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Diamondback Terrapin Mortality in the American Eel Pot Fishery and Evaluation of a Bycatch Reduction Device

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ABSTRACT: The effect of commercial fisheries on nontarget species is a burgeoning issue for both fishery managers and estuarine biologists. We documented diamondback terrapin (*Malaclemys terrapin*) bycatch in cloth-funnel eel pots used in a Maryland (United States) commercial American eel (*Anguilla rostrata*) fishery. Between 1992 and 2001, we obtained 40 male and 9 female terrapin captures and 1 male terrapin recapture from commercial eel pots. To quantify terrapin catch rates and evaluate a potential solution to terrapin bycatch in eel pots, we conducted two experiments that tested the effects of a novel eel pot bycatch reduction device on terrapin bycatch and eel harvest. We determined low terrapin bycatch rates (0.000–0.008 terrapins pot^{-1} d^{-1}) in pots with small entrance funnels and high terrapin capture rates (0.458 terrapins pot^{-1} d^{-1}) in pots with large entrance funnels. The BRD eliminated terrapin bycatch and had no effect on eel catch making it an economically-viable solution for terrapin mortality in eel pots. We demonstrated that terrapin bycatch can be a problem in the American eel pot fishery and that our bycatch reduction device is a simple and cost-effective solution to this problem.

Introduction

Bycatch, incidental capture and subsequent death of nontarget species and size classes in fishing gear, is a problem that confronts many fisheries (Alverson et al. 1994). Annual global bycatch has been estimated at 27 million metric tons, equivalent to nearly one-third the mass of the world's catch (Alverson et al. 1994). Bycatch results in both ecological and economic problems. Ecologically, bycatch results in population declines of vulnerable species, generally long-lived, iteroparous vertebrates (e.g., albatross (*Phoebastria* spp.): Inchausti and Weimerskirch 2001; sea turtles (*Cheloniidae* and *Dermochelyidae*): Magnuson et al. 1990), and discard accumulations may disrupt nutrient dynamics (Dayton et al. 1995). Economically, bycatch may result in declines of commercially-valuable species (e.g., Atlantic croaker [*Micropogonias undulates*]: Diamond et al. 2000). In recent years, increased recognition of the adverse ecological, economic, and ethical consequences of bycatch has led to development of increasingly selective fishing gear and practices (Alverson et al. 1994; Hall et al. 2000).

One bycatch problem that has received increased attention in recent years is the drowning of diamondback terrapins (*Malaclemys terrapin*) in commercial and recreational blue crab (*Callinectes sapidus*) pot fisheries (Seigel and Gibbons 1995; Roosenburg 2004). The diamondback terrapin is a small, obligate-estuarine turtle inhabiting brackish coastal waters from Texas to Massachusetts, United States. Although drowning in crab pots is the leading threat to terrapin populations in several states (Seigel 1993; Seigel and Gibbons 1995; Hoyle and Gibbons 2000; Gibbons et al. 2001; Roosenburg 2004), the problem of terrapin bycatch is not limited to crab pot fisheries. Terrapins also drown in cloth-funnel eel pots used in the commercial American eel (*Anguilla rostrata*) fishery, a spring and fall fishery of the mid Atlantic estuaries of the eastern U.S. (Roosenburg 2004). Information on terrapin bycatch in eel pots is limited to anecdotal observations (Roosenburg 2004). We present the first study of terrapin bycatch and bycatch reduction in cloth-funnel eel pots.

Cloth-funnel pots are a major gear used in the inshore eel fishery in North Carolina, Virginia, Maryland, Delaware, and New Jersey, U.S. Although estimates of commercial eel potting effort are unavailable, local eel potting effort can be high; commercial eel potters often fish several hundred cloth-funnel eel pots at a time (Roosenburg personal observation). Roosenburg (2004) suggests that terrapin capture rates in cloth-funnel eel pots may be similar to terrapin capture rates in crab pots. The large number of cloth-funnel eel pots fished in terrapin habitats, shallow, nearshore estuarine waters (Roosenburg 1991; Roosenburg et al. 1999), combined with the potentially high capture rates of terrapins in cloth-funnel eel pots, suggest that bycatch in commercial eel pot fisheries may represent an overlooked source of terrapin mortality in some areas.

The objectives of this study were to quantify the size, sex, age, and capture rates of terrapins in cloth-funnel eel pots and to evaluate the suitability of a prototype eel pot bycatch reduction device (BRD)

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for commercial American eel pot fisheries. To achieve these objectives, we documented terrapin bycatch in cloth-funnel eel pots fished in a section of the Patuxent River estuary, Maryland, between 1992 and 2001 and conducted an experimental eel pot fishery at this site in spring and summer of 2002. We discuss potential effects of bycatch in the eel pot fishery on local terrapin populations and the suitability of our BRD for reducing terrapin mortality in eel pots.

Materials and Methods

Study Area and Background Observations

We conducted our study in a section of the Patuxent River estuary, Maryland, located between Horse Landing and Long Point. Since 1987, mark-recapture studies of the diamondback terrapin have been ongoing in creek and nearshore river habitats along the western shore of the study site (Roosenburg 1991; Roosenburg and Dunham 1997; Roosenburg et al. 1997, 1999). From 1992 to 2001, we sporadically observed terrapins in cloth-funnel eel pots used by commercial fishers at the study site. We present the sex ratio, ages, carapace lengths, and mortality rate of terrapin bycatch. We removed many of these terrapins from eel pots within several hours of capture, so our mortality rate estimate almost certainly underestimates actual terrapin mortality rates in eel pots, because commercial eel pots remain submerged for one to several days.

Gear Specifications, Fishing Protocol, and Catch Quantification

We purchased cloth-funnel eel pots from two local suppliers. Eel pots were constructed of 1-cm square-mesh wire and measured 70 cm in length and 25 cm in diameter (Fig. 1). Each pot had an entrance funnel and an internal divider funnel constructed of double-knit polyester cloth. The narrow (inner) opening of eel pot entrance funnels measured 19–23 cm in perimeter. There is considerable variation in eel pot entrance funnel size, and pots with larger entrance funnels than ours frequently are used in the fishery (Radzio personal observation). To test for entrance funnel size effects on terrapin capture, we enlarged the entrance funnels of 11 pots to 25–29 cm in perimeter, which is representative of many pots used in the fishery. We refer to pots with small and large entrance funnels as small-funnel pots and large-funnel pots, respectively.

We developed a BRD intended to reduce terrapin bycatch in cloth-funnel eel pots while having no effect on eel catch. The BRD is a 7.7-cm (inside diameter), PVC ring that mounts around the narrow end of the cloth entrance funnel and is held in place using the existing entrance funnel rigging of eel pots (Fig. 1). The BRD physically prevents terrapins from entering eel pots by limiting the flexibility of the entrance funnel opening. Four entrance funnel-BRD size combinations were used in our experimental fishery: small-funnel pots without BRDs (SFSTD pots), small-funnel pots with BRDs (SFBRD pots), large-funnel pots without BRDs (LFSTD pots), and large-funnel pots with BRDs (LFBRD pots).

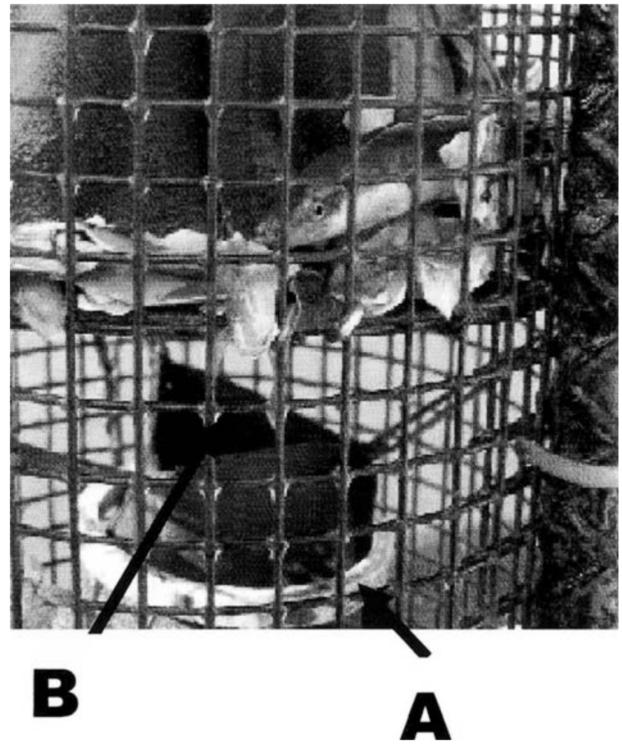

Fig. 1. Small-funnel eel pot with bycatch reduction device. The bycatch reduction device is a polyvinyl chloride ring (A) that functions to reduce terrapin bycatch by reducing the flexibility of the cloth-entrance funnel (B).

We baited eel pots with equal portions of crushed razor clams and fished them in creek, nearshore river, and offshore river habitats. Creek habitats were areas upstream of creek mouths. Nearshore river habitats were areas of the Patuxent River that were within 0.4 km of the shore and were less than 5 m deep. Offshore river habitats were all other areas of the Patuxent River.

We hauled pots and quantified catch and bycatch at the end of each fishing period. We measured straight-line carapace length (CL; in millimeters) and shell width (SW; in millimeters) using digital calipers. We sexed terrapins by determining the position of the anus relative to the edge of the carapace (Carr 1952). We aged terrapins by counting plastral scute annuli. The reliability of this aging technique was verified by examining the plastral scute annuli of terrapins captured in consecutive years at the study site (sensu Wilson et al. 2003). We recorded the identification numbers of previously marked terrapins and marked any unmarked terrapins to facilitate future recognition of recaptured individuals. Blue crab carapace width (1 mm) was measured using analog calipers, and sex and molt stage were recorded. We identified fish to species and measured their total length (1 mm) using calipers or a fish measuring board. We placed eels from each pot into zippered mesh bags and transported them to shore in tanks filled with river water and measured the mass (1 g) of each eel using an electronic balance.

Experiment 1

From May 4 to August 14, 2002, we fished SFSTD and SFBRD pots to quantify terrapin capture rates in pots with small entrance funnels and to test for BRD effects on bycatch and eel catch rates. To isolate location variation from treatment effects, we fished pots in pairs (75 m apart), one pot of each type, and alternated the relative positions of pot types at random between sets. Paired pots fished at 150-m intervals along nearshore and offshore river transects and at 100-m intervals along creek transects. We fished pots for 2-d set periods, with the exception of a small number of sets in which pots fished for 4 d, due to bad weather. Pairs fished for different periods of time in each habitat: 549 pot days (282 sets) in creek habitats along the western shore of the study site (Persimmon Creek and Washington Creek), 352 pot days (173 sets) in Buzzard's Island Creek, 889 pot days (439 sets) in nearshore river habitats along the western shore of the study site, and 869 pot days (429 sets) in offshore river habitats.

Experiment 2

From August 25 to September 6, 2002, we fished SFSTD, LFSTD, and LFBRD pots to determine the effect of entrance funnel size on terrapin bycatch and the effect of the BRD on bycatch and eel catch. To isolate location variation from treatment effects, we fished pots in groups of three, one pot of each type (50 m apart) per group in a triangular configuration and alternated the relative positions of pot types between sets. Adjacent groups were fished at least 75 m apart. Due to time constraints, pots were fished for 1-d set periods. We hauled pots 3–4 times daily to remove terrapins to minimize their mortality. We only removed other bycatch and catch at the end of each fishing period. Each pot type was fished for 120 pot days (120 sets) in Buzzard's Island Creek and adjacent nearshore river habitats.

Statistical Analysis

Bycatch and catch data did not conform to the parametric assumption of normality (Shapiro-Wilk test), even after transformation. We used nonparametric methods in all analyses. Alpha levels were set at 0.05. Chi-square goodness-of-fit analyses, with Bonferroni adjustments (α, n-comparisons), tested for BRD (Experiments 1 and 2) and entrance funnel size (Experiment 2) effects on bycatch frequency of occurrence. Because we removed terrapins from pots 3–4 times daily in Experiment 2, we analyzed terrapin captures in this experiment based on the number of hauls in which terrapins were present. Two-tailed, Wilcoxon signed ranks tests analyzed for BRD effects on the median number and median mass of eels caught per set (Experiment 1). We excluded uninformative paired sets (sets in which no pot type captured eels) from these analyses. Because eel potters relocate pots when catches are low, we conducted secondary analyses of eel catch from Experiment 1 using only paired sets in which the combined catch of both sets was six or more eels. We did not test for BRD effects on eel catch in Experiment 2 because eel catch was very low in that experiment. We used SPSS version 12.0 for Windows (SPSS Inc., Chicago, Illinois) in all statistical analyses.

Results

Background Observations of Terrapin Bycatch

Between 1992 and 2001, we documented 40 male terrapin captures, 9 female captures, and 1 male recapture in commercial eel pots fished at the study site. A large number of these, 15 male captures, 5 female captures, and 1 male recapture occurred in Washington Creek in May 2001. Ages of males for which an age could be determined (33 individuals) ranged between 3 and 15 yr. Ages of females ranged between 4 and 10 yr. Carapace lengths of males ranged between 10.7 and 15.9 cm. Carapace lengths of females ranged between 9.7 and 15.5 cm. Forty-eight captures and one recapture occurred in late spring, and one capture occurred in early fall. Eleven (22%) of 49 spring captures and recaptures resulted in drowning. The one terrapin captured in early fall survived. Many live-captured terrapins exhibited symptoms of hypoxic stress such as lethargy, labored breathing, and greatly reduced motor response. Had we returned these animals immediately, we suspect that they would have drowned, but terrapins usually revived within 1–2 h, when kept out of the water.

Experiment 1

SFSTD pots captured two terrapins in creek habitats (0.002 terrapins pot^{-1} d^{-1}; Table 1): one

TABLE 1. Number of sets with bycatch species present (total number of bycatch individuals) in small-funnel standard (SFSTD) and small-funnel bycatch reduction device (SFBRD) pots in Experiment 1 (n = 1,313 paired sets). Not included are rarely (< 20 sets per pot type) occurring species: hogchoker (*Trinectes maculatus*), mummichog (*Fundulus heteroclitus*), spot (*Leiostomus xanthurus*), white-fingered mud crab (*Rithropanopeus harrisii*), and black-fingered mud crab (*Panopeus herbstii*).

Species	SFSTD Pots		SFBRD Pots		df	χ^2	p
Terrapin (*Malaclemys terrapin*)	2	(2)	0	(0)	-	-	-
Blue Crab (*Callinectes sapidus*)	600	(908)	575	(846)	1	0.532	0.466
White Perch (*Morone Americana*)	119	(143)	78	(90)	1	8.533	0.003[a]
Oyster Toadfish (*Opsanus tau*)	100	(112)	82	(97)	1	1.780	0.182
Striped Bass (*Morone saxatilis*)	30	(36)	34	(43)	1	0.250	0.617
Atlantic Croaker (*Micropogonias undulates*)	21	(21)	7	(7)	1	7.000	0.008[a]

[a] Significant at Bonferroni-adjusted $\alpha = 0.01$.

adult male terrapin (CL = 12.4 cm, SW = 9.8 cm, age = 6 yr) in Washington Creek and one adult male (CL = 14.5 cm, SW = 10.2 cm, age = undetermined) in Buzzard's Island Creek. Both terrapins were captured in early June and drowned. No female terrapins were captured, and no terrapins were captured in nearshore or offshore river habitats. SFBRD pots did not capture terrapins.

Other bycatch consisted of 7 fishes and 3 crab species (Table 1). SFBRD pots captured white perch (*Morone americana*) and Atlantic croaker 34.5% and 66.7% less frequently, respectively, than SFSTD pots, but bycatch frequencies of other species did not differ significantly between pot types.

Nine-hundred and fifty-nine (73%) of 1,313 paired sets caught at least one eel and were included in eel catch analyses. There was no difference in the median number of eels caught per set in SFSTD pots (1 eel) and SFBRD pots (1 eel, n = 959, Z = −0.409, p = 0.682; Fig. 2). There was also no difference in the median mass of eels caught per set in SFSTD pots (0.110 kg) and SFBRD pots (0.121 kg, n = 959, Z = −0.020, p = 0.984). SFSTD pots caught 1,930 eels (total mass = 178.0 kg), and SFBRD pots caught 1,907 eels (total mass = 175.9 kg).

Among paired sets in which pots captured a minimum of six eels (218 sets, 17% of total), there was no difference in the median number of eels caught per set in SFSTD pots (5 eels) and SFBRD pots (5 eels, n = 218, Z = −0.076, p = 0.940). There was also no difference in the median mass of eels caught per set in SFSTD pots (0.373 kg) and SFBRD pots (0.369 kg, n = 218, Z = −0.502, p = 0.615).

Experiment 2

LFSTD pots captured terrapins at greater frequency (42 hauls) than SFSTD pots (1 haul, n = 43, χ^2 = 39.093, p < 0.001; Table 2). LFSTD pots captured 54 male terrapins (0.450 terrapins pot^{-1} d^{-1}) and one female terrapin (0.008 terrapins pot^{-1} d^{-1}), and SFSTD pots captured one male terrapin (0.008 terrapins pot^{-1} d^{-1}). The BRD eliminated terrapin bycatch in large-funnel pots; LFBRD pots did not capture terrapins (Table 2). Carapace lengths of males ranged between 11.9 and 16.4 cm. Shell widths of males ranged between 9.5 and 15.2 cm. Ages of male terrapins for which an age could be determined (9 individuals) ranged between 4 and 18 yr. All males were sexually mature. The female was a 3-yr old juvenile (CL = 14.4 cm, SW = 9.2 cm). All terrapins captured in this experiment survived, presumably because eel pots were checked approximately every 4 h during daylight hours to prevent terrapins from drowning.

Other bycatch consisted of 3 fishes and blue crabs. There were no significant differences in the bycatch frequencies of fish and blue crabs between LFBRD and LFSTD pots (Table 2). Both LFSTD and LFBRD pots caught eels in 13 of 120 sets. This low catch rate is insufficient to analyze for BRD effects on eel catch.

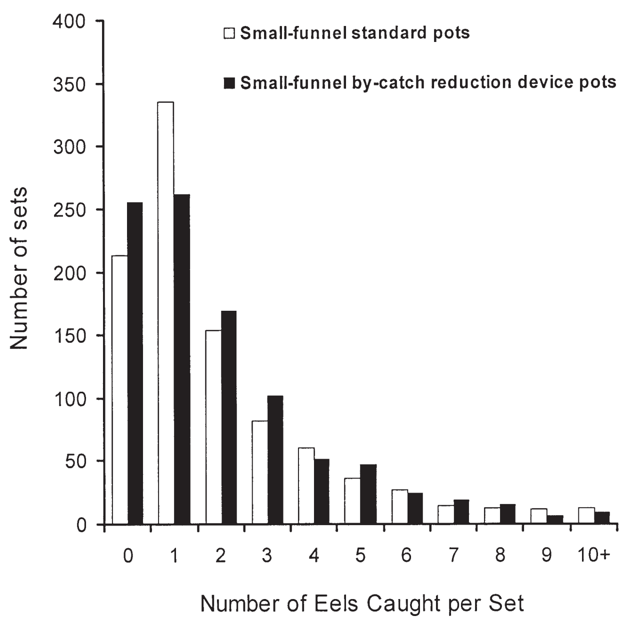

Fig. 2. Catch frequency histogram of eels in small-funnel standard (SFSTD) and small-funnel bycatch reduction device (SFBRD) pots (n = 1,313 paired sets).

TABLE 2. Number of sets with bycatch species present for fish and crabs; number of hauls with individuals present for terrapins (total number of bycatch individuals) in large-funnel standard (LFSTD) and large-funnel bycatch reduction device (LFBRD) pots in Experiment 2 (n = 120 sets).

Species	LFSTD Pots		LFBRD Pots		df	χ^2	p
Terrapin (*Malaclemys terrapin*)	42[a]	(55)	0	(0)	1	42.000	< 0.001[b]
Blue Crab (*Callinectes sapidus*)	54	(65)	55	(74)	1	0.009	0.924
White Perch (*Morone Americana*)	38	(53)	30	(44)	1	0.941	0.332
Striped Bass (*Morone saxatilis*)	29	(34)	20	(24)	1	1.653	0.199
Oyster Toadfish (*Opsanus tau*)	10	(13)	10	(11)	1	0.000	1.000

[a] Terrapins present in 42 hauls; we hauled pots 3–4 times daily to remove terrapins.
[b] Significant at Bonferroni-adjusted $\alpha = 0.01$.

Discussion

Terrapin Bycatch

LFSTD pots captured terrapins at a rate of 0.458 terrapins pot^{-1} d^{-1} in creek habitats, indicating that terrapin capture rates in cloth-funnel eel pots can be high. This finding suggests that terrapin mortality rates can increase substantially in areas where the eel pot fishery overlaps with terrapin habitat. This confirms our observation of high capture rates in the spring of 2001, when eel pots fished in a small creek tributary of the Patuxent River captured a minimum of 20 terrapins. Our high capture rate estimate was determined during the late summer, a period when commercial eel potting activity is minimal and terrapin activity is high. Eel pots may capture terrapins at different rates during the peak eeling seasons (spring and fall). In another study, conducted in late spring in nearshore habitats along the western shore of our study site, LFSTD pots captured terrapins at a rate of 0.060 terrapins pot^{-1} d^{-1} (Radzio and Roosenburg unpublished data), suggesting that regardless of season, pots with large entrance funnels may capture terrapins at high rates in creek and nearshore river habitats. Note that pots were fished further from shore in that study (150–400 m from shore versus < 200 m from shore in Experiment 2) and in another part of the estuary. The lower capture rate should not be used to infer that eel pots capture terrapins at lower rates in the spring than in late summer.

Although LFSTD pots captured terrapins at high rates, SFSTD pots rarely captured terrapins in our experimental fishery, suggesting that terrapin bycatch is very low in eel pots with small entrance funnels. It is unclear to what extent eel pots with small and large entrance funnels are used in the commercial fishery, but cloth-funnel eel pots with large entrance funnels are common in the Patuxent River fishery (Radzio personal observation). Pot funnel sizes vary among manufacturers, and as pots wear over several seasons of commercial use, the cloth becomes stretched and worn, resulting in larger entrance funnels. Pots with larger funnels are a greater threat because they capture terrapins at greater rates.

Although eel pots capture terrapins in early spring in Maryland (anonymous Patuxent River eel potter, personal communication), most terrapins probably survive capture during this time of year. The terrapin's temperature-dependent physiology allows them to remain submerged for long periods when water temperature is below 15°C (Roosenburg et al. 1997), but terrapins must surface frequently when water temperature is greater than 15°C (Roosenburg personal observation). Water temperatures typically exceed 15°C by mid May at our study site (Roosenburg personal observation). Eel potting effort can be high in both creek and nearshore habitats at our study site in late spring (Radzio and Roosenburg unpublished data), creating the potential for substantial terrapin mortality in eel pots.

Turtle populations are highly sensitive to chronic increases in juvenile and adult female mortality (Congdon et al. 1993, 1994; Heppell 1998). We did not capture mature female terrapins, suggesting that they are too large to enter eel pots. Small juvenile turtles prefer extreme nearshore habitats (Roosenburg et al. 1999), where eel potting activity is low. Consistent with this, juvenile females accounted for only 1 of 58 terrapins in our experimental fishery and only 1 of 13 terrapins in another experiment at our study site (Radzio and Roosenburg unpublished data). Juvenile female terrapins accounted for 9 of 49 terrapins documented between 1992 and 2001. Currently, terrapin bycatch levels in eel and crab pot fisheries are unknown. Implementation of observer programs in these fisheries would provide much needed information on terrapin bycatch levels in eel and crab pots.

Eel Pot BRDs

We demonstrated a substantial reduction in terrapin bycatch in cloth-funnel eel pots through the use of an inexpensive, simple BRD. In Experiment 1, terrapin bycatch was low, and although only SFSTD pots captured terrapins, the difference in terrapin bycatch between SFSTD and SFBRD pots was not significant. In Experiment 2, terrapin bycatch was considerably higher, and BRDs reduced terrapin bycatch in large-funnel pots by 100%. The smallest terrapin captured in this study was a 3-yr old female, measuring 9.2 cm in width, or 1.5 cm wider than the narrowest terrapin that the BRD is designed to exclude. Eel pots did not capture very small terrapins, capable of passing through BRDs, because small terrapins primarily use extreme nearshore and marsh habitats (Gibbons et al. 2001; Roosenburg personal observation), areas where commercial eel potting effort is low (Radzio and Roosenburg personal observations).

Bycatch reduction technologies may encounter resistance from fishers when it is perceived that the modifications may decrease fishing efficiency or increase operating costs (e.g., turtle excluder devices for coastal shrimp trawl fisheries: Buck 1990). Eel potting effort in Experiment 1 was comparable to that of a small, commercial eel potting operation (50–100 pots). We did not detect a BRD effect on eel catch for pots with small entrance funnels. A preliminary study, with limited statistical power, also detected no BRD effect on eel catch for pots with large entrance funnels (Radzio and Roosenburg unpublished data). We feel that it is unlikely that fishers would have the perception that the BRD reduces eel catch, because the BRD does not dramatically change the size of the eel pot entrance funnel opening, but rather reduces terrapin bycatch by limiting its flexibility. Demonstration of this point on a scale comparable to the commercial fishery is critical to implementing the use of the BRD in the eel pot fishery.

Our findings demonstrate the importance of incorporating variation in fishing gear design or condition in studies that quantify bycatch or test potential solutions to bycatch. Had we fished pots with only small or only large entrance funnels, we would not have accurately estimated terrapin capture rates or BRD effects. Despite considerable variation in the entrance funnel size of crab pots (Radzio personal observation), no study of terrapin bycatch in crab pots reports the sizes of the entrance funnels used. Included in these studies are four that test for BRD effects on blue crab catch (Wood 1997; Guillory and Prejean 1998; Roosenburg and Green 2000; Cole and Helser 2001). BRD effects on terrapin or blue crab catch would have been undetected in these studies if BRD by entrance funnel size effects exist. Studies using pots with large entrance funnels would be more likely to detect an adverse BRD effect on blue crab catch if pots with large entrance funnels catch crabs at higher rates than pots with small entrance funnels. Crab catch may be higher in pots with small entrance funnels, because pots with smaller entrance funnels may retain more caught crabs. We suggest that funnel size is an important variable in evaluating BRD effects and warrants consideration in future studies.

In addition to having no effect on eel catch, the BRD would have minimal effect on the operating expenses of fishers using the device. We estimate the cost of manufacturing and installing BRDs to be less than U.S. $0.05 per pot. BRDs can be installed easily during the pot construction process, with no additional tools or hardware. Because BRDs are constructed of PVC, they should outlast pots and be reusable. One disadvantage of our BRD design is that installing BRDs on existing pots requires removal and subsequent reattachment of the entrance funnel rigging. This problem could be mitigated by incorporating a small opening in the BRD, which would facilitate quick installation of BRDs on existing pots.

The BRD had little effect on fish bycatch and no effect on blue crab bycatch. Fish and blue crab bycatches were low in the spring, the period when commercial eel potting activity is highest (Radzio and Roosenburg unpublished data). Eel pots did not capture catfish (*Ictalurus punctatus* and *Ameiurus* spp.) in this study, but catfish bycatch can be high at our study site during freshet years (Roosenburg personal observation). Some eel potters consider catfish bycatch undesirable because catfish eat bait and take up space in pots that could potentially reduce eel catch. Further testing is needed to determine the effect of the BRD on large catfish bycatch.

Bycatch in commercial eel pot fisheries may result in substantial terrapin mortality in areas where eel pot fisheries using cloth-funnel eel pots overlap with terrapin habitat. BRD implementation represents an economically-viable solution to terrapin bycatch because it would reduce, if not eliminate, terrapin bycatch in cloth-funnel eel pots at minimal cost to commercial fishers. Currently, several states require BRD use in recreational crab pot fisheries, and two states require limited BRD use in commercial crab pot fisheries. Given apparent declines in many local terrapin populations (Seigel 1993; Seigel and Gibbons 1995; Gibbons et al. 2001; Roosenburg unpublished data), we recommend BRD implementation by commercial eelers using cloth-funnel eel pots. Before further management and conservation initiatives are enacted, it is imperative that the threat posed by fishing gear be removed or reduced. Failure to provide safeguards against bycatch, while relying on programs such as headstarting, constitutes a halfway technology-approach to turtle conservation (Frazer 1992; Seigel et al. 2000). The solution we present is both effective and economically feasible, indicating that this is a pragmatic fix for a serious problem.

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