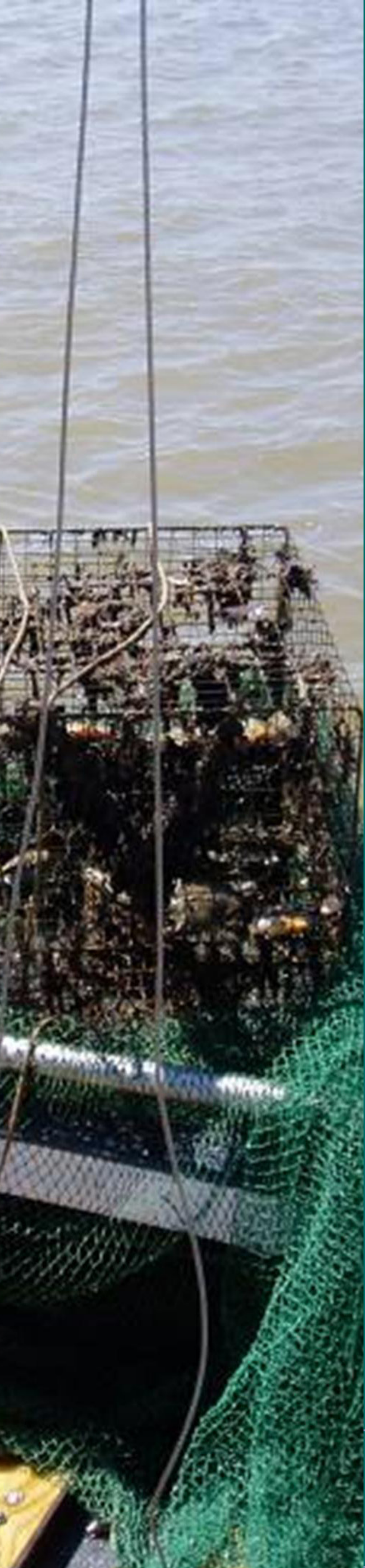

NOAA Submerged Derelict Trap Detection Methods Workshop

June 2-4, 2009

Silver Spring, MD, USA

Sarah E. Morison and Peter M. Murphy (eds.)

US Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration
Marine Debris Division
Silver Spring, MD 20910

National Oceanic and Atmospheric Administration
Technical Memorandum NOS-OR&R-32
August 2009

NOAA SUBMERGED DERELICT TRAP DETECTION METHODS WORKSHOP

June 2-4, 2009
Silver Spring, MD, USA

Sarah E. Morison[1] and Peter M. Murphy[2] (eds.)

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PREFACE

Welcome to the proceedings of the NOAA Submerged Derelict Trap Methodology Detection Workshop, held June 2-4, 2009, in Silver Spring, Maryland. These proceedings include a Detection System Selection Guide which was developed based on the discussion at the workshop and the presenter abstracts and presentations. This invitation-only workshop was hosted by the NOAA Marine Debris Program.

The objectives of this workshop were to review existing methods for locating, surveying, and assessing derelict traps, to share best practices across different projects, and to prepare a document that would be available to any interested party to assist them in choosing the best detection system. The workshop focused on presentations with discussion after each, coupled with a larger discussion at the end of days 1 and 2 to highlight similarities in activities and results, potential best methods, and identify any gaps in knowledge. Day 3 was used by those invitees who were writing project plans associated with derelict traps to incorporate the lessons learned on days 1 and 2 into their plans. All twelve presentations from days 1 and 2 are included here, with abstracts and slides as deemed appropriate by the presenters.

Days were organized to focus the first day on derelict pot detection methodology and the second day on techniques for assessing impacts to habitat, target and/or non-target species from derelict pots, which varied by project. A document developed based on the presentations and discussion from Day 1, a Detection System Selection Guide, is included in this Proceedings after the Table of Contents.

Appendices include the workshop agenda, and a list of workshop participants and contact information.

These proceedings are meant to be a compilation of the workshop presentations and one output (discussed at the workshop, but drafted and finalized afterwards, with attendee input). Presenters have sole responsibility for the view and data in their presentations. The content of presentations does not necessarily reflect the view of the National Oceanic and Atmospheric Administration.

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WORKSHOP OUTPUT:
Detection System Selection Guide

DERELICT POT DETECTION SYSTEM SELECTION GUIDE

When looking to reliably locate derelict pots on the bottom of any body of water, there are many variables that must be taken into account when deciding which technology to use. This document identifies key environmental and technological factors to consider when selecting a detection system to locate items of the appropriate shape and size of pot specifications. (Only through trial and error can derelict pots be distinguished from other targets of similar size.) If multiple systems are applicable the user should examine the technologies identified and conduct further research to determine which will work best in their environment.

Each of the detection methods carry their own inherent detection error, which will vary by the environment and conditions of the survey area. To ensure a successful assessment project, a ground truthing component should be incorporated to evaluate the detection error particular to the project. Ideally, this evaluation should be done early in the project so as to evaluate the efficacy of the method being used prior to completion of the entire survey area. This ground truthing is most commonly achieved through manual observation.

The tables below present different sets of information and variables to consider when selecting the detection method for a given survey area. The detection methods listed are side scan sonar, side imaging, multibeam sonar, diver tow, video, surface visual, and aerial visual. The information is presented in three matrices: by survey environment; survey approach, and logistical background. Taken together, this information will aid in the selection of the best method to detect derelict pots.

Table One: DETECTION SYSTEM APPLICABILITY*

DETECTION METHOD	SURVEY ENVIRONMENT								
	Flat Bottom	*Sandy / Muddy*	*Rocky =< Pebbles*	*Rocky > Boulders*	*Seamounts*	*High Relief Bottom*	*SAV > trap height*	*SAV < trap height*	*High Turbidity*
Side Scan Sonar	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes
Side Imaging	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Multibeam Sonar	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Diver Tow	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Video	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No
Surface Visual	Yes	Yes	Yes	Yes	No	No	No	Yes	No
Aerial Visual	Yes	Yes	Yes	No	Yes	No	No	Yes	No

*Please note, Table One is not meant to be an exhaustive list of all survey environments or habitat types, but rather to provide an initial list of environments in which survey techniques have been used in the past, and their relative effectiveness.

Table Two: IMPLEMENTED METHODOLOGIES

DETECTION METHOD	SURVEY PROTOCOLS				
	Water Depth *Surface to sea floor in work area*	***Elevation*** *Water Above sea floor Air Above sea level*	***Frequency***	***Swath*** *Coverage Area Width*	***Speed***
Side Scan Sonar	2 - 600 m	10% of water depth	300 - 600 kHz	20-50 m	4 - 5 kts
Side Imaging	1 - 10 m	N/A - Hull Mount	455 kHz	20-25 m	4 - 5 kts
Multibeam Sonar	> 2m; Frequency Dependent	N/A - Hull Mount	240 - 455 kHz	3.5 x Elevation	4 - 5 kts
Diver Tow	2 - 15 m	Topography Dependent	N/A	Vis Depedent	< 1.6 kts
Video	2 - 6000 m	Vis Dependent	N/A	Vis Dependent	< 1 kts
Surface Visual	Location Dependent	Surface	N/A	Vis Dependent	< 1 kts
Aerial Visual	0 m	300 - 1000 ft	N/A	Vis Dependent	85 - 110 kts

Table Three: LOGISTICAL INFORMATION

DETECTION METHOD	LOGISTICAL NEEDS				
	Platform	*Recording*	*Geo Referencing*	*Data Tracking*	*Recommended Special Equipment*
Side Scan Sonar	Vessel	Portable HD	GPS	Survey/ Acquisition/ Processing Software	Winch
Side Imaging	Vessel	Portable HD / RMU	GPS	dB	Extension Cable, Pole/Mount
Multibeam Sonar	Vessel	Portable HD	GPS	Survey/ Acquisition/ Processing Software	-
Diver Tow	Vessel	Video/Still Camera, Underwater Writing Tablet	GPS	dB	Manta Tow Bar
Video	Vessel	Video/Still Camera, Writable Surface	GPS	dB	Pole / Mount
Surface Visual	Vessel	Video/Still Camera, Writable Surface	GPS	dB	-
Aerial Visual	Plane	Still/Video Camera	GPS	dB	Synchronized GPS + Camera timestamps

GLOSSARY:

SAV	**S**ubmerged **A**quatic **V**egetation
SSS	**S**ide **S**can **S**onar
Vis	Visibility
HD	**H**ard **D**rive
GPS	**G**lobal **P**ositioning **S**ystem
dB	Database
RMU	**R**emovable **M**emory **U**nit (e.g., flash or USB drive)

ABSTRACTS AND PRESENTATIONS

OFFICE OF RESPONSE AND RESTORATION • NOAA's NATIONAL OCEAN SERVICE

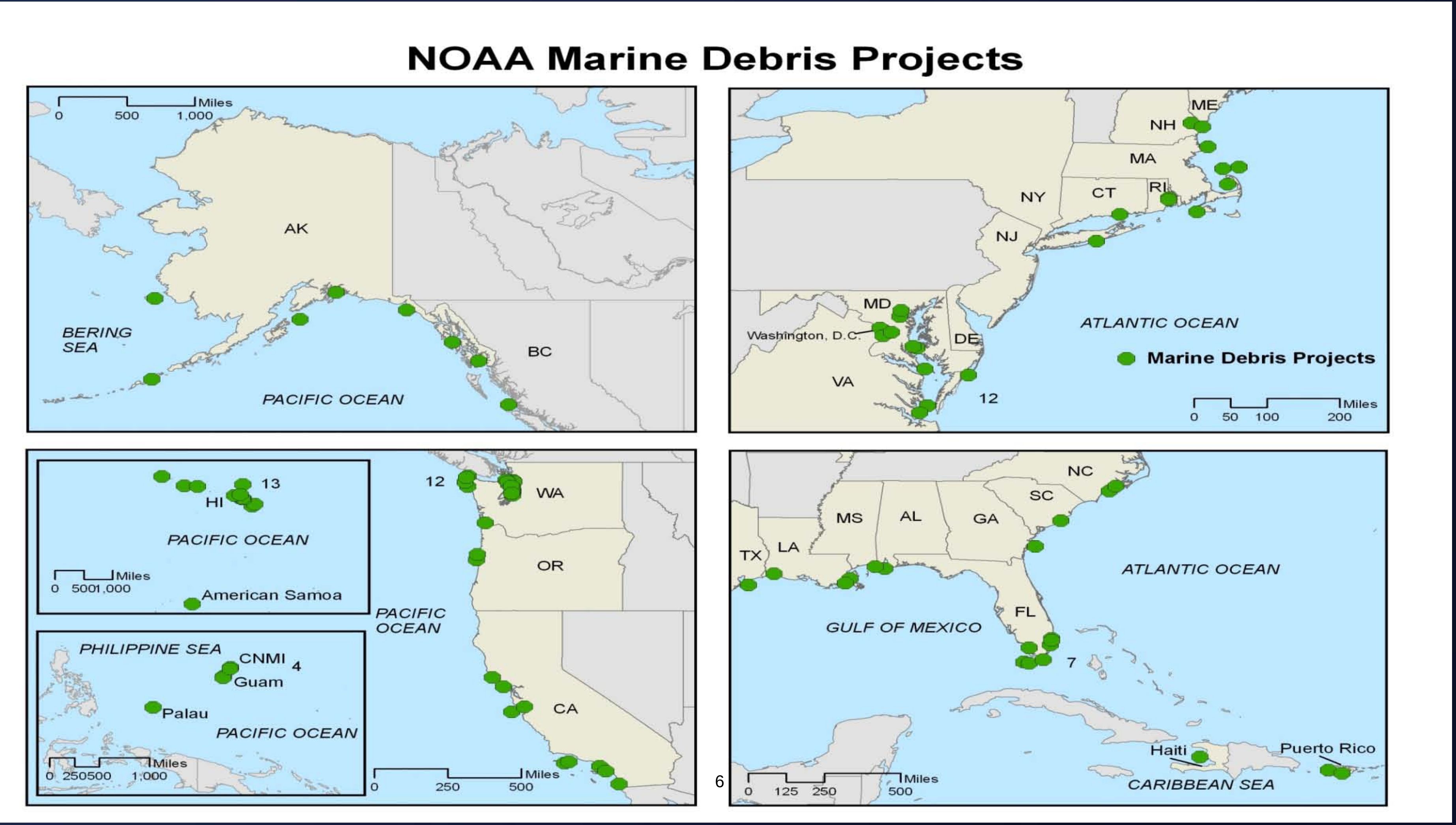
NOAA Submerged Derelict Trap Methods Detection Workshop

Introduction, Purpose and Expected Outcomes

Courtyard by Marriott
Silver Spring, Maryland
June 2-4, 2009

Holly Bamford, Ph.D.
NOAA Office of Response & Restoration
Marine Debris Program, Director

Previous Allocation of MDP Resources 2005-08



2009 Program Re-Focusing

Regional workshops
- Hawaii
- Alaska
- New England

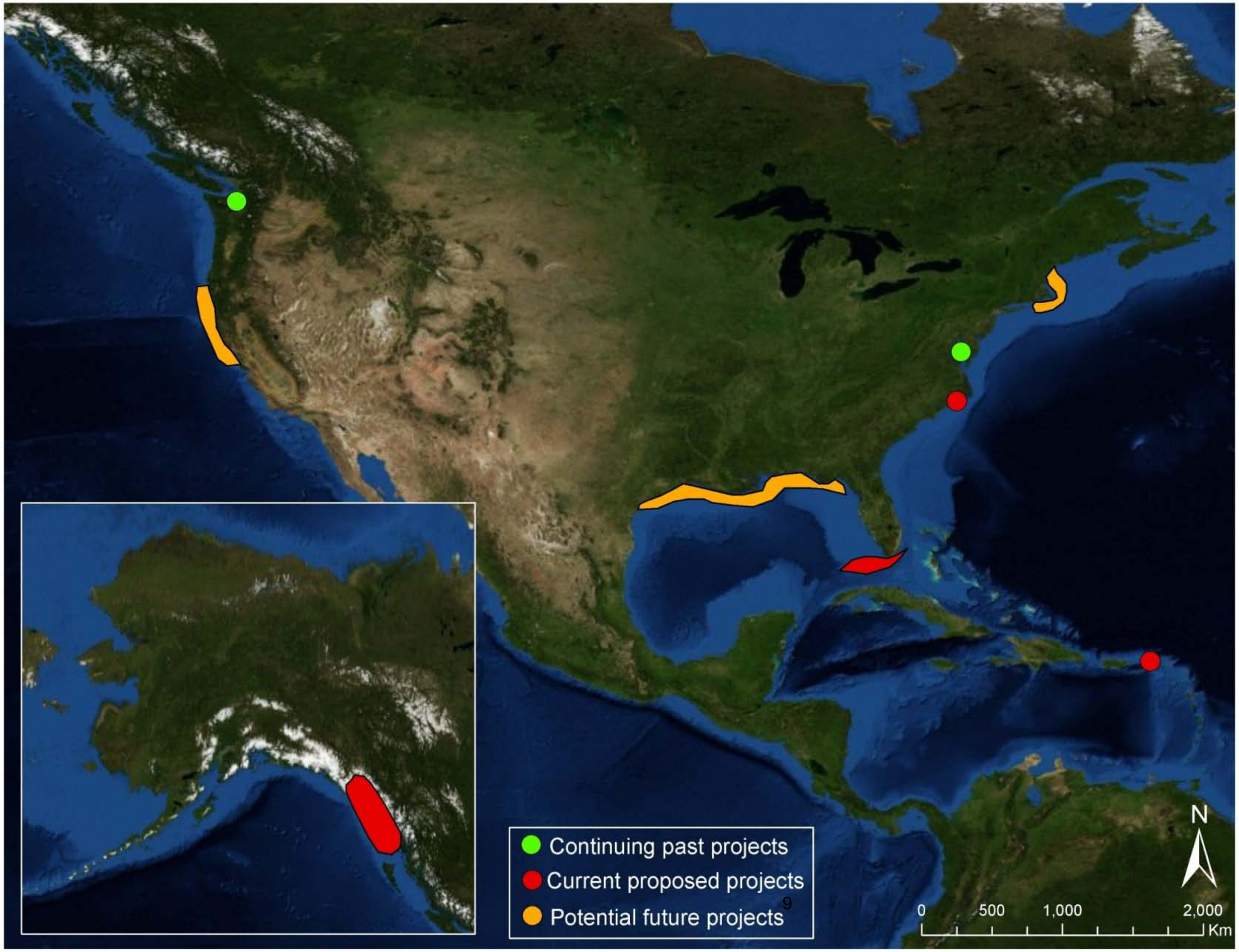
- Information Forum 2008 and Regional workshops
  - Assessment of what we know, what we don't know and what we need to know
  - Regional needs aligned with NOAA's mandates
- Development of a strategic plan
  - Base funded
  - Performance measures
- Focus efforts through research and internal projects
  - Move from proposal request to partnership projects

2009 MDP Priorities

1. Monitoring - National Marine Debris Quantification Index
   1. Quantify the density of marine debris along coastal shorelines, sediment/sand grabs, pelagic, and submerged.

2. Smart Partnerships
   1. Partnership grants
   2. Engage academia
   3. Investigate popular questions - GGP

3. Research - Assess impacts of Derelict Traps
   1. Species impacts (targeted and non-targeted species)
   2. Habitat impacts
   3. Economic impacts



Pot and Trap Fisheries

Dungeness
Spiny Lobster
American Lobster
Blue Crab
Fin Fish
Black Sea Bass
Stone Crab

Purpose of the Workshop

1. Compile and summarize derelict trap/pot assessment techniques
    1. Move towards standardization
    2. Sharing of information
    3. Reduce the likelihood of reinventing the wheel

2. Develop a national understanding of trap/pot impacts
    1. Links across projects
    2. Regional comparisons
    3. National significance

3. Develop better coordination and communication

Plan for the next three days

- Tuesday
  - Technologies to detect pots and traps
    - Occurrences, densities, conditions
  - What works, what doesn't, recommendations
- Wednesday
  - Impact assessments
    - Laboratory, controlled, and field observations
  - What works, what doesn't, recommendations
- Thursday
  - Utilize information from Tuesday – Wednesday to develop project plans for current proposed projects

Project Plans

1. Quantify the fishing effort in the region, percent of traps lost annually, causes of trap loss

2. Determine the number of derelict traps in study area
   1. Densities correlated with another parameter (habitat type, fishing efforts)

3. Derelict pot durability and behavior
   1. Rot cord, aging, lifetime, storm impact, navigation and fishing impact

4. Derelict trap impact quantification
   1. Targeted species mortality rates
   2. bycatch and mortality rates
   3. Habitat impacts

Expected Outcomes

- Extended Proceedings
  - Abstracts
  - Presentations
  - Discussions and recommendations from workshop
  - Contacts

- Draft Project Plans
  - Alaska
  - Florida
  - South Carolina
  - Caribbean (USVI)

Questions when Deciding on Side Scan Sonar/Things to Keep in Mind
Peter Murphy, NOAA

When setting out to locate sub surface targets, there are a number of variables whose answers, when taken together, can provide valuable insight on the most likely detection technique to provide optimal data. As new and more advanced detection technologies continue to be introduced, the list of potential detection techniques continues to grow as well. As presentations from experienced field staff during this workshop will demonstrate, the variables which dictate best practices can vary significantly both at a regional and local level. However, in order to facilitate communication and potential cross comparison, these variables have been collected from multiple projects to begin a rough framework of the key factors a user should take into account when designing the protocol for their detection effort. This list is not meant to be exhaustive, but rather to serve as a starting point for discussion and modification by the workshop attendees.

STEP ONE:

- How large is the area of study?
- What level of target detail is required?
- What data is required from processing of survey results?
  - Focused on pot/trap count and locations, or inclusive of species population data?

RESULT: Base technology selected – Side scan sonar, Mulitbeam sonar, video survey (ROV or tow)

STEP TWO:

- What is the depth of the water to be surveyed?
- What is the expected size of the smallest object necessary to be discovered?
  - For traps, what is the smallest trap or trap fragment which must be reliably discovered?
- What is the bottom topography?
  - Are there obstructions likely to cause acoustic shadowing?
- What is the bottom habitat?
  - Are there areas of concentrated plant-life?
- What is the degree of accuracy required for geo-referenced positions of pots?

RESULT: Planned base protocol selected, including frequency, planned target survey approach.

Abstract

Playing Hide and Seek with Derelict Pots:
Lessons learned during the Northwest Straits Initiative's derelict fishing gear survey and removal project.

Jeff June, Natural Resources Consultants, Inc. and the Northwest Straits Initiative

Sidescan sonar has been the mainstay of the derelict pot/trap detection methodology during the Northwest Straits Initiative's (NWSI) derelict fishing gear survey and removal project that began in 2002. The method provides a cost effective means of surveying a large area of seabed and detecting, and more importantly, accurately identifying and locating derelict pots and traps. A 28 foot aluminum skiff equipped with an outboard motor and a 600 kHz Marine Sonics® sidescan sonar tows a heavy towfish off a winch on the bow. The towfish is suspended approximately 10% of water depth off the seabed and towed at speeds of 2.5 to 4.0 knots. Most survey effort is conducted at a 50 m swath width (90 m overall coverage) with 20 m used in some situations and when a more detailed image is desired. Tracklines are output in Hypack, a marine navigation survey software, and area surveyed calculated and plotted on navigation charts with a GIS overlay of pot/trap targets detected. Additional equipment employed includes acoustic tracking of the towfish position relative to the differential GPS antenna on the vessel and inertial motion tracking of the pitch and roll of the vessel to correct for target location in deep water situations. Operational adjustments are necessary to correct for temperature and salinity aberrations, steep side slope conditions, vessel pitch and roll, towfish layback and offset and detection of interference from non-trap/pot targets is discussed. The NWSI sidescan sonar surveys produce detailed location information that allows divers to return days or even months later to within 2 to 3 m of the pot/trap location and conduct removal operations. Since 2002, 50 days of sidescan sonar surveys have detected 5,120 derelict pots/traps in Puget Sound, Washington. The NWSI methodology has been employed to find derelict traps/pots in California and North Carolina.

Side Scan Sonar Techniques in Chesapeake Bay - Maryland

Steve Giordano, NOAA CBO; Ward Slacum, Versar; Jay Lazar, NOAA CBO

In 2005 the NOAA Chesapeake Bay Office (NCBO) established the Derelict Fishing Gear Program (DFGP) to address concerns that derelict crab traps may be negatively affecting blue crab and other estuarine species in Chesapeake Bay. In order to effectively determine the overall effects of derelict traps, specific information on species mortality and injury are required along with the number of derelict traps residing in the system. Because traditional observational methods are hindered in the Bay by turbidity, side-scan sonar was used to identify and quantify the densities of derelict traps. In Maryland, a stratified random sampling design was developed that used side-scan sonar to collect transect data within areas of differing fishing activity. The processed sonar data were reviewed in a desktop analysis to quantify derelict traps in the imagery. Reviewers were trained to identify derelict traps through repeated ground-truthing surveys and reference imagery. Placing controls in the final data set assessed the accuracy of trap identification. Several lessons were learned throughout this project. Repeated evaluation and refinement of survey and groundtruthing methods is advised before during and after project completion.

Chesapeake Bay Virginia – Derelict Pot Assessment and Impacts

Abstract
Lost or abandoned (derelict) commercial fishing gear, including nets and pots, can present safety, nuisance, and environmental impacts in estuarine waters. Blue crabs and various fish species that are entrapped and die in derelict traps can act as an attractant to crabs resulting in a self-baiting effect. Derelict fishing gear damages sensitive habitat and continues to capture both target and by-catch species, leading to reduced fitness and significant acute and delayed mortalities (High and Worlund 1979; Guillory 1993; Bullimore et al. 2001; Guillory 2001; Matsuoka et al. 2005; Havens et al. 2008). Animals captured in derelict pots experience starvation, cannibalism, infection, disease, or prolonged exposure to poor water quality (i.e., low dissolved oxygen) (Van Engel 1982; Guillory 1993). The effect of derelict blue crab pots on diamondback terrapins (*Malaclemys terrapin*) and commercially important finfish has been documented (Smolowitz 1978; Guillory 1993; Roosenburg et al. 1997; Guillory and Prejean 1997). In the Gulf of Mexico, evidence that derelict pots contribute to significant mortalities in the blue crab fishery prompted the development of removal strategies to reduce the ecologic and economic impacts of derelict traps (Guillory et al. 2001).

In Florida, Alabama, Mississippi, and Louisiana, estimates derived from pot loss calculations suggest derelict pots numbered at 605,000 in 1993: though Guillory and Perret (1998) state that this number probably is an underestimate. Guillory et al (2001) using an annual total number of pots fished commercially at 1 million and a 25% loss/abandonment rate suggests 250,000 derelict pots are added to the Gulf of Mexico annually.

Investigations by the project team using side-scan sonar were conducted to locate derelict traps and assess their extent and accumulation rate. Additional investigations using experimental pots were conducted to calculate catch rates of marine organisms, trap degradation rates, and test degradable trap material (rot cord, degradable panels). It is estimated that about 20% of deployed traps are added annually to the Virginia portion of the Chesapeake Bay derelict pot population. Species captured in these lost or derelict pots include blue crab, croaker, perch, catfish, spot, red drum, striped bass, flounder, muskrat and diamondback terrapins. Derelict pots have been shown to captured between 50 and 100 blue crabs per trap per season and over a dozen croaker per pot per season. Of the blue crabs captured by derelict pots, a significant portion is comprised of reproductively viable females that, if they remained in the population, could produce 2 to 3 broods of a couple million larvae each. Derelict pots continued to capture organisms for over three years after they are lost, depending on salinity and energy levels, which suggests derelict pots could affect blue crab populations (Havens et al. 2008; Havens, personal observation).

An effort to remove derelict crab pots was conducted in Virginia during December 2008, January, February and March 2009. Fifty eight commercial watermen participated using Humminbird Side Imaging units and removed over 8,600 derelict pots which contained over 5,000 organisms (http://ccrm.vims.edu/marine_debris_removal/). This project will continue in the winter months for no more than two more years. With an annual accumulation rate of derelict pots estimated at about 20%, it is important to have a mechanism in place, once the removal program ends, which will render lost or derelict crab pots ineffective at capturing organisms.

In an earlier NOAA Marine Debris program/ National Fish and Wildlife Foundation study, “Testing of gear modification for blue crab traps”, the project team investigated the use of various degradable components on commercially available pots. The project’s four working assumptions were 1) the modification must render the pot ineffective of capturing marine life within one season of loss, 2) the material, once degraded must be environmental neutral, 3) the modification must be relatively inexpensive in order to be of practical use and 4) the modification must be relatively easy to enforce. Some states along the east and gulf coasts (Florida, New Jersey, and Texas) require biodegradable material on pots but most (Alabama, Delaware, Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Virginia, and the Potomac River Basin Commission) do not.

The study found that degradable (rot cord) latch connectors were not as effective at allowing escape as degradable cull ring panels. Seventy eight percent of the crabs entering pots modified with degradable plastic cull ring panels escaped within 1 hour as compared with pots modified with rot cord latches (14%) and gapped openings (11%) The odds of escape in the first 4 hours from a trap modified with a gapped opening or degradable rot cord are 5 times lower than the odds of escape from a trap modified with degradable cull rings. Experiment replicate number did not affect the odds of escape within 4 hours (Log-Likelihood = -45.188, G = 48.456, df = 4, p-value = 0.0001). Cull rings, or escape rings, allow small sublegal crabs to escape pots and commercial watermen must install them on pots anyway. In fact, the study found that simply relocating the cull ring from the upper chamber wall to flush with the upper chamber floor increased the likelihood of escape by undersized crabs by 39 times (Havens et al. In Press). The cull ring ‘panels’ expand the size of the units so that, once degraded, the hole matches the entrance funnel size. In practical terms, anything that can enter the pot would then be able to escape. The study found the best candidate, which met all four criteria, was the environmental safe degradable plastic polypropylene or polycaprolactone. The degradable plastic timeframe, which degrades in one season, coincides with annual removal and repair of pots and will allow for seasonal replacement of panels.

North Carolina Derelict Crab Pots: Shallow Water Side Scan Sonar Efforts

Andy Wood, Audubon North Carolina

Side Scan Sonar Survey Efforts

Several ongoing studies have proven Side Scan Sonar as a valuable tool for locating Derelict Crab Pots, though many studies have been conducted in water greater than 12 feet (four meters). The 2008-09 North Carolina DCP effort is focused on shallow water marsh and estuary habitats because a primary goal of this study is learning about impacts of DCP to the Diamondback Terrapin, *Malaclemys terrapin spp.*; a shallow-water reptile that is known to enter both active and derelict crab pots.

Using a Humminbird 1197c Side-Scan Sonar with built-in GPS, we have been able to survey more than 150 linear miles of coastline, particularly the Intracoastal Waterway and tidal creeks in SE North Carolina. The sonar unit includes a transducer and GPS which we mounted to a wooden out-rig that can be modified for use with different boats. To date we have run the rig from four separate vessels, though most of our work has been conducted from an 18 foot flat-bottom Southern Skimmer.

Sonar surveys are conducted to locate and record DCP and this information is collected on a 4 gigabyte high definition data card for later analysis. The sonar unit records water temperature, depth, vessel speed, direction, and GPS location. We carry a hand-held GPS to pinpoint DCP that are not accessible by boat. We also record salinity using a hand-held refractometer.

Our study originally attempted to survey selected regions of the entire NC coast but owing to inherent challenges including the large expanses of water associated with each survey site, a revised plan was developed in order to more fully explore the most likely places where commercial and recreational crabbing coincide with suitable terrapin habitat. While we were able to access and survey some 23 linear miles of Pamlico Sound on and around the dredge islands and shell rakes west of Ocracoke Island on the Outer Banks, our work north of there has been curtailed by inclement weather, especially heavy winds that create dangerous chop for our shallow-draft vessels.

Our work around Ocracoke was productive and included locating and removing several DCP from colonial waterbird nesting islands. We also observed one large live terrapin; one of the few we have seen during the study period. Conversations with former Outer Banks watermen, very familiar with the waters and crabbing industry, indicate that many DCP are lost due to boat propellers cutting the buoy line. Watermen in the area try to retrieve their valuable pots but storm-induced currents move the pots, including pots with rebar weight, and many are covered by shifting sands or incorporated into shell rakes; the latter example being something we observed during our survey.

Side-scan sonar was employed around several islands and shell rakes in depths up to about 12 feet. Numerous channels meander throughout Pamlico Sound and the challenge we faced was staying out of the deep channels (some over 20 feet deep) while not running aground. Our sonar surveys in deep water were conducted as a means to collect images to contrast and compare with shallow water sonar images. The results proved that the sonar system could recognizably detect DCP in both deep and shallow water (albeit deeper than two feet).

Conversations with former watermen indicate that commercial crabbing on the Outer Banks is an industry in some distress, though for unknown reasons. Many crabbers have abandoned the practice without passing the tradition to their offspring. We plan to explore a northern part of the Outer Banks near Oregon Inlet in June; an area still commercially crabbed.

South of Pamlico Sound in southeast NC there is still an active commercial crabbing industry and it is here that our study has been focused. We have extensively surveyed the shallowest waters of Topsail, Wrightsville, and Masonboro Sounds, and the east and west sides of the Lower Cape Fear River. In all areas, crab pot buoys are seen in warm weather months and our surveys have concentrated in specific fishing spots including crab pot lines that flank the Intracoastal Waterway (ICW) and tidal creeks that flow deep enough at low tides to allow access to crab boats, as evidenced by pot buoys and DCP.

Side-scan sonar is most helpful in the ICW and tidal creeks during mid to high tides. In very shallow waters less than two feet deep the sonar is less likely to detect DCP. Also, in very shallow water we find patches of eel grass and plumes of algae that appear as amorphous clouds on the sonar screen. We have frequently investigated geometric-shaped patches of algae and been rewarded by finding a DCP within the mass.

While we are able to visually locate DCP during low tides, the shallow water prevents access by boat. This has required use of hand-held GPS units to acquire accurate location data. Tidal creeks during tide change are generally turbid to the point that DCP in three feet of water may be invisible to the naked eye and it is in these conditions that side-scan sonar is most valuable. Most surveys, even in water less than four feet deep, require sonar as the only way to locate submerged DCP. That said, pinging a DCP in four feet of turbid water does not mean the trap will be retrieved. For this reason we have employed a strategy of exploring creeks at high tide for general DCP quantitative analysis and returning at low tide for retrieval and examination.

Once located and accessed, DCP are given a cursory examination to determine associated biota around the trap. Upon retrieval, traps are further examined to find small organisms able to slip through the trap mesh including shrimps, crabs and fishes. After hauling onto the boat or on a shoreline, the trap is opened using various wire cutters and pliers and all trapped organisms identified and released. Traps that are intact are either cut open to the point they can no longer trap animals, or they are smashed flat and left in place. This is the preferred practice for two reasons:

1. the traps are themselves habitat for encrusting marine organisms including oyster, sponge, algae, barnacle and worms
2. the quantity of DCP collected is too great for our boats to hold onboard

3. cost of landfill disposal can be very high owing to the weight of encrusted traps, in addition to transportation difficulty

Whenever possible, DCP rendered unusable are placed in marsh pools where they will not interfere with navigation or migrate into areas that will be used for future recruitment study sites. Field observations indicate that DCP displaced in this manner actually become important refuge for fishes and other free-moving and encrusting organisms.

Key challenges with the sonar are related to functional depth for the transducer (damaging it while running aground), its ability to define objects in water less than two feet deep, and the fact that images appear on the sonar screen several seconds and hence several feet after an object has been passed. The latter point is especially frustrating when attempting to retrieve DCP even in shallow water.

In general, use of side-scan sonar is extremely valuable for assessing numbers of DCP in deep waters, in addition to being helpful as an augment to visual surveys in shallow waters.

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Towed-Diver Derelict Spiny Lobster Trap Surveys in Florida Keys National Marine Sanctuary

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Research Questions

To effectively manage the spiny lobster trap fishery in the Florida Keys, and the growing trap debris problem, improved efforts are needed to quantify the distribution and abundance of derelict traps and trap-generated debris and to identify habitats that are sensitive to debris accumulation in the region. In this work, we surveyed a range of EFH types from known spiny lobster fishing zones to generate estimates of abundance and distribution of derelict traps and trap-generated debris in Florida Keys National Marine Sanctuary (FKNMS). The specific objectives of this study were to (1) generate estimates of the abundance, type, and spatial distribution of spiny lobster trap debris in FKNMS; (2) describe habitat-mediated patterns of trap debris accumulation, (3) relate patterns of trap debris accumulation to known patterns of commercial trap fishing effort, (4) assess the impact of derelict traps on selected habitat types, and (5) calculate mortality and by-catch rates of derelict traps.

Site Information

We used a geographic information system (ESRI® ArcGIS®) and a digital database of the benthic habitats and bathymetry of the Florida Keys to facilitate spatial delineation of the sample universe, sampling strata, and sample units. The sample universe encompassed all benthic habitats ≤ 15m deep located within the boundaries of FKNMS, from northern Key Largo to southwest of Key West. The sample universe was partitioned into six regions (strata) reflecting historic trap-use patterns in FKNMS, consisting of the Upper, Middle, and Lower Florida Keys on both the Atlantic Ocean and Florida Bay sides of the Florida Keys island chain.

Survey Technology / Methodology / Data Recording

The sample universe was overlain in ArcGIS with grid of 1 minute latitude × 1 minute longitude cells. Within each trap-use region, twenty grid cells to be sampled were randomly selected *a priori* from the all-inclusive list, with the center point of each cell serving as the start point for a single towed-diver survey transect (sample unit). The center point of each randomly selected grid cell was navigated to using a Garmin GPSMAP® 3206 chartplotter. Paired SCUBA divers were deployed with tow boards in hand, each equipped with a re-usable data sheet, timing device, and pencil. Tow boards were separately attached to the stern cleats of the tow boat using a 30 m long, adjustable polypropoline line. The towline was connected to a stainless steel swivel shackle attached to the towboard bridle. Placement of the towlines allowed for diver separation of 4 m. Divers were given one minute to descend and prepare for towing and towing commenced following a pre-arranged acoustic signal, at which point a waypoint was marked in the chartplotter to more accurately indicate the start of the tow. Using the chartplotter as a guide, the coxswain navigated for 1 km in the direction of a predetermined, randomly selected bearing (0 - 360°) while maintaining a speed of 1.6 knots, yielding an effective transect swath of 8 m x 1000 m (8000 m^2 or 0.8 hectares). Tow direction was altered when necessary to exclude land, boats, and other navigational hazards. Upon commencement of towing, divers launched their respective timing devices and maneuvered the tow boards to maintain approximately 1 m height off the bottom. Divers documented the type of habitat encountered at one-minute intervals, recorded individual debris items observed within 2 m on either side of their respective towline, and noted the habitat type that the debris was residing on. Habitat categories were generalized from an existing digital habitat database of the Florida Keys to include bare substrate, seagrass, hardbottom, and coral reef in addition to an unmapped algae category. After 1 km, the coxswain disengaged the boat engines and delivered a pre-arranged acoustic signal to indicate that the tow was complete. Upon cessation of towing, divers recorded the total tow time and used line pulls to signify disengagement from the tow boards. The divers then safely ascended to the surface and were retrieved by the boat. Immediately following diver retrieval, all data from the tow board data sheet was transcribed to an exact replica of the data sheet that had been copied to water-proof paper and secured in a dry box. The tow board data sheets were then erased for use in subsequent tows. At the conclusion of a field sampling event, the data was entered into an electronic database created in Microsoft Access.

Lessons Learned

Tow Methodology

"Quick-release" floats were mounted to the tow boards enabling the divers to indicate the location of whole or broken traps to be assessed for habitat impacts at the conclusion of a tow. It became apparent early on that this technique was not an effective mechanism to mark traps for a number of reasons. The drag forces experienced by the floats during towing caused them to come undone on a number of occasions, creating a potential entanglement hazard and leading to the termination of the tow. Oftentimes, although the float was released from the tow board, it did not completely unravel and thus was not visible at the surface. A number of floats that were successfully released were never re-located, particularly during choppy seas when visibility of the floats was compromised.

Data Analysis

The inability to effectively mark traps "on-the-fly" for relocation, prevented any determination of habitat impacts from existing derelict traps and trap-related debris and led to the use of experimentally deployed traps to address this question. The same situation arose for attempting to assess by-catch and mortality rates. It is our opinion that this issue will also need to be addressed utilizing experimentally deployed traps which can be secured in a known location and monitored over time.

Of 96 total random tows, only 22 had ghost traps present, consisting of both derelict stone crab (18) and spiny lobster (17) traps. The non-normal distribution of derelict traps observed per transect provides reduced capabilities for extrapolating the number of derelict spiny lobster traps Sanctuary-wide. However, we can conduct a power analysis to determine the number of tows required to develop a more robust trap loss estimate.

Data Storage

Due to differing preferences in software usage between the PI's, the Microsoft Access database was converted to a Microsoft Excel spreadsheet which resulted in a number of duplicate data records. As such, a fair amount of time was spent conducting quality control to ensure that the duplicate entries were indeed duplicates and if so, subsequently removed from the spreadsheet.

Recommendations

Given the location, water quality, and specific questions to be addressed, towed-diver transects proved to be an effective method for surveying derelict spiny lobster and stone crab traps and trap-generated debris in FKNMS. The status of traps (fishing or not) was easily classified and trap-related debris was readily identifiable by divers. Because habitat information was gathered “on-the-fly”, ground truthing was not required. Abundance and distribution estimates were easily estimated for trap-use regions and habitat type.

Dual-frequency identification sonar (DIDSON) has been shown to successfully identify wire blue crab traps in Pamlico Sound, North Carolina (soft bottom substrate, some vegetation). The use of such sonar in FKNMS has yet to be tested and may increase the ability to cover larger areas. Although whole-trap detection appears plausible, the ability to identify trap-related debris (i.e., slabs, slats, throats) remains to be seen, particularly in reef environments.

Derelict Crab Pot Impact Studies: Impact, morality and loss-rate.

Jeff June, Natural Resources Consultants, Inc. and the Northwest Straits Initiative

The Northwest Straits Initiative's (NWSI) derelict fishing gear survey and removal project that began in 2002 takes a science-based approach to derelict fishing gear removal. Divers and onboard biologist record information on derelict pots/traps found and impacts on marine habitat and animals. Additional studies have been conducted to estimate annual mortality of Dungeness crab (*Cancer magister*) and red rock crab (*Cancer productus*) from derelict crab pots and to estimate pot loss rates in recreational and commercial crab fisheries in Puget Sound.

Information collected during derelict pot/trap removal includes habitat type, water depth, number of live and dead animals entrapped by species, pot type (recreational or commercial), pot condition (fishing/not fishing) and the use and condition of required escape cord. If ownership can be determined, owners are allowed the opportunity to recover their pot/trap. Divers have removed 1,652 derelict crab pots during 72 diving days and collected data on 1,360 pots including 624 (46%) recreational pots and 736 (54%) commercial pots. Actively fishing pots totaled 491 (36%) and inactive pots 869 (64%). Although escape cord is required on pots by state regulation, 277 of the 1,360 pots (20%) were not equipped with escape cord. A total of 2,225 live and 519 dead animals were entrapped in the 1,360 pots. Derelict pots lost in eelgrass habitat were found impede eelgrass growth under the pot footprint and, in some cases, result in larger areas of eelgrass loss due to current scouring around the derelict pot. In an ongoing habitat recovery study, eelgrass density improved about 30% one year area derelict pot removal.

A study of 24 simulated recreational and commercial derelict pots is ongoing but preliminary information indicates that derelict pots without escape cord may kill between 0.062 to 0.083 Dungeness crab per day or 22 to 30 crabs per year until the pot deteriorates and stops fishing and use of escape cord may decrease mortality by 70%.

Subareas within two popular recreational and commercial Dungeness crab fishing areas were surveyed for derelict pots with sidescan sonar and divers removed all of the derelict pots. The areas were resurveyed after one fishing season and the number of newly lost pots provided an estimate of loss rate of crab pots per unit of seabed. In Dungeness Bay, a rather secluded bay with very little no fishing vessel traffic, pot loss rates ranged from 5.3 pots/km^2 between 2003 and 2004 to 13.4 pots/km^2 between 2007 and 2008. In Port Gardner, near the entrance to an active urban marina and on an industrial marine vessel transit zone, pot loss was over ten fold higher at117.9 pots per km^2.

Chesapeake Bay, Maryland – Derelict Pot Assessment and Impacts
Steve Giordano, NOAA CBO; Ward Slacum, Versar; Jay Lazar, NOAA CBO)

In 2005 the NOAA Chesapeake Bay Office (NCBO) established the Derelict Fishing Gear Program (DFGP) to address concerns that derelict crab traps may be negatively affecting blue crab and other estuarine species in Chesapeake Bay. Two types of information were being collected in the Maryland Bay to determine overall effects. A side-scan sonar survey was conducted in areas of the Bay where the commercial hard crab fishery occurred (1,785 km^2) to quantify derelict traps from the imagery, and a field experiment simulating derelict traps was also conducted to provide data on species mortality and other vital details. Based on the sonar survey it is estimated that nearly 85,000 traps could be on the bottom of the Maryland Bay and that the majority of these are near river mouths and in shallow to intermediate depths (1-8 m). Blue crab mortality was 19 crabs/trap/year in experimental traps and several species of bycatch were also documented including white perch, oyster toadfish, and spot. In the context of population impacts, the mortality rates of blue crab may not be significant when compared to commercial harvest or the overall abundance of crab in Chesapeake Bay. However, most of the areas that exhibit high derelict trap densities can be consider sensitive and ecologically important habitats for blue crab and other species. Therefore, targeted derelict trap retrieval efforts are recommended in addition to extensive education and outreach efforts to the public and commercial fishing industry.

Derelict Blue Crab Traps in the Virginia Portion of the Chesapeake Bay

David Stanhope, Kory Angstadt, Kirk J. Havens, Donna Marie Bilkovic
Center for Coastal Resources Management Virginia Institute of Marine Science
www.ccrm.vims.edu

See Abstract pages 17-18

North Carolina Derelict Crab Pots 101: shallow water efforts

David S. Lee, The Tortoise Reserve

For the past year Audubon North Carolina and The Tortoise Reserve have been working under a NOAA contract on issues related to abandoned and derelict crab pots in shallow water (<12 feet) portions of estuaries in North Carolina. Fortunately, NC Marine Fisheries has been looking into the problems associated with derelict pots for a number of years so we have a lot of unpublished back ground information that they have kindly shared. Our first contract year was primarily devoted to developing survey and removal methodology and identifying possible solutions. The main focus of our effort has been the effect of crab pots on local diamondback terrapin populations.

Terrapins are particularly vulnerable to drowning in crab pots, and because of their limited annual reproduction, slow growth, and longevity populations can quickly become depleted. Studies by others have shown that several decades of crabbing can deplete terrapin populations to the point that they will not recover. Terrapins suffer from a number of other conservation issues, but crab pots are believed by terrapin researchers to have a greater negative impact on local populations than all other factors combined. Most activity for diamondback terrapins occurs in shallow waters within 50 yards of land. Locating and removing pots from shallow water has resulted in some unanticipated challenges.

Surveys:

Two **air surveys** for crab pots were conducted during our study period. These surveys covered the area from the NC/SC line northward to Topsail Island, about 1/3 of the North Carolina coast. From these surveys we learned the following:

- Surveys need to be conducted from late winter through spring when water clarity is best.
- Surveys conducted during low tide on sunny days, with light to no wind, yield better results due to greater visibility.
- Air surveys are not appropriate for many areas because water depth, turbidity around inlets and the mouths of rivers, and other local conditions negatively affect trap visibility.
- Because of the extensive amount of land under military control in our study area large portions of the state’s coastal areas, including many of the sounds, are off limits to private aircraft.
- Federal aviation rules prevent low elevation flights in heavily developed coastal communities, which include some of the key crabbing areas.

- Accurate GPS readings for derelict pots are not possible from the air because the plane cannot be directly over the pots when pots are spotted.

- Slow moving (75-80 mph) aircraft flying at 300-500 feet can detect buoys of active pots as well as abandoned crab pots in clear shallow water. Approximate locations of abandoned crab pots can be identified on maps or in relation to fixed objects (bridges, boating channels, water towers, residential homes, etc.) The square nature of the pots can be seen from above and they stand out rather well. Pots that are damaged or covered irregularly with growth are not as apparent.

Air surveys would appear to be a quick and cost efficient way of locating areas of abandoned crab pot concentrations because extensive areas of coastline, marshes, tidal creeks, and sounds can be surveyed in hours. Air surveys give a quick overview as to where pots are being actively fished and thereby can be used as a reference of likely places to search for derelict pots even when derelict pots cannot be seen from the air. Actively fished pots have buoys that can be spotted from the air at all seasons regardless of water depth and turbidity.

In that all abandoned pots are not likely to be spotted from the air and pots in <3feet of water (depending on conditions) are not likely to be seen, air surveys are not recommended as a substitute for boat and/or side-scan sonar surveys. They should be most useful for locating areas of concentrations of abandoned pots for removal when time and other resources are limited and one wants to obtain maximum efficiency in pot removal in a short time period.

Visual surveys from boats are an effective way to locate, examine and remove shallow water derelict crab pots. Pots are most easily detected during low tide but the shallow nature of most tidal creeks within the marsh makes access difficult until high tide. Entering creeks during falling tides can lead to stranding of boats of crews, damage to the boat and to side-scan sonar units. Timing by season is also critical; water is clearest from mid winter through mid spring. During warmer seasons we found that pots were often not visually detected even when in as little as 12-18 inches of water. The warm estuarine waters support massive blooms of microorganisms that cloud the water. Visual surveys are the only way to detect partly submerged traps immediately adjacent to land and discarded ones that had been tossed into the marshes.

Results of our **side-scan sonar** detection surveys have been presented in an accompanying abstract (Andy Wood). For a variety of reasons side-scan sonar is not totally effective in extreme shallow water areas.

Discussions with local fishermen were helpful in learning about local crabbing locations, seasons, and methods and indicate that the fishermen are aware of the issues of ghost crab pots and the fact that they are competing with them for fisheries resources. However, few accept any personal responsibility for the problem, as it is always other people's traps or recreational boaters cutting lines with props that are causing the problems. Historically, watermen generally resist regulation changes that would alter pot design or placement.

Crab Pots and By-catch:

Over one million commercial crab pots are fished annually in North Carolina waters. Estimates of annual commercial trap loss have been made by NC Marine Fisheries. They estimate an average 17% annual loss with a range of 14 to 21%. Loss of peeler pots averages 11% per year. The number of fished pots has increased annually from 350,000 in 1983 to 1,285,748 in 2000. With a conservative estimate of 5-6 years of trap life for abandoned vinyl coated wire pots the number of viable ghost pots probably exceeds one million. In one study area in the southeastern part of the state we documented an 8-15 to 1 ratios of ghost to actively fished pots. Discussions with one fisherman indicated a loss of all but 8 of 30+ pots he had set the previous season.

Removal of abandoned and derelict pots is limited to a 15-day closure period in mid winter. During this time NC Marine Fisheries typically removes 5,000-8,000 pots per year with a ratio of about 4 to 1 of abandoned to ghost pots, as the ghost pots are more difficult to locate. They only cover a small portion of the state in any given year. For several regulatory and safety reasons the general public is not allowed to participate in crap pot clean up activities.

Information we recorded on derelict pots included location, depth/tide, water temperature, salinity, condition of the pot, by-catch, and trap associates. We also noted wire color, presence of cull rings, and when possible reason for trap loss. A large proportion of the loss seems to be from lines run over by recreational boaters as the crabbers often set traps immediately adjacent to the Inter-coastal and other waterways. NC Marine fisheries reported major trap loss after various hurricanes in the 90’s. Recreational pot loss appears to result mostly from faulty knot tying and neglect.

The state of abandoned and derelict traps is variable. Our data is mostly from traps recovered from 0-3 feet of water where trap decomposition is probably accelerated due to tidal exposure and an unknown percentage of damaged traps being ones tossed into shallow water and into intertidal areas to ‘dispose’ of them. We scored traps on a scale of 0-10 with 0 being intact new traps and 10 being rusted piles of wire. In shallow water zones less than 30% of the ghost pots were active, while 60-85% of the abandoned pots were actively capturing estuarine organisms.

The major **by-catch** species of ghost crab pots is the blue crab (91% of by-catch), with fin-fish making up 9%. Ghost pots catch 40-60 crabs per year although there is a 50% escape rate. By-catch is higher in peeler pots as escape rings are not required by state regulation. As a ball park figure, based on annual trap loss, trap life span of neglected pots, and number of crabs trapped per pot per year, minus a 50% escape rate, a conservative estimate of annual market sized blue crabs lost to ghost fishing is 10-15 million crabs in NC. The actual loss is certainly much higher. The blue crab supports the largest fishery in North Carolina with an average of over 43 million pounds per year landed since 1994.

Recreational crabbing in many aspects has more of an impact on terrapin by-catch issues than does commercial crabbing. Water front rental properties often provide crab pots and the renters have little knowledge of estuarine environments and proper use of such traps. Pots can remain deployed and unchecked for weeks, and lost pots tend to pile up under docks and are not recovered as the rental agents simply replace them with new ones. Recreational pots tend to be fished almost exclusively in shallow water and close to shore and in some areas do considerable damage to local terrapin populations. These same issues may also apply to the peeler crab fishery but we have not yet had the opportunity to look into this.

Recommendations:

From an ecological perspective there are some advantages to derelict crab pots, after less than two to three years in the water the substrate provided by the wire allows for substantial colonization of encrusting marine organisms. Oysters and ribbed mussels represent the major component of the biomass; we use the sizes of the former as a means for estimating the time the trap has been submerged. The traps produce miniature hard bottom real estate that is used by a variety of sponges and marine alga. Brittle stars, sea urchins, mud crabs, hermit crabs, various types of other crustaceans, tunicates, gobies, pinfish, oyster toadfish and other estuarine species inhabit the traps or a regular basis, and often in considerable numbers. Because of this traps we locate that are no longer functional have been for the most part left in place. Intact pots with impressive assemblages of associated marine biota are made inoperable and left in place.

Based on what we have learned to date we will make the following **recommendations** to N C Marine fisheries regarding proposed crabbing regulation changes in 2010.

- Revise regulations to require By-catch Reduction Devices for terrapins. The need and practically of these devises has already been established in studies both in North Carolina and other states. These devices should be required on all commercially sold pots, all recreational pots and any commercial pots fished in < 12 feet of water and/or within 100 yards of land. Traps used for peeler crabs are set in spring in shallow water and would benefit from even smaller sized opening in reduction devices. These would not affect the size or number of peeler crabs caught. It would be best if the excluders were installed at time of manufacture. We feel it is unlikely that recreational or commercial crabbers will install the excluders themselves.

- Soak times of 3 days or les are recommended.

- Biodegradable panels on all new traps sold in North Carolina should be required.

- Identification of trap ownership needs to be attached to the trap itself as well as the marker buoys.

- Permits to remove derelict pots should not be required, and permission for removal of abandoned and unidentified pots during the 15-day closure period should not be required. As it now stands waterfront property owners and coastal conservation groups cannot legally remove ghost or abandoned pots.

- Counties need to change regulations so that pots that are removed can be disposed of in public landfills for no charge.

- The current practice of out of season stacking and storage pots on estuarine islands and other water front areas needs to be discontinued as often pots are not retrieved and winter storms wash pots into the adjacent waters.

Research and Education:

While the overall effort will clearly benefit from **additional research** much can be learned from research into crab pot and terrapin issues already conducted both in North Carolina and nearby states. We discourage continuation of duplicate studies as awaiting for results only further delays a State-wide decision process. It is clear that the derelict pot issue is of both commercial and conservation concern and needs to be actively dealt with. Several local key studies have been conducted in the 1980-90's that indicate the need for regulatory change. In addition to our work, several terrapin studies are currently in progress by UNC-Wilmington and NC Marine Fisheries continues to collect data on derelict crab pots.

Inventories of by-catch under estimate the total amount of damage done by a single pot due to decomposition and predation rates of the various trapped organisms. In 2010 we will be studying the decomposition rates of terrapins and other by-catch species at different water temperatures and salinities and with different predatory by-catch associates, as well as rates of trap breakdown. These studies will be in controlled tidal lagoons in partnership with the Institute of Marine Science. We will also examine rates of ghost trap recruitment in specific areas once all ghost pots have been located and cleaned out of specific study areas.

In order to prevent this from being an ongoing problem be believe that **local education** efforts and involvement of a broad conservation community should be the major focus of long-term solutions. Of prominent importance are the education of waterfront property owners and the commercial fishing community. We have made presentations and participated in a number of regional and local meetings of herpetological groups, have set up displays and given talks at weekend coastal events, and currently had a class at a coastal elementary school adopt the terrapin/crab pot issue as a two year project. We have developed a statewide working group represented by state and federal agencies, coastal military bases, National Sea Shores and Wildlife Refuges, academic institutions, public aquaria and museums, conservation organizations, and individuals in the private sector. Through this working group an educational flyer has been prepared. Additionally, we have a web site (www.Tortoisereserve.org) and a list serve for information sharing among members of our state network. Audubon produced a video about the North Carolina terrapin/crab pot issue that has been widely circulated on the Internet.

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Appendix I: By-catch species reported from abandoned and ghost crab pots in North Carolina, those in **bold** make up a significant portion of the total by-catch.

Fishes

Blue Catfish
Blue Fish
Bowfin
Brown Bullhead
Chubsucker
Conger Eel
Filefish
Gag Grouper
Goosfish
Hake
Hogfish
Northern Puffer
Northern Searobin
Oyster Toadfish
Pigfish
Pilotfish
Pinfish
Pumpkinseed
Red Drum
Raked Solefish
Remora
Searobbin
Shark Sucker
Sheepshead
Southern Flounder
Southern Hake
Spadefish
Speckled Trout
Spiny Toadfish
Striped Bass

Striped Mullet
Summer Flounder
Spiny Puffer
Spot
Stingray
Warmouth
White Catfish
White Perch
Yellow Perch

Other vertebrates

Eastern Mud Turtle
Diamondback Terrapin
River Otter
Muskrat
Grebe (sp.)
Hooded Merganser
Common Tern
Various shorebirds and rails
Reported additional mortality to Bottle-nosed Dolphins, Loggerhead, Kemp's Ridley, and Green seaturtles mostly through crab pot rope entanglement.

Invertebrates

Blue Crabs
Conch (whelks)
Florida Horse Conch
Octopus
Flat-clawed Hermit Crab
Horseshoe Crab
Miscellaneous jellyfishes
Purple sea urchins
Red Umbrella Jellyfish
Snails
Spider Crab
Stone Crab
Rock Lobster
Spiny Lobster

Lobster Trap Loss, Ghost Fishing, and Impact on Natural Resources in Florida Keys National Marine Sanctuary

Thomas R. Matthews[1] *and Amy V. Uhrin*[2]
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Lost trap estimates

Estimates of the number of lost lobster traps are available from fishery dependent and fishery independent methods. Commercial trappers responding to mail surveys conducted at the end of each fishing season report non-hurricane trap losses from 10% to 28%. The proportion of traps lost did not change despite the progressive decrease as the number of traps in the fishery was reduced from 750,000 to 499,000. Trap loss was higher during years with tropical storms or hurricanes; for example fishermen reported losing most of their traps during 2005 as a result of Hurricanes Katrina, Rita, and Wilma. These estimates suggest that, at the present time, trap losses range from approximately 50,000 to 140,000 annually. A fishery-independent survey conducted during 2007 yielded a similar estimate. Towed-divers surveyed 96 0.8 ha transects in the heavily fished 500,000 hectare portion of Florida Keys National Marine Sanctuary east of Key West and recorded 5.4 incidences of trap debris per hectare. Approximately 6% of these incidences were of ghost traps capable of catching and confining lobsters. Extrapolation of the observed number of ghost traps to the total area surveyed suggests that the number of such traps is approximately 100,000 in that area of the Sanctuary.

Derelict Trap Condition

The vast majority of lobster traps in the Florida Keys are constructed of wood (90%). The remaining traps are wood-frame traps with one or more wire sides (8%), or all wire-sided traps with a wood top (2%). Interviews with fishermen suggest that wood traps have a serviceable lifespan of 2 to 4 years before they degrade beyond repair. This variability arises from some fishermen using their traps for only 4 months of the 8 month fishing season.

A study to evaluate the length of time a lost trap may ghost fish after being lost was conducted using new traps and traps that had been fished for six months. Of the 13 new traps, 12 remained fishing after three months and 9 after 6 months, and 5 after one year. Three remained fishing after 16 months when the study ended due to the disruption of Tropical Storm Fay. Of the 11 used traps, 5 remained fishing after three months. 2 after 6 months, and 1 after one year. This trap also was still fishing after 16 months. These studies indicate that lost traps can remain fishing for extended time frames.

During surveys by towed divers, trap debris was found in varying states of decay. As previously discussed, intact traps were 5.9% of the trap debris encountered, while broken traps (12.4%), pieces of wood (32.9%), concrete slabs (14.3%), wire (2.5%), plastic (5%), and rope (26.9%) made up the remainder of trap debris.

Ghost fishing Mortality and Habitat Impact

Estimates of lobster mortality in ghost traps are not available. However inferences can be made based on studies of lobster mortality in actively fished traps. Lobsters confined in actively fished traps have a mortality rate (F_c) ranging from 0.078 to 0.099. Given the potential magnitude of the number of ghost fishing traps, ghost fishing is likely a substantial source of lobster mortality. In contrast, mortality of fish bycatch in actively fished lobster traps was rare. Mortality rates (F_c) observed from over 100,000 fishing traps indicates fish mortality is <0.001. Although juvenile fish are commonly seen in and around wooden trap debris, these fish are not confined in the traps and fish may be using the debris as habitat. The role of trap debris as settlement habitat for juvenile fish remains to be evaluated.

A survey of the distribution of traps fished on the Atlantic ocean side of the Florida Keys revealed that approximately 13% we on hardbottom habitat and 2.5% we on coral reef habitats. Routine deployment and pulling of traps placed on those habitats caused an average of 1.28 injuries to coral, gorgonians, and sponges resulting in injury to 52 cm^2 of live tissue. Most damage to these habitats occurs as traps moved during storms with sustained high winds for multiple days. On average, 18 such storms occur each fishing season. In our studies, these storms cause traps on hardbottom and reefs to move and reduce percent living cover by 10% to 20% in an average 2.9m^2 impact area.

Implications for Overall Impact

The lobster fishery in the Florida Keys has existed for decades. It appears likely that the current ecosystem reflects long-term impacts from the fishery. Increased hurricane frequency is likely to cause greater trap loss and trap movement which may exacerbate impacts to the ecosystem. More work is required to assess the potential increased fishery yield if ghost fishing mortality can be reduced. Our recent observations and evaluation of the mechanisms that cause trap impacts on habitat have provided the needed insight fishermen and fishery managers need to develop more environmentally friendly traps and lobster fishing techniques to protect sensitive habitats.

APPENDIX A: Workshop Agenda

NOAA Submerged Derelict Trap Detection Methods Workshop
June 2-4, 2009
Courtyard by Marriott
Silver Spring, Maryland

Agenda

June 2, 2009
Side Scan Sonar and Towed Diver Techniques

8:00-8:30	Registration
8:30-9:15	Welcome and Purpose of the Workshop Holly Bamford, NOAA
9:15-9:45	Questions when Deciding on Side Scan Sonar/Things to Keep in Mind Peter Murphy, NOAA
9:45-10:30	Side Scan Sonar Techniques in Puget Sound, Washington Jeff June, Natural Resource Consultants, Inc.
10:30-10:45	Break
10:45-11:30	Side Scan Sonar Techniques in Chesapeake Bay - Maryland Steve Giordano, NOAA; Ward Slacum, Versar; Jay Lazar, NOAA
11:30-12:15	Side Scan Sonar Techniques in Chesapeake Bay – Virginia David Stanhope and Kory Angstadt, Virginia Institute of Marine Science
12:15-1:45	Lunch
1:45-2:30	Side Scan Sonar Techniques in Inshore North Carolina Andy Wood, Audubon North Carolina
2:30-3:15	Diver Tow Surveys in the Florida Keys, Florida Amy Uhrin, NOAA and Tom Matthews, FL Fish and Wildlife Conservation Commission
3:15-3:30	Break
3:30-5:00	Q&A and Structured Discussion Sampling designs, pot identification, density estimates

June 3, 2009
Impact Studies

8:30-9:15	Recap of what was captured from first day of discussion (looking closely at notes)
9:15-9:45	MDP Needs and Goals Holly Bamford, NOAA
9:45-10:30	Puget Sound, Washington – Derelict Pot Assessment and Impacts Jeff June, Natural Resource Consultants, Inc.
10:30-10:45	Break
10:45-11:30	Chesapeake Bay, Maryland – Derelict Pot Assessment and Impacts Steve Giordano, NOAA; Ward Slacum, Versar; Jay Lazar, NOAA)
11:30-12:15	Chesapeake Bay, Virginia – Derelict Pot Assessment and Impacts David Stanhope and Kory Angstadt, Virginia Institute of Marine Science
12:15-1:45	Lunch
1:45-2:30	Inshore North Carolina – Derelict Pot Assessment and Impacts David Lee, Tortoise Reserve
2:30-3:15	Florida Keys, Florida – Derelict Pot Assessment and Impacts Amy Uhrin, NOAA and Tom Matthews, FL Fish and Wildlife Conservation Commission
3:15-3:30	Break
3:30-5:00	Q&A and Structured Discussion Experimental designs

June 4, 2009

2009 Project Plans drafted

APPENDIX B: Workshop Participants

First name	Last name	Email	Street	City	State	Zip	Phone
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