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The effects of bycatch reduction devices on diamondback terrapin and blue crab catch in the North Carolina commercial crab fishery

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ABSTRACT

The diamondback terrapin (*Malaclemys terrapin*) is endemic to marshes, coves, and tidal creeks on the Atlantic and Gulf coasts of the United States. Currently, the terrapin is listed as a species of special concern in several states where one of the prominent threats to populations is the drowning of terrapins in commercial crab pots. Bycatch reduction devices (BRDs) that narrow the funnel opening on crab pots exclude terrapins, but BRDs face opposition from the fishing industry due to fears that they will decrease target species catch. The primary goals of this research were to examine the efficacy of two sizes of BRDs in excluding terrapins from crab pots and to assess the impact of BRDs on blue crab catch. Crab pots were deployed in paired and triplicate designs at estuarine sites along the central and southern coast of North Carolina in the summers of 2012 and 2013. A total of 4039 legal sized blue crabs and 14 terrapins were captured over the course of the study. Bycatch reduction devices did not have a statistically significant effect on catch rates or carapace width of legal-sized blue crabs. Thirteen of the 14 captured terrapins were in control pots, and one male terrapin was captured in a pot equipped with a large size BRD. An integrated approach that combines data on the spatial ecology and demography of terrapins with information on the most appropriate BRD dimensions for terrapin exclusion is most likely to succeed in addressing the issue of terrapin bycatch.

1. Introduction

Diamondback terrapins (*Malaclemys terrapin*) are native to the Atlantic and Gulf coasts of the United States, ranging from Massachusetts to Texas (Butler et al., 2004). They are typically found in coastal marshes, coves, and tidal creeks (Whitelaw and Zajac, 2002) and exhibit high site fidelity with small home ranges (Brennessel, 2006; Harden and Williard, 2012). Terrapins are designated as a species of special concern in several states, based on evidence of population declines and local extirpation (Seigel and Gibbons, 1995). Current factors contributing to the decline of the species include habitat degradation and pollution, motor vehicle mortalities, and nest predation (Brennessel, 2006; Butler et al., 2004; Feinberg and Burke, 2003; Wood and Herlands, 1997).

Among prominent threats facing terrapins is drowning in recreational and commercial crab pots (Brennessel, 2006; Roosenburg et al., 1997). The unintentional capture of terrapins in fishing gear has become a growing concern for fisheries managers and conservationists (Bishop, 1983; Butler, 2002; Crowder et al., 2000; Dorcas et al., 2007; Roosenburg, 1991). Terrapins enter crab pots out of curiosity, social behavior, and in search of food (Bishop, 1983; Butler, 2002). Once entrapped in a submerged crab pot, terrapins are not able to surface to breath and will drown in as little as 45 min (Crowder et al., 2000). Male and juvenile terrapins are more susceptible to being entrapped in crab pots, due to their smaller size, which may cause a demographic shift in populations towards older females (Roosenburg et al., 1997; Dorcas et al., 2007). Plastic and wire excluder devices, referred to as bycatch reduction devices (BRDs), that narrow the funnel opening on crab pots exclude terrapins (Morris et al., 2011; Rook et al., 2010). These devices face opposition from the fishing industry due to fears that they will decrease target species catch, however, several states including Maryland, Delaware, and New Jersey enforce BRDs in fisheries that overlap with terrapin habitats or areas that are close to the shoreline (Roosenburg, 2004). Specific BRD configurations must be assessed on a regional basis as terrapin demographics vary regionally and, therefore, the most effective BRD size for terrapin protection and maximum crab catch also varies by region (Roosenburg and Green, 2000; Roosenburg 2004).

Since 1950, North Carolina has ranked within the top three blue crab (*Callinectes sapidus*) producing states, and the blue crab commercial fishery is one of the most valuable in the state (NC DMF,

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2013). The issue of terrapin interactions with crab pots is addressed in the North Carolina Division of Marine Fisheries Blue Crab Fisheries Management Plan (NC DMF, 2013). Although the NC DMF currently does not require the use of BRDs in the state's blue crab fishery, the fisheries management plan recommends development of appropriate BRD specifications for use in North Carolina waters and the establishment of proclamation authority to implement BRDs in the fishery (NC DMF, 2013). Data regarding the efficacy of specific sizes of BRDs for terrapin exclusion and the impacts of BRDs on crab catch in North Carolina are critical for crafting a fair and effective management strategy for implementation of BRDs in the North Carolina blue crab fishery.

Hart and Crowder (2011) conducted terrapin bycatch research along the central coast of North Carolina from 2000 to 2004 using standard baited crab pots in a paired pot design to test 3 BRD configurations: 5.0 × 16.0 cm, 4.5 × 16.0 cm, and 4.0 × 16.0 cm (height × width). Their results indicated that larger BRD heights may be effective for excluding terrapins from crab pots without greatly impacting crab catch. A drawback to this study is that sampling occurred at only one location (Jarrett Bay, NC). Given that demographic characteristics of terrapin populations can vary regionally, additional data are needed to assess BRD configurations that will be most effective at reducing terrapin bycatch on a broader spatial scale.

The primary goal of our research was to examine the capacity of BRDs to exclude terrapins from crab pots without causing a reduction in blue crab catch or the size of legal crabs harvested. We assessed the efficacy of two sizes of BRDs (5.1 × 15.2 cm and 3.8 × 15.2 cm) at several locations along the coast of North Carolina, and incorporated a modified crab pot design (Rook et al., 2010) in order to reduce mortality of captured terrapins. The results of this research provide insight into the pros and cons of different BRD configurations and the overall utility of gear modification in preventing terrapin bycatch in the blue crab fishery.

2. Materials and methods

2.1. Modified crab pots and BRDs

Modified crab pots (Fig. 1A) were used to investigate the efficacy of two BRD configurations. Standard 2 ft commercial crab pots (61 cm × 61 cm × 61 cm) were fitted with a chimney (122 × 30.5 cm diameter) constructed from chicken wire to allow entrapped terrapins access to air during all phases of the tidal cycle. Square irons were fastened to the base of the pot for stabilization and a 180 cm length of 1.9 diameter PVC pipe was secured through the corner of the chimney and pot to reduce crumpling or folding of the chimney. Bycatch reduction devices were constructed from 12 gauge galvanized wire and 1.3 cm hog rings, assembled with hog ring pliers (Fig. 1B), into two dimensions, 2 × 6 in. (5.1 × 15.2 cm, "large") and 1.5 × 6 in. (3.8 × 15.2 cm, "small"). Sizes were based on size distribution of adult terrapins in North Carolina, regulations in other states, and commercially manufactured BRD dimensions (Harden et al., 2011; Hart and Crowder, 2011; Morris et al., 2011;

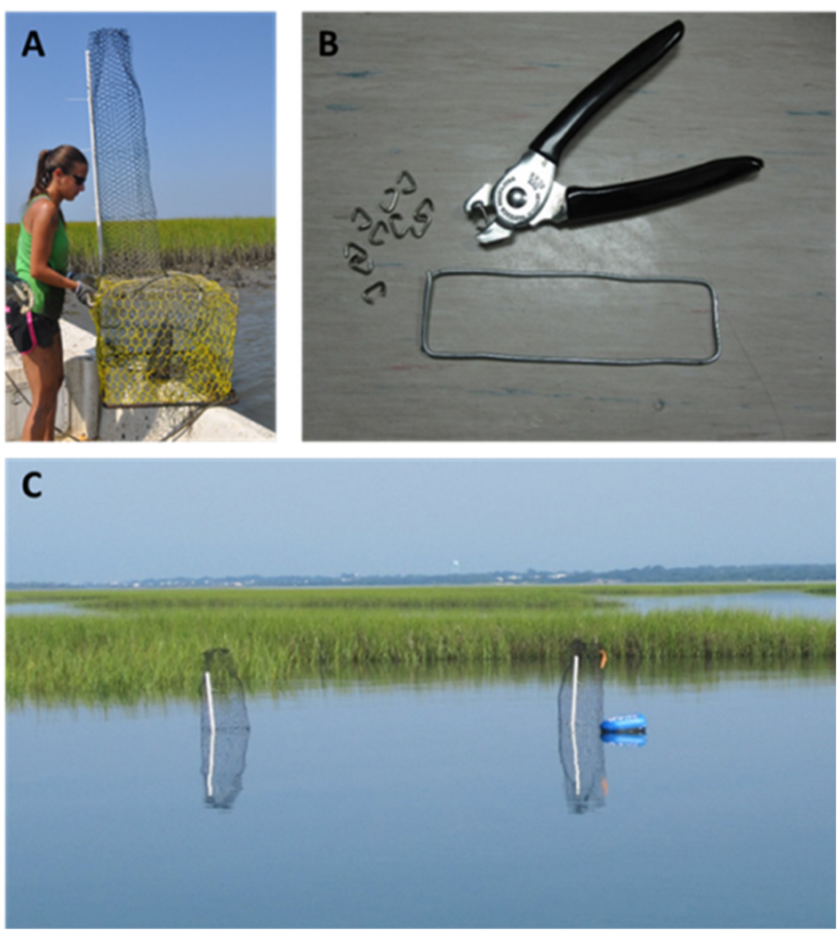

Fig. 1. Field deployments. A) Standard commercial crab pots (61 cm × 61 cm × 61 cm) were fitted with a chimney (122 cm × 30.5 cm diameter) constructed from chicken wire to allow entrapped terrapins access to air during all phases of the tidal cycle. B) Bycatch reduction devices constructed from 12 gauge galvanized wire, hog rings, and hog ring pliers. BRDs were two different dimensions, 5.1 cm × 15.2 cm(large) and 3.8 cm × 15.2 cm (small). C) Modified crab pots deployed in water in the paired pot design during the 2012 field season. A pot fixed with a BRD was always placed next to a control pot (not shown).