Herpetological Conservation and Biology 8(1):222–227.
Submitted: 30 November 2011; Accepted: 5 February 2013; Published: 30 April 2013.

LOW USE OF REQUIRED TERRAPIN BYCATCH REDUCTION DEVICES IN A RECREATIONAL CRAB POT FISHERY

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***Abstract.*—Bycatch in Blue Crab (*Callinectes sapidus*) pots threatens many populations of the Diamondback Terrapin (*Malaclemys terrapin*), a small turtle inhabiting estuaries from Massachusetts to Texas, USA and freshwater ponds in Bermuda. Bycatch reduction devices (BRD) dramatically reduce terrapin bycatch in crab pots with little or no effect on crab catch. Several states require BRDs in their commercial and/or recreational crab pot fisheries, and additional states are considering similar measures. In 1999, Maryland adopted a regulation requiring BRDs on all recreational crab pots fished in the state, but the extent to which recreational crabbers comply with BRD regulations and use the devices remains undocumented. To investigate compliance with the BRD regulation, we recorded the presence or absence of BRDs in recreational crab pots along shorelines and on piers at multiple locations within the Patuxent River estuary, Maryland in 2005 and 2010. Our findings of BRDs on < 35% of pots suggest that crab pots remain a major threat to terrapins in the Patuxent River, despite > 10 y of management attempts to reduce this source of mortality. Accordingly, we provide recommendations to promote greater compliance with BRD regulations in Maryland and in other states that have, or are considering, BRD initiatives.**

Key Words.—Blue Crab; bycatch reduction device; *Callinectes sapidus*; crab pot; Diamondback Terrapin; fisheries management; *Malaclemys terrapin*; mortality

INTRODUCTION

The Diamondback Terrapin (*Malaclemys terrapin*) inhabits estuaries from Massachusetts to Texas, USA (Carr 1952) and freshwater ponds in Bermuda (Parham et al. 2008). Commercial and recreational Blue Crab (*Callinectes sapidus*) pot fisheries overlap with terrapin habitats throughout most of the species' continental range. Accounts of terrapins drowning in crab pots date back to the 1940s, shortly after commercial crabbers in Chesapeake Bay began using pots to harvest crabs (Davis 1942). Subsequent observations indicate that crab pots, today used in both commercial and recreational Blue Crab fisheries, constitute a major source of terrapin mortality that can lead to serious declines in local terrapin populations (Siegel and Gibbons 1995; Roosenburg et al. 1997; Dorcas et al. 2007; Grosse et al. 2009).

Terrapin mortality in Blue Crab fisheries can be dramatically reduced by fitting crab pots with simple bycatch reduction devices (BRDs; Wood 1997). These small, rectangular wire inserts reduce pot entrance funnel size to physically exclude most terrapins from entering. Many studies indicate that BRDs represent a viable option for decreasing terrapin bycatch because they reduce terrapin capture, have little or no effect on crab catch, are inexpensive ($0.50–$2.00 US/BRD/entrance funnel), and are easy to install (Roosenburg and Green 2000; Cole and Helser 2001; Butler and Heinrich 2007; Rook et al. 2010). Some manufacturers voluntarily construct crab pots with BRDs pre-installed, demonstrating that BRDs can be economically feasible. However, most crab pots are manufactured without BRDs, and it is up to the buyer to install the devices. Currently, Maryland and Delaware require BRDs in their recreational crab pot fisheries, and New Jersey requires BRDs in recreational or commercial crab pots fished in waters less than 45.7 m wide (Maryland Department of Natural Resources 2013. Recreational Crabbing Summary for the Chesapeake Bay and Tributaries. Available from http://www.dnr.state.md.us/fisheries/regulations/regindex.asp?page=blue crab [Accessed 24 April 2013]; Delaware Department of Natural Resources and Environmental Control 2013. Recreational Crab Pot. Available from http://regulations.delaware.gov/AdminCode/title7/3000/3700%20Shellfish/3715.pdf [Accessed 24 April 2013]; New Jersey Department of Environmental Protection 2013. Recreational Crab Pots and Trotlines. Available from http://www.state.nj.us/dep/fgw/pdf/non-comm_crabpot_regs.pdf [Accessed 24 April 2013]; New Jersey Division of Fish and Wildlife Marine Fisheries Administration 2013. Commercial Regulations. Available from http://www.state.nj.us/dep/fgw/pdf/2012/comregs12.pdf [Accessed 24 April 2013]). Other states are also considering similar BRD requirements to protect terrapins.

Although BRDs have the potential to mitigate the problem of terrapin bycatch, anecdotal observations suggest that BRD regulations may be difficult to enforce

in recreational crab pot fisheries (Roosenburg 2004; Morris et al. 2011). Recreational crabbers may be unaware of BRD requirements, may resist using BRDs out of concern that they reduce crab catch, or they may fail to use BRDs due to the extra effort required to retrofit pots. In 1999, Maryland passed a regulation requiring BRDs on all recreational crab pots fished in the state (Roosenburg and Green 2000). However, even years after this regulation was enacted, we continued to frequently observe recreational crab pots without the devices. Herein, we quantify BRD use in recreational crab pots in several creek tributaries of the Patuxent River (Maryland) six and 11 y after the BRD requirement. The goal of our study was to document overall levels of compliance with the BRD regulation rather than evaluate temporal trends in BRD use, although we hoped to discover a perceptible increase in BRD use from 2005 to 2010.

MATERIALS AND METHODS

Study site.—We documented the presence or absence of BRDs in recreational crab pots at multiple locations within the Patuxent River estuary, a western tributary of Chesapeake Bay located in central Maryland, USA. We investigated BRD use in five creeks: Buzzard Island Creek (including a short section of river shoreline located immediately south of the creek), Island Creek, Mill Creek, Persimmon Creek, and Washington Creek (Fig. 1). Buzzard Island Creek, Persimmon Creek, and Washington Creek harbor terrapin populations (Roosenburg et al. 1999; Radzio and Roosenburg 2005). Island Creek and Mill Creek are larger and have more private residences with piers than Buzzard Island Creek, Persimmon Creek, or Washington Creek. Terrapins once inhabited Island Creek (Willem Roosenburg, pers. obs.), but their current status at that location is unknown. Terrapins are now rare or absent in Mill Creek (Willem Roosenburg, pers. obs.).

Crab pot surveys.—We located recreational crab pots on piers and along shorelines within approximately 20 m of the water and recorded the number of pots with and without BRDs. We made observations from small boats and, at some marinas, by walking on docks. Because piers are private property, we only counted pots that were out of the water and could be inspected from a boat with the aid of binoculars. We assumed that most

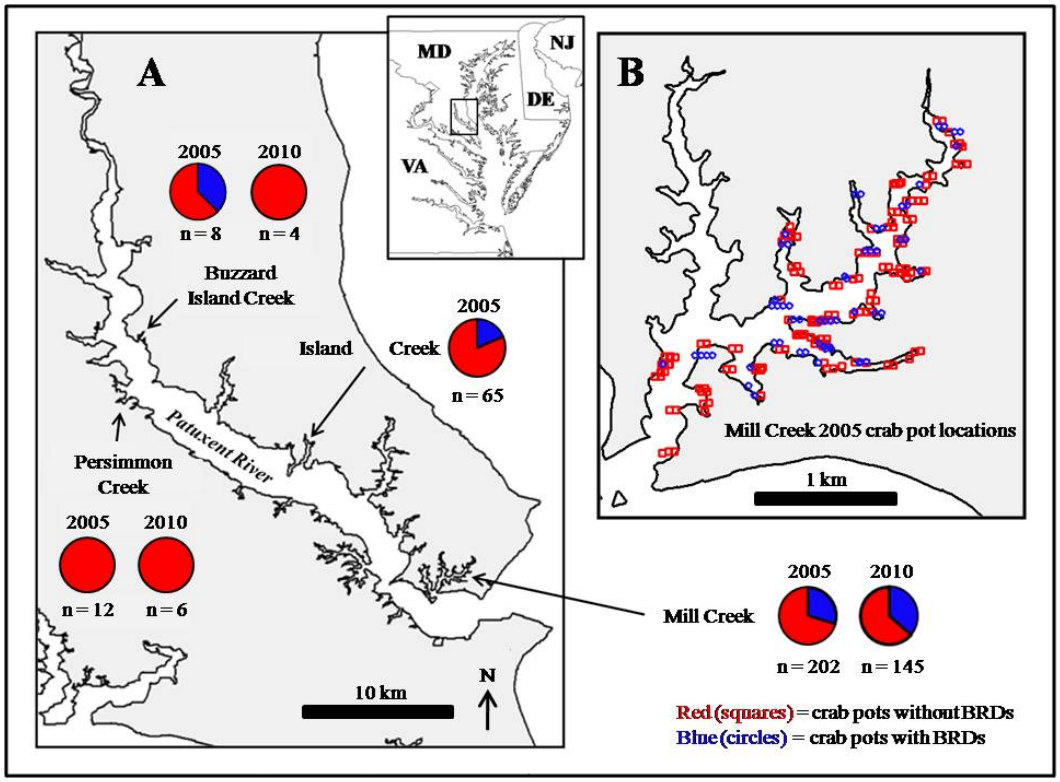

FIGURE 1. A: Total number of crab pots and percentage of pots with (blue) and without BRDs (red) at Patuxent River estuary survey locations. In addition to the four labeled creeks, we also surveyed Washington Creek (located immediately north of Persimmon Creek) in 2005, but did not observe any pots. B: The high density of pots with (blue circles) and without (red squares) BRDs observed in Mill Creek 2005.

observed pots were recently used because they were located near the water, often contained old bait or crab shells, and because we conducted our survey during the crabbing season. Maryland crab pots typically have two or four funnel entrances, requiring two or four BRDs, respectively, per pot. However, we counted a pot as having BRDs if it had at least one BRD in one funnel. Most pots with BRDs had a BRD in each funnel, but a small, undocumented number had BRDs missing from some funnels. We excluded pots that appeared to be used for commercial crabbing (e.g., > 10 pots in the vicinity of docked commercial fishing boats or stacks of bushel baskets) because BRDs are not required in the commercial fishery. Although commercial crab potting is not permitted in the Patuxent River estuary, some commercial crabbers that use pots in the main stem of Chesapeake Bay are based out of Mill Creek and store their pots along the shore of the creek. We also excluded pots that were in very poor condition, or the few pots for which we were unable to determine BRD presence or absence (e.g., pots with funnels obscured by other pots or objects on shore). We surveyed Buzzard Island Creek in June 2005 and October 2010; Island Creek in October 2005; Persimmon Creek in October 2005 and 2010; Mill Creek in October 2005 and 2010; and Washington Creek in October 2005. Due to time constraints, we did not completely resurvey Mill Creek in 2010, but did include a short portion of shoreline located just southwest of the creek that we did not survey in 2005.

RESULTS

In 2005, we determined BRD status (presence or absence) for eight crab pots at three locations at Buzzard Island Creek; 12 pots at three locations in Persimmon Creek; 65 pots at 21 locations in Island Creek; and 202 pots at 100 locations in Mill Creek (Fig. 1). We did not observe any pots in Washington Creek. In 2010, we determined BRD status for four pots at one location at Buzzard Island Creek, six pots at two locations in Persimmon Creek, and 145 pots at 76 locations in Mill Creek.

Use of BRDs was low in both 2005 and 2010, with little improvement during the 5 y between our surveys. In 2005, we observed BRDs on 75 of 287 (26%) pots for all creeks combined: three of eight (38%) at Buzzard Island Creek; zero of 12 (0%) at Persimmon Creek; 12 of 65 (18%) at Indian Creek; and 60 of 202 (30%) at Mill Creek (Fig. 1). In 2010, we observed BRDs on 53 of 155 (34%) pots for all creeks combined: zero of four (0%) at Buzzard Island Creek; zero of six (0%) at Persimmon Creek; and 53 of 145 (37%) at Mill Creek (Fig. 1).

DISCUSSION

This study is the first to examine compliance with a BRD regulation in a Blue Crab fishery. Our findings indicate that BRD use is low in the Patuxent River recreational crab fishery, despite the fact that BRDs have been required in this fishery for more than a decade. We observed BRDs on 26% of pots in 2005 and 34% in 2010, suggesting that BRD use may be increasing slowly, but the apparent change may also reflect differences in survey areas between years. Additionally, greater compliance occurred only in Mill Creek, while compliance decreased in Buzzard Island Creek and did not change in Persimmon Creek. Sample sizes were very small for the latter two creeks because the shoreline of these creeks is sparsely populated. Interestingly, despite the lower density of crab pots, the impact on terrapins may be greater in Persimmon Creek and Buzzard Island Creek because terrapins are known to occur in these creeks (Roosenburg et al. 1997; Radzio and Roosenburg 2005). Our consistent observations of low BRD use in each creek surveyed in 2005 and 2010 raises concerns about the effectiveness of current efforts to reduce terrapin bycatch and indicates that additional research is warranted to determine levels of compliance with the BRD regulation in other parts of the state.

Crab pots can capture terrapins at high rates (Roosenburg 2004), and even small numbers of pots can rapidly remove substantial numbers of terrapins from local populations (Roosenburg et al. 1997; Grosse et al. 2009; Rook et al. 2010). We believe that avoiding future declines in terrapin populations will require much higher rates of BRD use than those documented in this study. Furthermore, it will be difficult to reestablish populations in areas where they have been extirpated without successful integration of BRDs into the recreational fishery. Notably, even complete compliance with the BRD regulation will not eliminate terrapin mortality in the recreational crab pot fishery as BRDs do not prevent very small terrapins from entering pots (Roosenburg and Green 2000). Therefore, efforts should be made to maximize compliance with existing terrapin bycatch reduction measures.

There are many potential reasons why BRD use remains low in Maryland's recreational crab pot fishery. First, there may be a lack of public awareness about BRDs and their requirement in the recreational fishery. Our experience talking with waterfront property owners in the course of conducting other fieldwork in the Patuxent River estuary indicates that many individuals are unaware of the BRD regulation. Second, there may be an indifference to the regulation as many waterfront property owners may never have caught a terrapin and therefore feel there is no need for BRDs in their pots. Thus, many crabbers might not use BRDs because they believe they do not crab in terrapin habitat. In heavily

populated areas such as Mill Creek, decades of heavy recreational crabbing and shoreline development have likely dramatically decreased, perhaps extirpated local terrapin populations, leaving few remaining individuals to be captured in crab pots. Third, crabbers may not use BRDs due to the extra effort involved in obtaining and installing BRDs. Unfortunately, crab pots sold to recreational crabbers are often not equipped with BRDs, and thus, it becomes the responsibility of the crabber to both separately purchase and install BRDs. Many crab pot venders lack knowledge or information that identifies the requirement to have BRDs in recreational crab pots. Furthermore, many bait shops that sell pots do not have BRDs for customers to purchase. Finally, some recreational crabbers may be concerned that BRDs reduce crab catch, despite the fact that most research indicates that BRDs have little or no effect on crab catch (early studies reviewed in Roosenburg 2004; Butler and Heinrich 2007; Rook et al. 2010; Morris et al. 2011).

How can compliance be increased? First, banning the recreational use of crab pots would dramatically reduce the terrapin bycatch problem in Maryland tributaries, particularly because the commercial use of crab pots already is not permitted in most Maryland rivers and creeks, in part to reduce mortality of near-shore, air-breathing species such as terrapins. A ban on the recreational use of crab pots would be the most effective solution. However, this most effective solution would be a political quagmire, although it is strongly warranted based on the bycatch data (reviewed in Roosenburg 2004) and the low compliance rates we report. Alternatively, we suggest adopting a regulation that would require BRDs to be pre-installed on crab pots sold to recreational crabbers (Roosenburg 2004; Butler and Heinrich 2007). This would greatly increase compliance and eliminate the additional step for the recreational crabber of installing BRDs. Notably, cull rings, designed to reduce bycatch of sublegal size Blue Crabs, have been successfully implemented in Maryland's crab pot fishery. These devices are required in both recreational and commercial crab pots and are usually installed when pots are manufactured. Requiring BRDs in both commercial and recreational fisheries could provide an incentive for more manufacturers and retailers to sell pots with BRDs, making it easier for recreational crabbers to comply with the BRD regulation. Additionally, although education alone will likely not solve the terrapin bycatch problem, education via brochures or literature at the point of sale of crab pots should: (1) describe the problem of bycatch and the need for BRDs; (2) offer instructions for retrofitting pots; and (3) identify the penalties for lack of compliance. Finally, there is a need for improved enforcement, with penalties that will motivate compliance.

Our observation of little or no change in BRD use between 2005 and 2010 suggests that bycatch in recreational crab pots will continue to remove terrapins from local populations unless effective actions are taken to address this serious problem. Although we focused on Maryland in our study, the need to reduce terrapin bycatch in crab pots is a universal problem wherever terrapin habitat and crab potting overlap (Roosenburg et al. 1997; Wood 1997; Butler and Heinrich 2007; Grosse et al. 2009). Therefore, we strongly encourage continuing efforts to incorporate BRDs into both recreational and commercial crab pot fisheries operating within terrapin habitats throughout the species' range. Furthermore, we have identified the need for education, monitoring, and enforcement that should accompany regulations that are promulgated with the intention of protecting herpetofauna or other rarely encountered or undervalued species.

Acknowledgments.—We thank Dr. and Mrs. Norton Dodge and the staff of Cremona Farm for the use of facilities and their cooperation in this study. We are particularly grateful to Tom Repenning and Harriet Nettles for their hospitality and for loaning boats used during the 2010 surveys. We thank Dr. Harold Avery for providing comments on an earlier draft of this manuscript and Katherine Kelley for field assistance and discussions about terrapin bycatch.

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