Community-Based Marine Debris Removal in Pamlico Sound

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Abstract – Lost or abandoned, called derelict, fishing gear (DFG) represents one subset of marine debris that can result in degraded sensitive bottom habitat, unwanted capture of living marine species, hazards to safety and navigation, and reduced aesthetics. Since 2003, North Carolina water-based DFG removal primarily has occurred via N.C. Marine Patrol's annual cleanup conducted during the no-potting period. All crab pots must be out of internal coastal waters between Jan. 15 and Feb. 7 each year. During this time, Marine Patrol officers collect any encountered surface pots. For any pots that officers can identity owners, the fishermen are contacted, and even if fined, receive their pot(s) back. The rules surrounding private property make the Marine Patrol hesitant to involve the public in this cleanup effort. During the 2014 no-potting period, the Marine Patrol agreed to accept assistance from a select group of commercial fishermen within a narrowly defined geographic area and timeframe. This private-public cleanup occurred over a two-day period in northern waters with nine boat crews. Four crews were equipped with side-scan sonar units to search for rarely collected submerged (non-visible) pots, particularly in the vicinities of bridges where hangs and obstructions make for increased gear loss. Commercial fishermen partners located 110 crab pots using this technology, though only 75 were retrieved due to safety concerns and to limitations of the retrieval method. In total, fishermen removed 201 crab pots from the pilot area, while Marine Patrol removed an additional 163 pots. An associated land-based cleanup involved 27 volunteers from the general public removing 620 pounds of solid waste and 380 pounds of DFG, of which most was crab pots, from approximately 0.5 linear miles of shoreline on the north end of Roanoke Island, N.C. Overall, all participants claimed the pilot project as a success and felt that more trust was garnered between commercial fishermen and the N.C. Marine Patrol. Further, due to assistance from fishermen with the cleanup effort only half the normal number of Marine Patrol officers had to be on the water each day, thereby saving the State in human and financial resources.

Background

Derelict Fishing Gear Defined -The North Carolina Coastal Federation (Federation) has received feedback from commercial fishermen and the general public on how lost or abandoned, sometimes called derelict, fishing gear can result in: 1) degraded sensitive bottom habitat, 2) unwanted capture of living marine species through "ghost fishing"[1], 3) hazards to safety and navigation, and 4) reduced landscape aesthetics. Many of these stakeholders have expressed a desire for more extensive removal of derelict fishing gear (DFG) from our internal coastal waters and sought assistance from the Federation to develop a project that would allow this to occur.

Derelict fishing gear as used in this report includes nets, lines, traps/pots and other recreational or commercial harvest equipment that has been lost or abandoned in internal coastal waterways, representing as a subset of marine debris. The focus is not just on crab pots; efforts can best be summarized as having an overarching goal of fostering clean and safe water.

Current DFG Cleanup Efforts - N.C. Marine Patrol cleanup efforts of DFG, primarily consisting of derelict crab pots, began in 2003 and were timed with the annual no-potting period (Jan. 15-Feb. 7). Once internal coastal waters are closed to all crab, eel, fish and shrimp pots on Jan. 15 (15A N.C. ADMIN. CODE 03J.0301), Marine Patrol views all pots left in the water as

[1] Ghost fishing is the term used for lost or abandoned fishing gear that continues to catch fish. It is environmentally detrimental, and the fish caught is wasted. Food and Agriculture Organization of the United Nations (www.fao.org/fishery/topic/14798/en)

unlawfully set, and thereby, as having the authority to take enforcement action on individuals that intentionally have left large arrays, called strings, of pots in the water. For any pots that officers can identity owners, the fishermen are contacted, and even if fined for unlawfully set gear, receive their pot(s) back. If not, the pots are destroyed.

During that first year, the N.C. Marine Patrol located many abandoned (4,121) and ghost (953) pots (Table 1). Officers removed most all of the pots identified. Since 2004, however, Marine Patrol has witnessed a significant decline in the number of pots needing to be removed from waterways during the no-potting period. Marine Patrol believes this trend largely is attributable to the significant increase in cost-per-pot to approximately $40, as this price increase has spurred fishermen to search harder for their own missing pots.

Table 1. Number of derelict crab pots documented during N.C. Marine Patrol's annual statewide pot cleanup. January 15 through February 7 is the current period for no potting in internal waters. From 2003 to 2005, the period for no potting was shorter, spanning Jan. 24-Feb. 7. (Adapted from the N.C. Division of Marine Fisheries *Blue Crab Fishery Management Plan, Amendment 2*, Table 11.14.2 revised with 2013 cleanup numbers via personal communication, L.T. Henry, Feb. 27, 2013.)

	Number of Crab Pots			
Year	**Northern District**	**Central District**	**Southern District**	**Total**
2003	4047	900	127	5074
2004*	7708	527	108	8343
2005	2168	missing data	missing data	2735
2006	1117	391	24	1532
2007	896	135	24	1055
2008	757	190	110	1057
2009	589	257	60	906
2010	570	154	24	748
2011	656	183	141	980
2012	684	160	295	1139
2013	451	445	545	1441

*** During the winter of 2004, the high number of abandoned pots encountered was apparently a result of pot loss due to Hurricane Isabel (Sept. 2003).**

Marine Patrol views the program as a success, but it is labor-intensive and time-consuming. Marine Patrol uses aircraft to spot concentrations of pots prior to boat patrols. For the week prior and the two weeks of the removal, officers work pretty much exclusively on derelict crab pot collection.

Further, while Marine Patrol views efforts to recover abandoned surface crab pots during the closed season as successful, they acknowledge this effort does not address submerged pots that are not visible from the surface of the water. And yet still, while there are occasional small-scale cleanups performed by or under the supervision of Marine Patrol, there are no provisions for special cleanups, such as after a hurricane or other major storm.

Governing Regulations & Policies - In North Carolina, interested commercial fishermen, waterfront property owners and other members of the general public are not freely allowed to remove DFG, as the rules surrounding private property make the N.C. Marine Patrol hesitant to involve the public in gear removal. The most pertinent legislation relating to cleanup of DFG in

North Carolina internal coastal waters is North Carolina General Statute § 113-268, which describes how it is unlawful for any person to willfully steal, destroy or injure fishing gear lawfully set out in open waters of the State in connection with commercial fishing (inset below). There is neither a North Carolina law nor regulation that directly defines DFG, or a provision in the North Carolina statutes or regulations providing express authority for the removal of DFG. In the case of crab pots, they simply cannot be left unfished for more than five consecutive days (15A N.C. ADMIN. CODE 03I.0105(b)).

> *North Carolina General Statute § 113-268*
> *Injuring, destroying, stealing, or stealing from nets, seines, buoys, pots, etc.*
> (a) It is unlawful for any person without the authority of the owner of the equipment to take fish from nets, traps, pots, and other devices to catch fish which have been lawfully placed in the open waters of the State.
> (b) It is unlawful for any master or other person having the management or control of a vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net or pot which may lawfully be hauled, set, or fixed in such waters for the purpose of taking fish except that a net set across a channel may be temporarily moved to accommodate persons engaged in drift netting, provided that no fish are removed and no damage is done to the net moved.
> (c) It is unlawful for any person to willfully steal, destroy, or injure any buoys, markers, stakes, nets, pots, or other devices on property lawfully set out in the open waters of the State in connection with any fishing or fishery.
> (d) Violation of subsections (a), (b), or (c) is a Class A1 misdemeanor.
> (e) The Department may, either before or after the institution of any other action or proceeding authorized by this section, institute a civil action for injunctive relief to restrain a violation or threatened violation of subsections (a), (b), or (c) of this section pursuant to G.S. 113-131. The action shall be brought in the superior court of the county in which the violation or threatened violation is occurring or about to occur and shall be in the name of the State upon the relation of the Secretary. The court, in issuing any final order in any action brought pursuant to this subsection may, in its discretion, award costs of litigation including reasonable attorney and expert-witness fees to any party. (1987, c. 636, s. 1; 1989, c. 727, s. 112; 1993, c. 539, s. 849; 1994, Ex. Sess., c. 24, s. 14(c); 1998-225, s. 3.9.)

According to N.C. Marine Patrol definitions, “abandoned” pots are those that carry a buoy, float or some sort of owner identification; these only can be removed by Marine Patrol officers. For the purposes of this report, a “ghost” pot is defined as a pot that has no buoy or float attached and for which an owner cannot otherwise be identified. Theoretically, any person can collect and possess ghost pots at any time, but commercial fishermen often put subtle personal identifiers on their pots during construction, such as using a particular number of hog rings and in a particular pattern to connect wire mesh to a bottom iron. Therefore, the current policy stands as Marine Patrol having authority for all water-based derelict crab pot removal.

However, recently the Department of Environmental and Natural Resources (DENR) General Counsel and N.C. Department of Justice (DOJ) staff delivered unofficial opinions that citizens, such as commercial fishermen, could assist Marine Patrol officers with cleanup efforts during the no-potting period. The DENR and DOJ staff argument was that citizens would not have the first element of the statute, as there is no intent to steal, destroy or injure the gear. Further, DENR and DOJ staff saw no legal impediment to the partnership arrangement under the statute, as long as the pots removed are not lawfully set. They argued that if the pots are classified as derelict, there is some claim that they are no longer lawfully set out, which further nullifies the conditions of the statute.

Community-based DFG Demonstration Project - For the 2014 no-potting period, the N.C. Marine Patrol agreed to assist with a pilot project of a much-defined geographic scope and with no more than a dozen commercial fishermen to be overseen by the Federation. The project received North Carolina Sea Grant Blue Crab & Shellfish Research Program and National Oceanic & Atmospheric Administration (NOAA) Marine Debris Program grant monies to offset equipment and staff costs. Much of the project methodology was patterned after a Virginia cleanup effort. Nearly 32,000 derelict crab pots were recovered during a four-year Marine Debris Removal Program spearheaded by the Virginia Institute of Marine Science (VIMS).

Objectives

1. To develop protocols for public-private removal and disposal of DFG.
2. To test deep-water gear removal strategies, such as grapplers and snag lines.
3. To determine whether side-scan sonar can effectively and efficiently locate DFG when employed by fisherman during directed surveys.
4. To document the potential DFG has to continue fishing (entangling and killing marine life).
5. To test the hypothesis that there exists "garbage patches" in the Albemarle-Pamlico Estuarine System; areas where hangs and converging currents make for collecting of DFG.
6. To improve and develop commercial fishermen engagement and incentives for involvement in conservation efforts, as well as to strengthen partnerships among commercial fishermen, environmental nonprofits, scientists, law enforcement and resource managers.

Methodology

Recruitment and Training - To make citizen involvement legal in this pilot project, all commercial fishermen and general public volunteers were registered under a Scientific and Educational Collection Permit (SECP) issued by the state of North Carolina. For simplicity, the Federation simply added participant names to their existing SECP (No. 707067). Registry through the SECP allows these citizens to be considered "Agents of the State." Therefore, project participants were authorized by way of the SECP to clean up DFG. Following completion of the project, the added names were removed from the Federation's permit.

To solicit project participants, the Federation issued (Sept. 13, 2013) a press release, which was distributed via the Federation and N.C. Division of Marine Fisheries (DMF) lists of contacts. The only requirement for applicants was a valid standard commercial fishing license issued by the State. Marine Patrol screened all applicants for any major violations. Any applicant with a recent or extensive violation history was denied project participation. Fishing location, vessel size and existing onboard equipment, as well as willingness to travel to designated collection areas and availability, were additional factors considered when determining whether or not to accept an applicant. The Federation received a total of 30 completed applications by the Oct. 15, 2013 deadline.

Twelve vessels were selected for participation in the 2014 project, although three were forced to resign as a result of scheduling conflicts. In total, 17 fishermen (9 captains and 8 mates) assisted with the on-water cleanup, working out of the following ports: Hatteras Village, Wanchese, Manns Harbor, Kitty Hawk and Columbia. Captains were paid $300 per day, and mates received $100 per day. This payment was to cover labor, fuel and boat maintenance costs for each day

worked on the project. Of the nine vessels, four were trained to use a side-scan sonar unit to visualize the water bottom and detect submerged pots. The remaining five vessels were instructed to scan the water surface for derelict crab pots and other DFG.

On Nov. 18, 2013, Dave Stanhope of VIMS conducted a training session for fishermen participants using side-scan sonar. This training session included general instructions on the operation of the Hummingbird 1197c sonar units, as well as lessons learned on the water during the VIMS cleanup effort.

Final training sessions for both fishermen participants and general public volunteers took place the week prior to the cleanup. The volunteer training session served to educate volunteers on data collection procedures and various project logistics. Two groups of volunteers were recruited, those whose objective was to: (1) ride along with fishermen to aid in data collection, and (2) help offload collected pots from fishermen boats on cleanup days.

All participating fishermen completed a training to review data collection procedures and project logistics. N.C. Marine Patrol participated in the training to ensure collection protocols and on-water operations adhered to Agency policies, specifically speaking to proper protocol when a pot with a "personal unique identifier" should be discovered by participating fishermen. N.C. Marine Patrol requested that all fishing gear collected with an identifying feature (i.e., name/tag on a buoy, etc.) be returned to the rightful owner by contacting a Marine Patrol agent.

Field Work – This project included both land and water-based cleanup activities. The land-based cleanup occurred on Jan. 18, 2014 from 9-11 a.m. on approximately 0.5 linear miles of shoreline on the north end of Roanoke Island, along the Fort Raleigh Historic Site (National Park Service Outer Banks Group) property boundary (Figure 1). A Special Use Permit was acquired from the National Park Service to complete the work (No. USA13-2501-243). The Nature Conservancy and Dare County Public Works were partners. Donations of beach utility carts were made by Ocean Atlantic Rentals in Nags Head, N.C.

Water-based cleanup efforts occurred in targeted, geographically specific areas in northern internal coastal waters (Figure 2). With consultation from N.C. Marine Patrol, these areas were chosen because of their logistical convenience and prevalence of fishing activities.

Fishermen involved in this DFG project were not able to begin cleanup efforts until Jan. 20. This delay allowed Marine Patrol officers in District 1 time to scan the pilot area in search of large numbers of pots intentionally left behind, issuing citations as deemed necessary. This practice allowed fishermen participating in the cleanup project not to be involved in any enforcement actions. Water-based cleanup activities occurred on Jan. 20 and 21, from 8 a.m. to 2 p.m. Four fishermen crews were equipped with side-scan sonar units and specifically surveyed the water bottom within 300 yards of the Washington Baum, Virginia Dare Memorial, Manns Harbor, Wright Memorial and Alligator River bridges. All told, the nine fishermen crews and 14 Marine Patrol officers covered approximately 200,000 acres of internal coastal waters including upper Pamlico Sound, Croatan Sound, Roanoke Sound, lower Currituck Sound, Albemarle Sound, Alligator River and Kitty Hawk Bay. A third day of collection was planned; however, impending inclement weather in tandem with comparably low numbers of DFG (per N.C. Marine Patrol

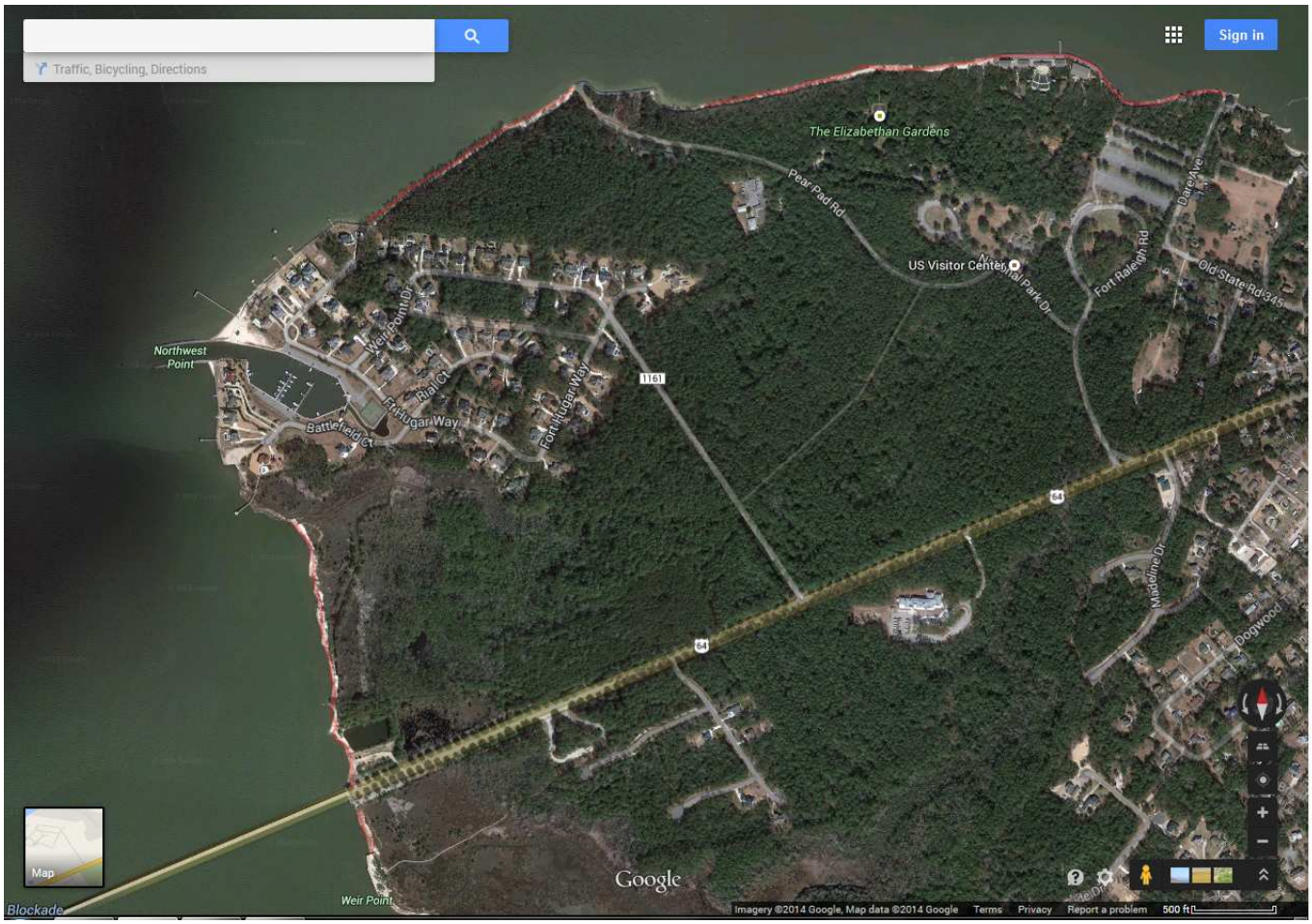

Figure 1. Map showing the north end of Roanoke Island, N.C., particularly Fort Raleigh Historic Site (National Park Service Outer Banks Group) property. Red lines show areas of shoreline where the land-based cleanup occurred on Jan. 18, 2014, and approximately measure in sum 0.5 linear miles.

flyovers and preliminary water investigations), made for a decision against a third day of project work. Instead, the third day was used as a "debrief session" for the participating fishermen.

All pots and other located DFG were brought into two recycling areas set up in the N.C. Department of Commerce's Wanchese Marine Industrial Park and N.C. Wildlife Resources Commission's (WRC) Manns Harbor Access Area, with on-water and land-based assistance from 10 volunteers, the Town of Manteo, Dare County Public Works, Jockey's Ridge State Park and The Nature Conservancy Nags Head Woods Ecological Preserve. A Special Use Permit (No. 10847) was acquired from the WRC for use of the Manns Harbor Access Area for staging the DFG cleanup. Dare County Public Works donated the use of two roll-off dumpsters at both the Wanchese and Manns Harbor sites.

Data Collection & Analysis - All fishermen participants recorded GPS coordinates of located pots, time taken to retrieve pots, and presence-absence of bycatch[2] for each derelict crab pot

[2] The term bycatch, used as a generic term, applies to that part of the catch made up of non-target species or species assemblages. Food and Agriculture Organization of the United Nations (http://www.fao.org/docrep/meeting/w3862e.htm)

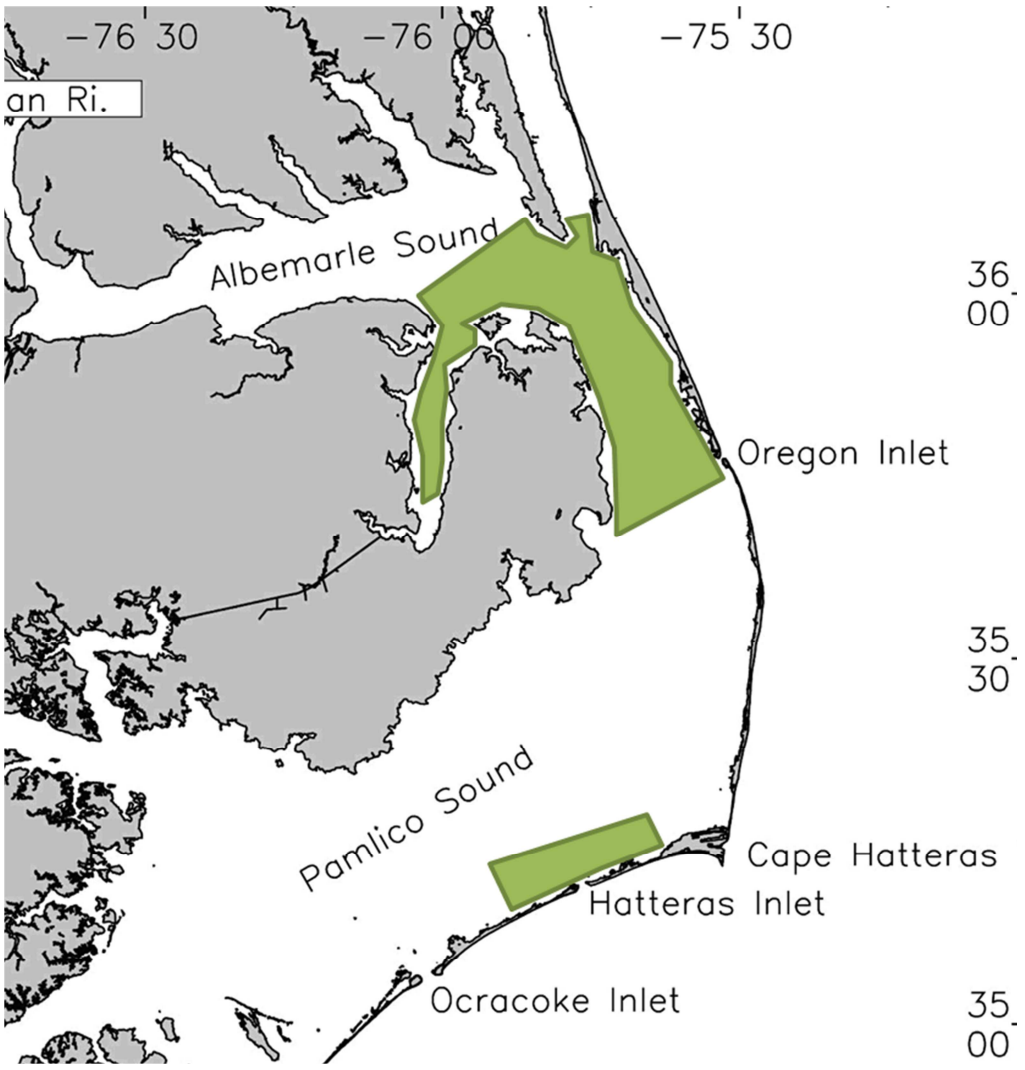

Figure 2. Water-based cleanup areas (in green) defined via consultation with N.C. Marine Patrol. Nine fishermen crews and 14 Marine Patrol officers covered approximately 200,000 acres of internal coastal waters including upper Pamlico Sound, Croatan Sound, Roanoke Sound, lower Currituck Sound, Albemarle Sound, Alligator River and Kitty Hawk Bay.

retrieved. Collected pots were photographed, as well. If the pot was irretrievable by fishermen crews using side-scan sonar due to safety concerns and to limitations of the retrieval method, only the GPS coordinate was recorded. Thus, the methodology of derelict pot collection was divided into two classifications: "Visual" and "Side-Scan."

The "Visual" collection method required fishermen crews looking for surface pots to use their knowledge of the local waters to target their efforts. Those using this method coordinated informally among other participating fishermen in their cleanup area, so as not to duplicate efforts. Since most surface pots still had a buoy or float attached, fishermen could use the float line and their crab pot puller to hoist in the derelict gear.

The "Side-Scan" protocol, largely modeled after the VIMS effort, required fishermen crews to use a grappling anchor - snag line combination retrieval method (Figure 3). The snag lines were

Figure 3. Snag line (left) and grappling anchor (right) used to retrieve pots located with side-scan sonar. To construct the snag line, hog rings affixed bent 12-penny nails approximately every six inches. Ends were weighted with approximately four pounds of lead.

constructed with Osprey #10 braided sink rope and were 80 feet long. Embedded (via hog rings) approximately every six inches were bent 12-penny nails, and the ends were weighted with approximately four pounds of lead.

If a pot was spotted on the sonar screen (Figures 4 and 5), the general protocol was to circle the pot with the snag line until hooked. Once hooked, the larger grappling hook was thrown to snag the derelict pot for hoisting aboard the boat. In contrast to the other five fishermen crews, side-scan crews were encouraged to explore areas they had observed as "hot-spots" to better understand and document accumulation areas for DFG.

Maps were created using ArcGIS software by Dr. Nathan Richards, Program Head Maritime Heritage, UNC Coastal Studies Institute, and Associate Professor with the Program in Maritime Studies, East Carolina University. Dr. Richards analyzed GPS points of collected and encountered pots in efforts to better illustrate "hot-spot" areas where DFG accumulates. Different notations were used for pots collected versus pots encountered and considered irretrievable. The discovery method of pots was also quantified, again, using different notations to show whether the Side-Scan or Visual method was used. For each pot encountered, a green check or red "X" was used to show one pot.

Bycatch results were visually quantified, validated by photographs taken, in the following ways: presence/absence of oysters, and number of finfish/blue crabs alive or dead.

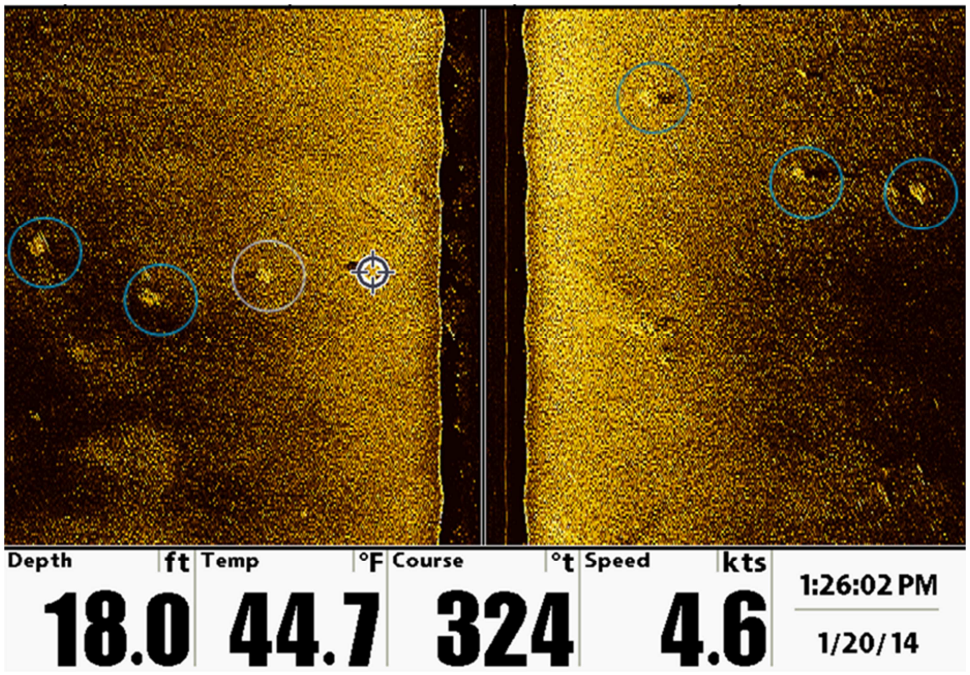

Figure 4. Screenshot from a boat using the side-scan method in the Croatan Sound. Pots are marked with circles. It is important to note here that there are several pots present in one screenshot (blue circles), although only one pot (grey circle) was denoted as being "encountered" on the map due to direct proximity to the boat (cross-hash with circle).

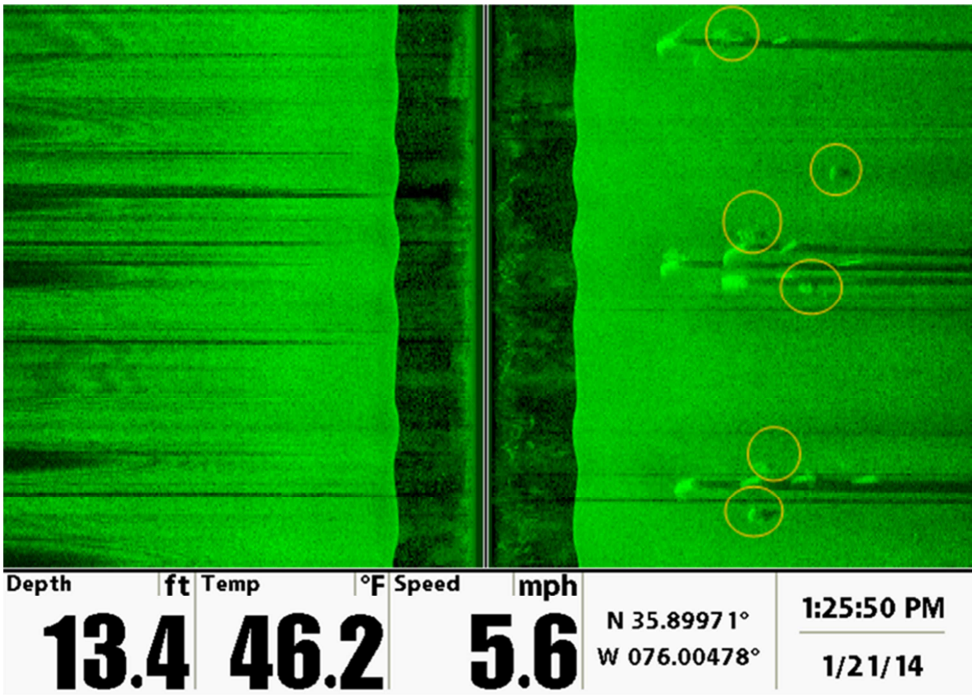

Figure 5. Screenshot from a boat surveying the Alligator River Bridge using side-scan sonar. The right side of the screen depicts the bridge pilings (larger squares with adjacent shadow lines). Pots are circled in orange. Note that, again, there are several pots spotted in one screen shot.

Results

Marine Debris Recovered - As a result of the land-based cleanup, 27 volunteers removed 620 pounds of solid waste and 380 pounds of derelict crab pots and other fishing gear. The 380 pounds of derelict crab pots were recycled at the Dare County's Solid Waste and Recycling Center.

As a result of the water-based cleanup, fishermen and Marine Patrol officers encountered 491 pots (collected or mapped). Fourteen Marine Patrol officers collected 163 pots; nine fishermen crews encountered 328 pots, collecting 201 (Figure 6). The remaining 127 pots were unable to be recovered but were mapped. Of the 328 pots encountered by fishermen, 133 pots were found using the Visual method, while 195 were found using the Side-Scan Sonar method. It is important to note that fishermen using side-scan sonar opportunistically encountered surface pots, which they removed; therefore, not all pots encountered by the four crews using side-scan sonar were submerged pots.

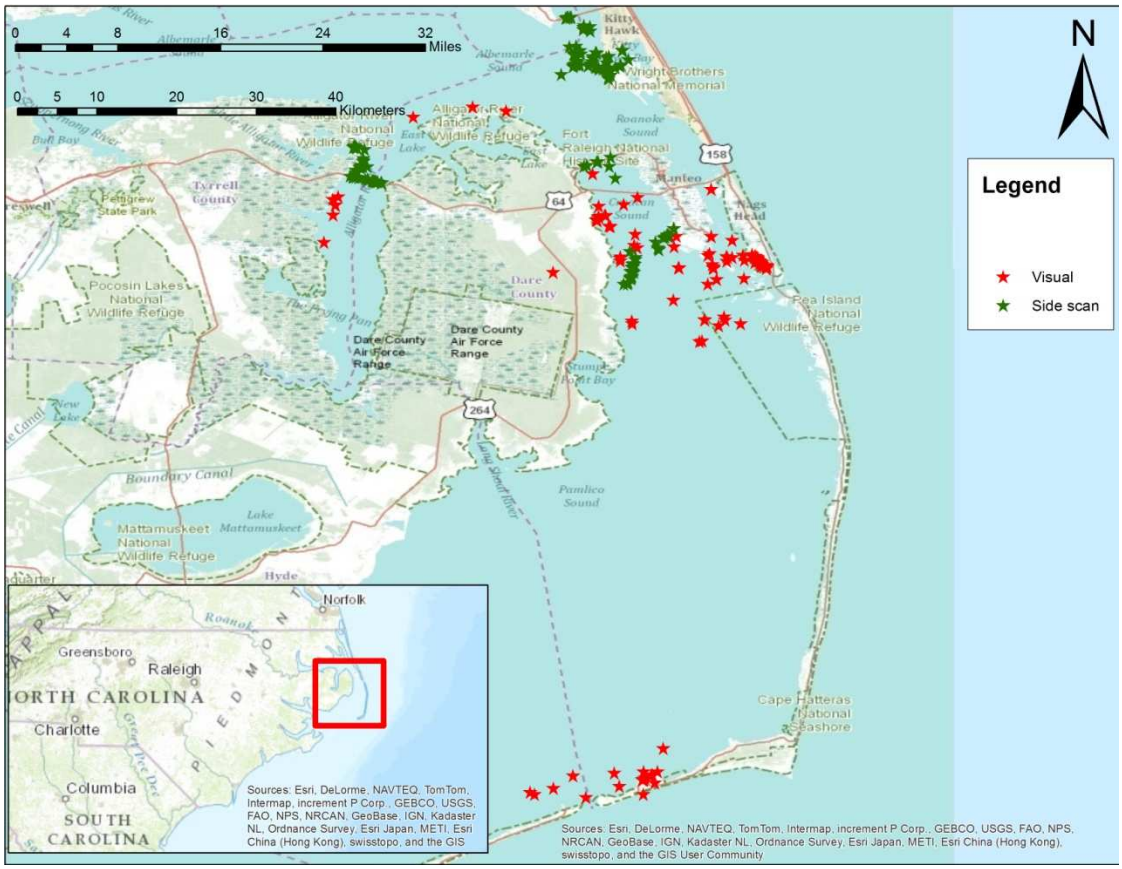

Figure 6. Nine fishermen crews encountered 328 pots in sum. Red stars indicate pots (totaling 133) encountered using the Visual method, while green stars denote pots (totaling 195) encountered on boats using side-scan technology. Note this map does not indicate pots retrieved, only those detected.

One shot of gill net was detected and recovered from the Alligator River by a side-scan sonar crew. Approximately 90 of the pots collected are suitable for artificial oyster reef creation, as funded outside of this scope of work by the NOAA Marine Debris Removal Program grant monies.

Analysis of Retrieval Methods - As stated above, crews encountered 328 pots in total, collecting 201 (Figure 7). Although the side-scan crews encountered more pots (195), they were able to retrieve less (75). Those crews using the Visual method to detect pots were able to retrieve more pots overall (126 out of 133). It is important to note that of the 75 pots retrieved by boats with side-scan units, only 22 of these were considered ghost (or submerged) pots. More simply stated, the side-scan sonar fishermen encountered more pots on average than those fishermen without the technology, but their retrieval success was less (Figure 8).

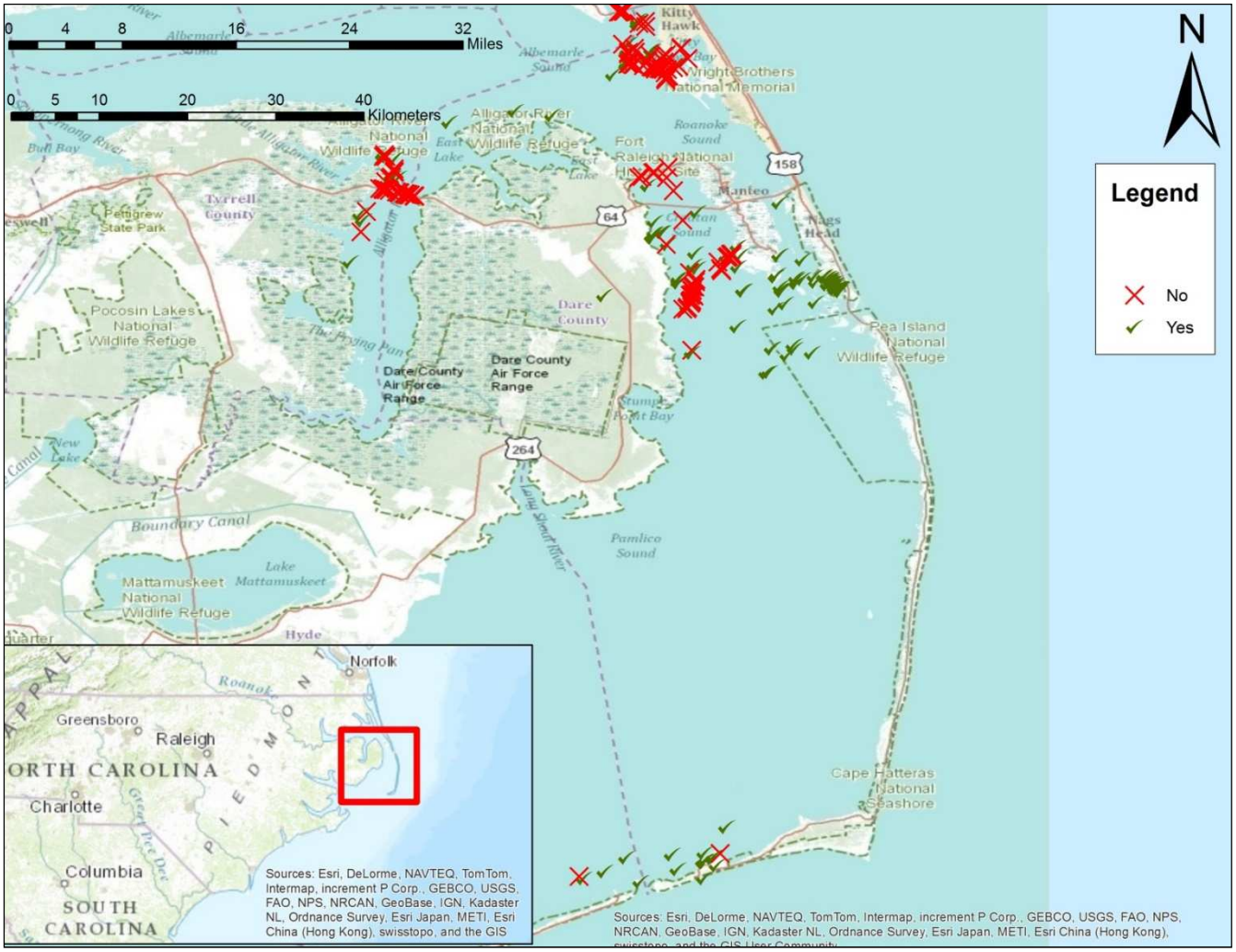

Figure 7. Nine fishermen crews encountered 328 pots, collecting 201 in total. The 127 pots not retrieved owed to inclement weather and hazardous collection areas preventing safe retrieval by crews. Side-scan crews encountered 195 pots but only retrieved 75. Those crews using the Visual method to detect pots retrieved 126 of the 133 total pots they encountered. Red "X's" denote pots encountered, not removed; green checks denote pots encountered and removed.

Retrieval time using the side-scan sonar, grappling anchor - snag line combination method averaged 12 minutes. This time was measured from the time the pot was spotted on the screen to the time the pot was placed on the boat. For the Visual method, there was no tracking method established to calculate retrieval time, therefore this value cannot be reported.

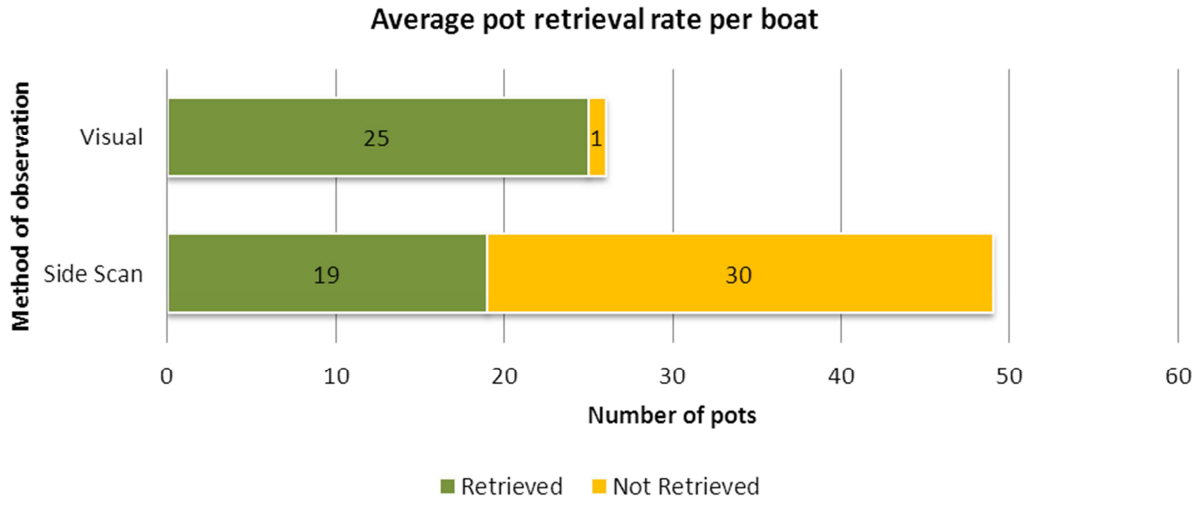

Figure 8. Comparison of pot retrieval rate per boat. Five boats using the Visual method retrieved (on average) 25 pots over two collection days. The four side-scan boats averaged 19 retrieved pots each, although they encountered much greater numbers (26 versus 49 pots) than those boats searching for buoyed pots with the Visual method.

Analysis of Submerged Pot Accumulations – Fishermen using side-scan were instructed to focus a portion of their efforts around bridges, where DFG was assumed to be clustered. Inadequate weather conditions and equipment malfunction prevented full scans of the Virginia Dare Memorial and Washington Baum Bridges. Alligator River, Currituck and William B. Umstead (Manns Harbor) Bridges were able to be surveyed fully.

Data indicate that areas around bridges and pilings were indeed found to be hot spots (Figures 9, 10 and 11). On these maps, it is important to note that one “mark” on the map depicting pots not collected often indicates more than one pot was present (note previous figures). In the Alligator River example (Figure 10), some of the screenshots that accompanied each GPS location indicated that more than one submerged pot was present at that location. This means that the number of pots reported as encountered are actually under-reported, as not all side-scan units functioned properly and saved screen shots to allow for true determination of all submerged pots within the entire swath detected by a given side-scan sonar unit.

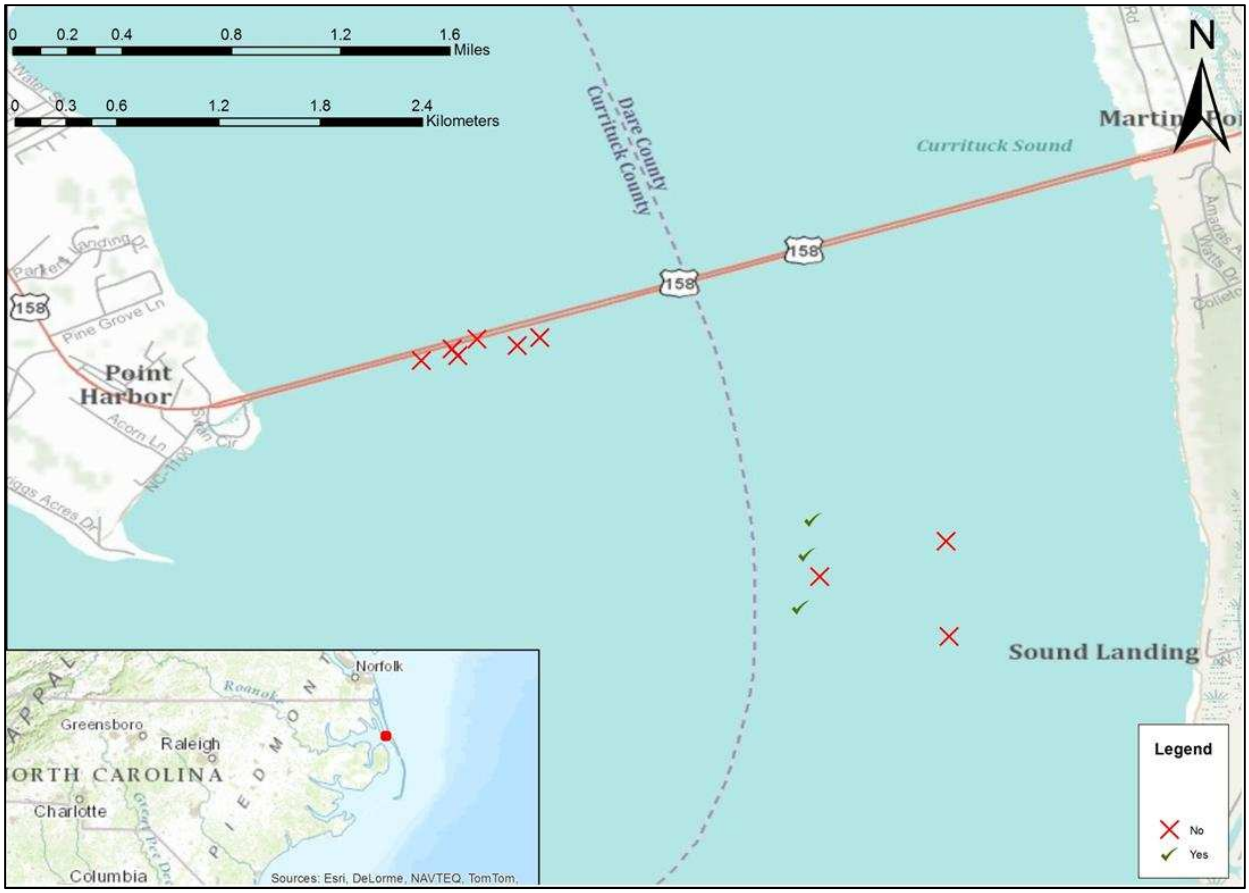

Figure 9. Pots encountered at the Currituck Bridge using side-scan sonar. Pots visualized only on the unit screen (and not retrieved) are marked with a red "X." It is important to note that during the scan of this bridge, weather conditions were not ideal. High winds and seas made visualization of submerged pots difficult. It is inferred that with calmer weather conditions, greater numbers of pots would be visible among the bridge pilings using side-scan sonar.

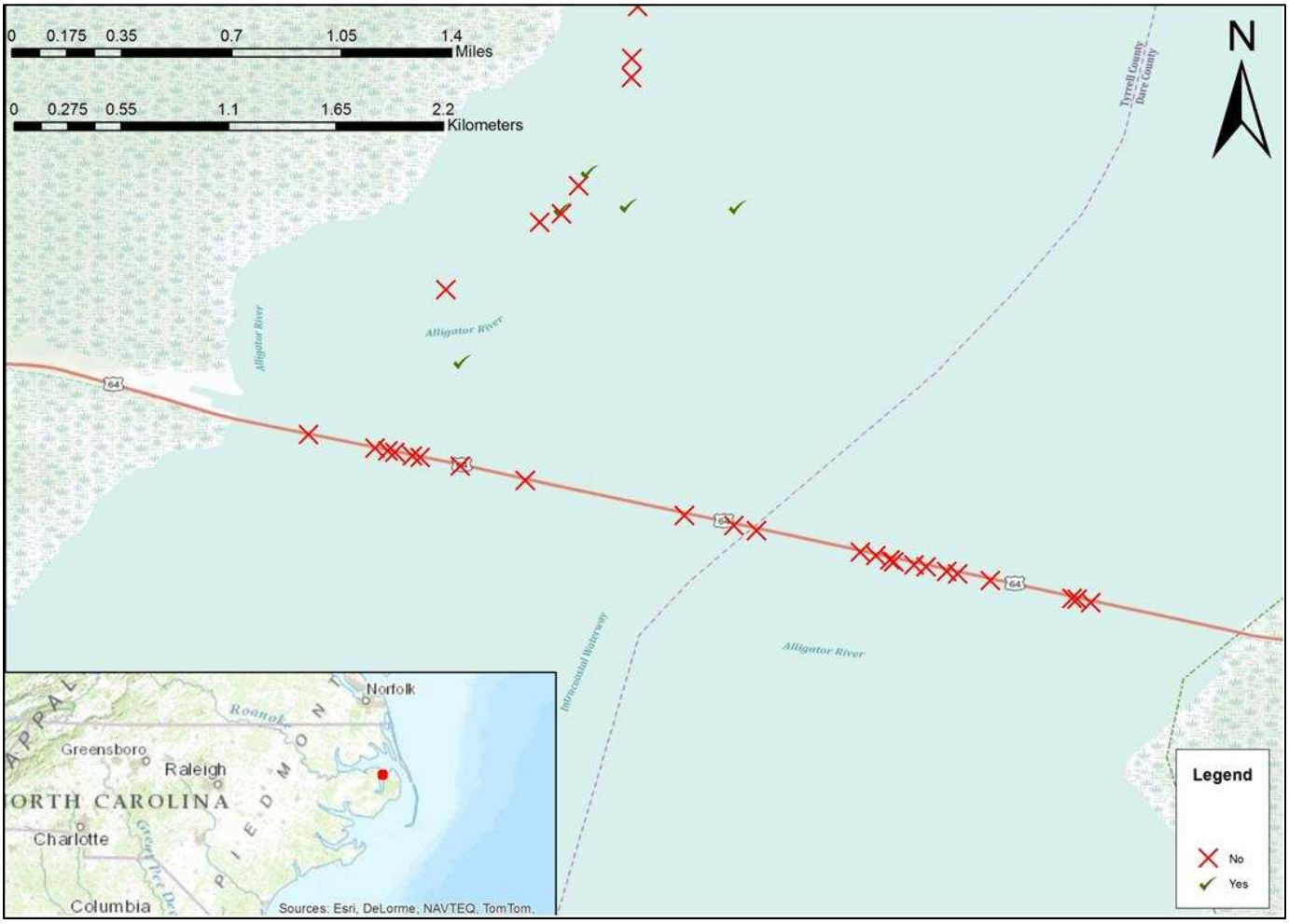

Figure 10. Pots encountered at Alligator River Bridge. Weather conditions were ideal for scanning at this location, which allowed for good marking of submerged pots. This area indicates a clear "hot-spot" area of gear accumulation both along the bridge and western shoreline. Red "X's" denote pots that were not retrieved; green checks show pots that were collected.

Figure 10 shows that the Alligator River Bridge represents an accumulation area for ghost pots. Along the bridge pilings, significant numbers of pots were observed, as well as along the western shoreline. It should be noted that one "X" does not necessarily denote one submerged pot. Clusters of pots were frequently observed along the bridge pilings, although were not noted differently than individual pots. Figure 10 also shows accumulation areas north of the Alligator River Bridge along the western shoreline of the river. This accumulation phenomenon also was observed in other open water areas where known "sloughs" and muddy areas of bottom are common.

Bycatch Encountered – Presence or absence of bycatch was noted for each pot that was retrieved by fishermen participants. There was no evidence of sea turtles or diamondback terrapins in any retrieved pots. Of the 201 pots retrieved, 13, or 6%, were considered "partial pots" and consisted of only one or all of the following: buoy, line or pot iron. These partial pots were removed from the bycatch analysis, as they were unable to retain bycatch.

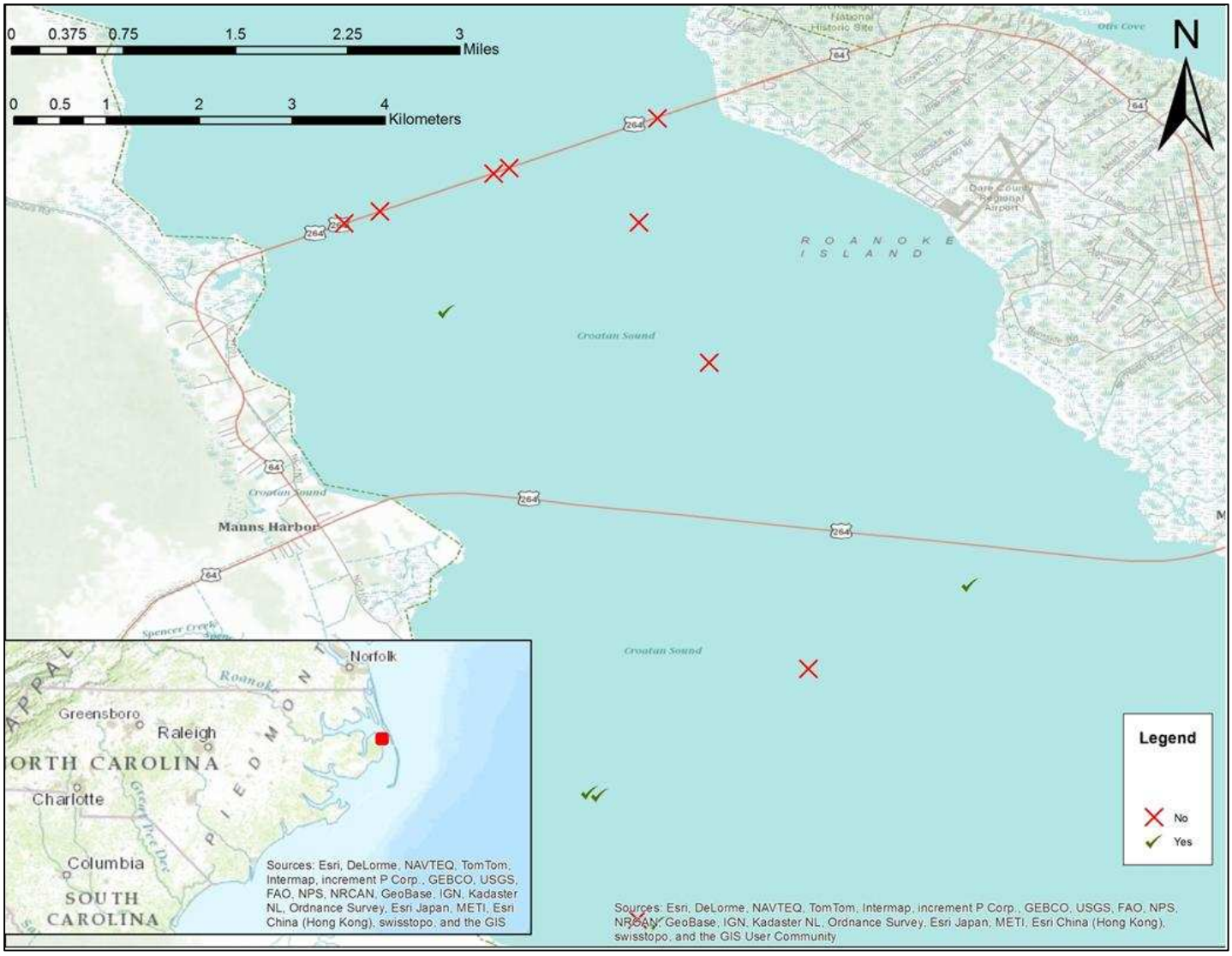

Figure 11. Pots encountered at William B. Umstead (Manns Harbor) Bridge. Collected pots are marked with a green check. Pots visualized on the screen only (and not retrieved) are marked with a red "X." It is important to note that during the scan of this bridge, weather conditions were not ideal. High winds and seas made visualization of submerged pots difficult. It is inferred that with calmer weather conditions, greater numbers of pots would be visible among the bridge pilings using side-scan sonar.

Out of the 188 intact pots retrieved, 103, or 55%, were free of any incidence of bycatch. There was a total of 242 blue crabs and 70 finfish found in collected pots (Figure 12); 17% of the bycatch were dead (n=54). If averaging out these results, 1.2 blue crabs and 0.35 finfish were encountered per pot during the collection. Oysters were seldom encountered encrusting the surface of pots collected, and were only observed on 7% (or 14 total) pots (Figure 13).

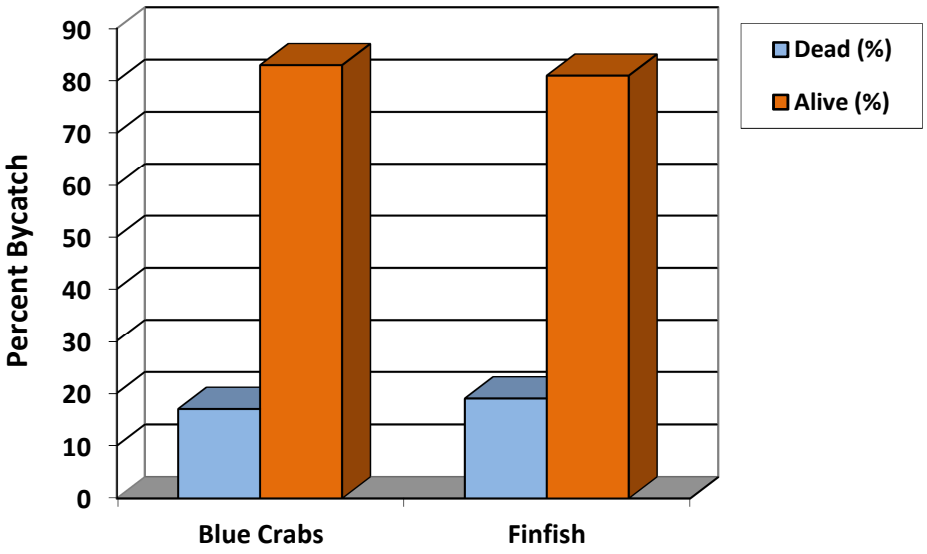

Figure 12. Percent of blue crabs and finfish found dead or alive from 188 whole, collected crab pots. A total of 242 crabs and 70 finfish specimens were observed, mostly all alive (83% of blue crabs, 81% of finfish). It is important to note that 55% (103 pots), were free of any incidence of bycatch.

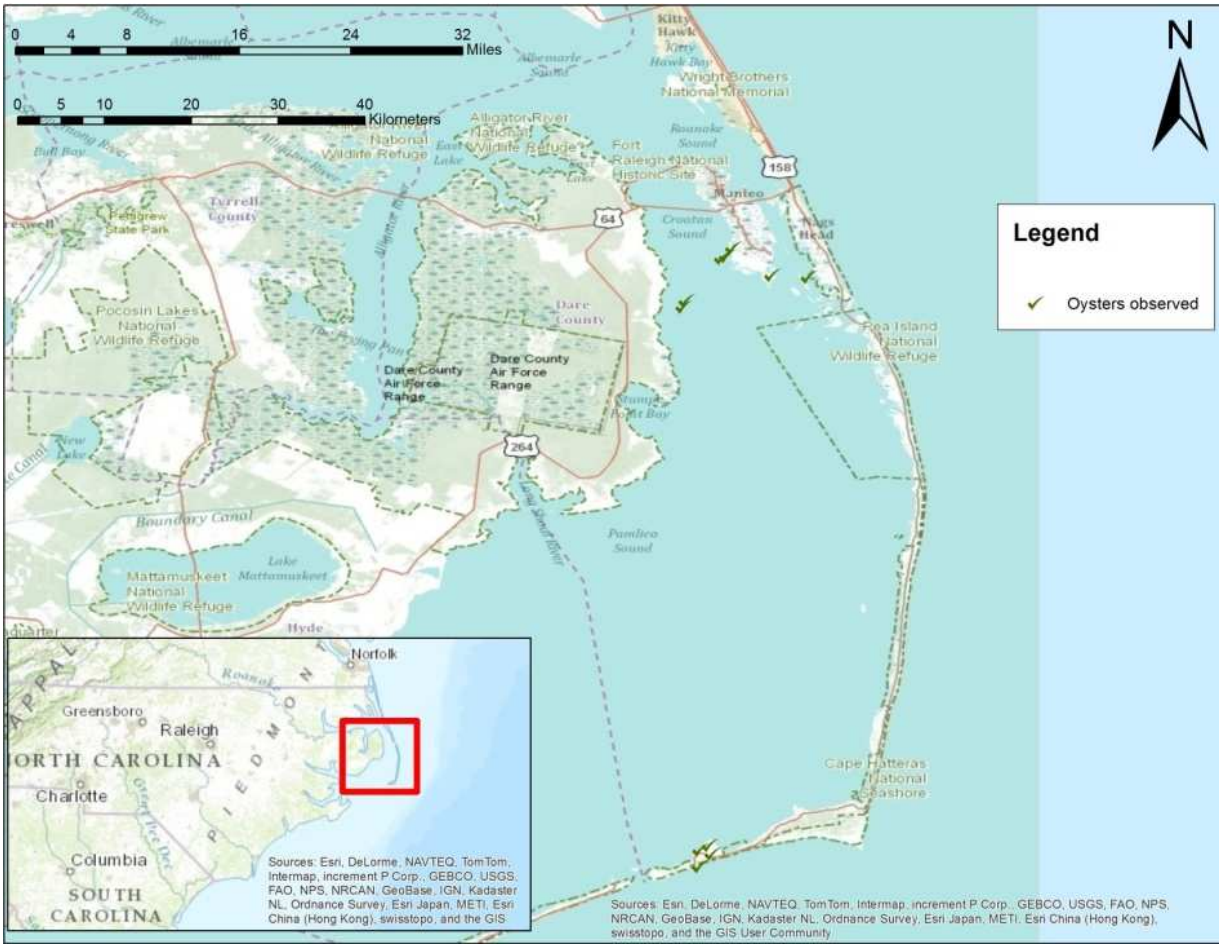

Figure 13. ArcGIS maps showing collection areas where oysters were observed fouling the surface of derelict crab pots. Oysters were only observed on 7% (14 total) of collected pots.

Conclusions

"Hot-spot" Areas - In general, hot spot areas should be a focus of collection efforts in future years and improved collection methods for un-buoyed pots are needed. With improved retrieval methods, success of derelict pot collection by fishermen using side-scan sonar would greatly improve. With future collections, this data will be compiled year-to-year to establish a better understanding of "hot-spot" areas for DFG. If collection areas were more narrowly defined, it would translate into less man-hours searching for gear on the water, thereby saving the State in human and financial resources. The DMF has produced extensive maps of various bottom types in internal coastal waters. With additional submerged pot data that will be collected in 2015 and beyond, these data on new submerged pot locations could be overlayed on the State's bottom-type map to better understand pot movement.

Incidence of Bycatch - It was hypothesized that oysters would be present in greater numbers on collected pots. The majority of fishermen accounts prior to beginning the project pointed to high numbers of ghost pots being heavily encrusted with oysters. However, oysters were not commonly observed on encountered pots, at least not as much as originally hypothesized. It is important to note that, in recent history, oysters are not commonly found north of Shallowbag Bay (see Figure 13), due to lower levels of salinity from the Bay northward to the Virginia state line. Collected data corroborates this historical presence of oysters in areas south of Shallowbag Bay.

Bycatch data from this project corroborated DMF's previous research that concluded blue crab mortality and bycatch may not be as significant as once assumed. Bycatch and mortality numbers were significantly lower than originally hypothesized in this study; the majority of pots collected were without any type of bycatch.

Side-Scan Sonar Use in Pot Retrieval – Participating boats had little trouble finding ghost pots with the sonar unit, although retrieving the submerged pots proved to be quite difficult. The lack of retrieval success with the Side-Scan Sonar method likely is due to: 1) weather conditions making it difficult to retrieve submerged pots, 2) the location of scanning (fishermen were near and around bridges and pilings where prolonged efforts to retrieve pots made safety a concern), and 3) inadequate retrieval methods (snag line and grappling hook were not effective for collecting unbuoyed pots).

Furthermore, sub-par weather conditions during the 2014 collection period precluded thorough scans of supposed hot spot areas around bridges. While the Alligator River Bridge showed a strong pattern of DFG accumulation amongst bridge pilings, other bridges showed significantly smaller accumulations of gear. This can be attributed to incomplete surveys due to hazardous weather conditions, and the small time frame window that the 2014 collection was expected to be completed in. This small window of time forced the DFG collection to be completed on days that were sub-par for the use of side-scan sonar. Fishermen participants suggested having an extended period of time where DFG could be searched for using side-scan sonar, even after the waters have been re-opened to crabbing. This would allow the waters to be re-opened to crabbing once the visual collection of DFG was complete, while still allowing project participants using side-

scan to have more options for appropriate fieldwork days. N.C. Marine Patrol has agreed to this protocol in future collections, beginning in 2015.

Weather seemed to be an unavoidable factor, given the standard harsh weather conditions during the chosen closure period. There was a very small window of time that this project was expected to be completed, as re-opening the waters to crabbing as soon as possible is of the utmost priority once the waters are deemed "clean."

The retrieval equipment (specifically the snag line) that was modeled after the VIMS effort did not prove to be adequate for the amount of wind and current in our sounds. As observed by fishermen, water currents and wind were substantial, which prevented the lines from snagging ghost pots settled on the bottom. The line tended to stay suspended in the middle column of the water. To remedy the problems with the snag lines, fishermen recommended three main alterations: (1) Add more line, (2) Increase amount of weight by incorporating more lead throughout the length of the line (as opposed to just the ends), and (3) Incorporate larger nails along the length of the snag line. The grappling hook proved to be effective in removing gear and will be used in the same manner for future collections.

Collaboration with N.C. Marine Patrol - Participating fishermen had a positive overall perception of the project, as did the Marine Patrol for the public-private partnership pilot. During the debrief session, many fishermen expressed interest in doing the project again, as they felt their involvement in the cleanup was appreciated. For future cleanup efforts, it is recommended that N.C. Marine Patrol officers working within the District where the project will take place attend an orientation detailing logistics and methodology of the planned DFG cleanup. This proved to be beneficial in 2014 for both fishermen and volunteers. After consultation with Marine Patrol, it is possible for this orientation to take place during District personnel meetings in 2015. Additionally, it is recommended that communication between hired fishermen and Marine Patrol officers take place over VHF radio, as cell phone communication is cumbersome while on the water.

Extension of Results
Accepted presenter at:

Southeast Atlantic Marine Debris Strategy Meeting
Charleston, SC
June 2014

N.C. Marine Debris Symposium
Sneads Ferry, NC
September 2014

7th Annual National Summit on Coastal and Estuarine Restoration
Washington, DC
November 2014

Media Coverage:

"Crab Pot Project Gets a Thumbs Up"
Coastal Review Online, The Coastland Times
January 2014
http://www.nccoast.org/Article.aspx?k=07a64f8c-1929-4130-9996-3ec5070f3945

"N.C. Conservationists to Begin Coastal Cleanup Project in 2014"
North Carolina Public Radio
October 2013
http://wunc.org/post/nc-conservationists-begin-coastal-cleanup-project-2014

"NCCF to start pilot program to collect and re-use crab pots"
Carteret County News-Times
September 2013

"When Crab Pots Become Problems"
Coastal Review Online
September 2013
http://www.nccoast.org/article.aspx?k=a3250e50-dfe0-470b-aaf0-75d4a676548d

Appendix A – Raw Data

VISUAL METHOD

Fisherman	Latitude	Longitude	Oysters?	Blue Crabs Alive	Blue Crabs Dead	Finfish Alive	Finfish Dead	Notes	Removed?
Scott	35.21790	-75.67977	Y	0	0	0	0	Pot in 8 in. of water, oysters were dead	Y
Scott	35.22103	-75.69408	N	0	0	0	0		Y
Scott	35.22135	-75.69320	N	0	0	0	0		Y
Scott	35.22148	-75.69292	N	0	0	0	0		Y
Scott	35.22162	-75.69293	N	0	0	0	0		Y
Scott	35.22140	-75.69320	N	0	0	0	0	3-4 old pots in same spot	Y
Scott	35.84455	-75.65842	Y	0	0	0	0	10 oysters dead on pot (inside creek) lots of pots alongshore	Y
Scott	35.23027	-75.69250	N	0	0	0	0		Y
Scott	35.22193	-75.69238	N	0	0	0	0		Y
Scott	35.22193	-75.69235	Y	0	0	0	0	Only 1 oyster dead attached to rope	Y
Scott	35.22677	-75.68252	N	0	0	0	0	Inside Durant's Point, creekside	Y
Scott	35.22655	-75.68288	Y	0	0	0	0	In about 2ft. of water hard to get off bottom	Y
Scott	35.22610	-75.68365	N	0	0	0	0		Y
Scott	35.22522	-75.68458	N	0	0	0	0		Y
Scott	35.22572	-75.68397	N	0	0	0	0		Y
Scott	35.22350	-75.69110	N	0	0	0	0		Y
Scott	35.22177	-75.69278	N	0	0	0	0		Y
Scott	35.22193	-75.69232	N	0	0	0	0		Y
Scott	35.22195	-75.69230	N	0	0	0	0		Y
Scott	35.23040	-75.67678	N/A	0	0	0	0	Could not get pot off bottom, had to leave it	N
Scott	35.22870	-75.72557	N	0	0	0	0		Y
Scott	35.20477	-75.81587	N	1	0	1	1		Y
Scott	35.20707	-75.82087	N/A	0	0	0	0	Could not get pot off bottom	N
Scott	35.20137	-75.75763	N	0	0	0	0	Just a piece of a pot	Y
Scott	35.21185	-75.79450	N	1	0	2	0	Two conchs also	Y
Scott	35.22585	-75.77238	N	0	0	0	0	Eight conchs in pot	Y
Scott	35.22148	-75.69310	N	0	0	0	0		Y
Scott	35.25668	-75.67033	N	2	0	0	0		Y
Scott	35.22562	-75.68415	N	0	0	0	0		Y
Scott	35.22530	-75.68455	N	0	0	0	0		Y
Scott	35.21395	-75.72018	N	0	0	3	0	Three sheepshead alive in pot	Y

Scott	35.22168	-75.69285	N	0	0	0	0		Y
Outland	35.97733	-75.84795	N	0	0	0	0		Y
Outland	N/A	N/A	N	2	0	0	0	GPS not functioning	Y
Outland	N/A	N/A	N	0	0	0	0	GPS not functioning	Y
Outland	N/A	N/A	N	0	0	0	0	GPS not functioning	Y
Outland	N/A	N/A	N	0	0	0	0	GPS not functioning	Y
Outland	N/A	N/A	N	0	0	0	0	GPS not functioning	Y
Outland	N/A	N/A	N	1	0	0	0	GPS not functioning	Y
Outland	35.98205	-75.88573	N	3	1	0	0		Y
Outland	N/A	N/A	N	0	0	3	0	Perch; peeler pot	Y
Outland	35.87158	-75.71513	N/A	N/A	N/A	N/A	N/A	Rope broke, lost the pot	N
Outland	35.85927	-75.73538	N	2	2	0	0		Y
Outland	35.85953	-75.73633	N	3	0	0	0	Two pots close together - took one photo	Y
Outland	35.86972	-75.74323	N	2	0	0	1		Y
Outland	35.90628	-75.75020	N	0	0	0	0		Y
Outland	35.83797	-75.70217	N	3	0	11	0		Y
Outland	35.82557	-75.70312	N	3	0	2	0		Y
Outland	35.74008	-75.70572	N/A	N/A	N/A	N/A	N/A	Rope broke, lost the pot	N
Outland	35.82302	-75.69983	N	0	0	2	0	Oystertoad, pinfish in pot	Y
Outland	35.73682	-75.70542	N/A	N/A	N/A	N/A	N/A	No pot - only buoy and iron	Y
Outland	35.81087	-75.71940	N	11	2	0	0	R.L. Morris, pot owner	Y
Outland	35.80798	-75.71870	N	7	1	0	0	R.L. Morris, pot owner	Y
Outland	35.81257	-75.71897	N	0	0	0	0		Y
Outland	35.84683	-75.72980	N	0	0	0	0		Y
Outland	35.84725	-75.73168	N/A	N/A	N/A	N/A	N/A	Rope broke, lost the pot	N
Outland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Rope broke, lost the pot	N
Johnson	35.88878	-75.61608	N	0	0	0	0	Buoy and iron only	Y
Johnson	35.78795	-75.57903	N	0	0	0	0		Y
Johnson	35.76355	-75.65888	N	0	0	0	0		Y
Johnson	35.82408	-75.65822	N	0	0	0	0		Y
Johnson	35.83622	-75.66328	N	0	0	1	0	Oystertoad	Y
Johnson	35.83595	-75.65537	N	0	0	0	0		Y
Johnson	35.83595	-75.61608	N	0	0	0	0		Y
Johnson	35.83526	75.61608	N	0	0	0	0		Y
Johnson	35.80382	-75.61497	N	0	0	0	0		Y

Johnson	35.79960	-75.61366	N	6	2	0	0		Y
Johnson	35.78155	-75.62008	N	0	0	0	0	Buoy and iron	Y
Johnson	35.73455	-75.60770	N	0	0	0	0	Old House Channel	Y
Johnson	35.74130	-75.60048	N	0	0	4	6	Sheepshead	Y
Johnson	35.78682	-75.61012	N	0	0	0	0	Buoy and line only, no iron	Y
Johnson	35.79928	-75.55377	N	4	0	0	0		Y
Johnson	35.80015	-75.65328	N	5	0	0	0		Y
Johnson	35.80003	-75.65255	N	2	0	0	0		Y
Johnson	35.80166	-75.55280	N	0	0	0	0		Y
Johnson	35.80166	-75.55280	N	2	1	1	0		Y
Johnson	35.80177	-75.55353	N	0	0	0	0		Y
Johnson	35.80242	-75.55366	N	6	0	0	0		Y
Johnson	35.80222	-75.55360	N	0	0	0	0		Y
Johnson	35.80262	-75.55408	N	0	0	0	0		Y
Johnson	35.80293	-75.55465	N	0	0	0	0		Y
Johnson	35.80293	-75.55663	N	2	0	0	0		Y
Johnson	35.80415	-75.55903	N	6	0	0	0		Y
Johnson	35.80462	-75.56027	N	4	0	0	0		Y
Johnson	35.80558	-75.56160	N	4	0	0	0		Y
Jones	35.97057	-75.95303	N	1	6	0	0	1 male, 5 females	Y
Jones	35.88068	-76.03777	N	N/A	N/A	N/A	N/A	Rope broke, lost the pot	N
Jones	35.87750	-76.04358	N	3	0	0	1	1 dead flounder	Y
Jones	35.87133	-76.04067	N	0	1	0	0		Y
Jones	35.87095	-76.04093	N	0	1	3	0	3 white perch	Y
Jones	35.86003	-76.04320	N/A	N/A	N/A	N/A	N/A	Broke buoy off	N
Jones	35.82880	-76.05363	N	0	1	0	0		Y
Daniels	35.81654	-75.61793	Y	0	0	0	0		Y
Daniels	35.81393	-75.62008	N	0	1	0	0	J. Carroll - Name on buoy	Y
Daniels	35.80769	-75.59875	N	1	0	0	0	Mickey Daniels - Name on buoy	Y
Daniels	35.81187	-75.59792	N	0	0	0	0	Buoy number - NC 1884-BH	Y
Daniels	35.81304	-75.59901	N	0	0	0	0	Kevin O'neal - Name on buoy	Y
Daniels	35.81179	-75.59255	N	0	0	0	0	This is what looks to be an "eel pot"	Y
Daniels	35.81444	-75.58020	Y	0	0	2	0	Two oyster toads	Y
Daniels	35.80857	-75.57867	N	0	0	0	0	Livesay - Name on buoy	Y
Daniels	35.80609	-75.56696	N	0	0	0	0	Iron, rope and buoy. No pot attached.	Y

Daniels	35.81503	-75.56995	N	0	0	0	0	JN Machie - Name on buoy	Y
Daniels	35.81378	-75.57034	N	1	0	0	0	JN Machie - Name on buoy	Y
Daniels	35.83124	-75.59245	N	0	0	1	0	No name on buoy	Y
Daniels	35.80145	-75.61386	N	0	0	0	0	M. Brodie	Y
Daniels	35.80035	-75.61373	N	7	2	0	0	WR Newsom	Y
Daniels	35.74098	-75.62344	N	0	0	0	0		Y
Daniels	35.74154	-75.62377	N	0	0	0	0	Floating buoy, nothing attached	Y
Daniels	35.71688	-75.62939	N	5	0	0	0	Red and white buoy, can't ID name or number	Y
Daniels	35.71732	-75.62643	N	10	1	0	0	KL Tillett on buoy - Asc. Gray on orange tag	Y
Daniels	35.81348	-75.56704	N	0	0	0	0	John Machie	Y
Daniels	35.81329	-75.56600	N	0	0	0	0	John Machie	Y
Daniels	35.81218	-75.56449	N	0	0	0	0	John Machie	Y
Daniels	35.81178	-75.56455	N	0	0	0	0	John Machie	Y
Daniels	35.81138	-75.56399	N	0	0	0	0	John Machie	Y
Daniels	35.81042	-75.56345	N	4	1	0	0	John Machie	Y
Daniels	35.80942	-75.56338	N	0	0	0	0	John Machie	Y
Daniels	35.80852	-75.56316	N	7	0	0	0	John Machie	Y
Daniels	35.80827	-75.56298	N	4	0	0	0	John Machie	Y
Daniels	35.80814	-75.56239	N	5	0	0	0	John Machie	Y
Daniels	35.80779	-75.56142	N	0	1	0	0	John Machie	Y
Daniels	35.80746	-75.56065	N	0	0	0	0	John Machie	Y
Daniels	35.80178	-75.55984	N	1	0	0	0	John Machie	Y
Daniels	35.80647	-75.55933	N	4	1	0	0	John Machie	Y
Daniels	35.80619	-75.55930	N	1	1	0	0	John Machie	Y
Daniels	35.80563	-75.55979	N	3	0	0	0	John Machie	Y
Daniels	35.80499	-75.56011	N	0	0	0	0	John Machie	Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y
CFed	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Y

Appendix A – Raw Data

SIDE-SCAN SONAR METHOD

Fisherman	Latitude	Longitude	Buoy Visible?	Oysters?	Blue Crabs Alive	Blue Crabs Dead	Finfish Alive	Finfish Dead	Notes	Collected?	Time Taken to Retrieve
Hemilright	36.07398	-75.76010	Y	N	2	0	0	0		Y; ID	
Hemilright	36.06934	-75.76077	Y	N	1	0	0	0		Y; ID	
Hemilright	36.07212	-75.76042	Y	N	1	0	0	0		Y; ID	
Hemilright	36.03907	-75.75009	Y	N	4	1	0	0		Y; ID	
Hemilright	36.03651	-75.74982	Y	N	3	2	0	0		Y; ID	
Hemilright	36.04286	-75.74569	Y	N	6	0	0	0		Y; ID	
Hemilright	36.04368	-75.74691	Y	N	5	1	0	0		Y; ID	
Hemilright	36.03306	-75.75099	Y	N	2	0	0	0		Y; ID	
Hemilright	36.03414	-75.76876	Y	N	0	0	0	0		Y; ID	
Hemilright	36.04142	-75.76980	Y	N	0	0	0	0		Y; ID	
Hemilright	36.04144	-75.76950	Y	N	0	0	0	0		Y; ID	
Hemilright	36.04133	-75.77171	Y	N/A	N/A	N/A	N/A	N/A	Iron only	Y; ID	
Hemilright	36.04368	-75.74691	Y	N	5	1	0	0		Y; ID	
Hemilright	36.03306	-75.75099	Y	N	2	0	0	0		Y; ID	
Hemilright	36.03414	-75.76876	Y	N	0	0	0	0		Y; ID	
Hemilright	36.04142	-75.76980	Y	N	0	0	0	0		Y; ID	
Hemilright	36.04144	-75.76950	Y	N	0	0	0	0		Y; ID	
Hemilright	36.04133	-75.77171	Y	N/A	N/A	N/A	N/A	N/A	Iron only	Y; ID	
Hemilright	36.04256	-75.77102	Y	N	0	0	0	0		Y; ID	
Hemilright	36.05078	-75.76887	Y	N/A	0	0	0	0		Y; ID	
Hemilright	36.03028	-75.76971	Y	N	1	0	0	1		Y; ID	
Hemilright	36.02895	-75.77202	Y	N	4	2	0	0		Y; ID	
Hemilright	36.02737	-75.77223	Y	N/A	N/A	N/A	N/A	N/A	Buoy, line, iron only	Y; ID	
Hemilright	36.01859	-75.78559	Y	N/A	N/A	N/A	N/A	N/A	Buoy, line, iron only	Y; ID	
Hemilright	36.02480	-75.74293	Y	N	0	0	0	0		Y	
Hemilright	36.02983	-75.71832	Y	N	3	1	0	0		Y	
Gallop	35.93402	-76.00772	Y	N	0	0	0	0		Y	1 min
Gallop	35.93571	-76.01676	N	N	0	0	1	0	Aaron Gallop's pot	Y; ID	3 min
Gallop	35.93594	-76.01658	N	N	1	0	1	0		Y	7 min
Gallop	35.93702	-76.01835	N	N	0	1	0	0		Y	12 min
Gallop	35.93708	-76.02000	N	N	1	1	0	0		Y	7 min
Gallop	35.93711	-76.02001	N	N	0	0	2	0		Y	20 min

Gallop	35.90722	-76.01731	N	N	0	0	0	0	A lot of mud	Y	10 min
Gallop	35.91442	-76.00964	N	N	0	0	0	0		Y	10 min
Gallop	35.91434	-76.00461	N	N	1	0	2	0		Y	20 min
Gallop	35.93788	-76.01923	N	N	0	0	3	0		Y	3 min
Gallop	35.93629	-76.02039	N	N	0	1	1	0		Y	4 min
Gallop	35.91058	-76.01805	N	N/A	N/A	N/A	N/A	N/A	Never tried to snag	N	N/A
Gallop	35.91367	-76.01373	N	N/A	N/A	N/A	N/A	N/A	Log too close; never tried to snag	N	N/A
Gallop	35.91423	-76.01269	N	N	0	0	0	0		Y	
Gallop	35.91407	-76.01273	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.91536	-76.01195	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.91597	-76.01144	Y	N	0	0	0	0		Y	1 min
Gallop	35.92035	-76.00950	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.92123	-76.00948	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.92362	-76.00921	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.93605	-76.01778	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.93806	-76.01925	N	N/A	N/A	N/A	N/A	N/A		N	
Gallop	35.93611	-76.02048	N	N/A	N/A	N/A	N/A	N/A		N	
Whitfield	35.80412	-75.70300	Y	N	0	0	0	0		Y	5 min
Whitfield	35.80485	-75.70408	Y	N	0	0	0	0		Y	5 min
Whitfield	35.79618	-75.70636	Y	N	0	0	2	0		Y	2 min
Whitfield	35.79578	-75.70757	Y	N	0	0	0	0		Y	2 min
Whitfield	35.79011	-75.70721	N	Y	0	0	1	0		Y	10 min
Whitfield	35.83379	-75.67012	Y	N	3	0	1	0		Y	2 min
Whitfield	35.83378	-75.67010	Y	Y	1	0	0	0		Y	1 min
Whitfield	35.83377	-75.67012	Y	N	N/A	N/A	N/A	N/A	Iron only	Y	1 min
Whitfield	35.83570	-75.66557	Y	Y	0	1	2	0		Y	1 min
Whitfield	35.80418	-75.70506	Y	N	11	0	0	0		Y	
Whitfield	35.78336	-75.71005	Y	Y	1	0	0	0		Y	
Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	Y	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	Y	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	Y	0	0	0	0	Oyster Creek	Y	

Appendix A – Raw Data

Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Whitfield	35.50673	-75.39505	N	N	0	0	0	0	Oyster Creek	Y	
Phillips	35.857385	-75.743299	Y	N	0	0	0	0		Y	
Phillips	35.858372	-75.743405	Y	N	0	1	0	0		Y	
Phillips	35.854584	-75.745173	Y	N	0	1	0	0		Y	
Phillips	35.854235	-75.746192	Y	N	0	0	0	0		Y	
Phillips	35.853308	-75.745167	Y	N	1	0	0	0		Y	
Phillips	35.879689	-75.699462	Y	N	2	1	0	0		Y	
Phillips	35.744761	-75.601506	Y	N	0	0	5	3		Y	
Phillips	35.73678	-75.582787	Y	N	0	0	0	0		Y	
Phillips	35.79492	-75.79492	Y	N	0	0	0	0		Y	
Phillips	N/A	N/A	Y	N	N/A	N/A	N/A	N/A		Y	
Phillips	N/A	N/A	Y	N	N/A	N/A	N/A	N/A		Y	
Phillips	N/A	N/A	Y	N	N/A	N/A	N/A	N/A		Y	
Phillips	N/A	N/A	Y	N	N/A	N/A	N/A	N/A		Y	
Phillips	N/A	N/A	Y	N	N/A	N/A	N/A	N/A		Y	
Phillips	N/A	N/A	Y	N	N/A	N/A	N/A	N/A		Y	

Appendix A – Raw Data

MARKED, IRRETREIVABLE POTS

Fishermen	Latitude	Longitude
Hemilright	36.07099	-75.75974
Hemilright	36.07287	-75.75304
Hemilright	36.06781	-75.75288
Hemilright	36.08365	-75.77458
Hemilright	36.08365	-75.77458
Hemilright	36.08269	-75.77893
Hemilright	36.03918	-75.73192
Hemilright	36.03811	-75.74769
Hemilright	36.01389	-75.73212
Hemilright	36.01726	-75.73158
Hemilright	36.02085	-75.73315
Hemilright	36.08324	-75.77577
Hemilright	36.08306	-75.77922
Hemilright	36.03181	-75.73421
Hemilright	36.03306	-75.75099
Hemilright	36.01524	-75.73260
Hemilright	36.01807	-75.72950
Hemilright	36.02429	-75.73059
Hemilright	36.08357	-75.77792
Hemilright	36.08244	-75.78086
Hemilright	36.03810	-75.73490
Hemilright	36.03079	-75.75295
Hemilright	36.03399	-75.76830
Hemilright	36.04991	-75.77644
Hemilright	36.03257	-75.76737
Hemilright	36.02928	-75.76623
Hemilright	36.02713	-75.74734
Hemilright	36.02480	-75.74293
Hemilright	36.02438	-75.73508
Hemilright	36.04011	-75.77026
Hemilright	36.04594	-75.76422
Hemilright	36.03051	-75.76914
Hemilright	36.02932	-75.76464
Hemilright	36.02658	-75.74607
Hemilright	36.02509	-75.73910
Hemilright	36.02642	-75.72453
Hemilright	36.04174	-75.77035
Hemilright	36.04199	-75.76353
Hemilright	36.02965	-75.77116
Hemilright	36.02805	-75.75514
Hemilright	36.02639	-75.74352
Hemilright	36.02488	-75.73730
Hemilright	36.02790	-75.71934
Hemilright	36.03565	-75.70970
Hemilright	36.04605	-75.71617
Hemilright	36.04568	-75.71714
Gallop	35.89616	-75.98833
Gallop	35.89631	-75.98896
Gallop	35.89635	-75.98919
Gallop	35.89718	-75.99296
Gallop	35.89748	-75.99448
Gallop	35.89759	-75.99498
Gallop	35.89780	-75.99593
Gallop	35.89790	-75.99649
Gallop	35.89804	-75.99741
Gallop	35.89813	-75.99760
Gallop	35.89832	-75.99824
Gallop	35.89848	-75.99896
Gallop	35.89948	-76.00374
Gallop	35.89971	-76.00478
Gallop	35.90018	-76.00707
Gallop	35.90179	-76.01440
Gallop	35.90245	-76.01740
Gallop	35.90284	-76.01925
Gallop	35.90292	-76.01961
Gallop	35.90308	-76.02041
Gallop	35.90315	-76.02074

Appendix A – Raw Data

Gallop	35.90327	-76.02132
Gallop	35.90391	-76.02439
Whitfield	35.81162	-75.70167
Whitfield	35.80961	-75.70193
Whitfield	35.80412	-75.70300
Whitfield	35.80485	-75.70408
Whitfield	35.80477	-75.70428
Whitfield	35.80121	-75.70558
Whitfield	35.79666	-75.70465
Whitfield	35.79485	-75.70371
Whitfield	35.79619	-75.70636
Whitfield	35.79578	-75.70757
Whitfield	35.79011	-75.70720
Whitfield	35.78773	-75.70726
Whitfield	35.78865	-75.70679
Whitfield	35.78971	-75.70645
Whitfield	35.79095	-75.70576
Whitfield	35.80050	-75.70549
Whitfield	35.81867	-75.70816
Whitfield	35.82942	-75.67908
Whitfield	35.82285	-75.67666
Whitfield	35.82161	-75.67561
Whitfield	35.82046	-75.67534
Whitfield	35.83380	-75.67011
Whitfield	35.83511	-75.66859
Whitfield	35.83570	-75.66557
Whitfield	35.83613	-75.66536
Whitfield	35.83628	-75.66521
Whitfield	35.83733	-75.66469
Whitfield	35.83719	-75.66522
Whitfield	35.83751	-75.66635
Whitfield	35.80418	-75.70507
Whitfield	35.78900	-75.70778
Whitfield	35.78336	-75.71005
Whitfield	35.78185	-75.71089
Whitfield	35.78168	-75.71499
Whitfield	35.91487	-75.76010
Whitfield	35.91601	-75.75664
Whitfield	35.91970	-75.74563
Whitfield	35.92024	-75.74412
Whitfield	35.92506	-75.72975
Whitfield	35.91493	-75.73155
Whitfield	35.90133	-75.72475