed interacting at the surface.

3.2 Avoidance Behavior

During the August 2008 an innovative approach to towing the ROV in search of loggerheads was tried. During the afternoon of August 20th the towed ROV momentarily ran into a loggerhead turtle while being towed at 4.5 knots at 10 meters in an area of 29 fathoms of water. The ROV

towing vessel was directly behind the commercial scallop vessel Grand Larson II, which was actively fishing 0.15 nm ahead of the ROV vessel. Scallop viscera and shell could be seen with the ROV in the water column as scallops were being shucked as us normal during scalloping operations. Details regarding this towed video system are given in the following section.

At 14:17:37 a loggerhead, T23 was recorded swimming towards the path of the ROV with its carapace turned toward the vehicle (Figure 12). At 14:17:38, T23 turns so that its tail is directly toward the ROV and its carapace hits the top of the towing bridle. At 14:17:39 the posterior part of the turtle's plastron was seen hitting the ROV as it swam forcefully to get out of the way. By 14:17:40 the turtle had cleared the ROV and was not seen again. The entire interaction with the ROV was over within 3 seconds, with no noticeable physical harm to T23 or ROV. T23 was never spotted from topside during this interaction.

3.3 Social Behavior

Kathyann-2008-3 T7:T8

At 12:17 on 8/19/09 day 1 on trip Kathyann-2008-3, the pair T7:T8 were spotted swimming on the surface by the masthead observer. The loggerheads were first acquired at a good distance (~200 meters) and initially mistaken for mola mola because of the unusual flipper slapping behavior they were engaged in. Both loggerheads were well within the size range to be considered juveniles neither turtle was a repeat sighting. Since they were juveniles it is impossible to determine the sex of each turtle from a superficial examination. ROV footage of the two loggerheads interacting was not obtained. Approximately 10 minutes of video of this behavior was captured from the masthead while the ROV was being prepared for deployment.

T7 was first seen with its plastron completely out of the water and both fore flippers waving in the air. At the same time T8 was directly underneath T7 pushing it up out of the water. After a few seconds on its back, T7 would roll back over and swim in circles with T8 chasing close behind. This behavior was repeated multiple times. It appeared that T8 was always doing the chasing and pushing to T7, never visa versa.

As T7 was being chase it would turn on its side with its carapace facing T8, in a similar manner as to the reaction previous loggerheads had to the ROV as well as to sharks observed in previous studies. Both loggerheads seemed to be preoccupied with each other and did not pay attention to the presence of the vessel. The loggerheads stopped this chase routine when the ROV was finally launched. T7 immediately swam away as the ROV approached and gained a visual of both loggerheads at a distance of about 5 meters. T8 immediately swam towards the ROV at the surface to within 2 meters. No ROV footage of the two loggerheads interacting was obtained; all footage was captured from the masthead while the ROV was being prepared for deployment. It was spooked by the backwash from the ROV reverse thrusters as it was trying to back away from the approaching turtle. T8 briefly dove to 1 meter with its carapace turned toward the ROV. It stopped for a few seconds at 1 meter, and again approached the ROV. When it was within 1 meter of the ROV, and quickly swam down to 10 meters where visual was lost for 2.5 minutes. T7 was reacquired 2.5 minutes later at the surface for 1 minute before it swam away at the surface and was lost.

Kathyann-2009-1

Similar behavior was observed again the next year during trip Kathyann-2009-1. Two separate instances of social behavior were seen on the same day within the same general area. The first was two pair (T29:T30 and T31:T32, T32:T33) spotted in the northwest quadrant of the Delmarva Access Area (Figures 13 and 14). A few hours and miles later, a group of four loggerheads (T34:T35:T36) were observed physically interacting with each other (Figures 15 and 16). Each social interaction was recorded on video with both the ROV and as well as from the masthead.

Social Pair T29:T30

Both of the social pairs T29:T30 and T31:T32 were initially spotted at 12:00 interacting on the surface 500 meters away from the vessel's starboard side. The depth at this location (37-57.5, 74-38.6) was 39 meters with a surface temperature of 19 C and bottom temperature of 8 C. Seas were 0.5 meters with partly cloudy skies. The pairs were separated from each other by approximately 100 meters. All loggerheads observed during this day had barrel fish (*Hyperoglyphe perciformis*) associated with them and occasionally grey triggerfish (*Balistes capriscus*) as well. As T29:T30 were approached by the ROV, T30 swam away and T29 remained. No ROV video of this pair was obtained by the ROV. T29 was followed by the ROV for 15 minutes before contact was lost at 11 meters.

Social Pair T31:T32

The ROV then headed over to T31:T32 without having to be retrieved and redeployed. Both loggerheads were acquired on video together at 12:30. Neither turtle paid attention to the ROV as it as the ROV initially approach. When first acquired on the surface 10 meters away, T32 was facing the ROV with T31 directly underneath pushing it towards the surface. This behavior was identical to that observed the previous year during the trip Kathyann-2008-3.

When the ROV approached to within 5 meters, T32 quickly darted away down to 2 meters while T31 turned and briefly swam toward the ROV. After a few seconds, T32 came back to the surface and approached T31 from behind. This approach by T32 seemed to have spooked T31 which reacted with a brief 15 second dive to about 5 meters, with T31 remaining at the surface. T31 then slowly floated straight up towards the surface with T32 directly above. When T31 was 1 meter from the surface, T32 started circling with its carapace facing T31. As soon as T31 reached the surface, T32 quickly dove to 1 meter, stopped, and then surfaced facing the ROV 1.5 meters away. T31 then took a quick breath that seemed to be interrupted by being spooked, possibly by the boat. During this time, T31 was not in view of the ROV. Ten seconds later, T31 took another breath, then dove to 2 meters and swam towards the tether, possible biting it as it passed. After quickly swimming past the tether it made a slow accent while watching the ROV and took a breath.

After a short pause just below the surface it dove down to 1 meter then slowly resurfaced for another breath. T32 repeats this shallow dive, slow ascent, and breathe pattern while swimming in a easterly direction. T31, which had not been in view for 4 minutes, is briefly seen again

approximately 10 meters below T32. This is the last time that T31:T32 were observed in close proximity to each other.

T32 was briefly lost while repositioning the vessel, then reacquired and tracked until 15:35, when the tether ran out and the turtle was lost. While following T32, two more pairs of loggerheads were sighted by the masthead 500 meters away. Several other single loggerheads were spotted in the general vicinity during this time; however numbers were not assigned since they could have been re-sightings of previous loggerheads.

Social Pair T33:T34a

Twenty minutes after loosing T32, the pair T33:T34a were recorded together. A total of 2 minutes of video with continuous interaction between T33:T34a was recorded using the ROV. T34a was missing a significant portion of its right hind flipper, apparently down to the joint. It was an old injury that seemed to be completely healed. At first T34a was observed swimming towards T34b as it swam towards the ROV. The two then engaged in a "dog fight" with T34 swimming in circles with its carapace towards T34a. T33 attempted to bite T34a on the top of its neck as well its the marginal scutes. T34a avoided these bites by constantly turning in clockwise circles and turning its carapace towards T33. The two swam in opposite directions after 3 clockwise circles by T34a conducted within 1 minute. T34a was not seen again.

Social Pair T33:T34b

T33 was tracked for another 35 minutes, when T34b came into view. It was uncertain at the time if this was a new turtle or a re-sighting of a previous turtle, so was given the name T34b. Upon closer inspection, it was later determined to be a previously unrecorded turtle. T33:T34b were recorded together for a total of 4.25 minutes. Whether one turtle was approaching the other could not be determined. However it was noted that a piece of floating debris was within 2 meters of T34b. Both loggerheads were within 1 meter of the surface when they first saw each other. The distance that they were able to see each other could not be determined. As they approached both came to the surface swimming directly towards each other. Both turtle appeared to be swimming at the same speed as they approached each other head-on both loggerheads.

Upon making physical contact, T34b turned and presented its carapace to T33 while remaining on the surface. Both loggerheads then stayed in this position without swimming for 40 seconds, with T33's head right against the middle of T34b's carapace. The flotsam can be seen 1 meter away at this time. After 40 seconds, T33 starts to push against T34b, forcing it upwards and almost flipping it. After T34b rights itself, T33 then takes a breath while T34b rights itself and floats motionless just under the surface with its tail towards T33. T33 then dives down and bites T34b's tail. They then begin swimming in circles with T34b turning it's carapace and being flipped over by T33's pushing it towards the surface. T34b's flipper breaks the surface 2 times while this is occurring. This behavior continues for about one minute. During this interaction, neither turtle appears to notice the presence of the ROV which is about 2-3 meters away.

After the 1 minute "dog fight", both loggerheads stop momentarily at the surface. Then T34b slowly dive to 2 meters and starts swimming in circle underneath T33. T33 remained floating at

the surface near the single piece of flotsam taking breaths while facing the ROV 2 meters away, while taking breaths every 10 seconds and occasionally watching T34a below. After a minute floating, T33 starts swimming towards the ROV, with T34b hanging around 15 meters behind it. This is the last time T34b was seen. The ROV goes into reverse as T33 starts swimming towards it, stopping to take breaths approximately every 15 seconds. This goes on for 1.5 minutes before T33 turns around and starts swimming north for 1 hour at 1 meter.

Social Pair T33:T34c

T33 was observed with yet another turtle T34c one hour after T34b. Because the encounter was brief and a good view of this was not obtained, it was named T34c. T33 was swimming north just under the surface for some time, then suddenly started swimming west for a few seconds an stopped, floating motionless at the surface. At this time T34c could be seen to the east about 2 meters below the surface and 15 meters away from the T33 and swimming south.

A large school of barrel fish could be seen swimming from T33 to T34c, even though the loggerheads were 15 meters apart.T33 then turned and swam quickly toward T34c. T34c stopped less than 1 meter below the surface as T33 approached from behind. Without hesitation, T33 swam up to T34c and bit it on somewhere around its tail. The ROV was less than 1 meter away from both loggerheads when T33 bit T34c. After biting, T33 remained motionless just below the surface as T34c quickly swam away and not seen again. T33 then continued swimming north 1 -3 meters deep for another 30 minutes until visual was lost due to a short tether.

Social Triple T35:T36:T37

After loosing visual of T33, the ROV was brought onboard and the vessel headed towards a group of three loggerheads (T35:T36:T37). Before launching the ROV, footage of T35:T36:T37 were recorded from the masthead directly above the loggerheads while they were alongside the portside of the vessel (Figure 17). T35 was much larger than the other two loggerheads, and based on its size and tail length, was probably a mature male. T35 was observed pushing T36 with T37 swimming within 1 meter of the two. Both T36 and T37 swam in circles around T35. T35 dove after looking directly at the vessel while taking a breath and was not observed again. The ROV was launched and T37 was immediately acquired with T36 less than 1 meter away. ROV footage was not obtained of these loggerheads interacting. At 16:18 the glare on the water was too great to relocate the loggerheads and they were not seen again.

3.4 Detailed Behavior Observations

Two loggerheads, T15 and T21, were followed to the seafloor during day 3 of the second ROV trip Kathyann-2009-1. Both loggerheads exhibited dive behavior very similar to that seen with another turtle diving to the seafloor during a previous ROV project. Both dives occurred on June 14, 2009 in the Delmarva Scallop Access Area. T15 was followed continuously to within 3 meters of the seafloor before it was lost due to a short ROV tether. Although this dive was cut short, there is enough footage to be able to compare behaviors between loggerheads. Following

T21 was more successful with an entire dive being recorded continuously along with 12 minutes following the turtle along the seafloor. A detailed description of both dives follows.

Dive to the Seafloor – T15

At 10:00 on 6/14/09, T15 was spotted on the surface from the masthead 50 meters off the starboard bow at position 38-01.8, 74-26.9. T15 was spotted in the middle of the Delmarva Scallop Access area. The wind was out of the north at 15-20 knots with sunny skies and seas of 1.5 m, the water depth was 49 meters. T15 was the first turtle spotted during day 3, which had begun foggy with calm seas. The turtle was definitely at juvenile, with some fouling around the fringes of its carapace. The vessel had just begun searching for loggerheads five minutes prior to spotting T15, after a two hour delay that morning fixing the ROV's tether. The ROV's clock was not set correctly during this trip, so the display time is referred to time code instead of real time.

Initial behavior – T15 was first acquired by the ROV just below the surface with a school of approximately eight barrel fish. The turtle seemed to immediately be interested in the ROV. T15 swam toward the ROV for the first eight minutes of observation. During this time it was as close as 1 meter to the ROV, which was using reverse thrusters to keep ahead of the turtle. The turtle dove twice to 1-2 meters but quickly returned to following the ROV. Two breaths were taken approximately 1 minute apart. After eight minutes swimming behind the ROV, T15 stops and floats at 1 – 2 meters for two minutes while looking at the ROV. After floating for 3 minutes, the turtle starts swimming slowly to the southwest at a depth of 2 meters.

Transit Swim - For the first 3 minutes following T15 on this heading, it would turn to look at the ROV every 30 seconds. After 3 minutes the turtle continues southwest at 1 meter, taking full strokes every 5 seconds. T15 took a short breath 12 minutes after beginning on the southwest heading and 16 minutes since the last breath. Two minutes later another breath is taken and then the turtle lingers at the surface for 1 minute next to a piece of translucent debris. It continues southwest just under the surface before taking another breath after 1 minute. The next two breaths are taken 10 minutes apart. During this time the ROV was behind the turtle 1 meter, and the turtle took a slight turn to look back at the ROV. Also around this time, another turtle (T16) was spotted on the surface from the masthead approximately 500 meters away. No interaction between these loggerheads was observed.

During the rest of the turtle northeast swim, 6 more breaths were taken: 2 were 10 minutes apart and 4 were 1-2 minutes apart. During one breath, the turtle floated on the surface for 2 minutes and took a bite at a piece of white debris. The debris appeared to be a piece of cardboard approximately 12"x12". It appeared not to ingest or break off any of the debris and only attempted one bite.

Pre-Dive behavior - T15 started its pre-dive behavior after tracking it for a total of 58 minutes. At this point it took a breath and floated on the surface with all four flippers dangling. During this time it was difficult to observe from the ROV's perspective the total number of breaths taken. It did look at the ROV briefly while floating on the surface, but it did not change its

behavior. After floating motionless on the surface for 3.75 minutes, the turtle started its dive to the seafloor.

Dive behavior - At time code 2:59:48 (~11:08 EST) T15 started a dive to the seafloor (Figure 18). It was lost at depth 49 meters (time code 3:02:00) just before landing on the seafloor. Depth at this location (38-01.8, 74-27.2) was 54 meters. Weather was sunny with the wind north at 15-20 knots and seas of 1.5 meters. The turtle's distance and position relative to the vessel was not recorded. The ROV was 1-2 meters away from the turtle when the dive started. The approximate total time it took the turtle to travel from the surface to the sea floor was approximately 2 minutes. The ROV was along the same horizontal plane (within 1 meter of the same depth) and within a distance of 2 meters of the turtle during most of the recorded dive.

Depth, time, and stroke count was logged at 5 meter intervals using the ROV screen display. These data were used to calculate speed and stroke rates. Sea water temperature was recorded with an Onset temperature/depth data logger as well as an Onset Tidbit temperature/time logger attached to the ROV's frame. The surface temperature at the beginning of the dive was 19.5 C and the bottom was 10 C for a change of -9.5 degrees C within 2 minutes.

The turtle started the dive at a steep angle (appears to be almost vertical) and swam using rapid strokes. At approximately 19 seconds into the dive (time code 03:00:07) the turtle had reached ~5 meters (speed = 0.3 m/s). At time code 03:00:21 the loggerheads depth was 10 meters and was using the same rapid stroke rate. During the 5 to 10 meters the turtle took ~ 7 complete power strokes in rapid succession. Stroke rate was roughly 0.5 stokes/second or 2 seconds to complete a full stroke cycle (from top to bottom back to top). Fifteen meters was reached at 03:00:34, 13 seconds from 10 meters for 0.4 m/s. Negative buoyancy started to occur at the thermocline which started at 32 meters. At around 32 meters T15's the stroke rate dropped dramatically from 4 strokes per 5 meters to 1.5 strokes per 5 meters. At 40 meters the turtle was completely negatively buoyant and went into a glide, taking no strokes the final 14 meters. The end of the thermocline was around 46 meters.

T15 reached the ocean floor at a depth of 54m at time code 03:52:40. The actual landing on the surface floor was not observed due to ROV loosing visual contact with the turtle. The last five meters of the turtle's dive were not recorded. During the last 10 meters the turtle was picking up speed, making it difficult for the ROV to keep pace. T15 was lost at 49 meters; however given its speed, trajectory, and distance to the seafloor it is a valid assumption that it made it to the sea floor shortly before the ROV arrived. An approximate time code for T15 to have reached the seafloor would be 03:02:05. Once the ROV was on the bottom it went into search mode, using the BlueView sonar to attempt to find the turtle on the seafloor, but was unsuccessful. T15 was lost on the bottom 0.38 miles from the initial sighting location. A total track line of 1 mile was covered while tracking T15. The sea floor characteristics at the dive location were flat sandy with sand dollars and sea scallop shells.

Dive to the Seafloor – T21

T 21 was initially spotted from the foredeck on the surface 10 miles to the southwest of T15 at 17:05 on 6/14/09. The position of when first sighted was 37-57.0, 74-35.9 where the water depth

was 45 meters with a sea state of 2 meters and sunny skies. T21 was tracked for a total of 1.5 hours before being lost while following it along the seafloor. The turtle's heading for the majority of this observation was oriented to the southwest and various behaviors were recorded during this time period. T21 was observed to have several healed injuries to its carapace and plastron, which are described and discussed in detail later. Two more loggerheads were sighted, T22 and T23, while T21 was being tracked but were not acquired with the ROV or seen in close proximity with T21. T21's dive to the seafloor was recorded by the ROV as well as 12 minutes of footage of it swimming along the seafloor (Figure19).

Initial behavior – T21 was first acquired by the ROV just below the surface with a school of approximately 30 barrel fish. The turtle was approached from behind to about 2 meters while swimming in a southerly direction less than 1 meter under the surface. It did not initially notice the ROV's presence until the wash from the reverse thrusters caused visual to be lost for 4 minutes. Upon reacquisition, T21 was facing the ROV at the surface of the water and cautiously showing it's carapace as the ROV approached to within 1 meter. T21 appeared to show immediate interest in the ROV. T15 swam toward the ROV for the first 8 minutes of observation. During this time it was as close as 1 meter to the ROV, which was using reverse thrusters to keep ahead of the turtle.

The turtle dove twice to 1-2 meters but quickly returned to following the ROV. Two breaths were taken approximately 1 minute apart. At this point the cracked carapace was clearly visible (Figure 20). As the ROV drifted approximately 5 meters away from the turtle, it turned and swam toward the ROV. Two breaths occur at time code 3:24:24. By time code 3:25:22, the turtle seemed to be comfortable with the presence of the ROV and approached it slowly head on to within 0.5 meters while floating on the surface. At 3:25:33 another injury to the carapace was seen above the left fore flipper. Additional carapace injuries can be seen at time codes 3:28 and 3:29.

This initial behavior was observed for 13 minutes before the turtle began swimming to the southwest. The total straight line distance covered during this time was 0.32 km and the track line distance was 0.50 km. Once the turtle became accustomed to the ROV, it paid little attention to it until diving to the seafloor.

Transit Swim – At time code 3:30:56, T21 began a consistent swim towards the southwest at an average depth of 1 to 2 meters. The transit swimming behavior was observed continuously for 55 minutes over a total straight line distance of 0.9 km and a track line distance 1.9 km before the pre dive behavior began. No feeding, prolong stopping, or altering of course was observed during this time. Visual of the turtle was never lost during this time period. The straightest segment of the entire track line was also observed during this transit swim. The turtle turned twice to briefly look at the ROV, but otherwise did not seem to directly pay attention to its presence 2 meters behind the turtle. The barrel fish and a single pilot fish were observed following T21 as is swam.

The average speed over ground was 1 km/hr for the straight line and 0.5 km/hr for the track line. Breaths were taken on average of every 5 minutes with a maximum time between breaths of 17

minutes and a minimum of 4 seconds (two breaths taken during a single surfacing). A stroke rate of 16 strokes per minute was observed throughout the swim.

A unique swim stroke behavior exhibited by T21 was an occasional offbeat or unsymmetrical stroke observed briefly approximately every 2 minutes. Photos illustrating this offbeat stroke are provided in Figure 21 although it is difficult to interpret this behavior through still shots. This behavior has been observed by the PIs only with this turtle. One theory for the cause of this offbeat stroke could be related to the significant injuries incurred by the animal, also which have only been observed by the PIs with T21.

Two other loggerheads, T22 and T23, were spotted while following T21 on the transit swim. Neither turtle was observed interacting with T21. T22 was spotted from the masthead on the surface 50 meters from 21 at time 17:10 with the position 37-56.8, 74-36.2. At 17:54, T23 was seen on the surface from the masthead about 1,000 meters from the vessel.

Pre-Dive behavior- T21's pre-dive behavior start1 hour and 8 minutes after visual was first acquired with the ROV. The pre dive was observed for a total of 5 minutes before the turtle dove to the seafloor. During this time the turtle exhibit behavior similar to that of other loggerheads before a seafloor dive. T21 floated on the surface, barely moving it flippers (except for occasional slow sculling or threading water strokes), nor paying attention to the ROV. The barrel fish associated with the turtle dispersed, but stayed within 5 meters of the turtle, some were swimming back and forth between the turtle and the ROV. Because the ROV was 2 meters behind the turtle, the number of breaths could not be observed. After 5 minutes suddenly takes a steep dive angle and with rapid strokes begins its dive to the seafloor.

Dive behavior - At time code 4:31:48, T21 started its dive to the seafloor. The ROV was 2-3 meters away from the turtle when the dive started. Depth at this location was 46 meters. The turtle took 1:52 seconds to dive from the surface to the seafloor at 46 meters. The ROV followed 1-3 meters away from the turtle at the same depth looking at its plastron. The ROV was along the same horizontal plane (within 1 meter of the same depth) and within a distance of 2 meters of the turtle during most of the recorded dive. Most of the dive was recorded, except for 7 seconds while going from 33 to 40 meters, when the turtle was going too fast for the ROV to maintain visual. The however last few meters were recorded as the turtle landed on the seafloor beneath the ROV.

Depth, time, and stroke count was logged at 5 meter intervals using the ROV screen display. These data were used to calculate speed and stroke rates. Sea water temperature was recorded with an Onset temperature/depth data logger as well as an Onset Tidbit temperature/time logger attached to the ROV's frame. The surface temperature at the beginning of the dive was 19.4 C and the bottom was 9.2 C for a change of -10.19 degrees C within 2 minutes. Approximately 15 of the barrel fish followed the turtle during its dive.

The turtle started the dive at a steep angle (appears to be almost vertical) and swam using rapid strokes. At approximately 18 seconds and 12 full power strokes into the dive (time code 4:32:05) the turtle had reached ~5 meters (speed = 0.26 m/s). A 32 seconds the turtle's depth was 10

meters and was using the same rapid stroke rate. During the 5 to 10 meters the turtle took 9 complete power strokes in rapid succession.

Neutral buoyancy started to occur at 30 meters. At around 30 meters T21's the stroke rate dropped dramatically from 4 strokes per 5 meters to 2 strokes per 5 meters. Most of the strokes taken at this time were not complete strokes. At 35 meters the turtle was completely negatively buoyant and went into a glide, taking no strokes the final 11 meters. T21's dive angle became more horizontal so that it came in for a gentle landing on the seafloor.

T21 on the Seafloor - T21 arrived on the sea floor at time code 4:33:40 with the ROV following behind and landing on the sea floor at 4:33:53. The ROV followed T21 along the sea floor for 12 minutes 41 seconds until visual was lost at time code 4:45:12 due to a short tether. The bottom characteristics at 46 meters were flat sandy bottom with some sand dollars, some surf clam shells, one live sea scallop, and occasional sponge. The water temperature at 46 meters was 9.2 C. Visibility was approximately 6 - 8 meters with enough ambient light to not require use of the ROV's lights. Due to the short tether, the ROV had limited maneuverability which often caused it to be pulled back by the vessel and bounced along the bottom.

Upon arriving on the seafloor, T21 immediately turns and approaches the ROV by walking along the sea floor with all four of its flippers. At this time the ROV which is slowly bouncing and being drug along the sea floor. The thrusters from the ROV as it tries to pull forward stirred up much sediment on the sea floor but did not seem to spook the turtle. The turtle followed the ROV at a distance of 1-2 meters as the ROV was being pulled backwards. T21 used a combination swim/walk by pushing off the sea floor with its hind flippers and stroking with its fore flippers. When the ROV rises 1 meter off the bottom, the turtle follows by swimming up 1 meter towards the ROV. Approximately 4 barrel fish continue to follow the turtle as it moves along the sea floor. As the turtle moves along behind the ROV, it looks to the sea floor, occasionally turning or diving as if it sees something on the sea floor. Perhaps the ROV was stirring up animals on the seafloor (much as a dredge would do). It also occasionally takes brief glides towards a fixed point on the bottom, seemingly investigating something it sees within 3 meters of it. During the glides, no strokes are taken but forward movement continues.

After 4 minutes of following the ROV as it is pulled by the vessel, the turtle stops paying attention to the ROV and starts moving in a variety of directions along the sea floor, no longer following the ROV. It made quick turns and changed direction regularly. The turtle swam/walked along the bottom with its head down looking at the sea floor immediately in front of it. It occasionally changes direction quickly and turns its head left or right as if spotting something on the bottom as it walks and swims along.

A single large sea scallop was observed on the bottom. The turtle swam/walked directly over it without pausing or paying any attention. The turtle was not observed chasing or eating prey on the sea floor. No crabs, fish, jellyfish or other potential prey other than the single scallop were observed on the sea floor. The turtle was last seen swimming/walking in direct contact with the sea floor with a southern heading. It was not reacquired with the ROV or from the fishing vessel. The water temperature at the time the turtle was lost was logged at 8.7 C.

3.6 Fish Associated with Loggerheads

During the June 2009 trip, (Kathyann-2009-1) schools of fish were observed associated with individual loggerheads in both large numbers and with more frequency (Figure 22). During other ROV observation trips, loggerheads were observed with fish, most common was grey triggerfish *(Balistes capriscus).* However these were not seen regularly with loggerheads, with up to approximately 6 fish for an individual turtle. During the June trip, the majority of loggerheads observed with the ROV had fish associated with them, often in larger schools of 10 or more. The primary fish observed was the barrelfish (*Hyperoglyphe perciformis*) with occasional grey triggerfish and pilot fish (*Naucrates ductor*). Barrelfish had not been seen with loggerheads during other observation trips. The barrelfish were observed swimming back and forth between the ROV as well as between turtle pairs. Several barrelfish were able to follow the loggerheads to the bottom and, in the case of T21, stayed with them on the seafloor.

3.7 Application of Multibeam Side Scan Sonar

The operation involved four days at sea. A summary of the operations and quality of these days follow:

19 August 2008 – The ROV was the primary instrument used to investigate visual sightings of loggerheads. The sonar was not deployed until 1315. The sea state was choppy. The sonar operations ceased at 1840 hours. The sea state made sonar operations marginal, at best.
20 August 2008 – The winds were northeast between 20-25 knots. The seas were up to 10 feet. These conditions were not favorable for sonar operations. No sonar operations were undertaken.
21 August 2008 – The sonar was deployed at 0708 and sonar operations continued for most of the day. The wind was light with a predominant direction from the NE. The visual and sonar surveys were sometimes stopped to deploy the ROV on loggerheads. Operations ceased at 1933 hours.
22 August 2008 – The sonar was deployed at 0704 and terminated about 1144 hours, when the vessel started to return to port. Winds were southeast about five knots and waves were less than one foot.

As weather permitted and we undertook transects to count loggerheads along certain tracks; the side scan sonar was also deployed. The first day, 19 August, the operations were predominately to directly observe loggerheads with the ROV. This activity is not discussed in this report, except on subsequent days when the sonar was active during ROV activity.

On 19 August, the sonar was active from 1315 until 1840. The sea state was choppy with swells which did interfere with vessel and tow fish stability. This sea state produced sea surface clutter that interfered with target detection and resolution. Figure 5 is one file of sonar imagery from this period. The track of the vessel is vertically displayed in the center of the image. The image is displaying the water column between 30 – 60 meters each side of the vessel. The area between 0 - 30 meters is not available when functioning in this mode. Considerable amorphous anomalies can be seen in the acoustic image, this is caused by the reasons mentioned above. This condition is worse than marginal for purposes of identifying targets as potential turtles (see also Figure 6).

On 20 August, winds and the resulting sea proved too severe for sonar operations. On 21 August, the sonar was deployed at 0708 and sonar operations continued until 1933 hours. . The targets are classified as to recorded sonar file order which is chronological, location in relation to the vessel, geographic position, size of the target, quality of the target in reference to probability of being a turtle, and estimated depth of the target. Twenty-two targets that may be turtles were seen (Appendix A). The target quality classification for three of those targets was high. Seventeen targets were considered as either low or medium in probability. Representative samples of all the targets are presented in Figures 7-11. On 22 August, the sonar was deployed between 0704 and 1144 hours. Three targets were considered high in probability. Eighteen targets were identified as being either low or medium possibilities of being turtles.

Target classification: size, shape and discreteness; Sonar targets were classified by size, shape and how discrete they were. The turtle may present a number of different profiles to the sonar and therefore one cannot rely, for example, on only a dorsal view of a turtle which may be the most recognizable. In regard to a discrete target, in calm seas the detection and probability of a target being identified is much more likely. In choppy sea states, where multiple targets are on the record, separating sea clutter from a probable target is most difficult. Hence the probability detection and identification is decreased. Under very choppy conditions, detection and classifying targets as turtles is impossible. The first day at sea, 19 August, provided a choppy sea surface of this nature. This greatly interfered with detection as reflection from waves was numerous in the sonar data (Figures 5-6).

Visual verification - On only one instance when a turtle was detected by sonar and the vessel turned to further locate the turtle (preferably visually – for verification), was a turtle visually seen. Other instances of turning to locate a sonar target of high probability did not present verification of the sonar targets.

ROV and turtle detection - Several opportunities were available to scan when in a stopped position and the ROV was deployed to encounter a turtle. The results in imaging are shown in Figures 14-15. The ROV is usually easy to detect. Only once of three limited instances was a turtle detected on the sonar. One purpose of deploying the sonar in this mode was to vector the ROV to the turtle when the ROV was unable to detect the turtle. The one instance would have provided a means to give the ROV operation the direction to the turtle, but not a clear indication of the relative depth of each. *Fish and other targets* - Fish were seen several times and in one instance porpoise. The fish and porpoise were usually distinguished from turtles by the elongated returns they presented.

Stationary application of the side scan sonar- In a stationary mode, the intention was to rotate the sonar to detect the ROV and turtle. This method requires good coordination between the sonar operator and the individual rotating the tow fish. In one instance the ROV and turtle were detected and some vectoring of the ROV would have been possible, but was not done in the encounter. This action does require coordination and some experience. A more effective means may be sector scanning sonar, but this too requires experience, good coordination and a relatively calm sea state. Fast scanning sector scan sonar would be preferred and one that can be directed at certain quadrants, but fast scanning usually does decrease detection except for the more expensive units.

4.0 DISCUSSION

4.1 Vessel Mounted Sonar

The application of side scan sonar to augment detection of turtles requires a relatively calm sea surface so that surface sea clutter does not interfere or inhibit detecting sea turtles. The sonar, in this case was mounted on the bow of a fishing vessel that was quite stable. However, pitching does become an issue that limits the detection. A deeper mounting of the sonar tow fish may increase the utility of the sonar. The sonar was only about 1.3 meters below the sea surface. Mounting the tow fish deeper would decrease the sea clutter but will probably not measurably increase the utility of the sonar to detect small targets (< one meter) in regard to a pitching vessel.

The Marine Sonic 900 kHz sonar was very sensitive to sea surface clutter and most side scan sonars are when used in very shallow situations. A sonar system less sensitive to the plane above the depth of the tow fish would increase the utility of the application. The question is the cost and availability of that system. The operator recommends a side scan sonar that has a 900 kHz frequency range. A lower frequency will have a greater range but will probably not have the necessary resolution. Higher frequency sonar will have the resolution but will probably not have the desired range. Further evolution and availability of sonar systems may change this recommendation.

Towing the sonar tow fish would have allowed for more operational time during the four day period at sea. Sea surface clutter would have been less, but not eliminated. The first day, for example, would have provided less sea surface noise and aided the operator to better identify likely targets. Towing the sonar fish on the second day would not have been possible with winds of 20 plus knots and waves approaching ten feet. Another possibility would be to lower the tow fish anther meter. This may reduce sea surface clutter, but it would not have measurably improved tow fish instability caused be pitching.

4.2 Deployment of Gear Mounted Cameras

Two camcorders (Panasonic SDR-H18 and Sony DCR-SR62) were used interchangeably. The camera was placed into an underwater housing and mounted on the bale. The camera was aimed aft to view the cutting bar and frame or forward to view ahead. A second camera, an underwater Deep Sea Power & Light, Inc (DSPL) model 2060 Multi-SeaCam mounted on the port end of the dredge depressor plate, was aimed across the dredge to gain a full view of the entire bale. This camera was connected by cable to an underwater housing containing a video recorder and power pack. The cameras did not record any turtle interactions.

The idea of placing video cameras on scallop dredges to record the interaction with sea turtles sounds very logical at first. We have successfully used this technique when we placed turtle carcasses in front of dredges to record the interaction (Milliken et al, 2007; Smolowitz et al, 2008). Even in the controlled conditions of these carcass tests it was not an easy task to accomplish and the effort was very time-consuming. In the natural environment of the fishery we

are additionally hampered by low interaction rates, limited daylight, limited light at depth, turbidity, and rough fishing conditions.

While this effort to video tape interactions with standard and turtle excluder dredges was ongoing, other research and development was underway with the new excluder dredge design both using video and catch comparisons (Smolowitz et al, 2006, Smolowitz and Weeks, 2008). This work was very successful and put more emphasis on the need to understand turtle behavior, as opposed to dredge fishing characteristics, on this project.

4.3 Turtle Behaviors

It is assumed that anytime when a visual of a turtle was lost before the ROV was deployed, was due to the presence of the ship. The vast majority of the time, loggerheads observed avoiding the vessel seemed to respond after visually spotting the vessel rather than the sound of the approaching vessel. On several occasion the vessel would pass within a few feet of a turtle on the surface without it ever recognizing the vessel's presence. Perhaps with all of the noise in the ocean, loggerheads have become accustomed to the sounds of vessels or they may not be able to determine direction/distance of the vessel, or it could simply be that they were asleep and not paying attention. Of course these observations are biased since there could have been a large number of loggerheads that avoided the vessel due to different cues but were never spotted. Occasionally a turtle seemed to exhibit an avoidance response to a sound made on the vessel topside, such as the crew talking or dropping something on deck. This only occurred while the turtle had its head above the surface, and could have also been a reaction to visually seeing the vessel and/or hearing the noise.

After some experience observing turtle behavior, it was easy to quickly assess the "mood" or cooperativeness" of a turtle upon sighting. This often seemed to be related to time of day and weather. During sunny calm day, especially in the middle of the afternoon, loggerheads tended to be more "relaxed" and easily approachable. Days with seas greater than 3 foot and overcast skies, the loggerheads were observed to be easily spooked and spent more time below the surface. There are of course many other variables that could affect the approachability of individual loggerheads (angle of the sun in relation to the vessel, presence of predators or other loggerheads, type of food available, water temperatures, efficiency of ROV deployment/piloting, presence of Sargassum, thermocline depth, previous and anticipated weather conditions, etc). This introduces selective bias of which loggerheads were observed, since we were not able to observe loggerheads that completely avoided the vessel or ROV. For future use we are maintaining a video record of each loggerhead observed (Figures 23 and 24).

4.3.1 Social Behavior

Fishermen and NMFS fisheries observers have reported sightings of loggerheads "doing the backstroke". Knowledge of this social behavior could be helpful when analyzing turtle takes in scallop gear, especially when loggerheads are caught within close temporal proximity. It could also have implications on what is known for breeding and social behavior of loggerheads. Nothing in the published literature describes the social behavior observed between two juvenile loggerhead turtles offshore. Several experienced NOAA turtle biologists from across the country

were consulted to explain this behavior. None had ever witnessed, heard of such a behavior, or could explain such loggerhead behavior. Some speculative theories have been put forward, such as: courting behavior, play, shell cleaning, territorial sparring or some other unknown social reason. There term coined to refer to this behavior among the crew was the "New Jersey Flip Off", since it was observed offshore of New Jersey and involved major flipper movement above the surface. This social behavior has since been repeatedly observed during more recent research trips and will be covered in more detail in future reports.

4.3.2 Turtle location within the water column

During the two research trips associated with this project, and two previous research trips, we have observed 171 loggerheads. All the loggerheads were originally sighted at or near the surface. None were originally sighted on the bottom either by dredge mounted cameras or ROV searches. These bottom searches included recently fished tow paths in areas where turtles were spotted in close proximity on the surface both temporally and spatially. In three years of doing this work with dredge mounted cameras we have over one hundred hours of bottom time and never initially encountered a turtle on or near the bottom. This still is a low amount of sample hours compared to the published take rates. However, we have successfully followed loggerheads to the seafloor using an ROV. This definitively establishes the fact that they do forage on the seafloor in the area of the sea scallop fishery in the mid-Atlantic.

A logical hypothesis is that the turtles are feeding on the bottom possibly attracted to the area by the fishing activity and the resulting discard of bycatch and shucked scallop shells/viscera. The problem with this hypothesis is the bottom water temperatures are significantly colder than loggerheads are known to frequent; especially for feeding. During this project the bottom temperature was about ten degrees Celsius. We also did not observe significant densities of crabs or shellfish that loggerheads are known to feed on, and most of the scallop discard we observed was consumed by fish and sharks in the water column behind the fishing vessel. This project established that the loggerheads do in fact frequent cold waters and also feed at these temperatures.

The literature would seem to support that the juvenile loggerheads are normally within 5-10 meters of the surface. The following is taken from the NMFS Protected species web site: "Post-hatchling loggerheads inhabit areas where surface waters converge to form local downwelling (Witherington 2002). These areas are characterized by linear accumulations of floating material, especially *Sargassum*, and are common between the Gulf Stream and the Southeast U.S. coast, and between the Loop Current and the Florida coast in the Gulf of Mexico. Post-hatchlings within this habitat are observed to be low-energy float-and-wait foragers that feed on a wide variety of floating items (Witherington 2002). Witherington (2002) found that small animals commonly associated with the *Sargassum* community, such as hydroids and copepods, were most commonly found in esophageal lavage samples."

The water temperature in the top 5-10 meters is in the range that loggerheads prefer. There is abundant Sargassum weed, with the associated fish and crustacean communities, floating in the areas where the interactions are occurring. We observed from 4 to 8 loggerhead turtles associated with the one large Sargassum mat we encountered in 2007. There are also large numbers of

jellyfish near the surface throughout the area. The problem with the concept that interactions occur near the surface is that scallop dredges spend almost no time in this part of the water column except next to the vessel. We have established that not only do the loggerheads feed on jellyfish near the surface; they also forage on the mid-Atlantic seafloor in depths greater than 60 m and temperatures colder than 8°C.

The amount of time a loggerhead spends on the surface depends on her swimming rhythm defined as the frequency, duration, and depth of diving activity (Sakamoto et al, 1990). Sakamoto's research effort found that the tracked turtles offshore dive deeper at night than during the day (>15 m vs <10 m). The rhythm of dive frequency and duration was disturbed by major weather events and passing through frontal zones. One turtle was observed to dive deeper with the passage of a typhoon indicating that turtles may change their diving periods according to weather conditions. Loggerheads were found to have a clear circadian diving rhythm offshore, closely correlated with sunrise and sunset, but not so clear when near shore (Ibid, 1990).

Turtle behavior during internesting periods probably differs in many ways from when turtles are actively foraging away from nesting areas. Studies of turtles in the internesting period have led to classification into six dive types (Houghton et al., 2002). In the internesting period turtles may be spending time on the bottom for resting or foraging purposes. Turtles traveling offshore may rest in the mid-water while a turtle near to nesting beaches may choose to rest on the bottom (Ibid, 2002). We still do not know if loggerheads rest on the bottom during the summer foraging season in the Mid-Atlantic.

Research in the Gulf of Mexico found that loggerheads spent more than 90% of their time submerged in any given season and that submergence time varied from 4.2 minutes in June to 171.7 minutes in January (Renaud and Carpenter, 1994). The metabolic rate of turtles decreases with decreasing seawater temperature which increases their capability to stay submerged longer. In a series of experiments in tanks, dive times in water temperatures ranging from 22-27 degrees C were as long as 40 minutes compared to a maximum of 120 minutes when water temperature was kept between 13-17 degrees C (Bentivegna et al, 2003). Satellite tracking of loggerheads off South Africa also found submergence time exceeding 90% for three post-nesting turtles proceeding to their foraging grounds (Luschi et al, 2003) In this case the turtles made numerous submergences of relatively short duration; mostly 10-20 minutes. Loggerheads made more dives during the day than at night though at night the submergence time was longer (Renaud and Carpenter, 1994). In a deep ocean setting, loggerheads were found to spend about 40% of their dive time in the top meter and seldom went below 100 meters (Polovina et al, 2003). In an aquarium environment, a loggerhead turtle spent 83.3% of its time resting on the bottom during a 155 minute period. It did this in 7 dives of 22 minutes mean duration with 1-3 breaths taken at the surface between dives (Hochscheid and Wilson, 1999). While we have not fully analyzed all our data it is apparent that the loggerheads we tracked were not spending much of their time breathing air above the surface. More relevant would be to calculate how much time was being spent at different depths. The ROV can give an indication (Figures 25-28; Tables 2-3) but satellite tagging will be needed for a more definitive answer.

Turtles can adjust their buoyancy by varying the amount of air they take in at the surface. For deeper dives the turtles take in more air thus have the capability of staying down longer than a shallow dive (Houghton et al, 2000). In addition, loggerheads have been found to maintain depth without swimming which indicates that they have neutral buoyancy at that depth by the process of controlling their air intake at the surface (Minamikawa et al, 2000). The observed turtles initially descend to the deepest point of their dive, then gradually ascend maintaining a near constant depth, and then head back to the surface. However, these tests were conducted on inter-nesting females, which are not actively foraging, and thus may not apply to turtle behavior on feeding grounds. This behavior, which conserves energy, may also take place during heavy weather when the turtle does not want to remain on or near the surface. Our limited observation indicates that the loggerheads we followed to the seafloor were positively buoyant to about 30 meters and then became progressively negatively buoyant. When returning to the surface they initially had to stroke hard but became more positively buoyant as they neared the surface.

In summation, the literature on submergence behavior is loaded with contrasting findings. Loggerhead turtles may spend about 4% of there time on the surface when transiting to feeding grounds and may spend 4-15% of their time on the surface when they are there (Lutcavage and Lutz, 1991; Papi et al, 1997). It now seems that individual turtles, under identical circumstances, have significantly different submergence patterns (Godley et al, 2003).

Tagging juvenile loggerheads seems to be a logical approach to find out where these turtles spend their time in the water column. The problem with this approach is capturing the juvenile turtles in order to place a transmitting tag on their carapace. The regulators have shown little interest in allowing us to pursue this approach. This leaves us with the video/sonar option. Video is not a useful tool at night or in bad weather conditions. We plan to continue ROV tracking of turtles and also get authorization to tag several loggerheads.

Comparisons of Dive Behaviors

The dive behavior of T15 and T21 was very similar to each other as well as that of a turtle recorded diving to the seafloor in 2008 (Kathyann-2008-1-T34 covered in previous report). A graphical and tabular comparison of these three dives is present in Figure 28.

The observed behavioral similarities between all loggerheads diving to the seafloor include:

- pre-dive behavior of floating motionless on the surface for ~4 minutes
- bottom temperature of less than 10 C
- uniformly flat bottom type consists of primarily of sand, shell hash and sand dollars
- no obvious effect of ROV on turtle behavior
- consistent stroke rates at depth
- consistent dive velocity
- consistent depth of negative buoyancy at 30 meters
- lack of food source in the water column

4.3.3 Water Temperature impact

We monitored sea water temperature using an Onset Corporation Tidbit temperature recorder attached to the scallop dredge and to the ROV. SST from the Tidbit conformed to that obtained from satellites and ranged 21-23 C in the areas where we encountered turtles. A number of turtles we tracked dove to depths as deep as 11 meters and fed on jelly fish; the water temperature at that depth was 16° C. One of the three loggerheads that we tracked to the sea floor, T34,, 60 meters deep, stayed in a temperature of 7.6° C for upwards of 8 minutes. We had to terminate our tracking of that turtle as we ran out of tether. When the ROV surfaced, T34 surfaced alongside of the ROV. We did not observe any overt symptoms of stress while the turtle swam along the bottom.

It is commonly recognized that sea turtle ecology, distribution and behavior, like all animals, will be constrained and influenced by physiology. We also know that sea turtles can avoid unacceptable sea water changes through migration, though sometimes their migration pathway can be blocked by cold water. Cape Cod Bay is an area where this frequently occurs and two institutions are frequently involved with this scenario; the New England Aquarium and NOAA's Stellwagen Bank National Marine Sanctuary. Sea turtles are cold blooded reptiles that are susceptible to quick changes in water temperature. According to the New England Aquarium's website, loggerheads exposed to "very cold water (<10 º C) become lethargic and float to the surface of the water". The website asserts that if the water temperature drops below 5-6 º C death can occur. The Stellwagen Bank National Marine Sanctuary website states that cold-stunning occurs when water temperatures fall below 12 º C. They further explain that under these conditions turtles can not swim or digest food. Our limited observations disprove these impacts of water temperature at least for short periods of exposure.

During this project we monitored bottom water temperatures in the Mid-Atlantic areas where we operated and found the temperature to be consistently below 10 ºC on the bottom. This is well within the range of expected bottom water temperatures for this area (Mountain and Holzwarth, 1989). Their long-term data base indicates that from June through October, bottom water temperature in the Mid-Atlantic Bight, where many of the turtle takes have occurred are normally below the 10 º C level associated with cold-stunning. The question arises why would T34 dive to the bottom where the water temperature was 7.6° C? The shock of going from surface waters of 22 º C to temperatures below 8 ºC would seem to be a significant deterrent to bottom feeding behaviors. To do this the loggerhead would have to have adaptations to regulate heat flow (Hochscheid et al, 2002). One adaptation that has been observed is a change in flipper blood flow which has a significant physiological cost. For example, a 10 º C difference in water temperature caused a 100-fold difference in blood flow (Hochscheid et al, 2002).

In the literature, cold stunning is reported to occur when water temperatures drop below 8 º C before turtles have the opportunity to swim away (Spotila et al, 1996). Another older source states that loggerheads become lethargic at 13-15 º C and adopt a "stunned" posture in water temperatures of about 10 º C (Mrosovsky, 1980). Turtles have been shown to stop feeding at water temperatures below 15 º C (Epperly et al, 1995). The lethal effects of cold water on loggerheads is a function of turtle size (Witherington and Ehrhart, 1989) Our current state of knowledge, which is very limited, would indicate that the loggerhead turtles should not be

foraging on the bottom in the mid-Atlantic, when most of the takes occur in the scallop fishery, due to the low bottom water temperatures. However, we now have T15, T21, and T34. We are starting to suspect that the literature is under-estimating loggerhead turtle capabilities in colder waters.

The idea that loggerheads may be going to the bottom to enter into some state of hibernation does not seem to be very plausible. No sea turtles have been reported to be taken in scallop dredges over the winter months; December through April. During these months, the bottom water temperature is even warmer than during the summer months (Mountain and Holzwarth, 1989). Known sea turtle hibernacula are restricted to a narrow zone around the 29 º N latitude but no evidence was found for sea turtles hibernating in the nearshore environment of Georgia and South Carolina (Ogren and McVea, 1995). A more recent paper suggests that the evidence indicates that sea turtles do not hibernate (Hochscheid et al, 2005). It has been found that sea turtles have increased dive duration during winter when water temperatures are colder (Godley et al, 2002; Storch et al; 2005). However, the depths are greater and the water temperature is significantly colder in the mid-Atlantic than in these studies.

It is commonly hypothesized that loggerheads are going to the bottom in the mid-Atlantic to feed, with little evidence that the turtles spend much time at the bottom depths where the interactions have occurred, mostly 49-57 m. In the southern North Atlantic, loggerheads are rarely taken by trawls in depths greater than 18 m even when aerial surveys show the turtles distributed over considerably deeper waters (Henwood and Stuntz, 1987). For benthic foraging to be beneficial, the turtle needs to gain more energy through eating than expanded in diving and keeping warm (Houghton et al, 2000). Loggerheads are capable of keeping their body temperature higher than the surrounding water temperature (Sato et al, 1993, 1998). In Sato's research the water temperature ranged from 24 º C on the surface to 20 º C on one deep dive to30 meters (mean dive depths were less than 10 m). This body heating would require significant energy for any lengthy stays on the bottom, especially in temperatures below 10 º C. The temperature differential between surface and bottom water temperatures that T34 experienced was greater than 14º C; a range that has not been reported in the literature to our knowledge. Temperature gradients of 4 º C, from 25 º C to 21 º C have been reported (Sakamoto et al, 1990).

Sea turtles are known to consume less at low temperatures than high temperatures (Bentivegna et al, 2003) and none of the studies indicate feeding at temperatures as low as that found on the bottom in the mid-Atlantic. What benthic organisms these turtle may be feeding on is an unknown and dietary habits cannot be extrapolated between regions (Burke and Sandora, 1993). Where benthic feeding has been reported the water depths have been very shallow (Burke and Sandora, 1993; Plotkin et al, 1993; Godley et al, 1997). We now have established that loggerheads in the mid-Atlantic do feed on crabs and other organisms they forage on the bottom in depths in excess of 60 m.

Deep dives have high energy costs. Loggerheads have the ability to control their buoyancy over a range of 14 m (Minamikawa et al, 2000). In the areas that the seas scallop fishery interacts most with the loggerheads, the bottom depth range is 49- 57 m (Murray, 2004). A turtle on or near the bottom has to expend energy by actively swimming or save energy by lying on the bottom in temperatures known to cause cold stunning. All three of the loggerheads we followed to the

bottom swam the first 30 meters and then glided the remaining distance. Once on the sea floor the loggerheads remained negatively buoyant as is had to swim to move up off the sea floor and forward. All the other loggerheads we observed with the ROV were diving to depths of 5-11 meters at most when the water depths were in excess of 50 m. We did lose track of several turtles beyond that depth range. In the open ocean environment, away from nesting beaches, where turtles are known to be actively foraging the shallow dives are the most frequently observed behavior. Polovina et al (2003) reported 70% of loggerhead dives tracked were no deeper than 5 m where turtles are foraging on aggregations of food associated with convergent temperature fronts.

4.3.4 Foraging behavior

Bartol (2000) describes evidence that would indicate that loggerheads use vision for foraging as well as avoidance behaviors. Our ROV video may provide support for this hypothesis but it is not definitive. When T39 turned its carapace towards the oncoming shark, it was possible that the turtle was looking in the direction the approaching shark. We observed numerous large jelly fish pass very closely to the feeding turtles but the turtles made no effort to swim towards the prey. One has to wonder if the turtle failed to see or smell the presence of the prey. Loggerheads have developed chemoreceptive systems and probably use them for foraging as well (Saito et al, 2000). Loggerheads can also use magnetic field sensory capabilities to not only return to natal beaches, but to seek out and return to feeding grounds (Lohmann and Lohmann, 1996; Avens and Lohmann, 2004). In one experiment, turtles tested during the summer oriented towards their point of capture, presumed to be their feeding area, while turtles tested in the autumn oriented southward (Avens and Lohmann, 2003).

While there seems to be agreement that adult loggerhead turtles in a post-nesting stage leave their nesting areas and migrate towards individually-specific residential feeding grounds, there is conflicting evidence on how they find these grounds or even if this is a valid hypothesis (Luschi et al, 2003). Luschi et al. believe the South African turtles use the coastline, bottom reference points, and biological compass cues for navigation. They also question whether a turtle that has such a large prey spectrum even needs a specific feeding site. Once in a foraging area, loggerheads seem to have the capability to move directly between patches of abundant sessile prey (Stoneburner, 1982).

There is evidence that adult loggerheads are able to deliberately switch to a pelagic offshore lifestyle (Luschi et al., 2003). In general, loggerheads when in the open ocean are considered to feed on macroplankton and when in neritic habitats feed mostly on benthic invertebrates. There is an indication that the different environments and forage may result in different diving behavior (Hatase and Sakamoto, 2004). Luschi et al (2003) found the turtles they were tracking in the middle of the Indian Ocean spent considerable time on the surface, sometimes not diving for hours. They speculated that the turtles might have been feeding on floating prey. In the oceanic environment, turtles have been found associated with fronts where they probably find shallow concentrations of forage (Polovina et al, 2003).

Stranded turtles along the Texas coast were found to have benthic invertebrates including crabs and mollusks as the predominant prey species (Plotkin et al, 1993). Crabs became the primary

species in the turtle diet as crab abundance increased over the season. Food items in the guts of the examined turtles also indicate the turtles feed on the sea surface as well as in the water column. While shrimp and fish exist within the water column, the authors felt that loggerheads can not capture these prey alive. Gut contents taken from loggerheads found near Queensland Australia indicate the turtles feed on slow moving, hard body invertebrates, primarily mollusks and crustaceans (Limpus et al, 2001). The fact that loggerheads are a fairly non-selective feeder on sessile and slow moving organisms has been established in many parts of the world (Godley et al, 1997). Where they have been found to eat mollusks, the shell size has been in the range of 10-30 mm (Ibid, 1997). Loggerheads also feed by digging below the sediment surface (Preen, 1996). Over 90% of the diet of loggerheads in waters off New York during the June-November period was found to be crabs including rock crabs ((Burke and Standora, 1993).

Shoop and Ruckdeschel (1982) speculated that discarded fish may be a major source of food for loggerheads based on stomach contents of stranded animals in the vicinity of shrimp fishing. They also felt that the fish discarded by the fleet attracted crabs, a major prey item consumed by the turtles. They postulated that fishing activity may maintain a higher population of turtles in an area due to the availability of the discarded fish, and concentrated crab population, thus increasing the risk of sea turtle interactions. They briefly discussed alternatives to handling the discard that might reduce turtle/shrimp trawl interactions. Shoop and Kenney (1992) hypothesized that loggerhead distribution might be modified by fishing activity in that if they are feeding on discard they may not need to migrate as far north as they would have otherwise. One can speculate even further and conclude that if fisheries are keeping more turtles to the south, they may be less likely to get trapped in cold water at the end of the season. More turtles may die each year due to cold kill than by the sea scallop fishery.

Evidence exists that loggerheads in the western Mediterranean are also opportunistic feeders on discarded bycatch (Tomas et al, 2001). In a shallow water (<2m) foraging site off Greece, four male loggerheads were observed feeding on bivalve molluscs, attached to a wall, and entrails of fish discarded by fishermen (Houghton et al, 2000). In cases where turtles were captured in trawls, fish was the dominant prey species. In this study the data strongly supported the turtles regularly feeding on discard to the point where the energetic benefits of a fish diet may possibly outweigh the risks of incidental capture. There is evidence that turtles that feed on nutrient rich material tend to grow larger than those that do not have that opportunity (Hatase et al, 2002). Turtles feeding on scallop viscera thus may grow larger and have greater survival characteristics than if this forage source was unavailable.

The single interaction with T23 could provide several insights relative to behavior leading to loggerhead bycatch in towed gear. This loggerhead, observed directly behind the fishing vessel and at a depth that discards were observed, gives creditability to the theory that loggerheads are foraging on discards and possibly being caught in the water column during haul back. In addition it reaffirms previous behavioral observations made with the ROV that the loggerheads were foraging at 10 meters in the water column and spending considerable time at that depth. Since T23 was never seen by spotters on either vessel and hitting one with a towed ROV is highly improbable, this interaction confirms that there is a potentially a large number of loggerheads present in the area but not observed.

The "turn carapace" behavior of the turtle when it perceived the towed ROV is the same behavior exhibited when sharks or other aggressive loggerheads were present. This behavior may work for loggerheads when trying to avoid being bit (since being bit is probably their major source of natural injury/mortality), but it is not effective in avoiding towed objects or fast moving vessels. Since an object towed in the water is a modern threat to the loggerheads, they may not have adapted to an appropriate evasive behavior or understand the probable path of the towed object (much like a deer in headlights). It seems that T23 swam up and toward the ROV instead of diving or swimming in the opposite direction. T23's behavior also leads to more questions into how far way loggerheads are able to sense danger and what cues they use to sense the threat (visual, sound, smell, etc).

The behavior during last second of the interaction is also of particular interest in understanding how bycatch occurs. At the last second T23 turns its tail toward the ROV right before it is overtaken and makes physical contact with the bridle and ROV. Interestingly, many incidental takes of loggerheads are caught wedged between the inside bail bars of the scallop dredge frame. Injury then occurs when the dredge is brought alongside the vessel or the frame is dropped on deck. These bycaught loggerheads are not observed with significant scraps or signs of forced submergence that would signify that it had be dragged along the seafloor. If these loggerheads are being caught in the water column during haul back, this "turn tail" and "turn carapace" avoidance behavior could be leading to the loggerheads being wedged into the dredge

The 2003 bycatch data for the scallop fishery shows that the majority of the turtle bycatch involved multiple interactions (Murray, 2004). One trip caught 4 turtles, two trips caught 3 turtles each, and three trips caught 2 turtles each accounting for 73% of the takes (16 out of 22 turtles taken). This would seem to imply that these vessels were behaving in a manner that increased the chance of catching a turtle; discarding possibly. The idea that small scale differences in fishing behavior can influence turtle catch rates has been put forth previously, but pooled data has prevented analysis of this possibility (Robbins, 1995).

Unlike previous observation trips in 2007 and 2008 covered in previous reports as well as more recent 2009 trips not covered in this report, no turtle were observed feeding. There was significantly less prey observed both on the surface and the water column as well as on the seafloor when compared to other observation trips in the same area.

In 2007, large rafts of Sargassum were observed with both loggerheads and potential prey/food sources associated with the rafts. During the spring 2008 trip, several loggerheads were observed foraging regularly on jellyfish found in the top 10 meters of the water column. There are of course several potential reasons feeding was not observed using ROV during the two trips summarized in this report. The most obvious and likely would be that the ROV simply did not observe a turtle that had the opportunity to feed or was not able to follow a turtle that was feeding. The loggerheads could have been in a different feeding "mode", search out fishery discards or bottom prey instead of the jellyfish or Sargassum since it was not present. During the June 2008 trip, many of the loggerheads that were observed were in closer proximity scallop fishing vessels actively fishing. Since no dives were observed during this trip, it is possible that the loggerheads were feeding differently and not diving as often for food. Observing a turtle feeding on fishery discards or benthic species is significantly more difficult to observe than those

feeding on the surface or dense schools of jellyfish. The fewer number of turtle tracked with the ROV during these two trips provided fewer opportunities to observe feeding behavior. Additional reasons could be related to the availability of prey species, turtle behavior, and the plethora of potential variables that link the two.

4.4 Turtle distribution

Our Transect data shows that we found the loggerheads in patches along a relatively narrow band running parallel to the depth contours (Figures 31-47). We do not believe SST is the key factor determining the distribution of these turtles during the June – September foraging season as the desirable water temperatures extend over a much broader area than the high densities of loggerheads. SST gets the turtles into the general area but other factors influence their location within that range.

Ninety-three percent of all observed turtle takes in the sea scallop fishery in 2001 and 2002 were in waters with SST warmer than 19 º C (Murray, 2004). Loggerheads are adversely affected by low water temperature and move to warmer waters in the fall; in the Mediterranean a drop of sea surface temperature (SST) below 20 º C triggers the migration to warmer waters (Bentivegna, 2002). Mediterranean loggerheads have been reported to encounter seasonal temperatures as low as 13 º C when diving (Bentivegna et al, 2003). In the central North Pacific loggerheads are found around oceanographic fronts with SST of 17 º C and 20 º C (Polovina, et al, 2000). In the Gulf of Mexico tracked loggerheads experienced 18 º C as the coldest mean water temperatures over a 5-10 month period (Renaud and Carpenter, 1994). In the mid-Atlantic region where the scallop fishery interacts with the sea turtles, the loggerheads occur most frequently in a range of SST 21-24º C (Shoop and Kenney, 1992). In fact, their research found only eight out of 2156 loggerhead sighted in SST of less than 10 º C. These eight turtles may have been sighted in a cold-stunned condition and in trouble.

There is a definite correlation between the sea water temperatures and general loggerhead turtle locations. Most work has examined this issue in terms of SST's and oceanographic fronts but not relative to bottom water temperatures and vertical temperature gradients. A survey of the waters off North Carolina related turtle presence to SST from satellite based sensors. Turtles could have occupied temperature ranges from 4.9º C to 32.2 º C but they were only observed where SST ranged from 13.3 º C to 28 º C (Coles and Musick, 2000). The study also found that the turtles preferred warmer waters within the range they occupied. Another study, examining the winter distribution of sea turtles in the vicinity of Cape Hatteras, found most of the turtles in waters with SST greater than 11 º C with frequent sightings along thermal fronts (Epperly et al, 1995).

In their juvenile to adult stages, loggerhead turtles are known to migrate annually into the Mid-Atlantic shelf region and forage there between June and November when sea surface temperatures (SST) warm to above 20°C (Shoop and Kenney, 1992; Hawkes et al., 2007). Beyond the seasonal relationship between temperature and turtle distributions, however, only moderate progress has been made in determining the environmental factors that may co-vary with or control these turtle distributions. For example, attempts to parameterize western North Atlantic turtle distributions have yielded some broad linkages to SST, Gulf Stream position, and bathymetry (e.g. Hawkes et al., 2007). Post-hatchling loggerheads have been closely associated

with floating Sargassum mats in downwelling fronts on the shoreward side of the Gulf Stream (Witherington, 2002) and have been found far from land in the central and eastern Atlantic (Bolten et al. 1992). In the central North Pacific, juvenile loggerheads have been strongly linked to oceanographic fronts characterized by distinct sea surface height, temperature and chlorophyll gradients determined from satellite data (Polovina et al., 2000). A generally accepted model is that hatchling loggerheads in both the Atlantic and Pacific spend a pelagic stage of life in the mid ocean gyres, where convergent oceanic fronts provide zones of enhanced food supplies (Carr, 1986; Olson et al., 1994; Bolten, 2003). The end of the pelagic phase is marked by entry into the continental shelf regions – along the U.S. Atlantic coast and Japan -- where foraging occurs in neritic and benthic environments.

The physical oceanography of the MAB region has been well described in a variety of studies (Wright and Parker, 1976; Beardsley and Winant, 1979; Chapman and Beardsley, 1988; Flagg et al., 2002; Johnson et al., 2001). Inspection of climatological ocean property fields leads us to postulate that ocean salinity may be a practical predictor of turtle distributions – more so than SST and bathymetry -- through its strong influence on horizontal density gradients and hence regional currents, and through its close association with chlorophyll concentrations. On the shelf, salinities range from >36 psu seaward of the shelf edge to <30 psu near shore and are the dominant factor creating and maintaining strong frontal features trending northeast to southwest along the entire shelf . Such fronts are not only sites of enhanced biological productivity transcending multiple trophic levels, but they may also act as boundaries creating distinct species transitions (Olson et al., 1994). Salinity distributions are very closely aligned with chlorophyll concentrations, a metric of biological productivity. We speculate that abundance of turtle food (i.e. jellyfish and Sargassum weed communities) may also align with these fields creating areas where sea turtles congregate – and areas where they do not. In short, we postulate that while temperature primarily controls the seasonal turtle distributions and migration, the structure of ocean currents and availability of food govern those distributions during the warm months. We have proposed an RSA project that will test the hypothesis that sea turtle distributions align with hydrographic properties (density, salinity, and chlorophyll) along frontal zones in the Mid Atlantic shelf region.

SSTs exhibit a north-south gradient of 4-6 °C over the MAB shelf in each month. Density, salinity and chlorophyll distributions all exhibit strong cross-shelf gradients, evidence that density in this domain is dominated by salinity and that salinity and chlorophyll concentrations are dynamically linked through ocean circulation. Density contours approximate a stream function for the geostrophic shelf circulation. From Nantucket to Cape Hatteras, the mean flow is along the shelf toward the southwest (Beardsley and Winant, 1979) and is a continuation of along shelf flows originating further north on the Scotian Shelf (Chapman and Beardsley, 1989). These flows are a consequence of density-driven along shelf geostrophic currents (created and sustained by continental runoff) and balanced by the Ekman circulation that is driven by surface wind stress. Winds that blow from a northerly direction, reinforce the along-shelf flows (i.e. they result in downwelling and convergent conditions), while southerly winds oppose the mean flow resulting in upwelling and divergence that cause near-surface waters to disperse laterally across the shelf. The cross-shelf gradients of salinity and chlorophyll signify that both of these property distributions are strongly linked to the mean advective field whereas temperatures are modified by other factors (surface heat fluxes) along the flow path.

Both winds and ocean properties exhibit strong seasonality that is evident in vertical sections of temperature, salinity and density. In winter, water temperatures over the shelf are colder than 6°C and average winds are from the northwest, whereas in summer southwesterly winds are dominant and surface temperatures warm to >20°C. The seasonal shift in average wind direction favors downwelling conditions in winter and results in a well-mixed, vertically homogenous water column and strong cross-shelf surface gradients. In summer, southwesterly winds and enhanced solar heating cause the water column to be strongly stratified with weaker cross-shelf surface gradients.

The monthly mean temperature fields can readily explain why sea turtles seasonally inhabit and depart from the MAB shelf region. On shorter timescales of days to weeks, however, the winds and currents are more variable. Anecdotal evidence as well as more rigorous studies (e.g. Hawkes et al., 2007) suggest that sea turtles are not randomly distributed on the shelf, but instead congregate in certain regions for varying amounts of time. To determine what environmental factors, if any, govern these sea turtle distributions requires investigation on synoptic timescales. We hypothesize that winds and currents set up environmental conditions that either favor or deter sea turtles geographically and that these conditions can be diagnosed from easily measured hydrographic properties (temperature, salinity and chlorophyll).

We consider salinity and chlorophyll together as complementary parameters. Previous studies have demonstrated that ocean optical properties estimated from remote sensing reflectance can be used as a surrogate for salinity mapping as well as a means of estimating biomass, primary production and heat flux (e.g. Johnson et al., 2001). Although both will be measured *in situ*, only chlorophyll can presently be measured by satellite. (Remote sensing of salinity will begin in 2010 with the launch of NASA's Aquarius mission) However, salinity is more closely tied to the dynamics of ocean circulation, and can be used to identify the types and origins of water masses found in the MAB region – i.e. slope water, Gulf Stream water, coastal waters, and shelf waters (Wright and Parker, 1976; Flagg et al., 2002)

4.5 Observed Injuries

Several healed injuries incurred by T21 were found on the animal after reviewing the ROV video of T21 in detail onshore. Most of these injuries would be considered significant and life threatening if they had been fresh. A total of 6 injuries were noted, including: 4 injuries to the carapace, one to the plastron, and one to the head. Other than a spot on top of the head, no other soft tissue appear to be damaged, missing, or scarred. Screen shots of each injury are provided in Figure 20. The cause(s) of the injuries is unknown. Similar injuries have been seen resulting from interactions with scallop dredges, vessel strikes, and propeller strikes. All the injuries appeared to be well healed and old enough for new fouling organisms to have starting growing on the injured areas. Other than the noted random offbeat or unsymmetrical strokes, this turtle did not behave any differently from loggerheads observed with the ROV prior or since. The stroke rates, speed, breathing rates, diving ability, surfacing rate, buoyancy, cold tolerance, and behavior toward the ROV were all similar to other observations made of loggerheads.

The offbeat/unsymmetrical strokes were taken on average every 2 minutes only while the turtle

was transit swimming (Table 5). This behavior was not seen while the turtle was on the surface, or during the pre-dive or dive. Nor was it observed while the turtle was swimming and walking along the seafloor. There was no noticeable pattern to which flipper was involved with the offbeat stroke. Sometimes both the front and back flipper on one side of the animal was involved, other times it was just the front or back flipper. Twice the fore flipper was seen moving as if scratching the other fore flipper. The PIs presented these observations to a veterinarian with expertise dealing with injured turtles and received the following statement:

> "The carapace injuries are older as evidenced by healing response and remodeling of bone at the margins. I can see a displaced fracture of the plastron, but cannot see it well enough to comment. Proximity of the first wound to the posterior cervical/anterior carapacial spinal cord and potential for unapparent internal injuries are potential concerns. However, based on the condition of the animal, your comments regarding behavior, and evident healing - it appears that the turtle is recovering without event and would reasonably be expected to continue to do so. Relatively blunt injuries, such as these, are very nonspecific and it is not possible to confidently state the cause without more circumstantial information. Watercraft collisions for example can produce all manners of sharp-force injury, blunt trauma, or combinations thereof."

The fact that this turtle survived multiple significant injuries likely caused by an anthropogenic sharp force and blunt trauma injuries to its shell could have applications to determination and quantification of mortalities caused by scallop dredges. It also has value in conservation gear design as well as animal rehabilitation protocols.

4.6 Towed video system

This operation was not the most successful but pointed us towards a future solution. The ROV electronics, thrusters, power delivery system, cameras, tilt mechanism, positioning system and multibeam sonar can all be removed from the ROV frame and flotation and mounted to a frame for towing operations. Frames such as these have been used widely for sonar and video imaging survey work.

Any towed configuration would need to be lightweight, robust and easily deployed and recovered by crew typically found on fishing boats. By changing the thruster control settings in the software of the Stingray, it is a simple matter to have the 4 thrusters on the vehicle reconfigured to provide 2 each lateral and vertical thrusters, allowing control of the towed vehicle from the handbox during towed-search mode. By simply towing the vehicle as it is, we demonstrated that it is possible to get data and images at up to 5 knots with limited ability to control depth and lateral position. A purpose-built frame should enhance the ability to collect better images.

To refine a towed frame configuration and develop operational techniques, it would take a few day trips operating at different speeds, using varying lengths of tether scope, defining the angles of control surfaces if needed and attachment points to achieve stability and operator control of depth and lateral position. This could be done over the winter and spring months.

5.0 CONCLUSIONS

Our main conclusion is that there are some significant differences between published literature and our direct observation of loggerhead behavior summarized as follows:

- We observed a loggerhead go through a temperature differential significantly larger than any we can find reported in the literature
- We observed a loggerhead active in 7.6 °C bottom temperatures for at least eight minutes and feed
- We observed a number of loggerheads average less than 2 minutes between breaths
- We observed three loggerheads feeding solely on jelly fish
- We observed several loggerheads with old injuries doing quite well.

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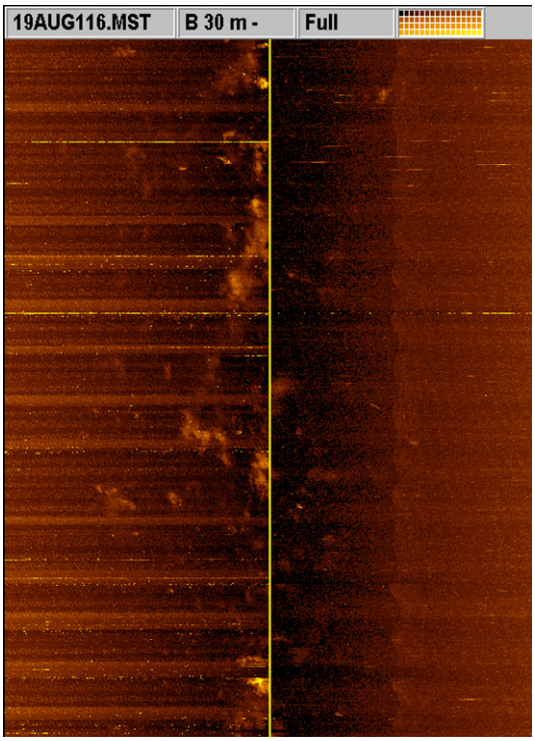


Figure 1. sonar file image from 19 August when sea conditions were not favorable to detect and identify sea turtles. The track of the vessel is the yellow vertical line in the center. The port side image shows pitching (the horizontal lines) and sea surface clutter (the "puffy" more-yellow forms).

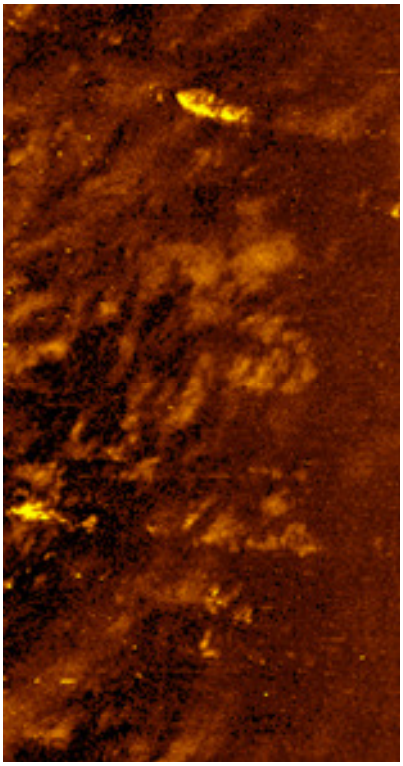
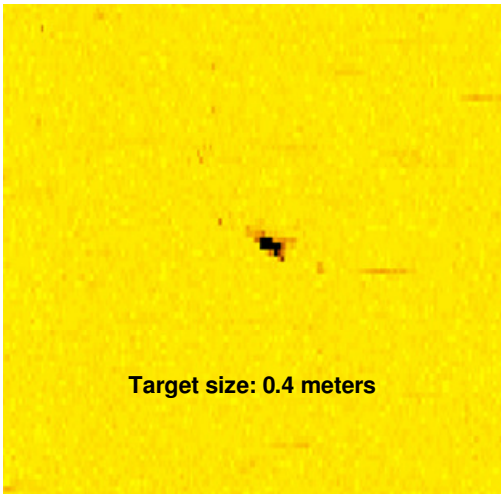


Figure 2. A sonar file image from 19 August 2008. This is the starboard channel. The image shows considerable sea surface clutter. The elongated hard (bright yellow) targets are not fish but probably an acoustic reflection of surface waves.



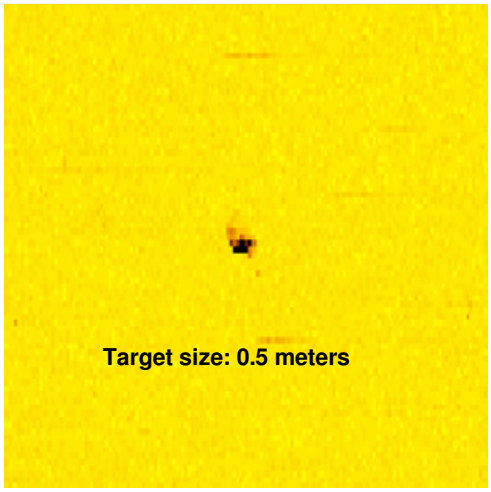


Figure 3a and 3b. Two discrete targets in the sonar record. The probability of each being a turtle are low and medium respectively. The horizontal, linear marks on the record are from the ship's depth finder.

Reference: Targets of 22 August 2008. Tgts; 012a and 012b; 39 01.48N; 073 35.59W

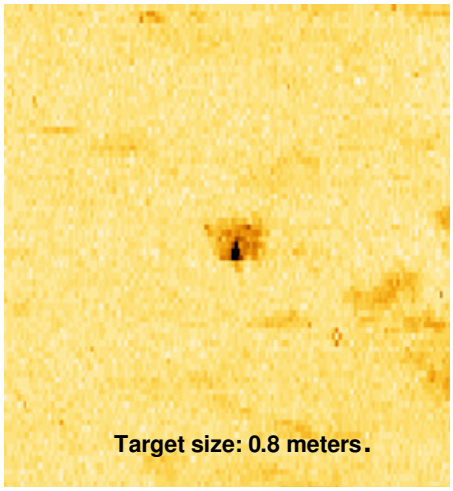
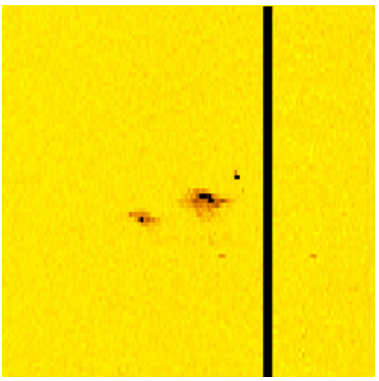


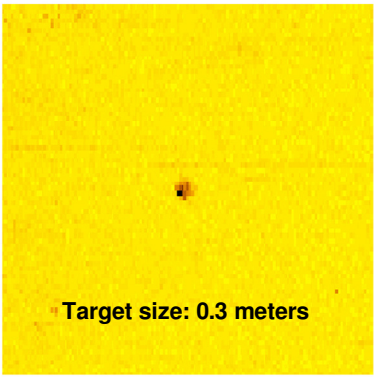
Figure 4. A hard target amidst surface sea clutter. The target differs from the clutter here shown because of a harder acoustic reflection.

Reference: Targets of 22 August 2008.
Tgts; 012a and 012b; 39 01.48N; 073 35.59W



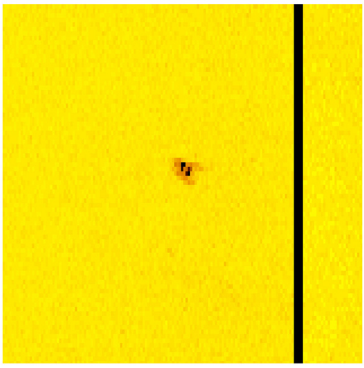
Reference: 21 August 2008.
Target 114.
38 40.57N 073 59.59W

Figure 5. Several acoustic returns with the largest target, which measures one meter, being the most probable turtle target. The sonar classification of this target was medium. The other targets may be surface sea clutter. The presence of clutter allows a question regarding the quality of the suspect prime target. The target is to port 32 meters. The vertical line represents the track of the vessel. An imaging delay was introduced in the return, which eliminates viewing the first 30 meters of the port and starboard record.



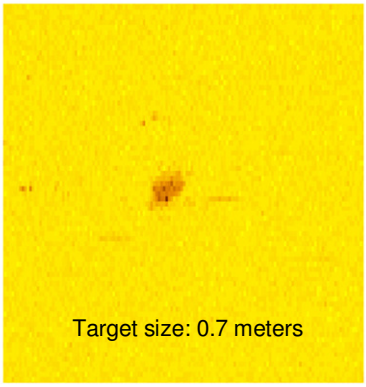
Reference: 21 August 2008. Target 138 38 41.74N 073 59.40SW

Figure 6. A discrete target observed when sea conditions were relatively calm. The sonar record of this area has no other significant targets. The target is considered high in probability.



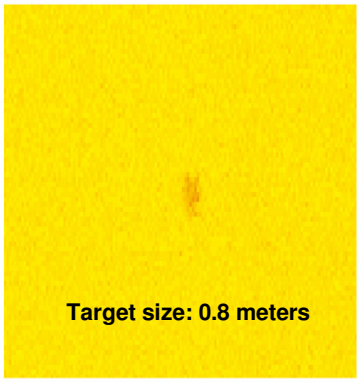
Reference: 21 August 2008. Target 159 38 43.16SN 073 59.73W

Figure 7. Another discrete target of high probability. The vertical black line is the vessel's track. The record is a delayed sonar image on the port side. The target was about 31 meters to port.



Reference: 22 August 2008. Target 025 39 02.598N 073 35.605W

Figure 8. This sonar target is a high priority target.



Reference: 22 August 2008. Target 070 39 05.511N 073 35.109W

Figure 9. This sonar target is of high priority. The vessel turned in the area and a turtle was visually sighted.

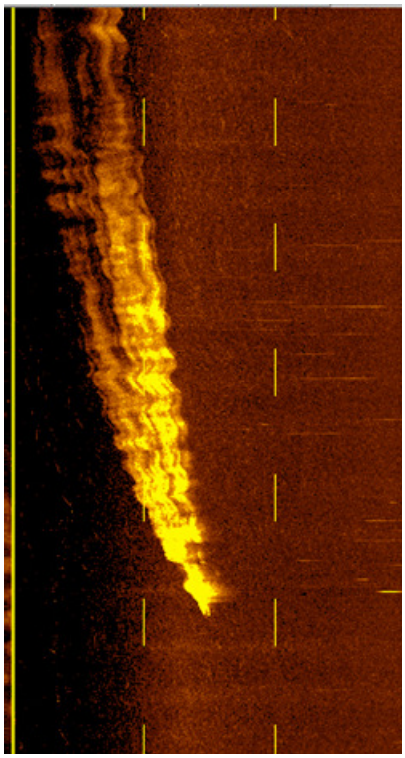


Figure 10. The ROV and its wake.
This a 30 meter wide, starboard-side channel (only) image of the ROV, which is at the bottom of the image and resulting yellow wake. No turtle is present in this image. The image was taken while the vessel was stationary and the tow fish pivoted at a uniform rate on the bow-mounted vertical pole.

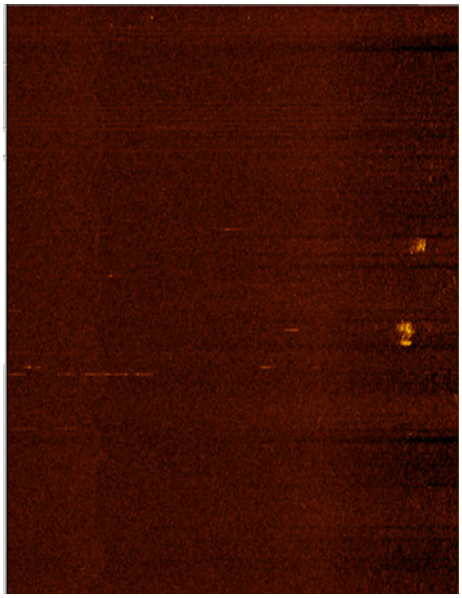
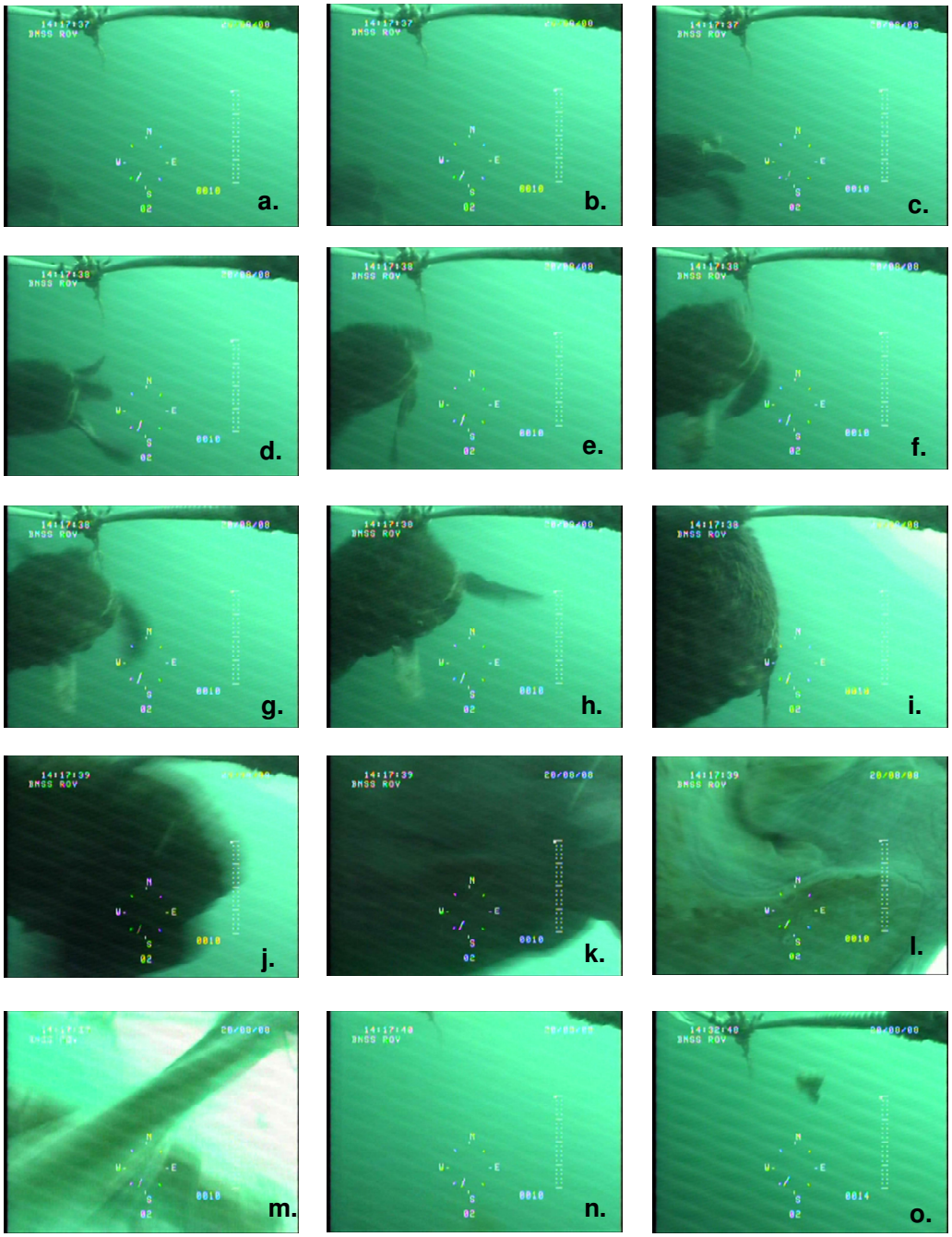
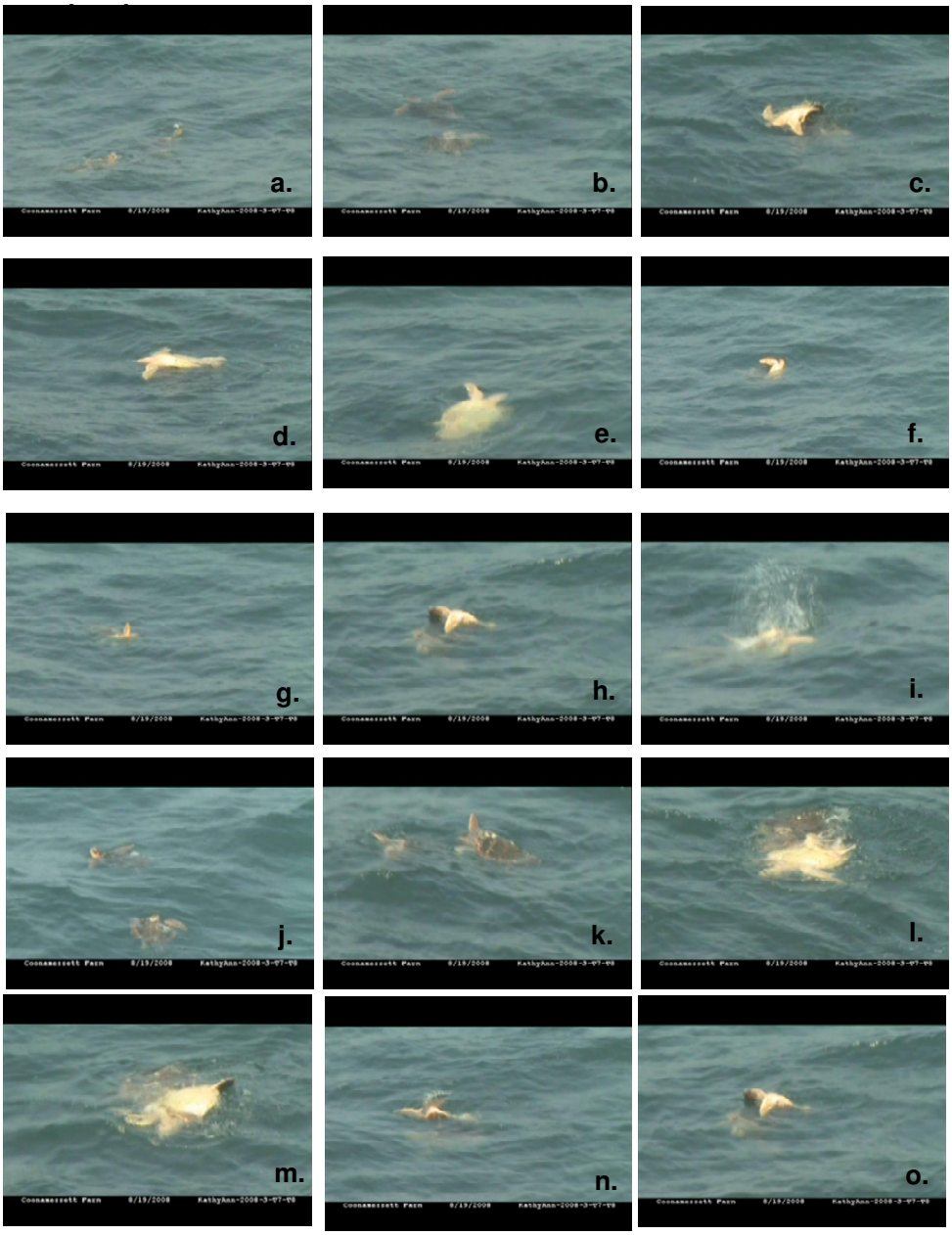


Figure 11. ROV and turtle.
This sonar image was made while the vessel was stationary. The sonar tow fish was slowly pivoted at a uniform rate so that the targets would be insonified. The turtle is the upper target and the stationary ROV the lower target. The horizontal lines are from the vessel's depth finder.

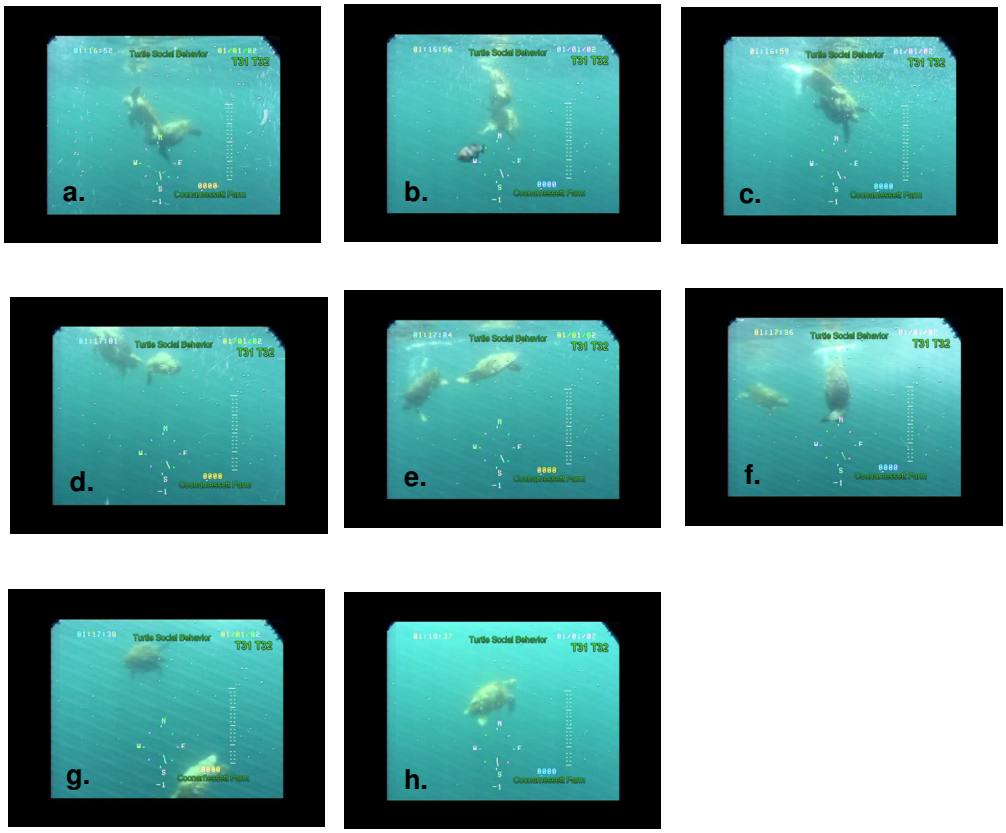
Figures 12a -12b. Series showing T23 interaction with ROV towed in discard wake of actively fishing. Last frame is of scallop viscera from shucking operation.



Figures 13a thru 13o. Series showing T29 and T30 during social interaction as recorded from the masthead during Kathyann-2008-3.

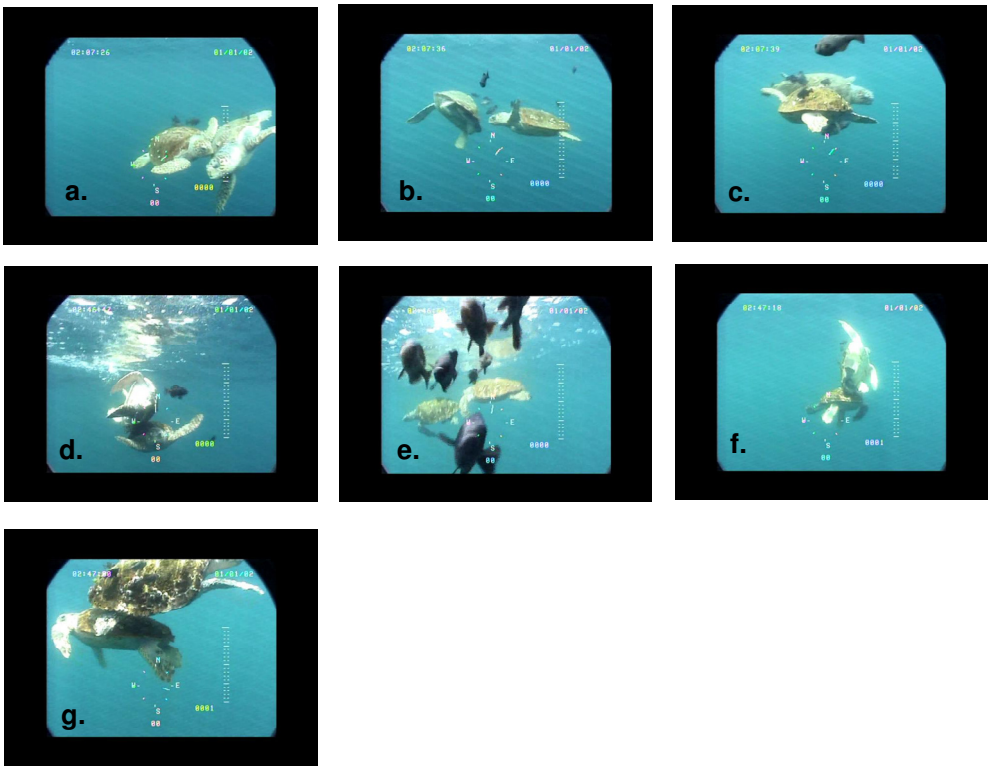


Figures 14a thru 14h. Series showing social interaction of T31 and T32 recorded by the ROV



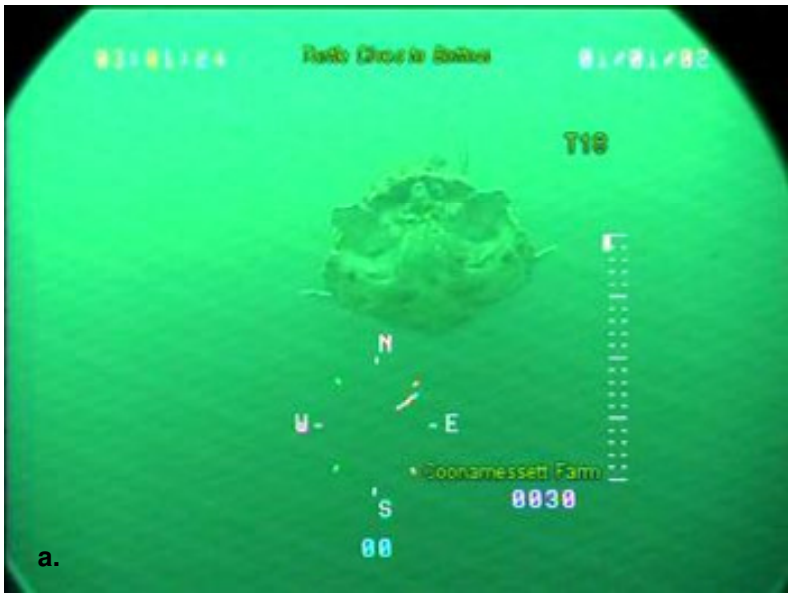
Figures 15a thru 15o. Series showing the social interaction of T33 and T34b as recorded by the ROV.

Figures 16a thru 16g. Series showing the social interaction of T33 and T34c as recorded by the ROV.



Figures 17a thru 17g. Series showing the social interaction of T35 ,T36, and T37 as recorded from the masthead.

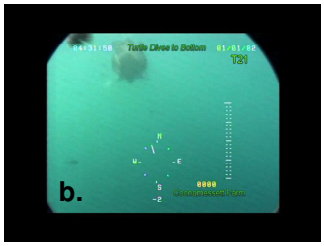
Figures 18a and 18b. Series showing T15 diving to the seafloor.

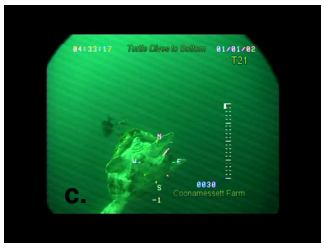


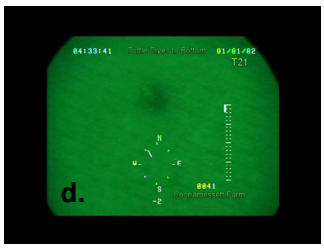
a.

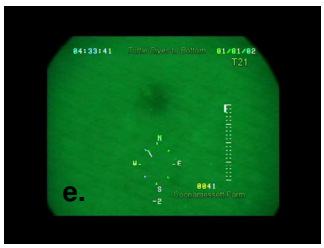
b.

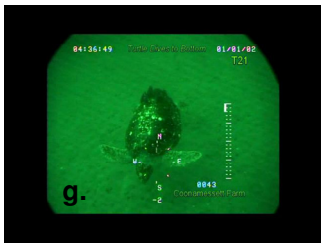
Figures 19a thru 19j. Series showing T21 diving to the seafloor.



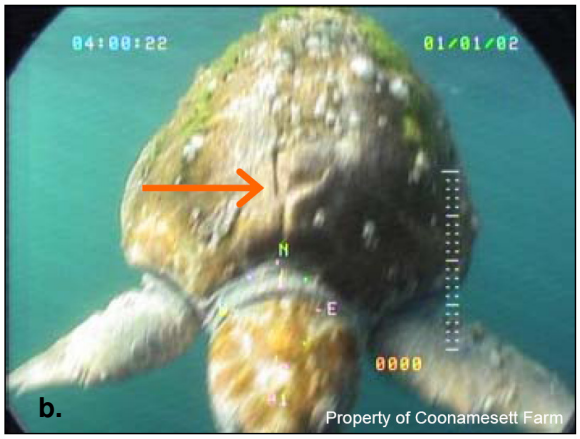


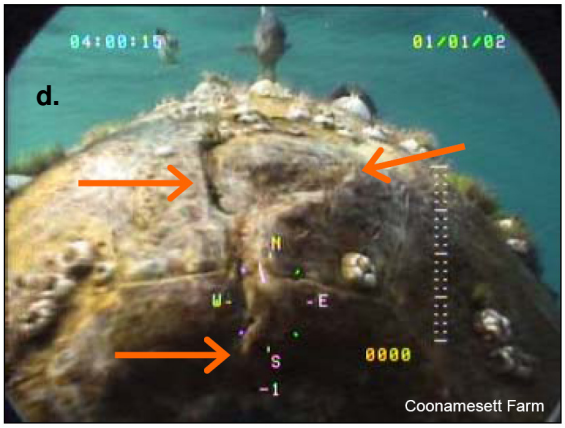


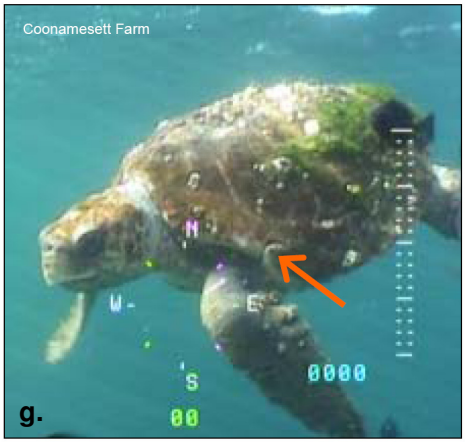


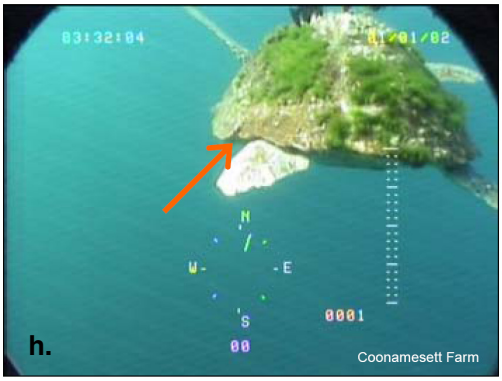


Figures 20a thru 20o. Injuries observed on T21.





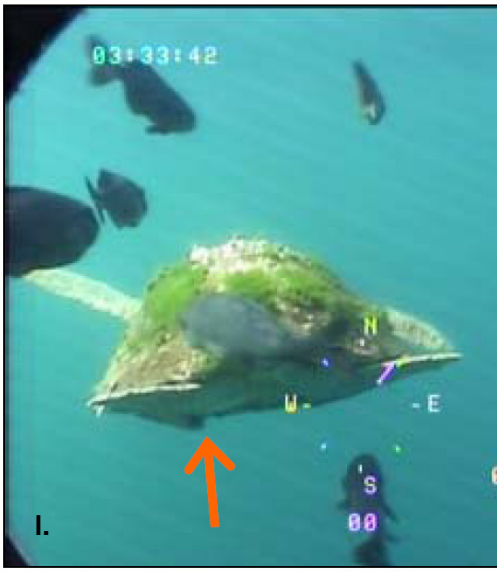

Coonamesett Farm
g.


h.
Coonamesett Farm

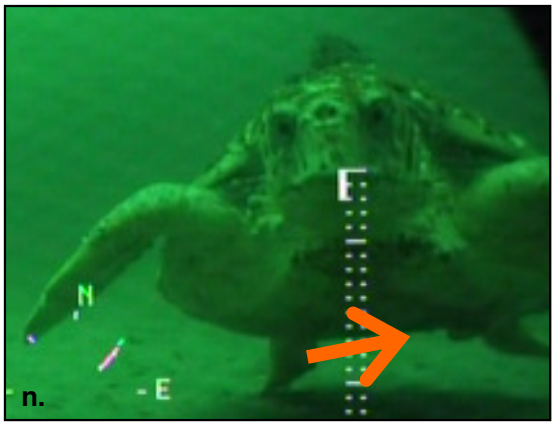
i.
Coonamesett Farm

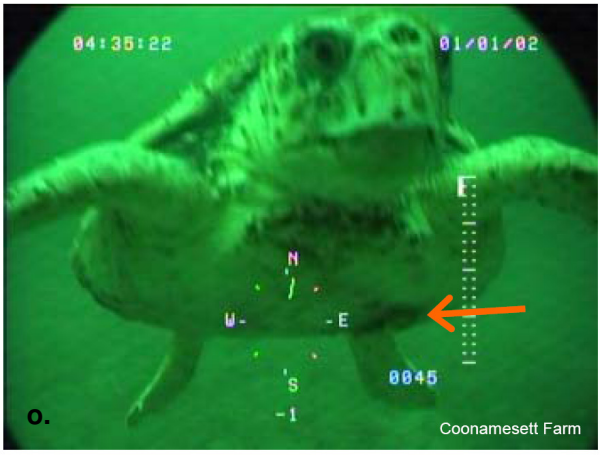
j.
Coonamesett Farm

k.

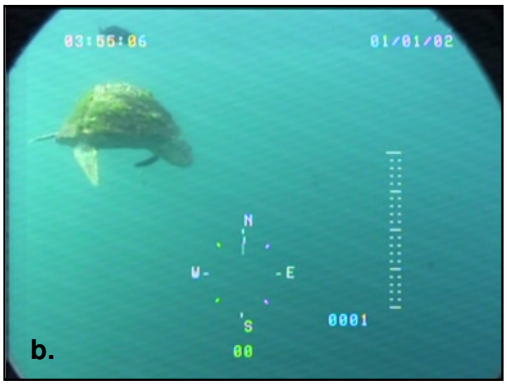

03:33:42
N
W-
-E
S
00
l.

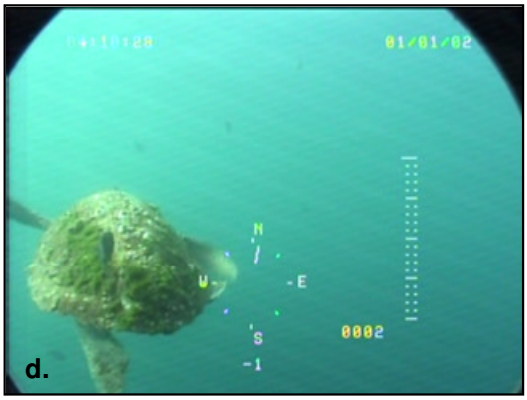
Coonamesett Farm
N
m.


E
N
-E
n.

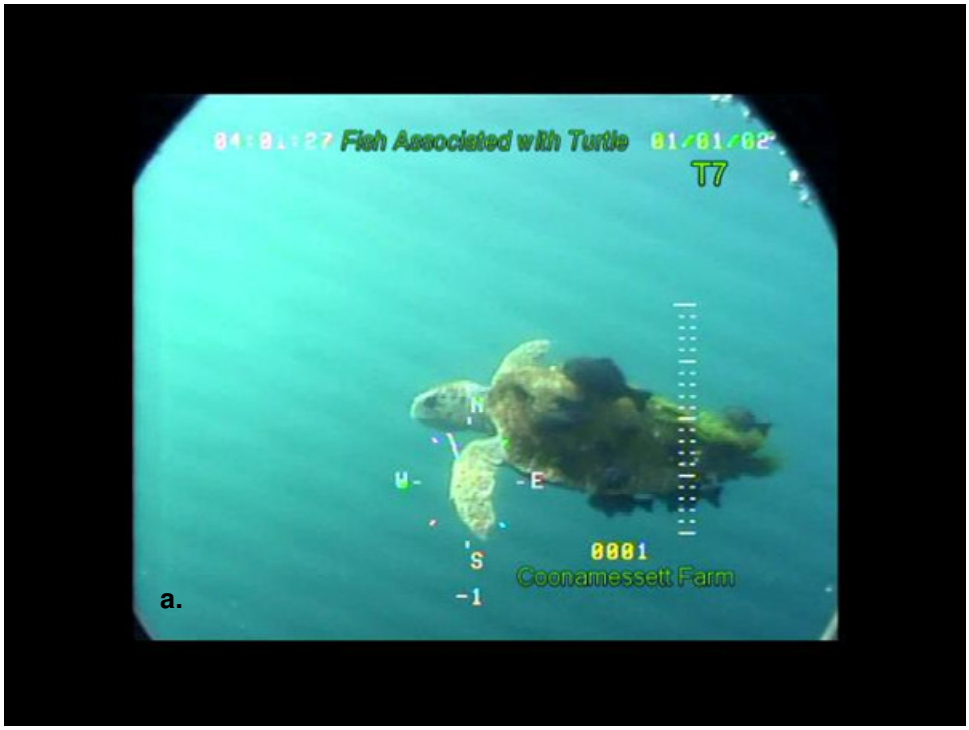

04:35:22
01/01/02
E
N
W-
-E
S
-1
0045
Coonamesett Farm
o.

Figures 21a thru 21d. Examples of unsymmetrical and offbeat strokes taken by T21.

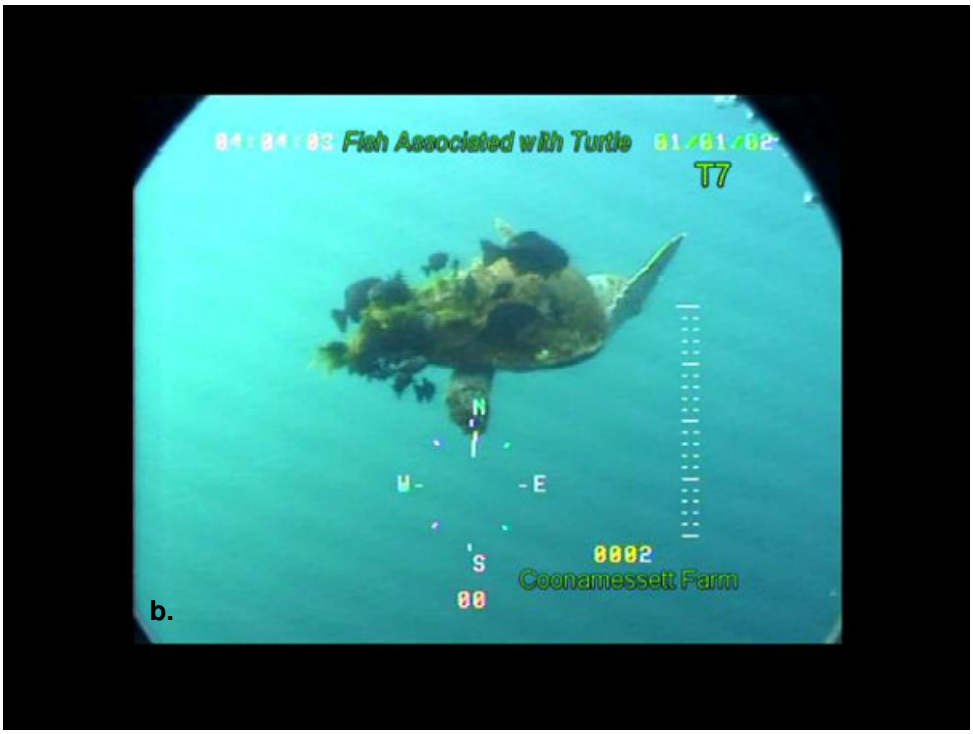




Figures 22a and 22b. Examples of fish associated with T7 .



a.



b.

Figure 23 T2 thru T46 . Gallery of turtles observed during Kathyann-2008-3.

KathyAnn-2008-3-T2

KathyAnn-2008-3-T3

KathyAnn-2008-3-T5

KathyAnn-2008-3-T7-T8

KathyAnn-2008-3-T9

KathyAnn-2008-3-T10

KathyAnn-2008-3-T14

KathyAnn-2008-3-T16

KathyAnn-2008-3-T18

KathyAnn-2008-3-T19-T20

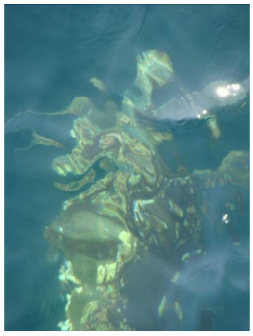
KathyAnn-2008-3-T28

KathyAnn-2008-3-T32

KathyAnn-2008-3-T23

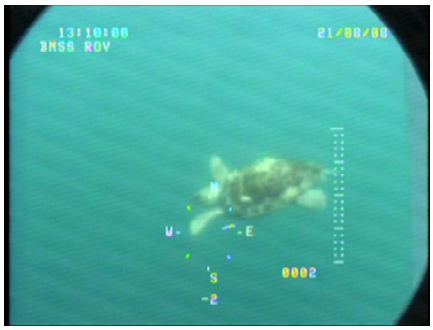
KathyAnn-2008-3-T25

KathyAnn-2008-3-T30



KathyAnn-2008-3-T34

KathyAnn-2008-3-T35



KathyAnn-2008-3-T36

KathyAnn-2008-3-TNK

KathyAnn-2008-3-T38

KathyAnn-2008-3-T44

KathyAnn-2008-3-T46

Figure 24 T1 thru T46. Gallery of turtles observed during Kathyann-2009-1.

KathyAnn-2009-1-T1

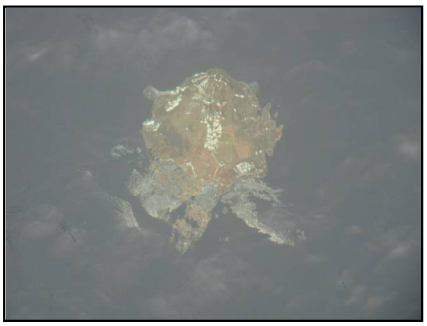
KathyAnn-2009-1-T3

KathyAnn-2009-1-T6

KathyAnn-2009-1-T5

KathyAnn-2009-1-T7

KathyAnn-2009-1-T8



KathyAnn-2009-1-T13

KathyAnn-2009-1-T15

KathyAnn-2009-1-T16

KathyAnn-2009-1-T18

KathyAnn-2009-1-T19

KathyAnn-2009-1-T21

KathyAnn-2009-1-T26

KathyAnn-2009-1-T29-T30-T31-T32

KathyAnn-2009-1-T33-T34-T35-T36

KathyAnn-2009-1-T38

KathyAnn-2009-1-T40

KathyAnn-2009-1-T41

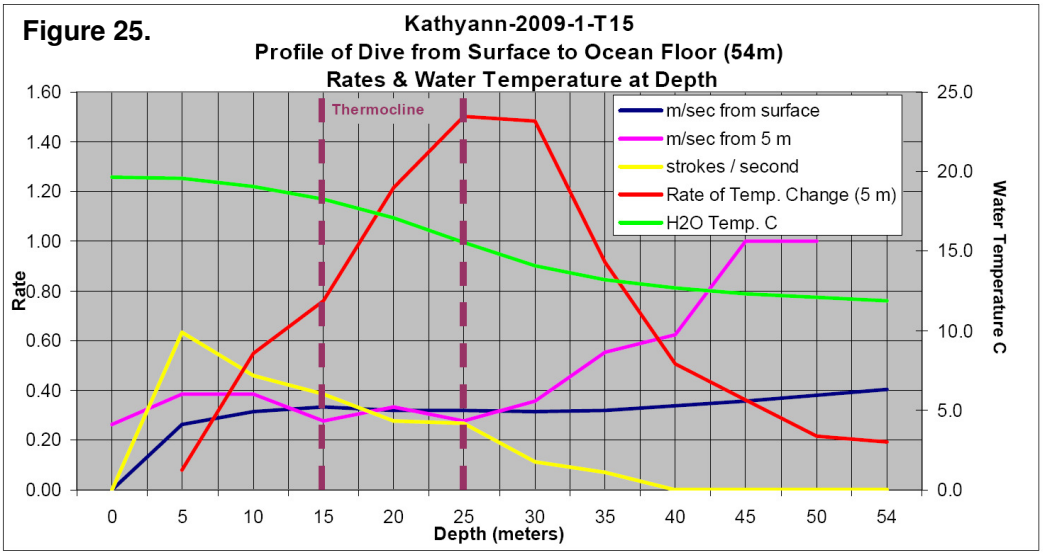


Figure 25.
Kathyann-2009-1-T15
Profile of Dive from Surface to Ocean Floor (54m)
Rates & Water Temperature at Depth
Thermocline
m/sec from surface
m/sec from 5 m
strokes / second
Rate of Temp. Change (5 m)
H2O Temp. C
Rate
Water Temperature C
Depth (meters)

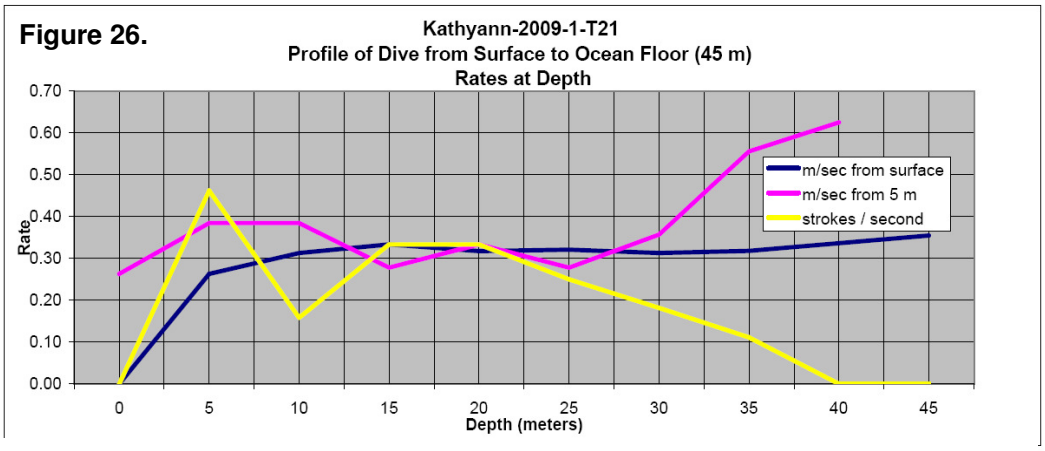


Figure 26.
Kathyann-2009-1-T21
Profile of Dive from Surface to Ocean Floor (45 m)
Rates at Depth
m/sec from surface
m/sec from 5 m
strokes / second
Rate
Depth (meters)

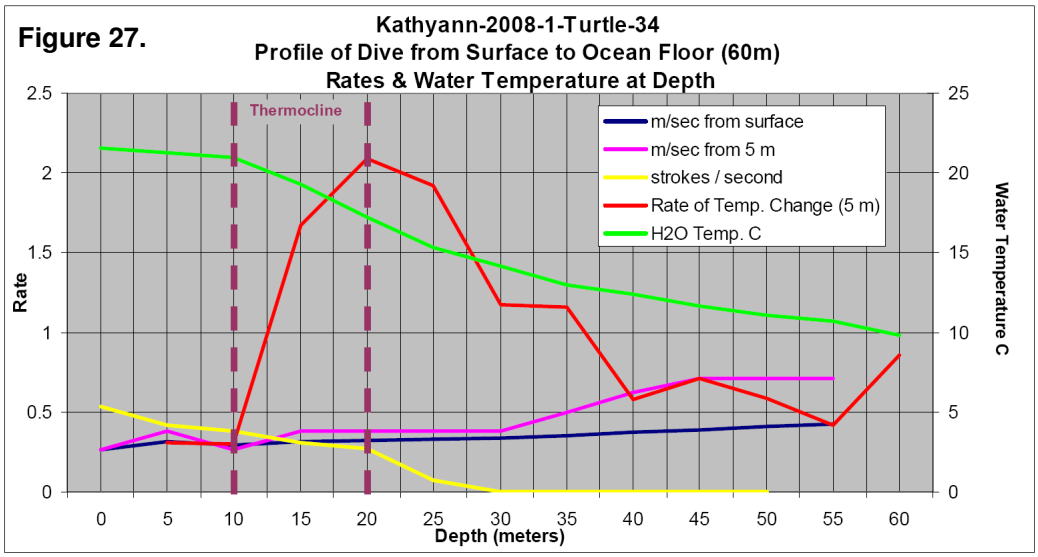


Figure 27.
Kathyann-2008-1-Turtle-34
Profile of Dive from Surface to Ocean Floor (60m)
Rates & Water Temperature at Depth
Thermocline
m/sec from surface
m/sec from 5 m
strokes / second
Rate of Temp. Change (5 m)
H2O Temp. C
Rate
Water Temperature C
Depth (meters)

Figure 28.

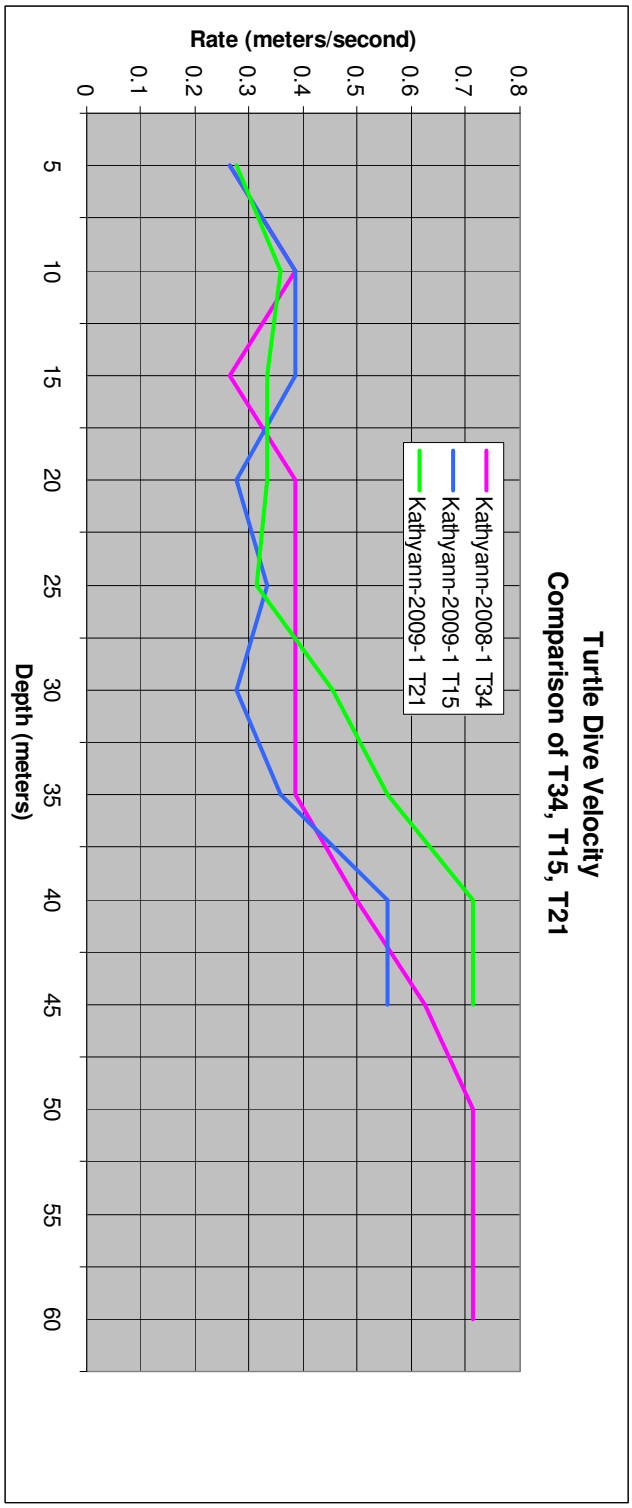

Turtle Dive Velocity
Comparison of T34, T15, T21
Rate (meters/second)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
45
50
55
60
Depth (meters)
Kathyann-2008-1 T34
Kathyann-2009-1 T15
Kathyann-2009-1 T21

Figure 29.

T15 Trackline
With Postion of Observed Behavior
Kathyann-2009-1

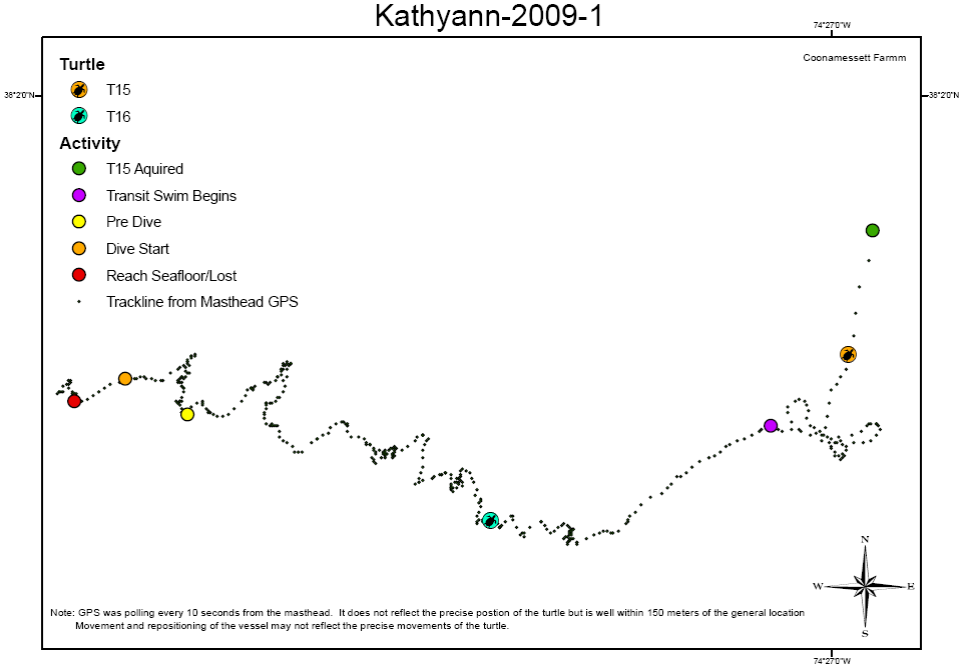


Figure 30.

T21 Trackline
With Postion of Observed Behavior
Kathyann-2009-1

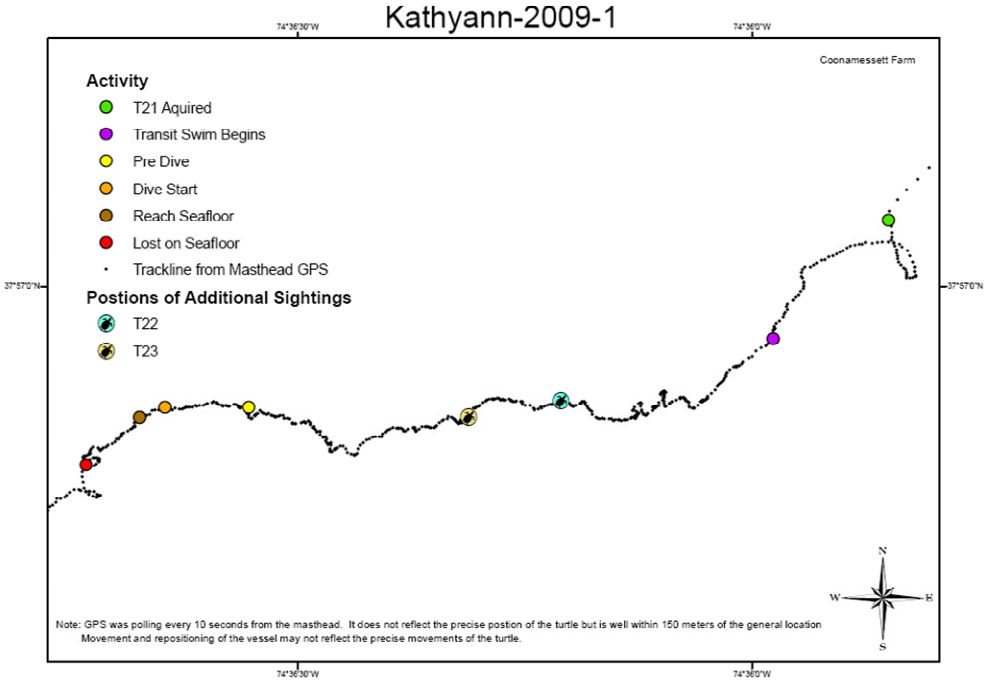


Figure 31.

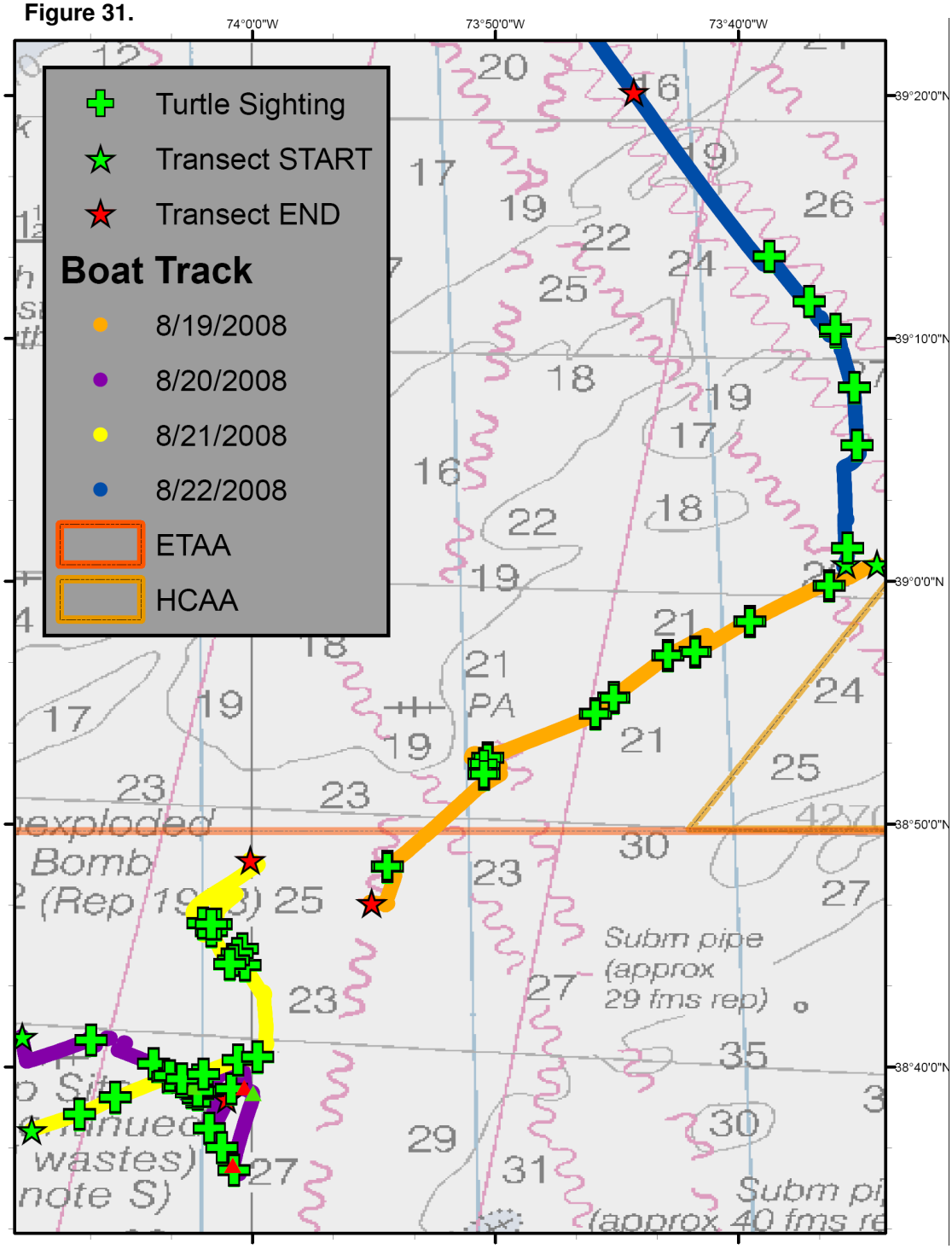

74°0'0"W
73°50'0"W
73°40'0"W
39°20'0"N
39°10'0"N
39°0'0"N
38°50'0"N
38°40'0"N
Turtle Sighting
Transect START
Transect END
Boat Track
8/19/2008
8/20/2008
8/21/2008
8/22/2008
ETAA
HCAA
Subm pipe
(approx
29 fms rep)

Figure 32.

Plot of Transect 1 and Turtle Sightings for 8/19/2008

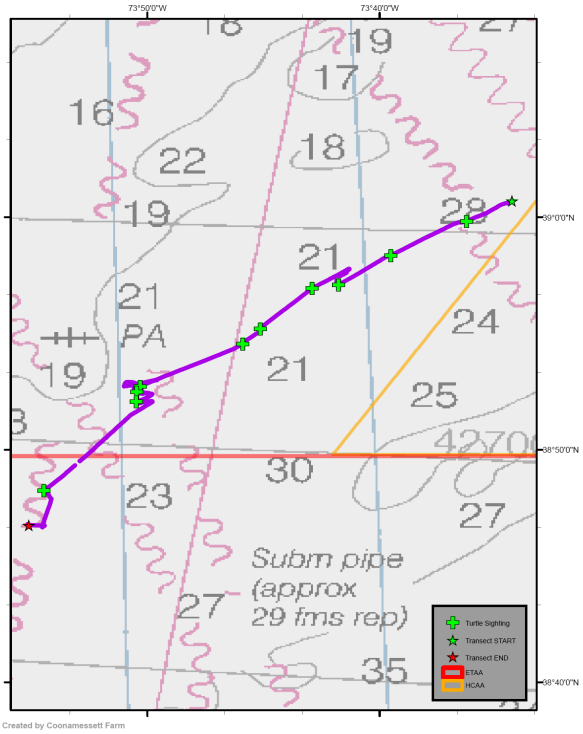


Figure 33.

Plot of Transect 2 and Turtle Sightings for 8/20/2008

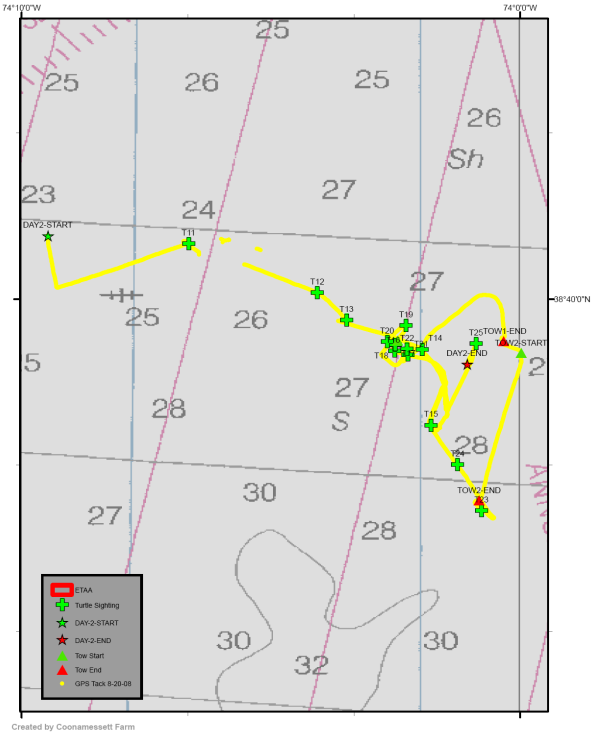


Figure 34.

Plot of Transect 3 and Turtle Sightings for 8/21/2008

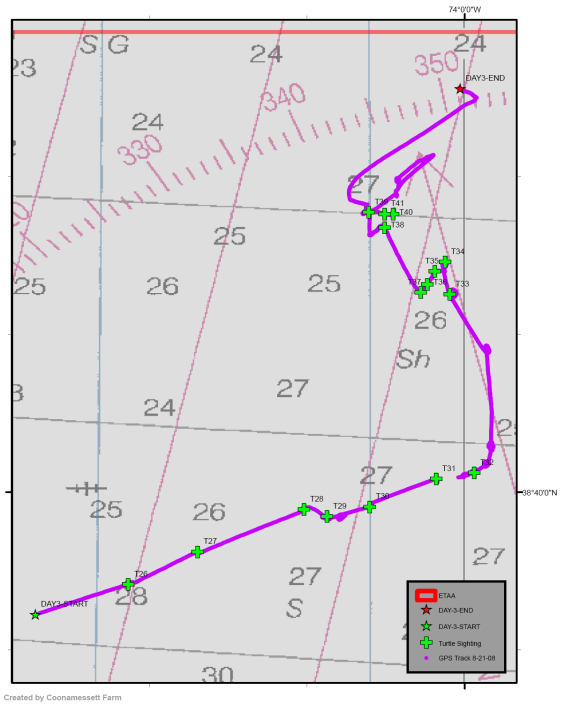


Figure 35.

Plot of Transect 4 and Turtle Sightings for 8/22/2008

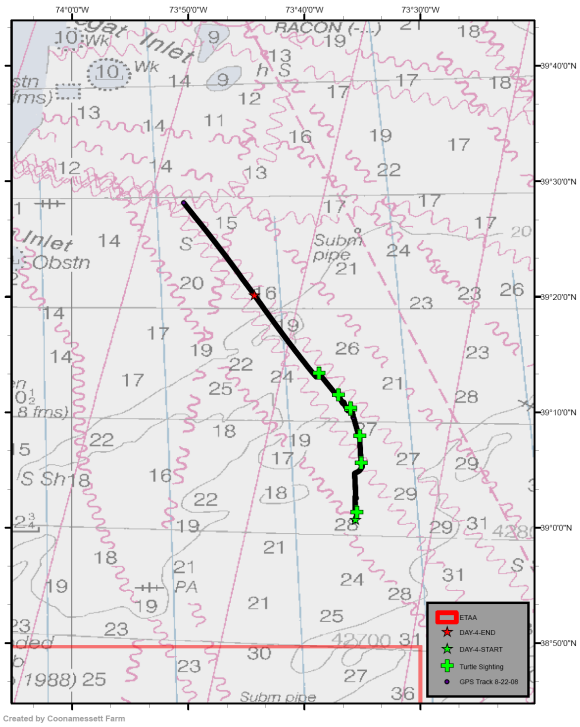


Figure 36.

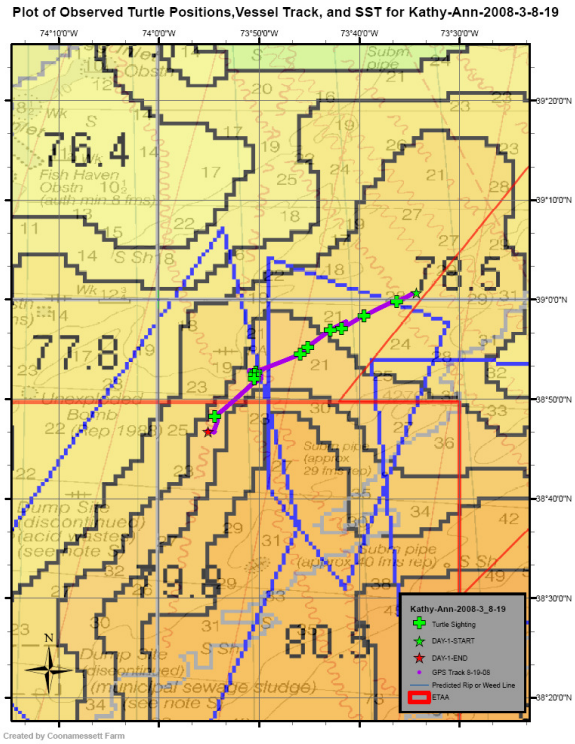


Figure 37.

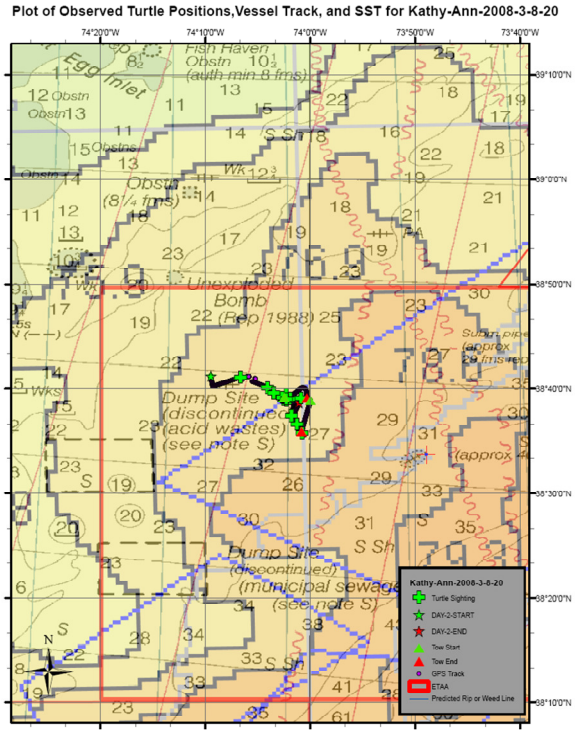


Figure 38.

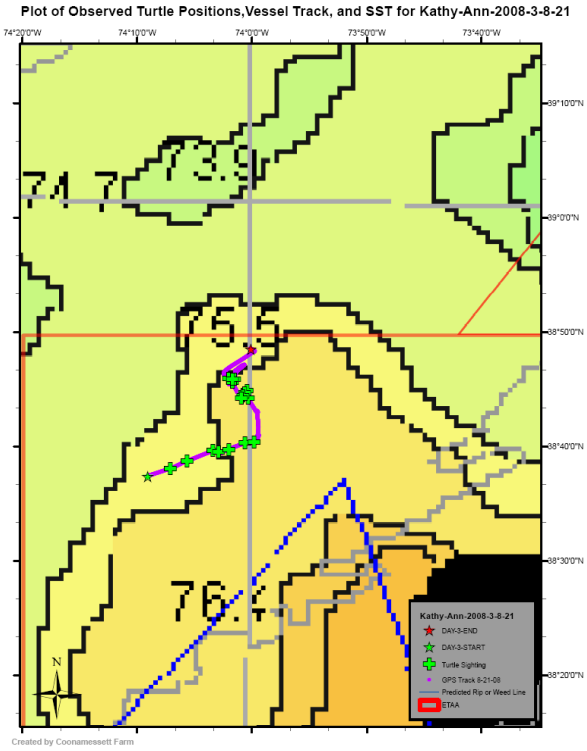


Figure 39.

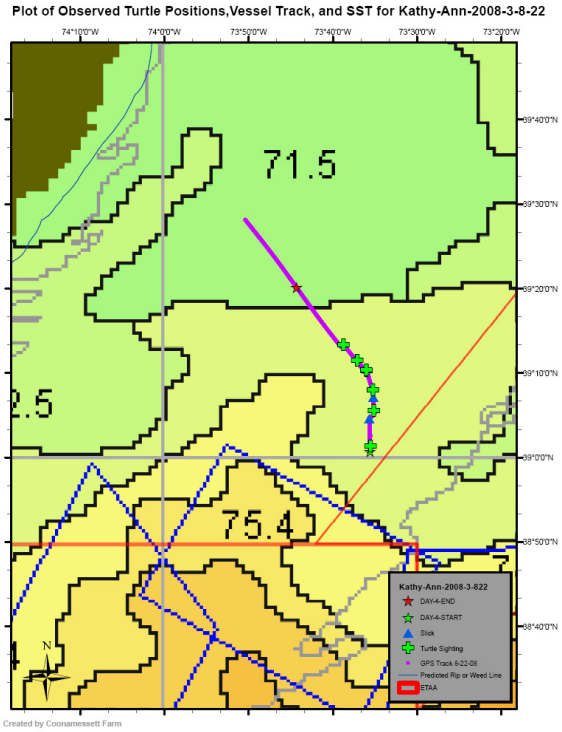


Figure 40.

Plot of Transects Conducted & Loggerhead Sightings During Trip KathyAnn-2009-1

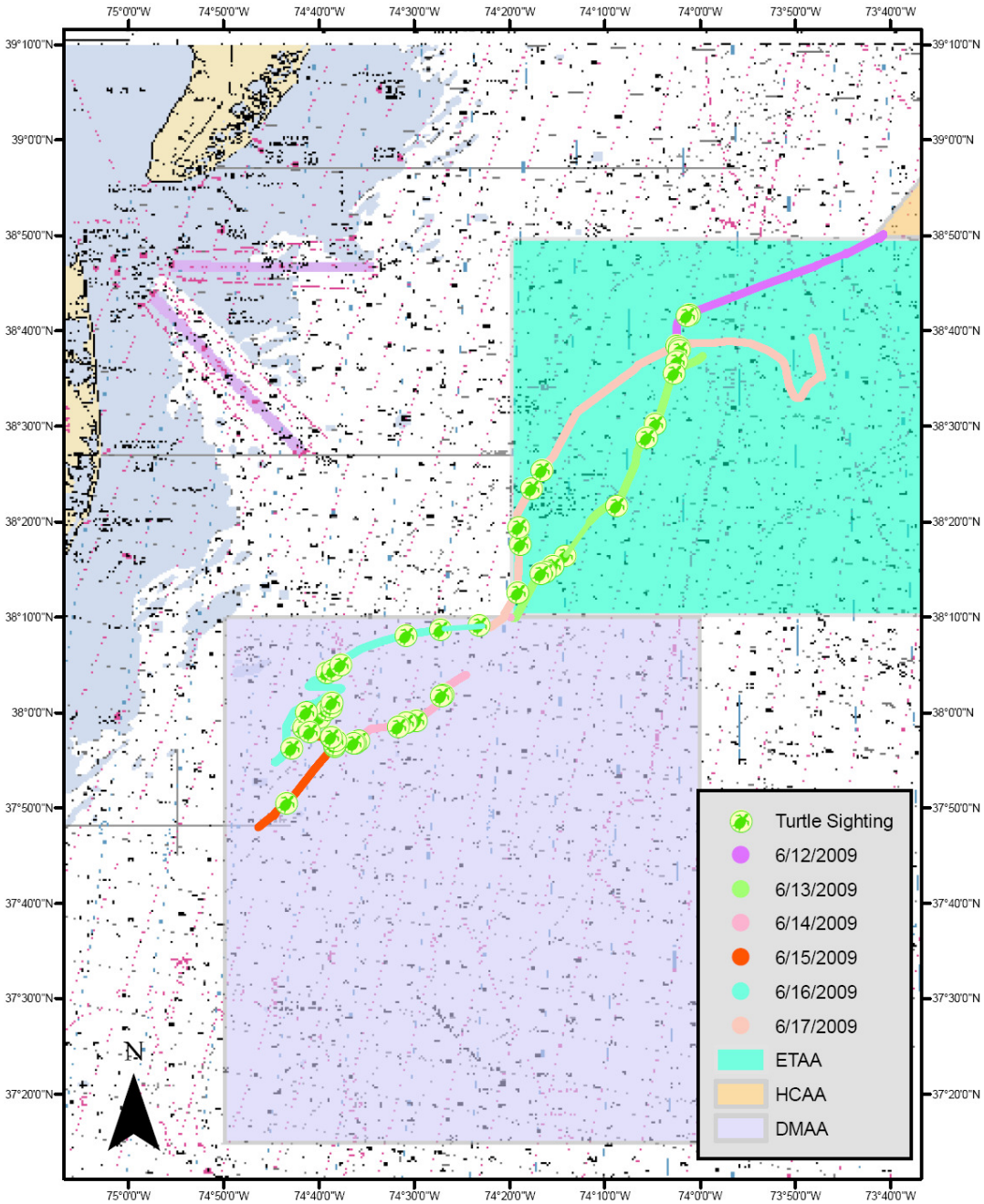


Figure 41.

Plot of Transects & Loggerhead Sightings
6/12/2009

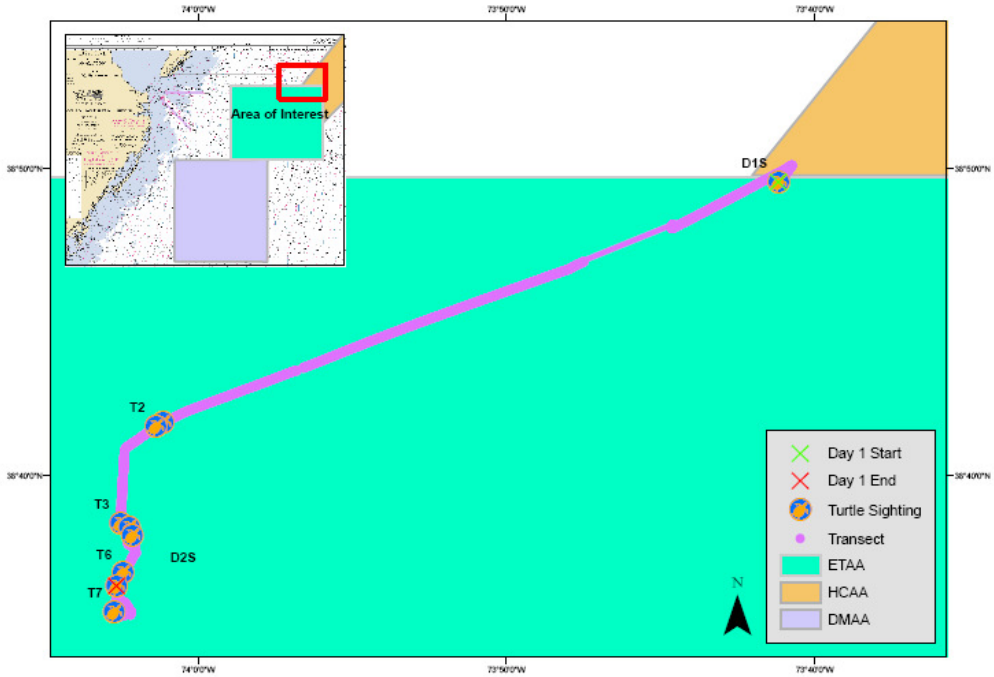


Figure 42.

Plot of Transects & Loggerhead Sightings
6/13/2009

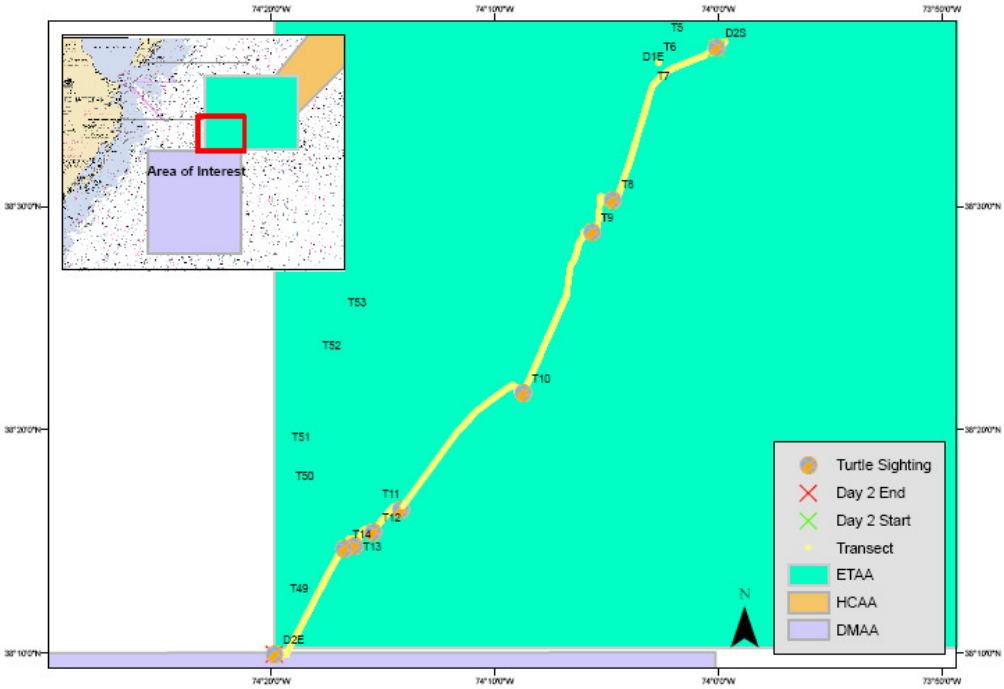


Figure 43.

Plot of Transects & Loggerhead Sightings
6/14/2009

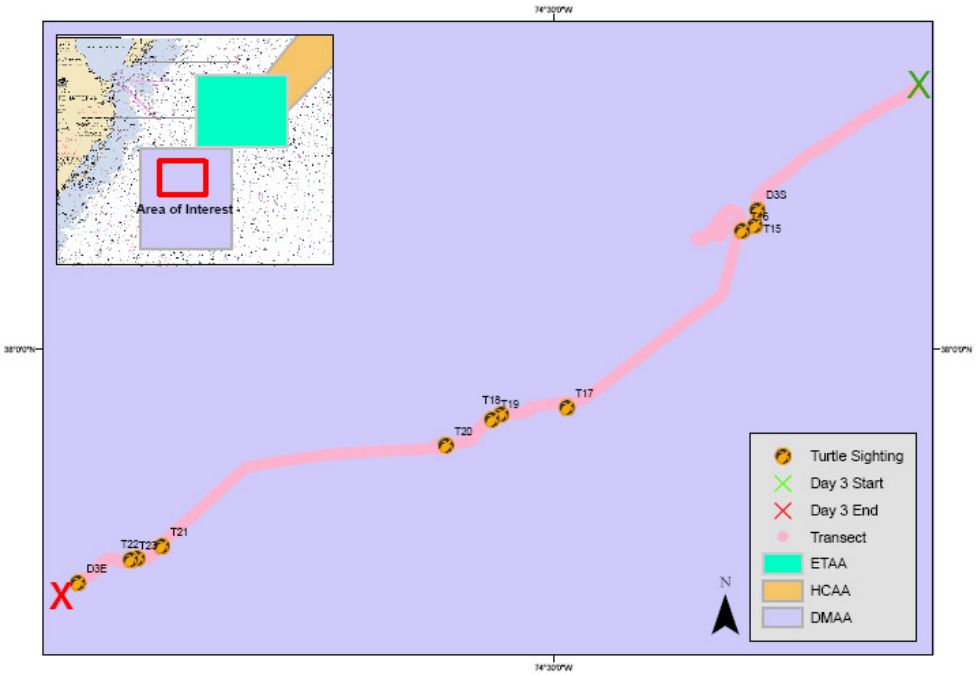


Figure 44.

Plot of Transects & Loggerhead Sightings
6/15/2009

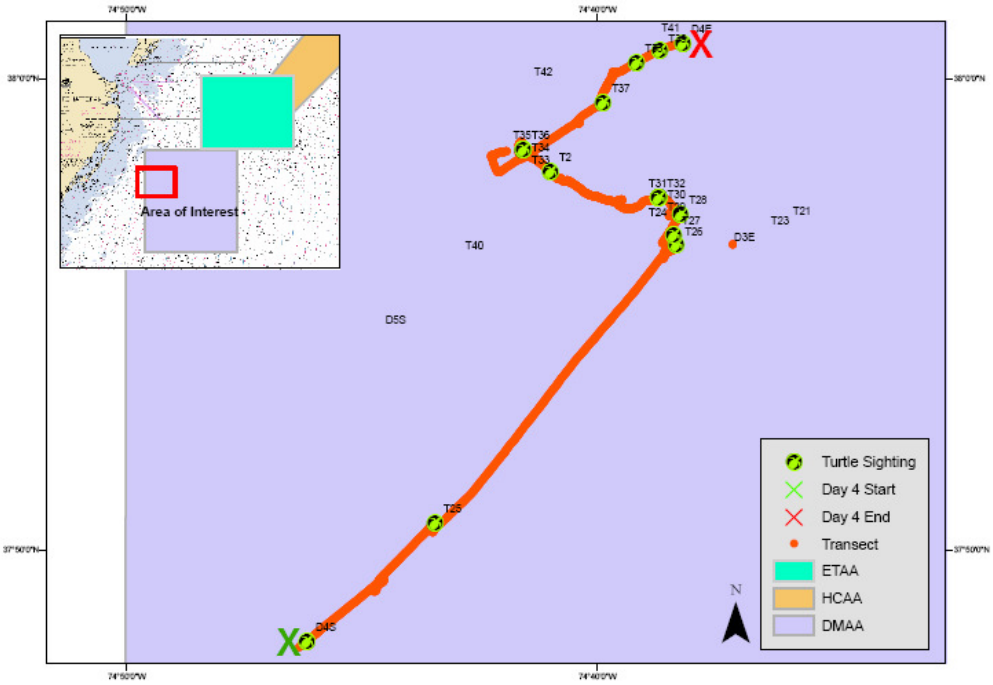


Figure 45.

Plot of Transects & Loggerhead Sightings
6/16/2009

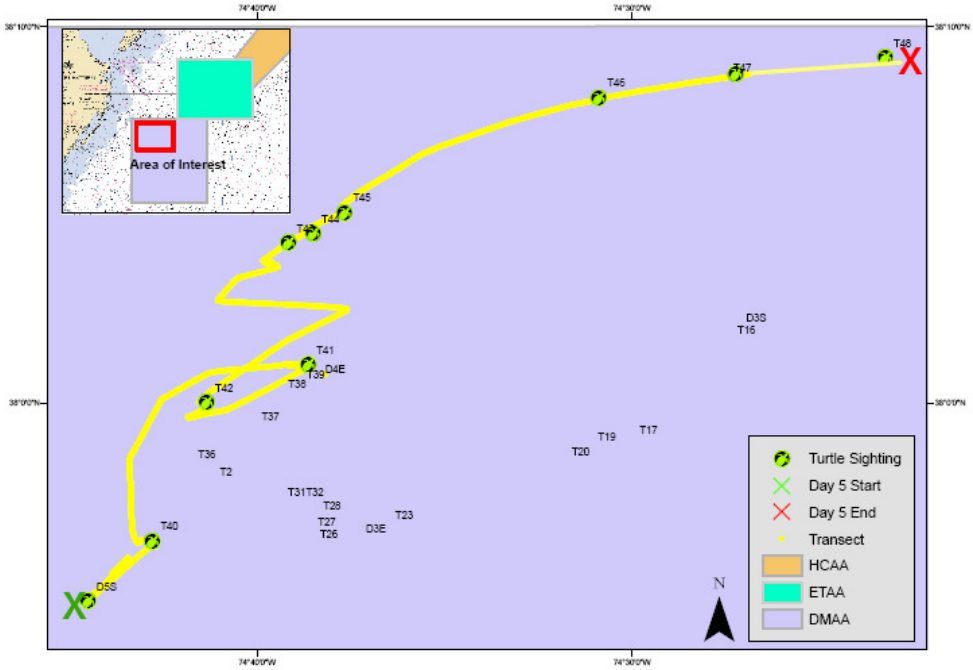


Figure 46.

Plot of Transects & Loggerhead Sightings
6/17/2009

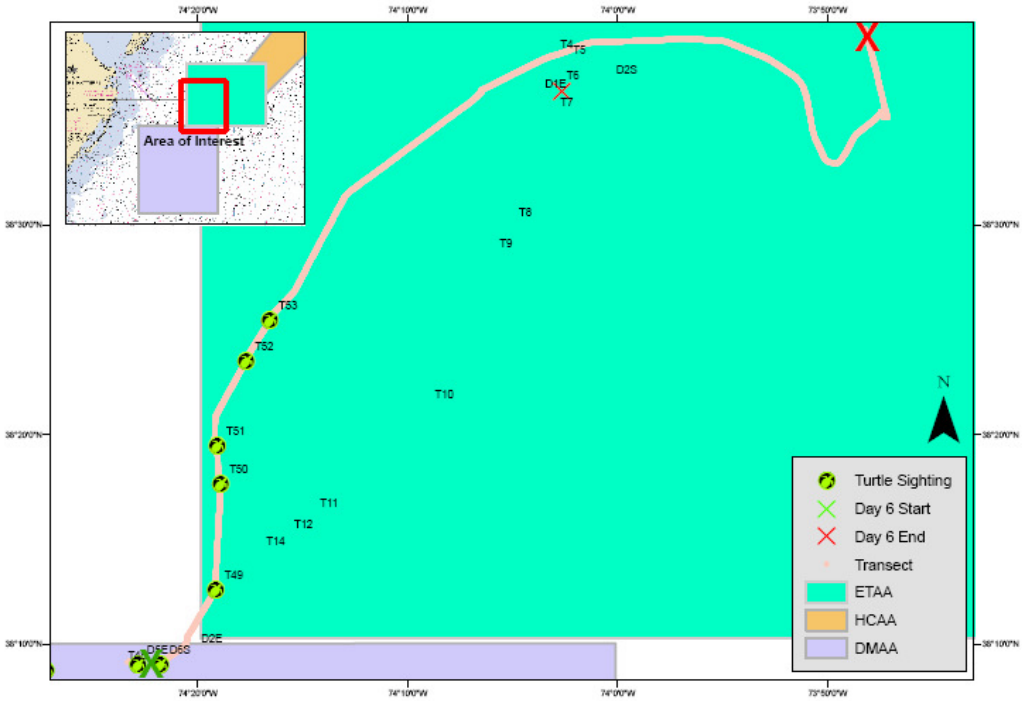


Figure 47.

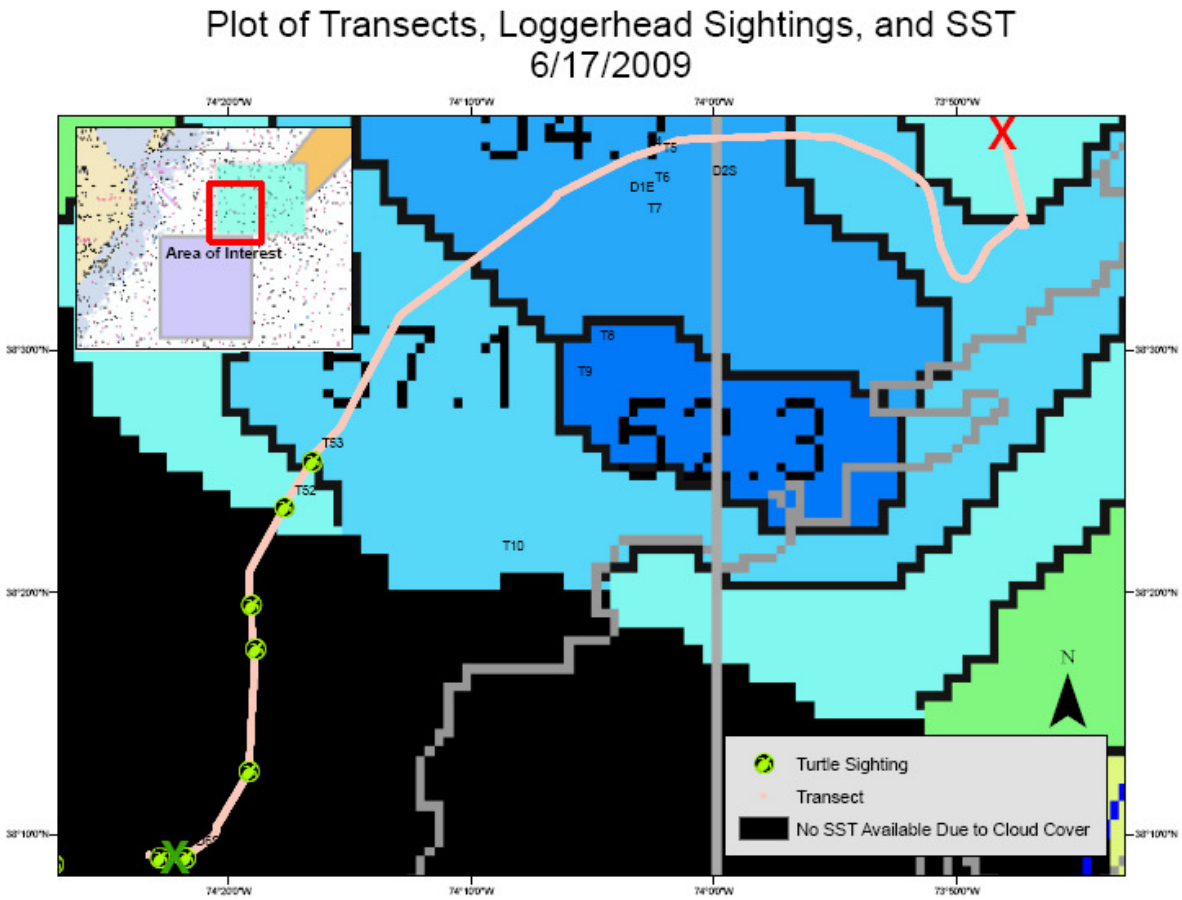

Plot of Transects, Loggerhead Sightings, and SST
6/17/2009
Area of Interest
T5
T6
D1E
T7
D2S
T8
T9
T10
TS3
TS2
N
Turtle Sighting
Transect
No SST Available Due to Cloud Cover

Figure 48.

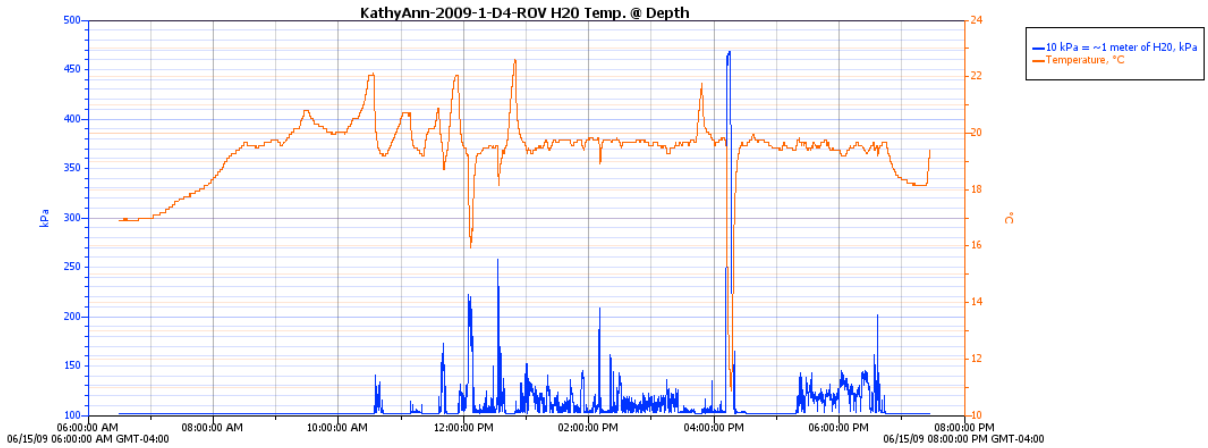


Figure 49.

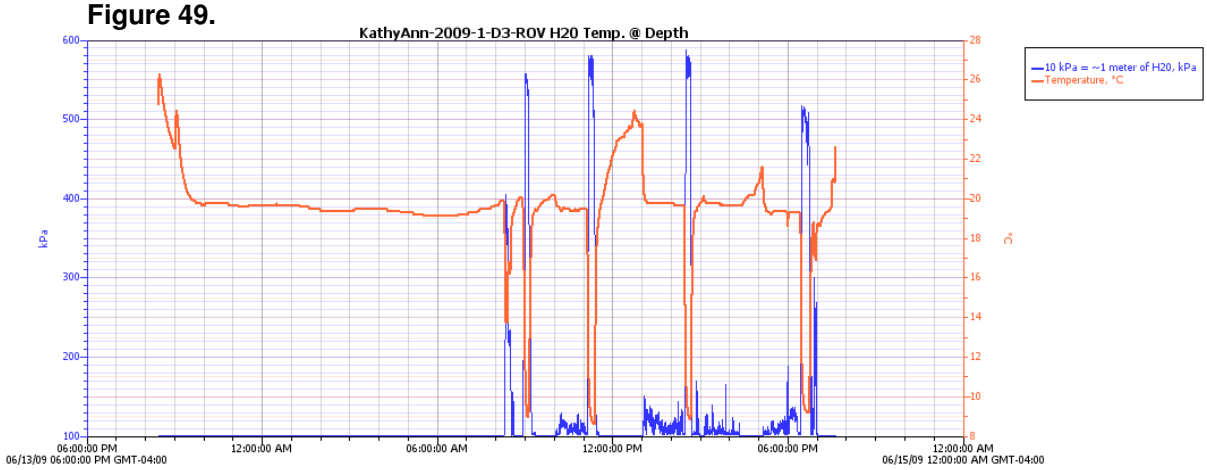


Figure 50.

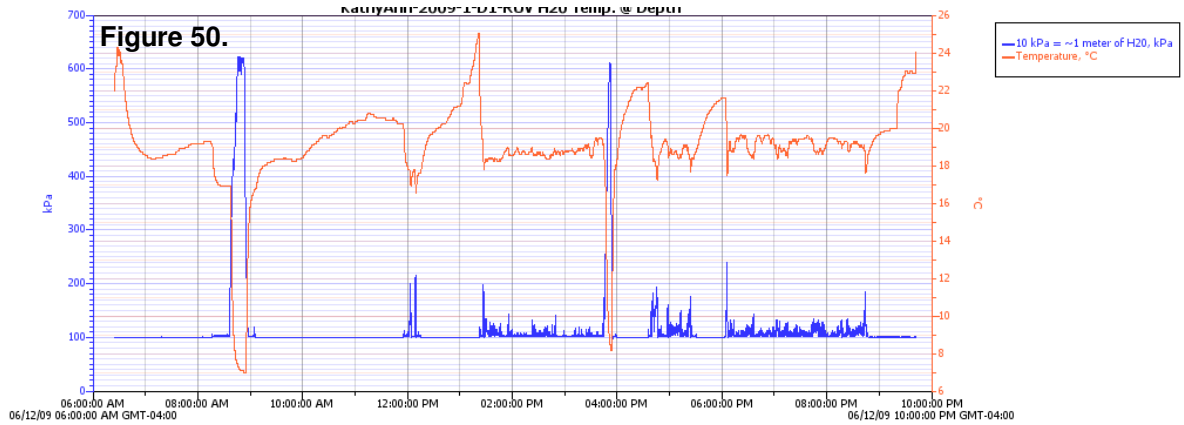


Figure 51.

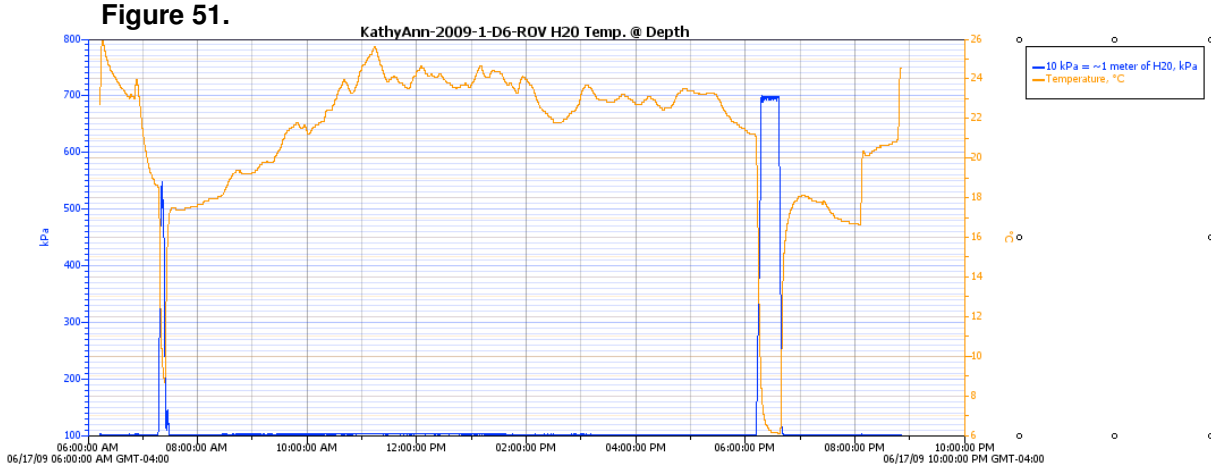


Figure 52.

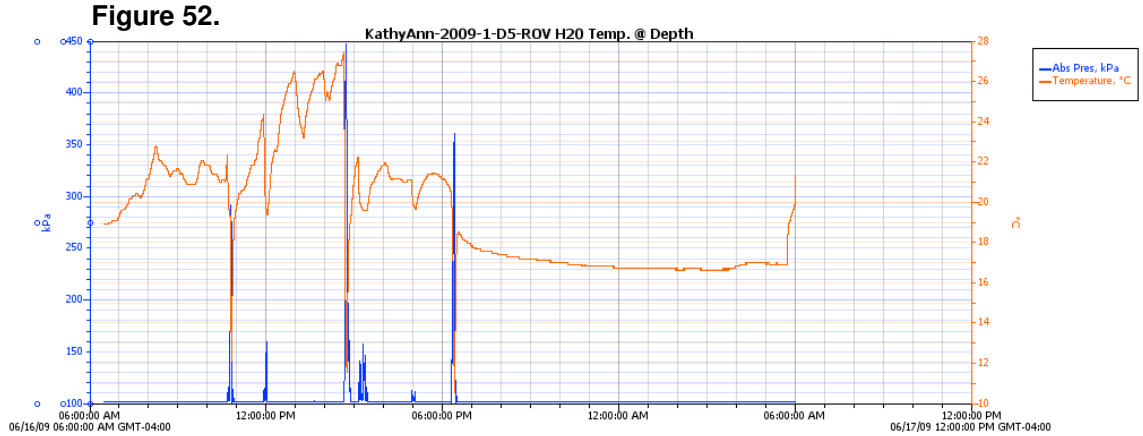


Figure 53.

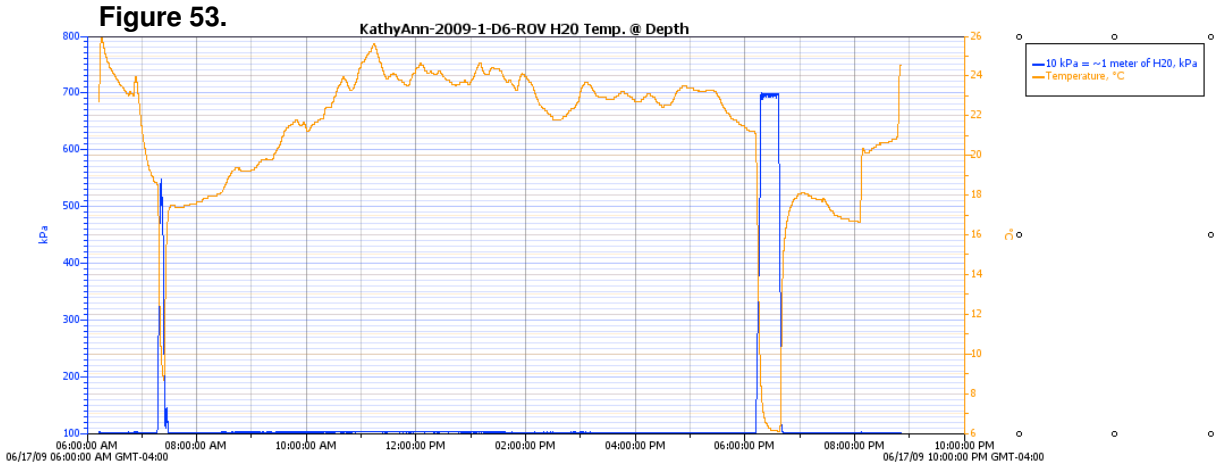


Table 1. Turtle Sighting Summary Kathyann-2008-3

TURTLE ID	DATE	TIME SIGHTED	TRANSECT	LAT SIGHTING	LONG SIGHTING	ROV DIVE	ROV CONTACT	NOTES
1	8/19/08	7:50	1	3859.7800	7336.5800	No	No	turtle was not seen from masthead and not re-acquired
2	8/19/08	8:36	1	3858.3500	7339.5300	No	No	large loggerhead
3	8/19/08	9:11	1	3857.1100	7339.5300	Yes	Yes	aggressive loggerhead
4	8/19/08	10:32	1	3856.8600	7343.0200	No	No	observed from masthead 200 m off port bow but soon lost in seas
5	8/19/08	11:03	1	3856.8600	7343.0200	No	No	on surface off stbd bow is a leatherback about 1.5 m in length
6	8/19/08	11:23	1	3854.5200	7345.9100	No	No	observed from masthead underwater
7	8/19/08	12:17	1	3852.6600	7350.5400	Yes	Yes	pair of turtle interacting
8	8/19/08	12:17	1	3852.6600	7350.5400	Yes	Yes	pair of turtle interacting
9	8/19/08	14:25	1	3852.4400	7350.0800	Yes	Yes	seems to be taking short breaths and moving submerged.
10	8/19/08	15:25	1	3851.9900	7350.3500	Yes	No	turtle was taking short breaths and diving while observed from deck
11	8/19/08	17:40	1	3848.2300	7354.4500	No	No	sighted from masthead on portside 50 m out, dove but was visible from the masthead just under the surface
12	8/20/08	8:32	2	3841.3900	7409.5000	No	No	probably a leatherback since it was black and elongated, was sighted from deck 50 m out from the port beam, probably a leatherback since it was black and elongated, was sighted from deck 50 m out from the port beam
13	8/20/08	9:25	2	3840.0900	7404.0600	No	No	sighted on surface 50 m to stbd taking a breath and then diving, was a large loggerhead
14	8/20/08	9:44	2	3839.5600	7403.6100	No	No	sighted from pilot house dead ahead 50 m, It dove right after being spotted. It was a large loggerhead
15	8/20/08	10:28	2	3839.0000	7501.9600	No	No	large loggerhead, was spotted from deck 10 m off the stbd bow, took a breath then dove
16	8/20/08	11:16	2	3837.3800	7401.6400	No	No	sighted astern 100 m then dove. The turtle was in the wake of the GLIII that just set her dredges
17	8/20/08	11:38	2	3838.2600	7402.5000	No	No	observed in wake of GLIII which is 1 nm ahead
18	8/20/08	11:57	2	3838.9400	7402.5000	No	No	50 m to stbd; GLIII 100 m off port bow
19	8/20/08	12:05	2	3839.1100	7402.4800	No	No	were sighted off the stbd bow together in contact with each other, One remained on surface; one dove. One was much larger than the other
20	8/20/08	12:05	2	3839.1100	7402.4800	No	No	were sighted off the stbd bow together in contact with each other, One remained on surface; one dove. One was much larger than the other
21	8/20/08	12:13	2	3839.4600	7402.3300	No	No	off bow
22	8/20/08	12:44	2	3838.9000	7402.2100	No	No	on surface 70 m to port and then dives
23	8/20/08	14:19	2	3838.6500	7359.9900	Yes	Yes	seen hitting ROV while towing
24	8/20/08	15:16	2	3835.7600	7400.7800	No	No	astern
25	8/20/08	15:54	2	3836.7100	7401.2800	No	No	dead ahead, soon dove
26	8/20/08	17:45	2	3839.1300	7400.8800	Yes	No	ahead, dove
27	8/21/08	7:31	3	3838.0900	7407.1300	No	No	spotted from masthead 30 m abeam to port taking short breaths and remaining below the surface. Could not maintain a visual sighting
28	8/21/08	8:02	3	3838.7200	7405.6000	No	No	spotted from deck 50 m to stbd. It took a reath and dove. It was difficult to see due to the low sun angle.
29	8/21/08	8:35	3	3839.6100	7403.4300	Yes	No	spotted from masthead while submerged about 2 m out from vessel and 2 m below surface when just off bow
30	8/21/08	9:18	3	3839.4900	7402.9400	Yes	No	sighted briefly from deck while taking a breath off the port side about 30 m out. It was then resighted lying submerged from the masthead.
31	8/21/08	10:05	3	3839.6900	7401.9800	No	No	spotted dead ahead from masthead about 20 m. It was submerged about 2 m deep. Could not re-locate.
32	8/21/08	10:31	3	3840.2900	7400.5700	Yes	No	Turtle dove and avoided vessel.
33	8/21/08	11:03	3	3840.4400	7359.8000	No	No	sighted from masthead 30 m to port beam but quickly dove out of sight
34	8/21/08	12:42	3	3844.2800	7400.2700	No	No	spotted on surface from pilot house 50 m off the stbd bow. The turtle dove almost immediately.
35	8/21/08	13:08	3	3844.8600	7400.3600	Yes	Yes	on surface 80 m off stbd bow seen from pilot house
36	8/21/08	13:48	3	3844.6800	7400.5700	No	No	sighted 100 m to port, No contact; turtle dove. Three F/V's working within 2-4 nm of our position.
37	8/21/08	15:13	3	3845.6000	7401.7100	Yes	No	on surface 50 m to port
38	8/21/08	15:57	3	3845.9200	7402.0000	No	No	very large, takes breath and dives just below surface. 1610: Sportfishing boat runs right over Turtle 38's location.
39	8/21/08	17:46	3	3845.9400	7401.4900	No	No	past close aboard port side about 1 m down
40	8/21/08	18:00	3	3846.0700	7402.0500	No	No	
41	8/22/08	7:22	4	3901.3700	7335.5500	No	No	spotted from masthead 20 m off port bow; took breath and dove.
42	8/22/08	8:51	4	3905.6300	7335.0500	No	No	spotted from foredeck 2 m abeam the bow submerged about 1 m down; small loggerhead
43	8/22/08	9:39	4	3907.9800	7335.2500	No	No	sighted from masthead 30 mk off port bow- took breath and dove. Spited again from masthead submerged about 1 m but soon lost in sun glare. Very poor sighting conditions due to clouds and glare.
44	8/22/08	10:30	4	3910.2900	7336.0700	Yes	No	was spotted after we circled on a sonar target ROV Dive 15 but unable to acquire turtle which is still submerged but visible from masthead
45	8/22/08	11:40	4	3911.5300	7337.0900	No	No	Small loggerhead that was sighted from masthead 100 m ahead to stbd submerged. It then came up and took a breath and dove and was lost.
46	8/22/08	12:10	4	3913.2600	7338.8000	Yes	Yes	Large loggerhead sighted from masthead 100 m out to port near surface, brief visual of turtle

Table 2. Turtle Sighting Summary Kathyann-2009-1

Date	Transect	Disc	Time Code	ROV Dive	Turtle ID	Visual	Event	Depth (m)	Direction	Jellies
8/19/2008	1	1	9:18:05	1	3	Y				none
8/19/2008	1	1	9:18:45	1	3	Y		surface		none
8/19/2008	1	1	9:20:07	1	3	Y	breath		E	none
8/19/2008	1	1	9:20:55	1	3	Y	breath			none
8/19/2008	1	1	9:21:37	1	3	Y		2	NE	none
8/19/2008	1	1	9:22:00	1	3	Y		surface	NE	none
8/19/2008	1	1	9:23:16	1	3	Y		0	N	none
8/19/2008	1	1	9:23:32	1	3	Y	breath	0	N	none
8/19/2008	1	1	9:25:14	1	3	Y	hits ROV	0	N	none
8/19/2008	1	1	9:24:30	1	3	Y	under ROV	0	N	none
8/19/2008	1	1	9:25:40	1	3	Y	under ROV	0		none
8/19/2008	1	1	9:26	1	3	Y	front/under ROV	0		none
8/19/2008	1	1	9:30:00	1	3	Y	pushing ROV	0	N	none
8/19/2008	1	1	9:31:40	1	3	Y	carapace in view	0		none
8/19/2008	1	1	9:33:28	1	3	Y	in view then lost	0		none
8/19/2008	1	1	9:35:49	1	3	Y	back in view	0	SE	none
8/19/2008	1	1	9:40:30	1	3	Y	under ROV	0		none
8/19/2008	1	1	9:40:42	1	3	Y		0	SE	none
8/19/2008	1	1	9:41:40	1	3	Y	carapace under ROV	0		none
8/19/2008	1	1	9:44:32	1	3	N	small fish	0		none
8/19/2008	1	1	9:45:13	1	3	N	small fish	0		none
8/19/2008	1	1	9:47:00	1	3	N	ROV at surface, lost visual	0		none
8/19/2008	1	1	9:48:15	1	3	N	recovery	0		none
8/19/2008	1	1	9:53:35	2	3	N	launch	0		none
8/19/2008	1	1	10:08	2	3	N	no visual, recovery	0		none
8/19/2008	1	2	12:18:40	3	7 & 8	Y	launch	surface		few
8/19/2008	1	2	12:24:53	3	7 & 8	Y	2 turtles on surface	0		few
8/19/2008	1	2	12:27:18	3	7 & 8	Y	turtles dive	11	W	none
8/19/2008	1	2	12:27:37	3	7 & 8	Y	breath	0		none
8/19/2008	1	2	12:29:08	3	7 & 8	Y		0	E	none
8/19/2008	1	2	12:29:53	3	7 & 8	Y		1	NE	none
8/19/2008	1	2	12:29:56	3	7 & 8	N	lost visual			none
8/19/2008	1	2	12:34:24	3	7 & 8	N	ROV dives, lost visual	18		none
8/19/2008	1	2	12:30:00	3	7 & 8	N	video back	0		none
8/19/2008	1	2	12:45:07	3	7 & 8	N	ROV bottom	44		none
8/19/2008	1	2	12:45:45	3	7 & 8	N	bottom	47		none
8/19/2008	1	2	12:51:20	3	7 & 8	N	sponges on bottom	47		none
8/19/2008	1	2	12:52:59	3	7 & 8	N	ROV ascent			none
8/19/2008	1	2	12:54:20	3	7 & 8	N		28		few
8/19/2008	1	2	13:04:48	3	7 & 8	N	recovery			none
8/19/2008	1	3	14:51:56	4	9	N	launch			none
8/19/2008	1	3	14:55:01	4	23	Y	turtle visual	0	E	none
8/19/2008	1	3	14:55:28	4	23	Y	turtle dives	3		none
8/19/2008	1	4	15:28:32	5	24	N	launch			none
8/19/2008	1	4	16:07:00	5	24	N	recovery			none
8/20/2008	2	5	12:23:08	6	NA	N	launch			none
8/20/2008	2	5	12:24:36	6	NA	N	water column	3		none
8/20/2008	2	5	12:25:20	6	NA	N	water column	2		none
8/20/2008	2	5	12:25:55	6	NA	N	water column	1		none
8/20/2008	2	5	12:35:10	6	NA	N	water column	2		none
8/20/2008	2	5	12:55:05	6	NA	N	recovery			none
8/20/2008	2	6	12:56:26	7	NA	N	launch			none
8/20/2008	2	6	13:01:15	7	NA	N	water column	16		none
8/20/2008	2	6	13:08:52	7	NA	N	scallop visera	6		none
8/20/2008	2	6	13:09:55	7	NA	N	water column	12		none
8/20/2008	2	6	13:10:50	7	NA	N	water column	13		lions
8/20/2008	2	6	13:11:28	7	NA	N	scallop visera	12		none
8/20/2008	2	6	13:12:39	7	NA	N	water column	11		moon
8/20/2008	2	6	13:16:27	7	NA	N	water column	7		few
8/20/2008	2	6	13:18:36	7	NA	N	scallop visera	8		none
8/20/2008	2	6	13:23:11	7	NA	N	water column	9		none
8/20/2008	2	6	13:31:36	7	NA	N	water column	6		none
8/20/2008	2	6	13:33:15	7	NA	N	water column	5		none
8/20/2008	2	6	13:34:35	7	NA	N	water column	4		none
8/20/2008	2	6	13:36:45	7	NA	N	water column	4		few
8/20/2008	2	6	13:45:35	7	NA	N	water column	13		few
8/20/2008	2	6	13:46:59	7	NA	N	water column	39		few
8/20/2008	2	6	13:47:41	7	NA	N	water column	35		few
8/20/2008	2	6	13:48:55	7	NA	N	recovery			none
8/20/2008	2	7	14:07:50	8	23	N	launch			none
8/20/2008	2	7	14:13:06	8	23	N	water column	43		none
8/20/2008	2	7	14:13:30	8	23	N	water column	52		none
8/20/2008	2	7	14:17:38	8	23	Y	TURTLE RUN INTO ROV	10		none
8/20/2008	2	7	14:28:23	8	23	N	scallop shell	12		none

Table 3. T15 Seafloor Dive Summary

Turtle Depth (m)	Time Code	H2O Temp. C	Temp. Change (5 m)	Time from surface	Time to 5 m	m/sec from surface	m/sec from 5 m	# of strokes	strokes / second	strokes / meter	Comments
0	2:59:48	19.7		0	0	0.00	0.00	NA	NA	NA	intial part of dive, steep dive angle
5	3:00:07	19.6	0.08	0:00:19	0:00:19	0.26	0.26	12	0.6	NK	ROV at same depth as turtle
10	3:00:20	19.0	0.55	0:00:32	0:00:13	0.31	0.38	6	0.46	0.6	ROV at same depth as turtle
15	3:00:33	18.3	0.76	0:00:45	0:00:13	0.33	0.38	5	0.38	0.5	ROV at same depth as turtle
20	3:00:51	17.1	1.21	0:01:03	0:00:18	0.32	0.28	5	0.28	0.5	ROV at same depth as turtle
25	3:01:06	15.6	1.50	0:01:18	0:00:15	0.32	0.33	4	0.27	0.4	ROV at same depth as turtle
30	3:01:24	14.1	1.48	0:01:36	0:00:18	0.31	0.28	2	0.11	0.2	pausing after downward part of stroke, not full power strokes
35	3:01:38	13.2	0.91	0:01:50	0:00:14	0.32	0.36	1	0.1	0.1	flipper held along dorsal plane of turtle during middle of stroke cycle, picking up speed, more stuff in water column
40	3:01:47	12.7	0.51	0:01:59	0:00:09	0.34	0.56	0	0.0	0.0	ROV ~1 meter behind turtle, flipper held along dorsal plane of turtle during middle of stroke cycle, more jellies
45	3:01:55	12.3	0.36	0:02:07	0:00:08	0.35	0.63	0	0.0	0.0	ROV ~3 meters behind turtle, flipper held along dorsal plane of turtle during middle of stroke cycle, lots more jellies
50	*3:02:00*	*12.1*	*0.22*	*0:02:12*	*0:00:05*	*0.38*	*1.00*	*nk*	*nk*	*nk*	time estimates, ROV lost visual, turtle further from ROV, turtle picking up speed
54	*3:02:05*	*11.9*	*0.19*	***0:02:17***	*0:00:05*	*0.40*	*1.00*	*nk*	*nk*	*nk*	**temperature of 8.5 was recorded soon after reaching the bottom for a difference of -11.2 C from surface temperature**
Total H2O Temp. Difference: -7.8 C				**Averages:**	**0:00:12**	**0.33**	**0.50**	**2.88**	**0.2**	**0.29**	

Table 4.

T21 - Observation Summary

Activity	Time Code Start	Total Time	Straight Line Distance (km)	Straight Line Speed km/hr	Track Line Distance (km)	Track Line Speed km/hr	General Heading	Average Depth	Notes:
Initial Behavior	3:17:57	0:12	0.32	0.6	0.50	0.4	SW	<1 m	becoming acquainted with ROV, ROV influencing behavior
Transit Swim	3:30:56	0:55	0.90	1.0	1.90	0.5	SWW	1-2 m	swimming on one heading, no deep dives or foraging, ROV no longer significantly influencing behavior
Pre Dive	4:26:00	0:05	0.14	0.6	0.16	0.5	SWW	surface	floating on surface preparing for dive to seafloor
Dive	4:31:48	0:01	0.05	0.4	0.06	0.3	SW	0.32 m/sec	dive to seafloor
Walking on Seafloor	4:33:40	0:11	0.15	1.2	0.20	0.9	SW	46 m	moving along seafloor in direct contact with seafloor
Lost Visual	4:45:12							46 m	lost while on bottom due to short tether
	Totals:	1:27:15	1.56	0.76	2.82	0.52	SWW		
	Total Straight Line from Beginning to End:		1.40						

Note: GPS was polling every 10 seconds from the masthead. It does not reflect the precise position of the turtle but is well within 150 meters of the general location. Movement and repositioning of the vessel may not reflect the precise movements of the turtle.

Table 5.

T21 - Unsymmetrical Stroke Log

Number	Time Code	Time Difference	Notes
1	3:31:56		transit swim begins at 3:30:56, no offbeat strokes during initial behavior
2	3:33:21	0:01:25	
3	3:39:44	0:06:23	
4	3:40:58	0:01:14	
5	3:45:43	0:04:45	
6	3:49:34	0:03:51	
7	3:53:22	0:03:48	
8	3:55:05	0:01:43	
9	3:58:47	0:03:42	
10	3:59:01	0:00:14	
11	4:01:39	0:02:38	
12	4:03:15	0:01:36	
13	4:03:26	0:00:11	
14	4:06:22	0:02:56	
15	4:06:51	0:00:29	
16	4:08:11	0:01:20	
17	4:08:29	0:00:18	
18	4:10:29	0:02:00	
19	4:16:56	0:06:27	
20	4:22:16	0:05:20	
21	4:24:01	0:01:45	
22	4:24:38	0:00:37	
23	4:24:44	0:00:06	
24	4:25:19	0:00:35	
25	4:25:27	0:00:08	pre dive behavior begins at 4:26:00

Average Time Difference: 0:02:14
Max Time Difference: 0:06:27
Min Time Difference: 0:00:06

Breath Log Summary	Total Before Pre Dive Behavior	Initial Behavior	Transit Swim
Total Time:	1:01:38		
Average Time Between Breaths:	0:03:25	0:01:43	0:05:04
Max Time Between Breaths:	0:17:02	0:01:41	0:17:02
Min Time Between Breaths:	0:00:04	0:00:04	0:00:55

Appendix A. Kathyann-2008-3

Sonar targets during 22 August 2008 survey

Sonar file	location	Latitude(N)	Longitude(W)	Length(m)	Depth(m)	Probability	Comment
21-Aug							
2	port 7m	38 37.531	74 08.748	1.3m	<10	low	
8	port 32m	38 38.059	74 07 .155	2.0m	<5	low	
25	port 31m	38 38.263	74 06.664	0.6m	<5	low	
25	port 31m	38 38.683	74 05.821	1.5m	~5	medium	
40	port 38m	38 38.981	74 05.025	0.3m	?	low	
49	port 31m	38 39.429	74 03.897	0.5m	<5	low	
59	port 37m	38 39.660	74 03.175	complex	<10	low	
63	stbd 47m	38 39.500	74 02.905	0.7m	<5	medium	
70	stbd 32m	38 39.484	74 02.658	0.4m	<5	low	
98	ROV	wake	no turtle	seen			
105	stbd 31m	38 40.349	73 59.915	0.7m	<5	low	
107	port 32-41	38 40.395	74 00.029	multiple tgts	~5		boat turn
114	port 32m	38 40.570	73 59.586	1.0m	<5	medium	
122	port 36m	38 40.933	73 59.457	0.5m	<5	medium	
131	stbd 44m	38 40.988	73 59.418	0.4m	5-10m	low	
138	stbd 37m	38 41.741	73 59.405	0.3m	~5	high	
148	stbd 33m	38 42.750	73 59.497	0.7m	<10	low	
159	port 31m	38 43.165	73 59.731		5-10m	high	
195						ROV and turtle	
214						ROV and wake	
235	port 55m	38 45.412	74 02.029	0.6m	<10	low	
241	stbd 58m	38 45.946	74 01.979	1.0m	~5	ROV	
259	port 45m	38 46.691	74 01.204	1.0m	~5	low	
287	stbd 32m	38 45.953	74 02.123	0.7m	5-10m	high	
294	port 33m	38 46.759	74 02.167	0.7m	5m	low	
294	port 40m	38 46.727	74 02.216	1.6m		medium	
294	other	targets	probably fish				
319	fish	swimming					
					flat sea surface files 113-120		

APPENDIX B: Trip Narrative F/V Kathy Ann 2008-3

We left Barnegat Light, NJ at 1900 on August 18, 2008. We steamed all night to a position just west of the Hudson Canyon Access Area and about 8 nm north of the ETAA. At 0700 on August 19th we began Transect 1 (39-00.71; 73-34.30) at a speed of 4.3 knots. Wind was 20 knots; seas 4-6 feet. It was sunny but spotting conditions were poor.

0750: Turtle 1 was spotted from the masthead when on top of a wave about 50 m to stbd (38-59.78; 73-36.58). The turtle was not seen from deck and not re-acquired. 0836: Turtle 2 was spotted from the masthead 50 m to stbd (38-58.35; 73-39.53) This was a large loggerhead that was on the surface then dove out of sight. 0844: Resumed Transect 1.

0911: Turtle 3 was sighted from the masthead about 50 m to port (Station 1: 38-57.11; 73-41.77). The turtle had large white barnacles on its back. 0918: Launched ROV Dive 1. 0919: Acquired turtle 3 on video (38-57.22; 73-41.86, 26.5 fms). 0948 Turtle 3 continues to follow the ROV usually staying underneath the vehicle possibly rubbing its carapace deliberately on the ROV bottom. Wind is a problem so recovered ROV to reposition vessel; turtle 3 waiting on surface. Turning vessel around. 0955: ROV Dive 2 in water (38-57.59; 73-41.46, 27.3 fms) Turtle no longer in sight. 1003: Retrieving ROV; vessel drifting at 1.1 kn to NE. 1010: Resumed Transect 1 (38-57.77; 73-41.30, Hdg 235)

1032: Turtle 4 observed from masthead 200 m off port bow but soon lost in seas (38-56.86; 73-43.02, 26.5 fms). 1103: Turtle 5 on surface off stbd bow is a leatherback about 1.5 m in length (38-55.21; 73-45.11, 26.3 fms). Turtle dove. 1123: Turtle 6 observed from masthead underwater (38-54.52; 73-45.91, 26.2 fms). 1128: Resumed Transect 1.

1217: Two turtles (Turtle 7 & Turtle 8) sighted from foredeck 50 m to stbd (Station 2: 38-52.66; 73-50.54, 23.5 fms). The turtles were on the surface interacting with each other; flopping around upside down one on top of the other. Launched ROV Dive 3. 1224: Acquired one of the turtles on video. Wind 15 knots; seas 3-4 feet. 1232: Lost contact; diving ROV to sea floor. Drift 1.3 kn, 061T. 1245: Searching sea floor. 1306: ROV onboard; putting bow mounted sonar in water. 1316: Resumed Transect 1 with sonar heading 260T to area of previous sighting (38-52.98; 73-49.70). 1330: Searching around sighting area (38-52.91; 73-50.78, 23.0 fms) 1425: Turtle 9 observed from masthead under surface (38-52.51; 73-50.43). Bright sun glare making Turtle 9 difficult to see; it was on surface when lost astern. 1433: Resumed Transect 1 (38-52.53; 73-50.27, 23.8 fms).

1435: Spotted Turtle 9 again under surface then lost again in glare. 1447: Spotted again; Turtle 9 seems to be taking short breaths and moving submerged. 1453: ROV Dive 4 in water (Station 3: 38-52.44; 73-50.08, 23.3 fms). Acquired aTurtle 9 on video. 1455: Lost contact. 1514: ROV onboard resumed Transect 1.

1525: Spotted Turtle 10 from foredeck 50 m to port (Station 4: 38-51.99; 73-50.35) 1530: ROV Dive 5 in water but unable to acquire Turtle 10. The turtle was taking short breaths and diving while observed from deck. 1608: Resumed Transect 1 (38-52.07; 73-49.28, 22.8 fms). 1740: Turtle 11 sighted from masthead on portside 50 m out (38-48.23; 73-54.45) It dove but was visible from the masthead just under the surface. The wind and sun were from the same direction making an ROV launch difficult. 1800: Searching around the sighting area. 1845: Ended operations for the day.

August 20, 2008

0720: Began Transect 2 (38-41.39; 74-09.50, 27.3 fms). Wind NE 15-20 knots; seas 4-6 feet. Bright sun; poor sighting conditions. 0832: Turtle 12, probably a leatherback since it was black and elongated, was sighted from deck 50 m out from the port beam (38-41.15; 74-06.68, 26.7 fms) The turtle dove quickly. 0836: Resumed Transect 2 Hdg 140, 3.0 knots.

0852: F/V Grand Larsen III 3.0 nm away brg 180T. 0925: Turtle 13 sighted on surface 50 m to stbd taking a breath and then diving (38-40.09; 74-04.06, 29.5 fms) It was a large loggerhead. 0928: Resumed Transect 2. GLIII 1.7 nm away brg 180T. 0930: Spotted Turtle again; assumed it was Turtle 13; it took a breath and dove. 0944: Turtle 14 sighted from pilot house dead ahead 50 m (38-39.57; 74-03.46) It dove right after being spotted. It was a large loggerhead. 0951: We maneuvered to resume transect when Turtle 14 was spotted again from the masthead just

submerged below the surface 30 m ahead (38-39.56; 74-03.53). GLIII 1.7 nm brg 140T. 1000: Laying too alongside Turtle 14 re-rigging the ROV for towing. The turtle is submerged just below the surface (38-39.56; 74-03.61).

1028: Turtle 15, a large loggerhead, was spotted from deck 10 m off the stbd bow (38-39.00; 75-01.96, 28.7 fms). It took a breath then dove. 1100: Laying too near GLIII rigging ROV (38-37.41; 74-01.59, 29.7 fms). 1116: Turtle 16 (38-37.38; 74-01.64) sighted astern 100 m then dove. The turtle was in the wake of the GLIII that just set her dredges. 1138: Turtle 17 (38-38.26; 74-01.49, 29.5 fms) observed in wake of GLIII which is 1 nm ahead. 1157: Turtle 18 (38-38.94; 74-02.50, 28.3 fms) 50 m to stbd; GLIII 100 m off port bow.

1205: Turtles 19 and 20 were sighted off the stbd bow together in contact with each other (38-39.11; 74-02.48). One remained on surface; one dove. One was much larger than the other. 1213: Turtle 21 (38-39.46; 74-02.33, 29.2 fms) off bow. 1244: Turtle 22 (38-38.90; 74-02.21) on surface 70 m to port and then dives. 1245: Streaming ROV astern.

1304: ROV Tow 1 (Station 5: 38-39.04; 74-01.97, 29 fms) Falling in behind GLIII. 1315: GLIII observes sea turtle off her portside. 1324: GLIII 0.17 nm ahead (38-39.90; 74-01.03, 29.3 fms) ROV at 10 m depth. 1346: Ending ROV Tow 1 (38-29.22; 74-00.34, 28.3 fms) ROV was at 5 m towards end of tow.

1415: ROV Tow 2; added extra weight directly to ROV (38-38-65; 73-59.99, 28.5 fms)
1419: Turtle 23 seen hitting ROV (38-38.35; 74-00.10) ROV at 10 m depth; 4.7 knots. GLIII ahead 0.156 nm towing dredges. 1454: Ending ROV Tow 2 (38-35.95; 74-00.82, 29.7 fms) 1516: Turtle 24 astern (38-35.76; 74-00.78, 29.5 fms) Wind 10-15 knots, seas 3-5 feet. 1530: Heading N back to area GLIII was working earlier in the day. 1554: Turtle 25 dead ahead (38-36.71; 74-01.28, 29.3 fms) soon dove.

1633: Laying too in fished area (38-38.21; 74-01.52, 28.7 fms). ROV being re-rigged from towing to dive mode. Tilt bar no lnger operational; camera being mounted in a fixed position. 1650: ROV Dive 6 (Station 6: 38-38.05; 74-01.47, 28.5 fms) Dive to sea floor searching. Drift 0.6 knots, 170T. 1717: ROV onboard (38-37.77; 74-01.47, 28.8 fms) Heading N searching for turtles. 1745: Turtle 26 ahead; dove (38-39.13; 74-00.88, 28.3 fms0 1750: ROV Dive 7 (38-39.12; 74-00.86, 28.3 fms) searching for turtles. 1830: ROV onboard (38-38.72; 74-01.05, 28.5 fms) End operations for the day.

August 21, 2008

0700: Placing bow sonar into water. 0706: We are west of GLIII by 5 nm. Wind is East at 5 knots; seas 1 foot. Began Transect 3 (38-37.42; 74-09.26, 28.5 fms) Speed 4.7 knots, Hdg 140T. Sonar scanning 30-60 m out to each side. 0731: Turtle 27 (38-38.09; 74-07.13, 29 fms) spotted from masthead 30 m abeam to port taking short breaths and remaining below the surface. Could not maintain a visual sighting. O744: Resumed Transect 3 (38-38.10; 74-06.93, 29 fms).

0802: Turtle 28 (38-38.72; 74-05.60, 28 fms) spotted from deck 50 m to stbd. It took a reath and dove. It was difficult to see due to the low sun angle. 0809: Resumed Transect. 0835: Turtle 29 (38-39.61; 74-03.40, 29.8 fms) spotted from masthead while submerged about 2 m out from vessel and 2 m below surface when just off bow. 0839: ROV Dive 8 in water searching for submerged turtle 29 (38-39.64; 74-03.43) Vessel drift 0.4 kn, 340T. 0908: ROV onboard; Resumed Transect 140T (38-39.68; 74-03.29, 30.2 fms).

0918: Turtle 30 (38-39.49; 74-02.94) sighted briefly from deck while taking a breath off the port side about 30 m out. It was then resighted lying submerged from the masthead. 0920: ROV Div e 9 in water searching for the submerged turtle. 0943: ROV onboard (38-39.44; 74-02.85, 28.7 fms). Resumed Transect 090T. 1005: Turtle 31 (38-39.69; 74-01.98, 29.3 fms) spotted dead ahead from masthead about 20 m. It was submerged about 2 m deep. Could not re-locate. 1012: Resumed Transect east (38-39.76; 74-01.98, 28.5 fms).

1031: Turtle 32 on surface dead ahead 20 m out (38-40.29; 74-00.57, 27.8 fms). Turtle dove and avoided vessel. 1033: ROV Dive 10 in water searching for submerged turtle; masthead lost visual contact. 1040: ROV onboard (38-40.26; 74-00.56; 27.7 fms). No contact; resumed Transect NE. 1103: Turtle 33 sighted from masthead 30 m to port beam but quickly dove out of sight (38-40.44; 73-59.80, 28 fms). 1109: Resumed Transect.

1242: Turtle 34 spotted on surface from pilot house 50 m off the stbd bow (38-44.28; 74-00.27, 27.3 fms) The turtle

dove almost immediately. 1247: Resumed transect north towards four scallop vessels. 1308: Turtle 35 on surface 80 m off stbd bow seen from pilot house (38-44.86; 74-00.36, 26.8 fms). 1309: ROV Dive 11 in water acquires Turtle 35. 1315: Lost turtle at 12 m depth; ROV diving to sea floor. Drift 0.6 kn, 220T. 1348: ROV proceeding to another Turtle 36 sighted 100 m to port (38-44.68; 74-00.57, 26.7 fms). 1350: No contact; turtle dove. Three F/V's working within 2-4 nm of our position.

1430: There are several turtles in the vicinity of our vessel; they are hard to track visually as they are barely sticking their heads up when breathing. Retrieving ROV; wind and seas calm. 1450: ROV on deck; steaming up to F/V Elizabeth (38-44.22; 74-00.98, 27 fms). 1513: Turtle 37 on surface 50 m to port (38-45.60; 74-01.71, 26.5 fms) 1516: ROV Dive 12 in water; turtle dives. 1543: ROV onboard (38-45.47; 74-01.94, 26.3 fms). 1550: Proceeding towards F/V Elizabeth. 1557: Turtle 38 on surface (38-45.92; 74-02.00, 26.7 fms). ROV under repair; testing sonar on the turtle which is remaining on surface. 1604: Turtle 38, which is very large, takes breath and dives just below surface. 1610: Sportfishing boat runs right over Turtle 38's location.

1643: ROV Dive 13 (38-47.11; 74-00.66, 26.5 fms) is at location where the F/V's are hauling and re-setting gear. 1721: ROV on deck; camera still not working right. We are heading towards some turtles sighted in the distance. 1746: Turtle 39 past close aboard port side about 1 m down (38-45.94; 74-01.49, 26.5 fms). Laying too. 1800: Turtle 40 ahead; Turtle 39 astern (38-45.87; 74-01.66). 1823: ROV camera repaired. ROV Dive 14 (38-46.07; 74-02.05, 27 fms). 1845: ROV on deck (38-46.25; 74-02.44, 27.7 fms). WE are positioning ourselves behind F/V Elizabeth to search her tow track. 1933: ROV Dive 15 (38-48.34; 73-59.75, 26.3 fms). Searching area where F/V Elizabeth hauled and set. 2000: End operations (38-48.53; 74-00.11).

August 22, 2008

0700: Sonar in water; range set 30-60 m. Wind SE 10-15 knots; seas 1-2 feet. Partly cloudy. 0705: Started Transect 4 (39-00.60; 73-35.67, 29 fms) Heading north outside the western boundary of the HCAA at 4 knots. 0722: Turtle 41 (39-01.37; 73-35.55, 29.7 fms) spotted from masthead 20 m off port bow; took breath and dove. 0726: Resumed Transect 4 at 4 knots, 000T.

0750: Manuevering to investigate sonar target. 0759: Resume Transect. 0851: Turtle 42 (39-05.63; 73-35.05, 26.2 fms) spotted from foredeck 2 m abeam the bow submerged about 1 m down; small loggerhead. 0859: Could not relocate; resumed Transect. 0939: Turtle 43 (39-07.98; 73-35.25; 29 fms) sighted from masthead 30 mk off port bow- took breath and dove. Sptted again from masthead submerged about 1 m but soon lost in sun glare. Very poor sighting conditions due to clouds and glare. 0947: Resumed Transect.

1030: Turtle 44 sighted from foredeck 10 m off port bow submerged 1 m. It was spotted after we circled on a sonar target (39-10.29; 73-36.07, 24.8 fms). 1033: ROV Dive 15 but unable to acquire turtle which is still submerged but visible from masthead. Difficulty is due to inability to tilt camera. Drift 0.4 knots, 040T. 1045: ROV searching sea floor. 1100: Retrieving ROV (39-10.17; 73-36.20, 24.5 fms). 1105: Resume Transect 4.

1120: Searching around for sonar target (39-10.75; 73-36.68, 22.0 fms). 1126: Resumed Transect. 1140: Turtle 45 (39-11.53; 73-37.09, 23.5 fms). Small loggerhead that was sighted from masthead 100 m ahead to stbd submerged. It then came up and took a breath and dove and was lost. 1150: Sonar onboard.

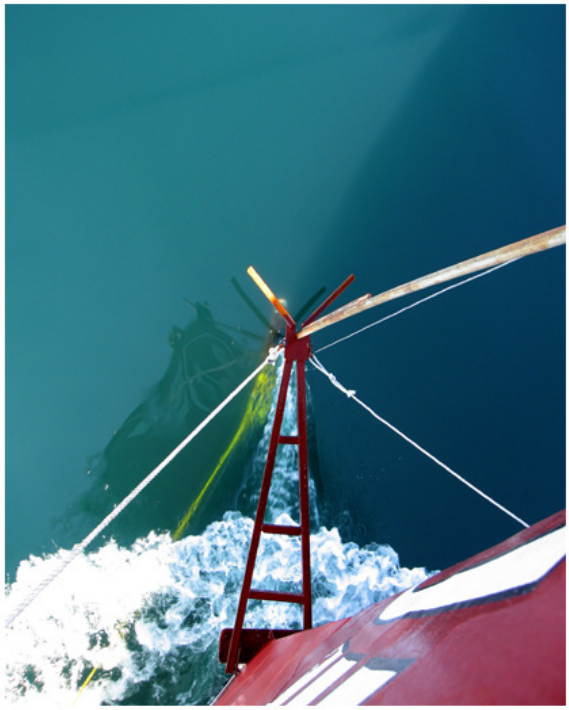
1210: Turtle 46 (39-13.26; 73-38.80, 26.2 fms) Large loggerhead sighted from masthead 100 m out to port near surface. 1212: ROV Dive 16 in water trying to acquire but tilt bar problem makes difficult; turtle still visible from masthead. 1230: Retrieved ROV (39-13.09; 73-38.91, 26.2 fms) Resumed Transect. Wind now NE 10-15 knots, seas 2-3 feet. 1330: Ended operations (39-19.64; 73-43.95, 17.7 fms). Poor visibility. Enrout to Barnegat Light.

Figure 1. The bow mounted towfish not quite deployed. The vertical pole is reinforced with a welded bar welded to the pole. The pole is steadied by the lower bow brace.

Figure 2. The towfish is raised and secured on deck when noit in use.

Figure 3. The bow mount for the sonar. The pole and sonar are in the deployed, vertical position. A horizontal handle assists turning the sonar tow fish when the vessel is not moving. When underway a pin secures the tow fish from turning. The hand winch in the foreground aids in raising and lowering the pole and tow fish.

Figure 4. Looking down vertically as the vessel is underway. The tow fish is aligned in a fixed position. The pole is secured to the lower bow brace.



APPENDIC C:

On Thursday, June 11, 2009 the F/V Kathy Ann departed Barneget Light New Jersey and headed for the northern boundary of the Elephant Trunk Access Area (ETAA).

June 12, 2009

0730: Started Transect 1 (38-50, 73-40), speed 5 knots, heading 240°, wind SW at 10-15 knots, seas 1 m, overcast. 0810: Laying too for **ROV Dive 1**; a bottom search (38-48, 73-44, 54 m). 0906: ROV on deck; resume transect; raining. 1038: Rain clears; visibility improves. 1150: Spotted **Turtle 1** from masthead 200 m ahead and on surface; loggerhead with barnacles (38-41.7, 74-01.1, 53 m). 1156: **ROV Dive 2** in water. 1214: Turtle not acquired, ROV on deck, continuing transect.

1221: **Turtle 2**, a small loggerhead, spotted from foredeck 50 m directly ahead of vessel and dove under vessel (38-41.6, 74-01.3, 53 m). 1226: **Turtle 2** not seen again, continued transect. 1243: (38-40.8, 74-02.3, 53 m) Heading 180°, wind south at 5-10 knots, seas 1 m. 1317: **Turtle 3** spotted from masthead on surface 200 m off port bow (38-38.4, 74-02.5, 53 m). 1323: **ROV Dive 3** in water. 1330: **Turtle 3** acquired on video (**Take 1**); a juvenile loggerhead. 1422: **Turtle 4** spotted from masthead on surface bearing 260°, 1000 m out (38-38.3, 74-02.2); we are still tracking **Turtle 3**. 1503: Two turtles bearing 270°, 100 m out; assume one is **Turtle 4**; other is **Turtle 5**. 1540: Lost video contact with **Turtle 3** while still on surface then lost visual from vessel; going to bottom search (38-38.1, 74-02.0, 53 m). 1600: ROV on deck.

1635: **Turtle 6** sighted from masthead. 1640: **ROV Dive 4** launched (38-36.8, 74-02.4, 53 m) and **Turtle 6** acquired n video (**Take 2**); a small loggerhead. 1730: Lost contact; ROV on deck (38-36.9, 74-02.5); resumed transect. 1800: **Turtle 7**, a large loggerhead spotted from masthead 500 m ahead. 1803: Launched **ROV Dive 5** (38-35.5, 74-02.2, 55 m) seas 0.5 m, wind calm. 1604: **Turtle 7** acquired on video (**Take 3**); has school of fish associated. 2021: Sunset, average drift 0.5 knots to the north. 2048: Ceased tracking (38-36.4, 74-02.6). End of the day's operations.

June 13, 2009

0740: **ROV Dive 6**- bottom search dive (38-36.9, 74-00.2, 53 m). Wind NE 10-15 knots, seas 1.3 m, overcast. 0800: ROV on deck; start Transect 2 (38-36.7, 74-00.6, 54 m) Speed 5 knots, heading, 195°. 0930: Spotted **Turtle 8** from pilot house 200 m off starboard bow (38-30.3, 74-04.6, 61 m) 0935: Launched **ROV Dive 7** but lost visual contact of turtle from vessel; visual sighting conditions very poor. 0955: ROV on deck; no contact with **Turtle 8**.

1030: **Turtle 9**, a large loggerhead, spotted from the masthead submerged 100 m off starboard bow (38-28.8, 74-05.5, 59 m). 1035: **ROV Dive 8** in the water. 1050: No ROV contact made with turtle; resuming transect. 1134: Altered heading to 200° (38-26.0, 74-06.8, 57 m). 1231: **Turtle 10**, a small loggerhead, spotted from masthead submerged passing 10 m away down the starboard side (38-21.6, 74-08.7, 57 m). 1230: Launched **ROV Dive 9**. 1239 **Turtle 10** acquired (**Take 4**). 1244: Lost contact with Turtle 10. 1246: ROV on deck; searching area. We occasionally spot the turtle but it is submerged and hard to see under the conditions. Fog is closing in on area. 1301: Resumed transect (38-21.9, 74-09.2) Very foggy with about 30 m visibility.

1420: **Turtle 11**, a juvenile loggerhead, spotted from foredeck on surface passing 50 m off starboard side (38-16.5, 74-14.2, 54 m) It dives and is hard to see. 1428: Too elusive, resumed transect. 1430: Re-sighted; **ROV Dive 10** in water. 1445: No contact; ROV on deck. 1505: **Turtle 12** spotted from foredeck 20 m abeam to port just under the surface (38-15.4, 74-15.4, 54 m). Launched **ROV Dive 11**. 1510: **Turtle 12** acquired (**Take 5**). 1519: Lost contact; ran out of tether. ROV onboard; trying to get visual on turtle from vessel. 1534: Resumed transect (38-15.4, 74-15.9, 52 m).

1546: **Turtle 13** spotted from masthead submerged 30 m off port side (38-14.8, 74-16.3, 50 m). 1555 Launched **ROV Dive 12**. 1557: Acquired **Turtle 13** (**Take 6**); a large loggerhead with fish associated. 1615: Lost contact with turtle when it made a steep dive. 1630: ROV on deck; resumed transect (38-15.1, 74-16.5, 49 m). 1638: **Turtle 14** spotted from masthead submerged coming down port side 30 m out (38-14.7, 74-16.8, 50 m). Lost visual from vessel; trying to relocate. 1645: Resumed transect. 1800: Launched **ROV Dive 13** (38-09.9, 74-19.3, 50 m); bottom search and tether fails. Replaced tether and continued dive. 1900: Ended operations for the day.

June 14, 2009

0743: Laying too drifting SW at 1.0 knots; wind N at 10-15 knots, seas 1 m. Foggy. 0815: **ROV Dive 14** in water (38-03.5, 74-25.2, 45 m) bottom search mode. Tether has problems; ROV back on deck. Find short in long tether; have to replace with short tether. 0954 Start Transect 3; wind N at 15-20 knots, seas 1.5 m. 1000: **Turtle 15** spotted from masthead on surface 50 m off starboard bow (38-01.8, 74-26.9, 49 m). 1005: **ROV Dive 15** launched; **Turtle 15** acquired on video (**Take 7**); turtle is an organism encrusted small loggerhead with a few fish associated. 1024: **Turtle 16** spotted from pilot house 500 m off stern quarter bearing 350 on surface (38-01.8, 74-27.2, 49 m). 1112: **Turtle 15** dives to bottom. Upon arriving at sea floor the tether runs out and contact is lost. 1130: ROV on deck; vessel search for **Turtle 15**. 1151: End search; resume Transect (38-02.0, 74-27.3, 48 m). Fog cleared, overcast.

1210: Heading 220°. 1238: **Turtle 17** spotted from masthead submerged 50 m off port side (37-59.1, 74-29.8, 52 m); lost visual contact; trying to relocate. 1240: Resume Transect. 1300: **Turtle 18**, a loggerhead, spotted from masthead on surface 50 m off starboard bow (37-59.0, 74-30.7, 50 m); submerged and hard to see. 1305: Launched **ROV Dive 16**; **Turtle 18** acquired on video (**Take 8**). 1407: **Turtle 19** spotted from masthead on surface bearing 000°; 100 m out (37-58.9, 74-30.9, 50 m). 1432: **Turtle 18** dives and is lost from ROV video at 8 m; ROV dives to bottom to search (37-58.8, 74-31.1). 1440: **Turtle 18** re-spotted from masthead just to starboard. 1450: ROV back on surface; turtle no longer in sight. 1459: ROV on deck; resumed transect (37-58.6, 74-31.2).

1508: **Turtle 20** spotted from masthead on surface off port side (37-58.5, 74-31.6, 49 m). 1510: **ROV Dive 17** launched; **Turtle 20** acquired on video (**Take 9**). 1615: Lost contact. 1620: ROV on deck; resumed Transect.

1638: (37-58.4, 74-33.5). 1649: Changed heading to 220°. 1710: **Turtle 21** spotted from foredeck 50 m off port side on surface (37-57.0, 74-35.9, 45 m). 1712: Launched **ROV Dive 18**; acquired **Turtle 21** on video (**Take 10**); large loggerhead with many fish associated. 1747: **Turtle 22** spotted on surface 50 m from **Turtle 21** (37-56.8, 74-36.2). 1754: **Turtle 23** spotted from masthead 1000 m out bearing 140°. 1840: **Turtle 21** dives to bottom and is followed along bottom for ten minutes until tether runs out. 1900: ROV back on deck; end of day's operations.

June 15, 2009

0730: Laying too in the Delmarva Access Area (37-47.8, 74-46.5), wind NE at 10-15 knots, seas 0.5 m, overcast. Start Transect 4 heading 045° at 5 knots. 0814: **Turtle 24** (37-49.4, 74-44.5, 43 m) spotted from pilot house just coming up to surface 40 m abeam to starboard; it dove and could not be re-sighted. 0822: Resumed Transect.

0853: **Turtle 25**, a large loggerhead, spotted from masthead on surface 50 m off starboard side (37-50.5, 74-43.4, 43 m); dove immediately; did not re-sight. 0857: Resumed Transect. 1035: Sea surface has been very grey making sighting difficult; sky now having a few breaks in the cloud cover. 1040: **Turtle 26**, a small loggerhead, spotted from masthead 500 m ahead on surface (37-56.4, 74-38.3, 41 m). 1045: **ROV Dive 19** launched. 1046: **Turtle 26** acquired on video (**Take 11**); many fish associated. 1050: Long tether failed; lost power to camera. 1052: ROV on deck; changing to short tether. 1100: Resumed Transect.

1110: **Turtle 27** spotted from foredeck submerged 30 m off starboard bow (37-56.7, 74-38.4, 39 m). 1120: **ROV Dive 20** launched; glare very bad; no contact. 1130: ROV on deck; resume Transect. 1144: **Turtle 28** spotted from masthead submerged 30 m off port bow (37-57.1, 74-38.4, 39 m). 1148: **ROV Dive 21** launched; turtle no longer visible due to glare. 1153: ROV on deck; resume Transect.

1200: Two pairs of turtles, **Turtles 29 & 30** and **Turtles 31 & 32**, sighted on surface 500 m to starboard (37-57.5, 74-38.6, 39 m). 1204: **ROV Dive 22** launched. 1206: **Turtle 29** acquired on video (**Take 12**); second pair still together visible on surface 100 m away. 1220: Lost contact with **Turtle 29** at a depth of 11 m; ROV heading towards second pair of turtles. 1230: Acquired **Turtles 31 & 31** on video (**Takes 13 & 14**). 1250: Lost contact; retrieving ROV to reposition vessel. 1300: ROV back in (**Dive 22**); re-acquired one of the turtles. 1417: (37-57.8, 74-40.7, 34 m); still tracking one to two turtles of the group on video. The sky is now partly cloudy; sea surface now blue with much glare, seas 0.5 m.

1529: Two more pairs of turtles visually sighted (**Turtles 33 & 34** and **Turtles 35 & 36**) bearing 100° about 500 m

out (37-58.4, 74-41.5, 35 m). Other single turtles have been spotted visually from the vessel during this ROV dive but not recorded due to uncertainty if a new turtle. 1535: Lost contact; tether ran out; ROV retrieved. 1550: Heading towards second group of turtle pairs (**Turtles 33, 34, 35, 36**). 1601: **ROV Dive 23** launched; three of the turtles were together and we acquired one on video (**Take 15**) but soon lost contact; too much glare (37-58.4, 74-41.7, 37.5 m). 1618: Too much glare to relocate turtles; ROV descends to sea floor to look around.

1640: ROV onboard; resuming Transect (37-58.4, 74-42.2, 38 m). 1715: **Turtle 37** spotted from masthead (37-59.1, 74-40.4, 31 m); turtle was submerged and not re-sighted. 1727: **Turtle 38** spotted from foredeck on surface 50 m off port bow (37-59.5, 74-39.9, 31 m). 1730: **ROV Dive 24** launched; **Turtle 38** acquired on video (**Take 16**). 1847: Lost contact when video signal tripped off. 1855: ROV on deck; resumed Transect. 1914: **Turtle 39** spotted from masthead off starboard beam submerged (38-00.6, 74-38.7, 33 m); could not relocate; resumed Transect. 1930: Ended operations for the day.

June 16, 2009

0641: Laying too in Delmarva Access Area (37-55.7, 74-43.6). Overcast; wind ENE 10-15 knots, seas 1 m. 0712: **ROV Dive 25**, Mini-Rover, bottom search mode (37-55.2, 74-44.0, 34 m). 0745: ROV on deck; commence Transect 5 (37-54.7, 74-44.5); heading 040°, speed 5 knots. 0824: **Turtle 40** spotted from foredeck; on surface 100 m to port (37-56.4, 74-42.8, 32.5 m); dove as we approached. 0833: **Turtle 40** was not re-sighted; resumed Transect heading 000° due to glare and wind.

0902: Common dolphins, and a similar speckled species, swimming alongside. 0953: Seas now 1.5 m; sighting conditions poor, wind NE 15-20 knots, white caps. Heading changed to 045° (38-00.0, 74-42.0, 30 m). 1020: Heading 090, seas 1.5 m, wind east at 20 knots (38-00.9, 74-40.3, 32 m). 1046: **Turtle 41** spotted from main deck 30 m off port beam (38-01.0, 74-38.6, 36.6 m) 1050: **ROV Dive 26** launched; turtle dove, a small loggerhead. 1103: No contact; ROV on deck; resumed Transect heading 090°. 1114: changed course to 220°. 1150: Changed course to 060° (37-59.6, 74-41.8).

1200: **Turtle 42** spotted from foredeck 100 m out on surface (38-00.0, 74-41.4, 31 m). 1205: **ROV Dive 27** launched; turtle is submerged at a depth of about 3 m and is difficult to see from vessel. 1212: No contact; ROV on deck; resumed Transect heading 060°. 1312: Changed course to 280° to test sighting capability. 1343: Changed course to 045° (38-02.7, 74-41.0, 37 m). 1407: **Turtle 43** spotted from foredeck on surface 100 m to port; soon submerged (38-03.6, 74-39.5, 38 m) 1412: Not re-sighted; resumed Transect.

1429: **Turtle 44** spotted from masthead 20 m off starboard side submerged (38-04.3, 74-39.2, 21.8 fms). Not re-sighted; resumed Transect. 1443: **Turtle 45** spotted from pilot house 100 m off starboard bow on surface then dives (38-04.5, 74-38.5, 19.7 fms). 1450: **ROV Dive 28**; a bottom search. 1505: ROV on deck; resumed Transect. 1516: **Turtle 46** spotted from masthead submerged 50 m dead ahead (38-05.0, 74-37.7, 18.7 fms). 1520: **ROV Dive 29** launched. 1528: ROV acquires **Turtle 46** on video (**Take 17**). 1533: Lost contact. 1537: ROV on deck.

1706: **Turtle 47** spotted on surface from pilot house 50 m off port bow (38-08.1, 74-30.9, 24.8 fms). 1707: **ROV Dive 30** launched; turtle dove and contact lost. 1720: ROV on deck; resumed Transect. 1825: **Turtle 48** spotted on surface from foredeck 50 m off port bow then dives (38-09.2, 74-23.2, 25.8 fms). Not re-sighted. 1830: **ROV Dive 31** launched to conduct bottom search. 1840: ROV on deck; could not make bottom due to drift. End of the day's operations.

June 17, 2009

0700: Laying too near boundary between ETAA and Delmarva (38-09.1, 74-21.7, 25.8 fms) Wind E at 10-15 knots, seas 3-4 feet, partly cloudy. 0710: **ROV Dive 32**; bottom search with a repositioned tether tow point to center of vehicle. Drift 1.2 knots at 240° ; ROV can not maintain bottom with short tether under these conditions. 0730: ROV on deck; start Transect 6 (38-08.9, 74-22.0, 25.5 fms); heading 060°, speed 5 knots.

0845: **Turtle 49** spotted from foredeck 80 m abeam to port on surface; dove immediately (38-12.6, 74-19.2, 28.5 fms); did not re-sight; resumed Transect. 0852: Changed course to 000° to stay shallow. 0954: **Turtle 50** spotted

submerged along port side of vessel (38-17.7, 74-18.9, 27.2 fms). 1022: Did not re-sight; resumed Transect. 1018: **Turtle 51** spotted 80 m off port beam from foredeck; dove right away (38-19.4, 74-19.1, 26.3 fms). 1022: Not re-sighted; resumed Transect.

1037: Changed course to 020°. 1112: **Turtle 52** spotted from foredeck submerged 3 m deep 10 m off port side (38-23.5, 74-17.7, 26.7 fms). 1120: Re-spotted Turtle 52 as it took a short breath, heading north. 1124: Turtle 52 seen a third time; took short breath and dove. 1128: Resumed Transect. 1149: **Turtle 53** spotted from masthead on surface just ahead; dove under vessel (38-25.5, 74-16.5, 28.7 fms). 1157: Not re-sighted, resumed Transect. Sky now overcast; sea surface very grey.

1300: Changed course to 090°; heading towards F/V Celtic. 1720: Arrived at F/V Celtic which is towing dredges (38-33.5, 73-50.25, 33 fms). 1808: ROV Dive 33; bottom search in area where F/V Celtic hauled dredges (38-35.2, 73-47.4, 33.3 fms) 1850: ROV on deck; deteriorating weather conditions. The decision is made to return to port.