

**BEFORE THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL
PROTECTION**

**PETITION FOR RULEMAKING TO REDUCE DIAMONDBACK
TERRAPIN MORTALITY FROM BLUE CRAB POTS**



*Navesink River
Save Coastal Wildlife*

Center for Biological Diversity

CU Maurice River

Hackensack Riverkeeper

Delaware Riverkeeper

NJ Conservation Foundation

Project Terrapin

October 13, 2026

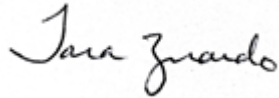
Notice of Petition

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Pursuant to the New Jersey Administrative Procedure Act, N.J.S.A. 52:14B-4(f), and N.J.A.C. 7:1D-1.1, the Center for Biological Diversity, CU Maurice River, Hackensack Riverkeeper, Delaware Riverkeeper, New Jersey Conservation Foundation, and Project Terrapin, LLC (“petitioners”) respectfully petition the New Jersey Department of Environmental Protection (“Department” or “NJDEP”) to amend its crab-management regulations, including N.J.A.C. 7:25-14, and adopt associated measures necessary to substantially reduce the preventable drowning of northern diamondback terrapins (*Malaclemys terrapin terrapin*) in blue crab pots.

Specifically, Petitioners primarily request that NJDEP:

- 1. Require a bycatch reduction device (“BRD” or “terrapin excluder device”) to be securely installed in every entrance funnel of every commercial-style blue crab pot used in waters of the State for both commercial and recreational crabbing, eliminating the existing geographic limitation that generally restricts mandatory terrapin excluders to pots deployed in man-made lagoons and narrow waterways.**

2. **Replace the State's existing 2 × 6 inch maximum-opening standard with the more protective 4.5 × 12.0 centimeter (approximately 1.75 × 4.75 inch) rectangular BRD standard.**

Complementary measures include the following:

3. **Establish seasonal crab-pot closures in identified high-risk diamondback terrapin habitats**, particularly during periods when terrapins are active and vulnerable to pot mortality, with priority given to tidal creeks, shallow estuarine waters, salt-marsh complexes, and other areas documented by NJDEP or reliable scientific data as supporting significant terrapin populations.
4. **Establish and fund a recurring statewide program to locate and remove abandoned, lost, and otherwise derelict (“ghost”) crab pots** from New Jersey's coastal and estuarine waters, with particular emphasis on known diamondback terrapin habitat.
5. **Increase enforcement of crab-pot and BRD requirements**, including targeted compliance inspections in terrapin habitat, inspection of commercial and recreational crab pots, and appropriate penalties and corrective action for pots lacking compliant BRDs, biodegradable panels, identification, or other required equipment.
6. **Require terrapin-protection information to be distributed in connection with every recreational and commercial crab-pot license** and make comparable educational material available through New Jersey's recreational saltwater fishing registration and licensing systems. At minimum, NJDEP should provide every crab-pot licensee with a brochure explaining BRD requirements, proper BRD installation, the risk crab pots pose to terrapins, proper pot placement and retrieval, reporting of lost gear, and instructions for reporting terrapin captures and mortalities.
7. **Establish monitoring and reporting requirements** sufficient to evaluate compliance, quantify terrapin bycatch and mortality, identify geographic and seasonal mortality hotspots, evaluate ghost-pot mortality, and measure the effectiveness of these conservation measures.

Petitioners request that the Department grant the statewide BRD portion of this Petition independently even if the Department determines that additional development is necessary before adopting one or more complementary measures.

The Center for Biological Diversity (Center) authored this petition. The Center is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center is supported by more than 1.8 million members and online activists throughout the United States, including almost 40,300 members and supporters in New Jersey. The Center and its members are deeply concerned about the conservation of imperiled wildlife—including diamondback terrapins—and their essential habitats.

Citizens United to Protect the Maurice River and Its Tributaries, Inc. (CU Maurice River) is dedicated to protecting the watershed of the Maurice River and the region known as Down Jersey, thereby enabling current and future generations to enjoy the environmental, recreational,

cultural, and scenic resources of this Wild & Scenic global treasure. CU Maurice River empowers individuals, organizations, and neighboring communities to promote the region's enduring well-being and quality of life. CU Maurice River invites participation and fosters responsible stewardship. CU Maurice River supports education, awareness, and informed decision-making utilizing fieldwork, research, and advocacy.

Hackensack Riverkeeper is dedicated to protecting, preserving, and restoring the Hackensack River watershed and its fish and wildlife habitats through advocacy, education, conservation, and litigation.

Delaware Riverkeeper Network works across the Delaware River watershed on the issues, actions, regulations, legislation, policies, programs, and decisions that impact the health of waterways across the four-state watershed region of Pennsylvania, Delaware, New Jersey, and New York. Delaware River Network protects and restores the Delaware River Watershed for the benefit of all.

New Jersey Conservation Foundation is dedicated to protecting New Jersey's land, natural resources, wildlife habitat, and open spaces through land conservation, stewardship, and environmental advocacy.

Project Terrapin, LLC is dedicated to the conservation of diamondback terrapins through scientific research, public education, habitat protection, and efforts to reduce human-caused mortality, including bycatch in crab pots. The organization works to advance practical conservation measures that protect terrapin populations and their coastal habitats in New Jersey.

Petitioners have an interest in the conservation of native wildlife and in ensuring that New Jersey employs readily available and scientifically supported measures to prevent avoidable mortality of diamondback terrapins.

I. Executive Summary

Diamondback terrapins (*Malaclemys terrapin*) are highly vulnerable to mortality in submerged blue crab pots. Terrapins enter crab pots but, as air-breathing turtles, may drown when unable to escape and reach the surface. This source of mortality is particularly consequential because terrapins are long-lived, slow-maturing animals whose populations depend heavily on the survival of adults and subadults. The scientific literature has documented both chronic mortality from actively fished pots and acute mortality from lost or abandoned "ghost" pots, and crab-pot mortality can contribute to severe population declines and local extirpation.¹

This threat is not hypothetical in New Jersey. Research conducted in New Jersey documented the capture and mortality of northern diamondback terrapins in commercial-style crab pots. Wood (1997), for example, captured 19 terrapins in commercial crab pots at a rate of approximately 15 terrapins per 100 trap-days. Four drowned even though the experimental pots were checked twice daily to minimize mortality; Wood observed that pots in the commercial fishery generally

¹ See attached Appendix A.

were checked no more than once per day and concluded that mortality of captured terrapins could have approached 100 percent under ordinary fishing conditions.²

New Jersey conservation researchers continue to identify crab-pot bycatch as a major threat to the State's terrapins³ and the state already regulates crab pots to address it. The State requires terrapin excluder devices, also known as bycatch reduction devices (“BRDs”), on commercial-style crab pots deployed in certain narrow waterways and man-made lagoons. But the existing rule generally protects terrapins only where pots happen to be deployed in waters falling within its geographic criteria. Terrapins are not confined to waterways less than 150 feet wide or to man-made lagoons; they inhabit salt marshes, tidal creeks, bays, coves, and other estuarine habitats. Thus, an otherwise identical crab pot capable of capturing and drowning a terrapin may require a BRD in one location but not in nearby terrapin habitat merely because the latter falls outside the rule's geographic boundary.

A statewide GIS analysis further demonstrates the extraordinary extent of this regulatory gap. Of approximately 70,530 acres of mapped terrapin-associated tidal waterways, 66,892 acres (94.8%) fall outside the estimated geographic coverage of New Jersey's existing BRD requirement. Only 5.2% fall within areas covered by the 150-foot waterway-width and man-made-lagoon provisions. As illustrated in Figure 1, the current regulation thus leaves nearly 95% of mapped terrapin-associated tidal waterway acreage outside mandatory BRD protections, underscoring the need for a uniform statewide requirement.

Indeed, NJDEP itself has now expressly recognized the inadequacy of limiting BRD requirements in this manner. The Department's 2025 State Wildlife Action Plan identifies terrapin bycatch associated with recreational or subsistence fishing as a “Highest” threat and establishes an action to:

“Expand legal requirements for Bycatch Reduction Devices (BRD) to all estuarine habitats inhabited by Northern Diamond-backed Terrapins to reduce the impacts of bycatch decreasing mortality risk to terrapins and improving populations.”⁴

NJDEP's current Marine Region Action Plan continues to publish that action and assigns it to the regulatory-action category, “Create, amend, or influence regulation.”⁵ The principal statewide BRD requirement requested in this Petition would therefore implement, rather than depart from, a conservation action that NJDEP has already determined is warranted.

A uniform BRD requirement is the most straightforward and administrable means of accomplishing that objective. Conditioning protection on mapped terrapin habitat would continue to leave protection dependent on the completeness and currency of distribution data, while conditioning it on waterway width perpetuates the arbitrary geographic distinction in the existing rule. A statewide equipment standard instead establishes a simple rule for crabbers and

² *Id.*

³ Brian Williamson, *Helping Terrapins Catch a Break*, The Wetlands Institute (Nov. 19, 2022), <https://wetlandsinstitute.org/helping-terrapins-catch-a-break/>.

⁴ New Jersey Department of Environmental Protection, *2025 New Jersey State Wildlife Action Plan, Marine Region*, Action C.7.1.3.0, “Expand legal requirements for Bycatch Reduction Devices (BRD) to all estuarine habitats inhabited by Northern Diamond-backed Terrapins to reduce the impacts of bycatch decreasing mortality risk to terrapins and improving populations.”

⁵ *Marine Region*, N.J. Dep’t of Env’t Prot., <https://dep.nj.gov/swap/regions/marine/> (last visited Sept. 25, 2026).

enforcement officers alike: every entrance funnel on every commercial-style crab pot must contain a compliant BRD regardless of where the pot is deployed. Such a requirement would protect terrapins occurring outside presently mapped or surveyed habitat, avoid disputes over geographic boundaries, and make compliance readily observable during enforcement inspections.

The requested 4.5×12.0 centimeter (approximately 1.75×4.75 inch) BRD standard is also supported by substantial scientific evidence. Cole and Helser (2001) conducted a four-year experiment in the Delaware River estuary involving 52 sets of experimental pots deployed in ten tidal tributaries and inland bays. The study tested multiple BRD dimensions and captured 372 terrapins and 3,522 legal-sized blue crabs.⁶ The 4.5×12 cm device substantially reduced terrapin capture while retaining the large majority of legal-sized blue-crab catch.⁷

The broader scientific record reinforces the conclusion that appropriately sized BRDs can dramatically reduce terrapin entry without preventing the continued harvest of blue crabs. New Jersey research is especially instructive. Wood's experiments found that a 5×10 cm BRD reduced terrapin capture by approximately 90 percent while crab catch rates increased, and a 4.5×10 cm configuration excluded all terrapins in the relevant experiment while crab catch rates were approximately 9 percent higher than in unmodified pots.⁸ These results demonstrate that restricting the dimensions of a crab-pot entrance can sharply reduce terrapin capture without necessarily reducing blue-crab harvest.

More recent research conducted in Barnegat Bay, New Jersey, specifically evaluated the 4.5×12 cm BRD requested here, along with other BRD configurations. Wnek et al. (2019) compared BRD-equipped and control pots in Barnegat Bay and reported that terrapins were captured in control pots but not in the BRD-equipped pots during the study.⁹ Taken together with the Delaware Bay research and the broader BRD literature summarized in Appendix A, these studies provide substantial empirical support for replacing New Jersey's existing approximately 5×15 cm (2×6 inch) opening with the more protective 4.5×12 cm standard.

The requested rule would also impose a comparatively modest change in fishing practices. BRDs are simple devices installed at crab-pot entrance funnels; they do not require abandonment of commercial-style crab pots or elimination of the blue-crab pot fishery. Existing outreach

⁶ Cole, R.V. & Helser, T.E. (2001). Effect of Three Bycatch Reduction Devices on Diamondback Terrapin *Malaclemys terrapin* Capture and Blue Crab *Callinectes sapidus* Harvest in Delaware Bay. *North American Journal of Fisheries Management* 21(4): 825–833. [https://doi.org/10.1577/1548-8675\(2001\)021%3C0825:EOTBRD%3E2.0.CO;2](https://doi.org/10.1577/1548-8675(2001)021%3C0825:EOTBRD%3E2.0.CO;2).

⁷ Not every experiment has produced identical results, and some studies have detected reductions in certain categories of crab catch. The scientific literature as a whole, however, demonstrates that appropriately sized BRDs substantially reduce terrapin entry while permitting continued harvest of legal-sized blue crabs. Particularly relevant are studies of the proposed 4.5×12 cm configuration, including work conducted in New Jersey and the Delaware Bay region.

⁸ Wood, R.C. 1997. The impact of commercial crab traps on northern diamondback terrapins, *Malaclemys terrapin terrapin*. Pages 21–27 in J. Van Abbema, ed. *Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference*. New York Turtle and Tortoise Society, New York, New York.

⁹ Wnek, J.P., A. Perdon & S. Holmberg. 2019. *Analysis of Bycatch Reduction Devices (BRDs) on Blue Crab Captures and Effectiveness of Preventing Bycatch: A Study Conducted at Barnegat Bay, NJ*. Ocean County Vocational Technical School, Center for Research and Applied Barnegat Bay Studies, Marine Academy of Technology and Environmental Science. Aug. 20, 2019. DOI: 10.13140/RG.2.2.18317.49120.

materials demonstrate both the simplicity of installation and the feasibility of integrating BRD use into ordinary crabbing practices: BRDs can be secured to each funnel, while crabbers continue to use otherwise conventional commercial-style pots. The scientific evidence similarly demonstrates that the biological characteristics separating terrapins from legal-sized blue crabs permit properly dimensioned BRDs to reduce terrapin entry while continuing to allow legal-sized crabs to enter.¹⁰

The case for statewide protection is particularly compelling because the current geographic limitation adds regulatory complexity without making an unprotected pot safer. A crab pot does not cease posing a drowning risk when a waterway becomes wider than 150 feet. Yet under the existing rule, crabbers and enforcement personnel may have to determine whether a particular waterway satisfies a width threshold at mean low tide or qualifies as a man-made lagoon before determining whether a BRD is required. A uniform rule eliminates that problem: if a person uses a commercial-style blue crab pot in New Jersey waters, every entrance funnel must contain a compliant BRD. The same rule applies to every crabber and every covered pot.

BRDs should serve as the minimum statewide safeguard rather than the State's only response to crab-pot mortality. Even with BRDs, particular locations may present unusually high risks because of terrapin abundance, crab-pot density, habitat characteristics, seasonal movements, or documented mortality. Lost and abandoned pots present an additional threat because they can continue capturing animals after they cease providing any fishing benefit. The scientific literature documents both the continuing "background" mortality associated with actively fished pots and potentially acute mortality associated with derelict pots.¹¹ Accordingly, the Petition also asks NJDEP to establish targeted seasonal protections in particularly high-risk areas, create a recurring ghost-pot identification and removal program, strengthen compliance and enforcement, integrate terrapin-protection information into crab-pot licensing, and establish monitoring and reporting sufficient to evaluate the effectiveness of these measures.

These complementary measures should not, however, delay the central and immediately implementable reform requested by this Petition. The State does not need to know the location of every terrapin, quantify every unreported drowning, or identify every future mortality hotspot before requiring a proven preventive device on crab pots. NJDEP already recognizes crab-pot bycatch as a serious threat, already requires BRDs in some New Jersey waters, and has expressly called for expansion of the legal requirement throughout estuarine habitats inhabited by terrapins.

For these reasons, Petitioners request that NJDEP amend N.J.A.C. 7:25-14 and related provisions to require a 4.5 × 12 cm BRD in every entrance funnel of every commercial-style blue crab pot used in New Jersey waters, whether commercial or recreational, and adopt the complementary seasonal, ghost-pot, enforcement, education, monitoring, and reporting measures set forth below. At a minimum, NJDEP should grant and initiate rulemaking on the statewide BRD requirement independently of any determination that additional development is necessary for one or more of the complementary measures.

¹⁰ See Exhibit A, Brochure.

¹¹ See Appendix A.

II. Existing New Jersey Regulations are Inadequate.

New Jersey already recognizes both the danger crab pots pose to diamondback terrapins and the effectiveness of bycatch reduction devices. Existing regulations require terrapin excluder devices on commercial-style crab pots deployed in certain narrow waterways and man-made lagoons.¹² The existing device generally restricts pot entrances to no larger than six inches wide and two inches high. That rule was an important conservation measure when adopted, but it is no longer adequate in light of the available scientific evidence.¹³

First, the existing regulation is geographically underinclusive. Diamondback terrapins do not occur only in man-made lagoons and narrow waterways. They occupy salt marshes, tidal creeks, bays, coves, and other estuarine habitats throughout coastal New Jersey. Crab pots deployed in suitable terrapin habitat can capture and drown terrapins regardless of whether the particular water body falls within the existing width-based regulatory threshold.¹⁴ The arbitrary consequence is that a crab pot capable of drowning a terrapin must contain an excluder when placed on one side of an artificial regulatory boundary but may be deployed without one in nearby terrapin habitat.

The magnitude of this geographic deficiency is illustrated by the statewide GIS analysis in Figure 1. The analysis estimates that nearly 95% of terrapin-associated tidal waterway acreage falls outside the existing BRD requirement. Although the precise boundaries are subject to limitations in available shoreline data, the results demonstrate that the current 150-foot and man-made-lagoon restrictions exclude the overwhelming majority of mapped terrapin-associated tidal waters from mandatory BRD protections.

¹² See N.J.A.C. 7:25-14.

¹³ See Appendix A.

¹⁴ New Jersey Division of Fish & Wildlife. 2016. *New Jersey Freshwater Fishing Digest*, pp. 12–15 (species account for Northern Diamondback Terrapin). See also Roosenburg, W.M. & Green, J.P. 2000. Impact of a bycatch reduction device on diamondback terrapin and blue crab capture in crab pots. *Ecological Applications* 10: 882–889. DOI: 10.1890/1051-0761(2000)010[0882:IOABRD]2.0.CO;2.

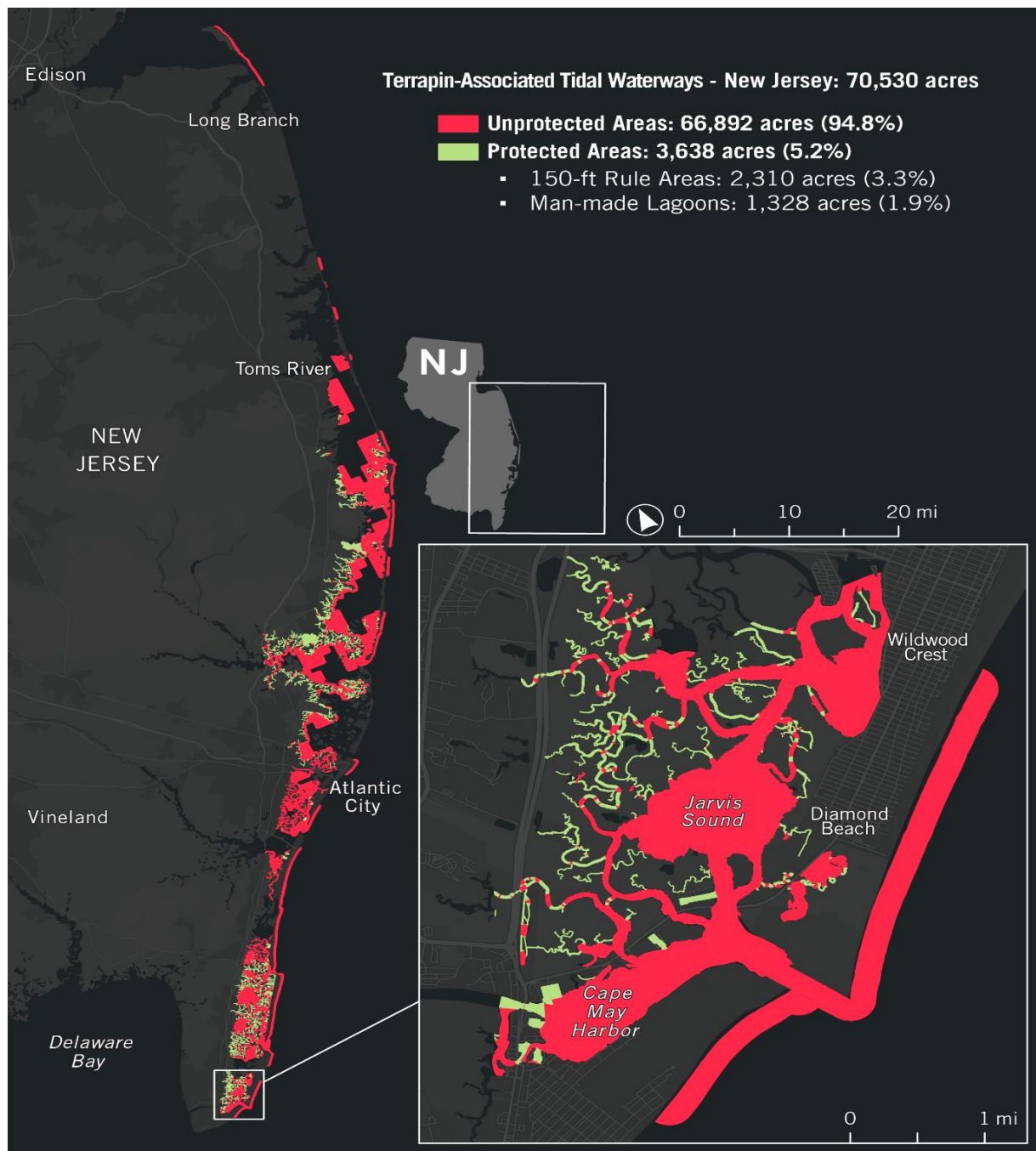


Figure 1. Geographic gaps in New Jersey's existing diamondback terrapin bycatch reduction device requirements. Statewide GIS analysis of 70,530 acres of terrapin-associated tidal waterways identifies 66,892 acres (94.8%) outside the existing BRD requirement (red) and 3,638 acres (5.2%) within areas covered by the requirement (green). Covered areas include waterways meeting the 150-foot width criterion and qualifying man-made lagoons. The inset illustrates the substantial extent of the regulatory gap in the Cape May region. The analysis demonstrates that existing geographic restrictions exclude the overwhelming majority of mapped terrapin-associated tidal waterway acreage from mandatory BRD protections.¹⁵

¹⁵ GIS analysis prepared by Connor Phillips, GIS Analyst, Center for Biological Diversity (Oct. 9, 2026). Methods and Data Limitations: Terrapin-associated tidal waterways were identified using NJDEP Landscape Project 3.4

Second, New Jersey's existing approximately 5×15 cm (2×6 inch) opening is not the most effective available design for preventing terrapin mortality. More protective BRDs have been tested and shown capable of dramatically reducing terrapin entry while retaining the great majority of legal-sized blue crab catch.¹⁶

There is consequently a straightforward and inexpensive means of substantially reducing this source of mortality: require an appropriately sized BRD on every crab pot deployed in New Jersey waters.

A. Crab Pots are Killing Terrapins in New Jersey

The threat posed by blue crab pots to diamondback terrapins is not merely theoretical or extrapolated from studies elsewhere in the species' range. Terrapins have been captured and killed in crab pots in New Jersey, including in actively fished commercial-style pots and abandoned or lost "ghost" pots. New Jersey-specific research has documented substantial capture rates, drowning mortality, and mass-mortality events, while experiments conducted in New Jersey and the adjoining Delaware estuary demonstrate that bycatch reduction devices can substantially reduce that mortality.

Roger Wood's research in New Jersey provided early direct evidence of the danger commercial-style crab pots pose to terrapins. In experiments using crab pots without effective excluders, Wood documented capture rates ranging from approximately 0.054 to 0.49 terrapins per pot-day. Subsequent scientific reviews have continued to cite Wood's New Jersey results as among the documented examples of substantial terrapin capture in unmodified crab pots.¹⁷

In one component of Wood's study, 19 diamondback terrapins—eight males and eleven females—were captured in commercial crab pots, at a rate of approximately 15 terrapins per 100 trap-days. Four of those terrapins drowned even though the experimental pots were checked twice daily specifically to minimize mortality. Wood noted that commercial crabbers generally checked their pots no more than once per day and concluded that mortality among captured terrapins under ordinary fishing conditions could have approached 100 percent.¹⁸

Those findings are particularly significant because terrapins can drown relatively quickly after entering a submerged pot. The scientific literature summarized in Appendix A reports that

occupied habitat data and adjacent tidal waterways within 1,000 feet, based on NJDEP's 2015 National Hydrography Dataset (NHD). Areas subject to existing BRD requirements were estimated using NJDEP's 2020 land-cover data to identify man-made lagoons and shoreline-to-shoreline width measurements at 50-foot intervals to identify waterways ≤ 150 feet wide. Because statewide mean low water (MLW) shoreline data were unavailable, widths were estimated using mapped NHD waterbody boundaries rather than surveyed MLW shorelines. Although measurements near the 150-foot threshold are subject to uncertainty, only 4.5% of transects measured 151–200 feet, while 52.9% exceeded 200 feet. The map represents estimated regulatory coverage, not a definitive legal delineation.

¹⁶ See Appendix A.

¹⁷ Butler, J.A. & G.L. Heinrich. 2007. The effectiveness of bycatch reduction devices on crab pots at reducing capture and mortality of diamondback terrapins (*Malaclemys terrapin*) in Florida. *Estuaries and Coasts* 30(1): 179–185. <https://doi.org/10.1007/BF0278297>.

¹⁸ See Appendix A.

terrapins trapped underwater can die in less than five hours.¹⁹ Thus, regularly tending a pot does not eliminate its mortality risk; Wood's New Jersey experiments produced deaths even under a twice-daily checking regime more intensive than ordinary commercial practice.

Wood's work also demonstrated that the problem is preventable. New Jersey BRD experiments tested devices that restricted the size of crab-pot entrances and found substantial reductions in terrapin capture. A synthesis of BRD research reports that all four New Jersey studies conducted since 1989 found reductions of at least 80 percent in terrapin bycatch with BRDs, while some experiments simultaneously produced increases in crab catch.²⁰ These results helped establish the scientific foundation for the use of terrapin excluder devices in crab pots.

More recent research in Barnegat Bay provides particularly compelling evidence because it examined BRD performance under present-day New Jersey conditions and directly exposed the weakness of the State's existing geographic restriction.

Wnek, Perdon, and Holmberg (2019) experimentally compared control crab pots without BRDs to pots fitted with several BRD configurations, including the 4.5 × 12 cm device requested in this Petition, in Barnegat Bay near Waretown, New Jersey. The experiment found that no non-target species were captured in any BRD-equipped pots, while both terrapins captured during the experiment entered control pots lacking BRDs.²¹

Critically, the researchers reported that both terrapins were captured in control pots located more than 150 feet from shore—locations where New Jersey's existing spatial restriction did not require BRDs. They specifically observed that many crab pots placed along the Barnegat Bay shoreline fall outside the BRD requirement for spatial reasons.²²

That finding illustrates the fundamental defect in the present rule. NJDEP currently requires turtle excluders in commercial-style crab pots set in man-made lagoons or water bodies less than 150 feet wide.²³ Yet the Wnek study actually captured terrapins in unprotected pots outside the geographic boundary where the State requires the preventive device. The width of a waterbody plainly does not render a crab pot incapable of capturing a terrapin.

The Barnegat Bay research also found evidence that crab pots do not necessarily remain where crabbers initially deploy them. Based on derelict-pot recovery work, the researchers reported that pots can move because of strong currents and seasonal winds, with movement affected by pot weight and bottom substrate. They specifically noted that pots initially fished farther from shore may move toward terrapin habitat following strong storms. This provides another reason not to

¹⁹ *Id.*

²⁰ *Diamondback Terrapin Bycatch in Crab Traps*, ArcGIS StoryMaps, <https://storymaps.arcgis.com/stories/3555d14f5ca2442e960a955d00f68044> (last visited Sept. 25, 2026).

²¹ Wnek, J.P., A. Perdon & S. Holmberg. 2019. *Analysis of Bycatch Reduction Devices (BRDs) on Blue Crab Captures and Effectiveness of Preventing Bycatch: A Study Conducted at Barnegat Bay, NJ*. Ocean County Vocational Technical School, Center for Research and Applied Barnegat Bay Studies (Aug. 20, 2019), DOI: 10.13140/RG.2.2.18317.49120.

²² John P. Wnek, Alaina Perdon & Steven Holmberg, *Analysis of Bycatch Reduction Devices (BRDs) on Blue Crab Captures and Effectiveness of Preventing Bycatch: A Study Conducted at Barnegat Bay, NJ* (Marine Academy of Technology & Environmental Science, Aug. 20, 2019), DOI: 10.13140/RG.2.2.18317.49120.

²³ N.J. Dep't of Env't Prot., Div. of Fish & Wildlife, *Blue Claws: Crabbing in New Jersey*, <https://dep.nj.gov/njfw/fishing/marine/blue-claws-crabbing-in-new-jersey/> (last visited Sept. 25, 2026).

condition the use of a simple gear modification on a pot's location relative to an artificial geographic boundary.²⁴

New Jersey's derelict-crab-pot recovery work provides even more dramatic evidence of the consequences of leaving crab pots accessible to terrapins.

Beginning in 2015, the Conserve Wildlife Foundation of New Jersey and partners, including the Marine Academy of Technology and Environmental Science and Stockton University, undertook extensive efforts to locate and retrieve lost and abandoned crab pots in Barnegat Bay. During the first three field seasons alone, the project recovered approximately 1,300 derelict crab pots and documented their bycatch.²⁵

In 2016, a single recovered crab pot contained the remains of 17 diamondback terrapins.²⁶ The subsequent Barnegat Bay research examined that mortality event in greater detail. Of the 17 terrapins recovered from the pot, researchers determined that 11 were sufficiently large that they might not have become trapped had the pot contained BRDs. Most importantly, BRDs were not required at the location where that pot was recovered under New Jersey's existing geographic regulation.²⁷

The 17-terrapin pot provides a concrete New Jersey example of precisely the mortality this Petition seeks to prevent. A single unprotected pot outside the existing BRD zone was capable of killing a substantial number of terrapins, including animals that researchers concluded might have been excluded by BRDs.

The scale of the underlying ghost-pot problem is also substantial. In a later NOAA-supported phase of the Barnegat Bay project, project partners removed another 947 derelict crab pots and 6,280 pounds of debris. NOAA expressly identifies derelict crab pots in New Jersey as capable of entrapping wildlife including diamondback terrapins.²⁸ Conserve Wildlife Foundation likewise reports that ghost pots continue fishing after being lost and that trapped animals can attract additional animals, perpetuating the cycle of mortality.²⁹

These observations are consistent with the broader scientific literature. Crab pots can produce both recurring "background" mortality from actively fished pots and concentrated mortality from

²⁴ Wnek, J.P., A. Perdon, and S. Holmberg. 2019. *Analysis of bycatch reduction devices (BRDs) on blue crab captures and effectiveness of preventing bycatch: A study conducted at Barnegat Bay, NJ*. Ocean County Vocational Technical School, Center for Research and Applied Barnegat Bay Studies, Marine Academy of Technology and Environmental Science. DOI: 10.13140/RG.2.2.18317.49120.

²⁵ Emily Heiser, *Fishing for a Cleaner Barnegat Bay*, Conserve Wildlife Foundation of New Jersey (Dec. 8, 2018), <https://conservewildlifenj.org/2018/12/08/fishing-for-a-cleaner-barnegat-bay/>.

²⁶ *Id.*

²⁷ Wnek, J.P., A. Perdon, and S. Holmberg. 2019. *Analysis of bycatch reduction devices (BRDs) on blue crab captures and effectiveness of preventing bycatch: A study conducted at Barnegat Bay, NJ*. Ocean County Vocational Technical School, Center for Research and Applied Barnegat Bay Studies. DOI: 10.13140/RG.2.2.18317.49120.

²⁸ Nat'l Oceanic & Atmospheric Admin., Marine Debris Program, *Identification and Retrieval of Derelict Crab Pots to Reduce Bycatch in Barnegat Bay, New Jersey: Phase II*, <https://marinedebris.noaa.gov/removal/identification-and-retrieval-derelict-crab-pots-reduce-bycatch-barnegat-bay-new-jersey-phase-ii> (last visited Sept. 25, 2026).

²⁹ Conserve Wildlife Found. of N.J., *The Barnegat Bay "Ghost" Crab Pot Project*, <https://conservewildlifenj.org/projects/barnegat-bay-crab-pots-project/> (last visited Sept. 25, 2026).

individual lost or abandoned pots.³⁰ Because multiple terrapins can enter the same pot, even a relatively small number of unprotected ghost pots can cause disproportionate mortality.

The Department's own conservation assessments confirm the significance of these observations. NJDEP's Endangered and Nongame Species Program has identified "drowning in commercial-style crab pots" as a source of increased mortality for northern diamondback terrapins in New Jersey.³¹ NJDEP has also publicly identified "drowning in crab traps" among the threats that again placed New Jersey terrapins at risk after their historical recovery from commercial exploitation.³²

Most importantly, NJDEP's current State Wildlife Action Plan expressly identifies recreational or subsistence fishing—including the "accidental catching of northern diamondback terrapins in crab pots"—as a "Highest" threat in the Marine Region.³³ The Plan does not merely recognize the problem; it identifies the regulatory response that this Petition asks NJDEP to implement:

"Expand legal requirements for Bycatch Reduction Devices (BRD) to all estuarine habitats inhabited by Northern Diamond-backed Terrapins...."³⁴

The Plan separately calls for increased BRD use through educational outreach aimed at recreational crabbers and increased compliance.³⁵ Thus, NJDEP's own conservation planning reaches the same fundamental conclusion supported by decades of New Jersey and regional research: the existing level of BRD protection is insufficient and legal requirements should be expanded.

The evidence is therefore unusually concrete. Terrapins have drowned in actively fished crab pots in New Jersey; terrapins have been captured in unprotected Barnegat Bay pots outside the area where existing regulations require BRDs; researchers recovered the remains of 17 terrapins from a single ghost pot at a location where BRDs were not required; and NJDEP itself has classified accidental crab-pot capture as a Highest threat and called for expansion of legal BRD requirements.³⁶

These facts demonstrate why the current geographic limitation is inadequate. The biological risk presented by a crab pot does not disappear when a waterbody exceeds 150 feet in width. The available New Jersey evidence instead demonstrates that terrapins encounter and die in crab pots outside the waters presently covered by the BRD mandate. Requiring an appropriately sized

³⁰ See Appendix A.

³¹ Karena DiLeo, New Jersey Department of Environmental Protection, Division of Fish & Wildlife, Endangered & Nongame Species Program, *Species Status Review of Amphibian and Reptiles: Final Report* (Jan. 7, 2016), https://www.nj.gov/dep/fgw/ensp/pdf/herp_status_rprrt.pdf.

³² N.J. Dep't of Env't Prot., *DEP Issues Administrative Order Closing Diamondback Terrapin Season Due to Increased Harvest Pressures* (Mar. 2, 2015), https://dep.nj.gov/newsrel/15_0017/.

³³ N.J. Dep't of Env't Prot., *Marine*, State Wildlife Action Plan, <https://dep.nj.gov/swap/regions/marine/> (last visited Sept. 25, 2026).

³⁴ *Id.*

³⁵ *Id.*

³⁶ See Appendix A; see also Wnek, J.P., A. Perdon, and S. Holmberg. 2019. Analysis of bycatch reduction devices (BRDs) on blue crab captures and effectiveness of preventing bycatch: A study conducted at Barnegat Bay, NJ. Ocean County Vocational Technical School, Center for Research and Applied Barnegat Bay Studies. August 20, 2019. DOI: 10.13140/RG.2.2.18317.49120.

BRD in every entrance funnel of every commercial-style crab pot would address that documented regulatory gap with a simple, tested, and readily enforceable conservation measure.

B. Scientific Support for a 4.5 x 12cm BRD

Multiple studies evaluating the requested 4.5×12 cm opening have found substantial reductions in terrapin entry with little or no significant effect on blue-crab catch.

Study	Location	BRD	Terrapin effect	Crab-catch effect
Cole & Helser 2001	Delaware Bay	4.5×12 cm	38% ↓ males; 96% ↓ females	~12% ↓ legal crabs
Roosenburg & Green 2000	Chesapeake	4.5×12 cm	82% ↓	No significant effect
Butler & Heinrich 2007	Florida	4.5×12 cm	Reduced mortality/bycatch	No significant difference
Rook et al. 2010	Chesapeake	4.5×12 cm	—	Equivalent catch
Wnek 2019	New Jersey	4.5×12 cm	No terrapins caught in BRD pots in trial	No significant difference in crab number

Most importantly for this rulemaking, research conducted in Barnegat Bay, New Jersey found no significant difference in the number of blue crabs captured in pots equipped with BRDs and control pots and found the 4.5×12 cm treatment comparable to controls with respect to crab dimensions.³⁷

Cole and Helser (2001) conducted a four-year study of BRDs in the Delaware River estuary, testing 5×10 cm, 5×12 cm, 4.5×12 cm, and 3.8×12 cm devices against control pots. The experiment involved 52 sets of pots in ten tidal tributaries and inland bays and captured 372

³⁷ See Appendix A; Butler & Heinrich: no significant difference in number, measurements, or sex of legal crabs; Rook et al.: equivalent crab catch; Roosenburg & Green: no adverse effect on crab size or number and an 82% reduction in terrapin capture; Wnek (2019), Barnegat Bay, New Jersey: no significant difference in the number of blue crabs captured in BRD versus control traps and no relevant size/height disadvantage for the 4.5×12 cm device.

diamondback terrapins and 3,522 legal-sized blue crabs. The results demonstrate the importance of BRD dimensions.³⁸

The 4.5×12 cm BRD produced a statistically significant reduction in terrapin captures, reducing capture of male terrapins by approximately 38 percent and female terrapins by approximately 96 percent.³⁹ At the same time, the reduction in legal-sized blue crab catch was approximately 12 percent. The researchers therefore specifically recommended the 4.5×12 cm BRD for recreational crab pots because it would effectively protect subadult and reproductive female terrapins, while producing only a relatively small reduction in legal blue crab catch.⁴⁰

C. BRDs Are an Inexpensive & Practical Conservation Measure.

Requiring bycatch reduction devices on all commercial-style blue crab pots would impose a relatively small equipment cost. BRDs are simple rectangular inserts made of rigid wire or plastic that are secured inside a crab pot's entrance funnels; they do not require crabbers to replace the pot itself. New Jersey already requires terrapin excluder devices in each funnel of covered commercial-style pots, so the proposed rule would expand the geographic scope of an existing type of gear requirement while reducing the maximum opening from approximately 2×6 inches to 1.75×4.75 inches.⁴¹

Published research has estimated BRDs to cost approximately \$0.50 to \$2.00 per entrance funnel and describes them as inexpensive and easy to install.⁴² A more recent terrapin-protection rulemaking petition identified commercially available BRDs for as little as \$0.45 each, while also noting that BRDs can be fabricated by crabbers themselves and have sometimes been distributed without charge through conservation programs.⁴³

A current retail check provides a conservative upper-bound comparison. One commercially available four-pack of terrapin excluder devices is presently listed for \$14.99, or approximately \$3.75 per device. Accordingly, using the published scientific-literature cost range, four BRDs would add approximately \$2–\$8 to a four-entrance pot. Even at the higher \$3.75-per-device retail example, four devices would cost approximately \$15. The proposed requirement therefore involves modification of existing gear rather than replacement of the underlying crab pot.

³⁸ Cole, R.V. & Helser, T.E. 2001. Effect of Three Bycatch Reduction Devices on Diamondback Terrapin *Malaclemys terrapin* Capture and Blue Crab *Callinectes sapidus* Harvest in Delaware Bay. *North American Journal of Fisheries Management* 21:825–832.

³⁹ The importance of protecting adult females cannot be overstated. Diamondback terrapins are long-lived turtles characterized by delayed maturity and life histories in which adult survival is critical to population persistence. Removing adult females through recurring drowning mortality can therefore have population-level consequences far beyond the number of turtles found in individual traps. *Id.*

⁴⁰ *Id.*

⁴¹ *New Jersey Mollusks & Crustaceans*, eRegulations, <https://www.eregulations.com/newjersey/fishing/saltwater/mollusks-crustaceans> (last updated May 11, 2026).

⁴² Radzio, T.A., J.A. Smolinsky, and W.M. Roosenburg. 2013. Low use of required terrapin bycatch reduction devices in a recreational crab pot fishery. *Herpetological Conservation and Biology* 8(1): 222–227.

⁴³ *Petition to Protect Diamondback Terrapins (Malaclemys terrapin) from Mortality in Blue Crab Pots by Requiring Bycatch Reduction Devices in Near-Shore Waters* (Ctr. for Biological Diversity et al. Feb. 12, 2025), <https://www.biologicaldiversity.org/programs/biodiversity/pdfs/VA-crab-bycatch-reduction-petition-02-12-2025.pdf>.

III. New Jersey's Conservation Plans Support Expanding BRD Requirements.

NJDEP has itself identified the northern diamond-backed terrapin (*Malaclemys terrapin terrapin*) as a Species of Greatest Conservation Need (“SGCN”) in New Jersey’s 2025 State Wildlife Action Plan (“SWAP”). The designation is significant because NJDEP defines SGCN as species with small or declining populations, species that are at risk, or species otherwise in need of management attention; the 2025 SWAP is expressly intended to identify the threats facing such species and the priority conservation actions needed to address those threats. The northern diamond-backed terrapin appears on the 2025 SGCN list in the “State/Federal Status” category, reflecting its status as a regulated SGCN, and NJDEP identifies its New Jersey habitats as including back bays, estuaries and tidal rivers and streams, beaches and dunes, riparian and floodplain zones, and tidal wetlands and flats. NJDEP’s designation thus independently recognizes the terrapin as a species warranting focused conservation attention and provides important context for the Plan’s more specific findings concerning crab-pot mortality and BRDs.⁴⁴

More specifically, the 2025 SWAP identifies accidental capture of northern diamond-backed terrapins in crab pots as a “Highest” threat and identifies expansion of legal BRD requirements as a conservation action to address that threat. The Plan expressly calls for the State to:

“Expand legal requirements for Bycatch Reduction Devices (BRD) to all estuarine habitats inhabited by Northern Diamond-backed Terrapins to reduce the impacts of bycatch decreasing mortality risk to terrapins and improving populations.”⁴⁵

The Action Plan likewise calls for increased BRD outreach and compliance and identifies derelict fishing gear as a wildlife threat.⁴⁶ Thus, NJDEP has already identified the regulatory deficiency addressed by this Petition and has already identified expansion of BRD requirements as an appropriate conservation response. The Department should now translate that conservation objective into an enforceable statewide requirement.

IV. NJDEP Should Establish Seasonal Crab-Pot Closures in High – Risk Terrapin Areas.

BRDs should be the minimum statewide safeguard, not the State’s only management tool. NJDEP should also identify areas where the density of terrapins, crab-pot effort, habitat characteristics, documented mortality, or other factors produce particularly high bycatch risk. In those locations, the Department should prohibit or restrict crab-pot deployment during periods of greatest terrapin activity and vulnerability.

⁴⁴ New Jersey Department of Environmental Protection, Fish & Wildlife, *2025 New Jersey State Wildlife Action Plan: Species of Greatest Conservation Need*, <https://dep.nj.gov/swap/sgcn> (identifying *Malaclemys terrapin terrapin*, Northern Diamond-backed Terrapin, as an SGCN).

⁴⁵ New Jersey Department of Environmental Protection, *State Wildlife Action Plan: Marine Region, Actions and Threats for this Region, Action C.7.1.3.0 (2025)* (identifying accidental capture of northern diamondback terrapins in crab pots as a “Highest” threat and calling for expansion of legal BRD requirements to “all estuarine habitats inhabited by Northern Diamond-backed Terrapins”).

⁴⁶ *Id.*

The Department should use existing occurrence data maintained by the Endangered and Nongame Species Program, available research and monitoring data, reported mortalities, and additional field surveys to designate seasonal Terrapin Protection Areas.

Such closures could be geographically narrow and temporally targeted. They therefore provide a means of addressing exceptional mortality hotspots without unnecessarily restricting crabbing elsewhere.

V. NJDEP Should Establish a Ghost Pot Removal Program.

A crab pot can continue fishing after its owner leaves it unattended and, if lost or abandoned, can continue capturing animals as “ghost gear.” Terrapins entering a submerged pot cannot surface to breathe and can drown. Multiple terrapins may enter the same pot, making even a relatively small number of unprotected pots capable of producing significant mortality. Lost and abandoned crab pots therefore pose a particularly unnecessary source of mortality because they can continue capturing and killing wildlife without providing any fishing benefit.⁴⁷



Drowned terrapins found in the Delaware Bay in waters greater than 150 feet wide

⁴⁷ Roosenburg, W.M., W. Cresko, M. Modesitte & M.B. Robbins. 1997. *Diamondback Terrapin (Malaclemys terrapin) Mortality in Crab Pots*. Conservation Biology 11(5): 1166–1172. See also Grosse, A.M., J.D. van Dijk, K.L. Holcomb & J.C. Maerz. 2009. *Diamondback Terrapin Mortality in Crab Pots in a Georgia Tidal Marsh*. Chelonian Conservation and Biology 8(1): 98–100. DOI: 10.2744/CCB-0729.1.



*Drowned terrapins found in the Delaware Bay in waters greater than 150 feet wide
Delaware Riverkeeper*

New Jersey should establish a recurring, adequately funded derelict crab-pot retrieval program in cooperation with commercial and recreational crabbers, conservation organizations, municipalities, academic institutions, and other partners.

The program should:

- systematically survey known terrapin habitats for lost and abandoned crab pots;
- establish a simple reporting mechanism through which crabbers, boaters, researchers, and members of the public can report lost or abandoned pots;
- authorize and coordinate safe retrieval;
- prioritize high-density terrapin habitats and known mortality hotspots;
- record the location and condition of recovered pots and the organisms found within them;
- analyze recovered-pot data to identify geographic patterns and prevent future gear loss; and

- publish annual statistics concerning pots located and removed, animals recovered, and areas surveyed.

New Jersey has already recognized the conservation value of this approach. NJDEP's conservation programs have specifically identified locating and removing ghost crab pots from coastal waterways as a means of reducing mortality of diamondback terrapins and other estuarine and marine species.⁴⁸ A permanent program would convert successful project-based efforts into an enduring component of the State's marine-resource management program.

VI. Enforcement Must Accompany the New Requirements.

A BRD requirement protects terrapins only if crabbers actually install and retain compliant devices. NJDEP should therefore develop an enforcement strategy concurrently with adoption of the rule.

Conservation Police Officers should conduct targeted inspections during the crabbing season, with emphasis on areas where crab pots overlap known terrapin populations. Inspections should determine whether pots contain correctly sized and securely installed BRDs in every entrance funnel and otherwise comply with identification, biodegradable-panel, tending, placement, and licensing requirements.

NJDEP should also establish a mechanism for reporting apparently unlawful crab pots and should undertake periodic compliance surveys to determine the percentage of recreational and commercial pots containing correctly installed BRDs.

The Department would ideally publish compliance statistics annually. This information would then allow NJDEP to determine whether education alone is producing adequate compliance, or whether additional inspections and enforcement measures are necessary.

VII. Education Should be Integrated into Crab-Pot Licensing.

New Jersey already requires a non-commercial crab-pot license to use non-collapsible Chesapeake-style crab pots. That licensing system provides an exceptionally efficient mechanism for reaching precisely the people whose behavior determines whether terrapins are protected. NJDEP should provide a terrapin-protection brochure or information sheet with every recreational crab-pot license and commercial crab license or renewal. NJDEP should also distribute the information through its Saltwater Recreational Registry, Marine Digest, website, boat ramps, marinas, bait-and-tackle shops, fishing organizations, and other appropriate outlets.

For licenses purchased electronically, the information should be displayed during the licensing process and provided electronically with the license. For in-person transactions, license agents should provide a printed copy.

The brochure should include:

- a photograph and identification information for the diamondback terrapin;

⁴⁸ New Jersey Department of Environmental Protection, Fish & Wildlife, *Conserve Wildlife Matching Grants Program*, NJDEP, available at NJDEP Fish & Wildlife — Conserve Wildlife Matching Grants Program (last visited Sept. 11, 2026).

- an explanation that terrapins can enter submerged crab pots and drown;
- the dimensions of the required 4.5×12 cm BRD;
- a clear diagram showing correct installation in every funnel;
- an explanation of the biodegradable-panel requirement;
- instructions for immediately releasing incidentally captured terrapins;
- instructions for reporting dead or injured terrapins;
- information on reporting lost or abandoned crab pots;
- information concerning seasonal Terrapin Protection Areas;
- penalties for noncompliance; and
- a QR code linking to NJDEP's current crab-pot and terrapin-protection regulations.

A brochure template, as developed by Project Terrapin, has been attached to this petition for reference. Exhibits A and B demonstrate that NJDEP need not develop an outreach program from scratch. Existing materials already illustrate BRD installation, responsible pot rigging, ghost-pot prevention, and bycatch reduction and could readily be adapted to NJDEP's licensing and outreach systems.

VIII. Monitoring & Reporting

NJDEP cannot effectively manage a mortality source that it does not adequately measure. The final rule should therefore establish or expand a system for reporting terrapin interactions with crab pots. NJDEP should collect information concerning location, date, pot type, BRD status, number and sex of terrapins when determinable, whether each animal was alive or dead, and whether the pot was actively fished or derelict.

The Department should periodically publish these data in an aggregated form sufficient to protect sensitive wildlife-location information while allowing researchers, policymakers, crabbers, and the public to evaluate the effectiveness of the program.

These data should also inform future seasonal closures, enforcement priorities, outreach efforts, and any necessary refinement of BRD requirements.

IX. Proposed Regulatory Language

A statewide gear requirement is the most administrable means of implementing the Action Plan's habitat-based objective. Terrapin distribution is incompletely mapped and dynamic; crab pots and lost gear can move; habitat boundaries are not necessarily apparent to crabbers or enforcement officers; and requiring a crabber to determine whether a particular location constitutes documented terrapin habitat recreates the boundary problem inherent in the current rule. A uniform gear standard eliminates those uncertainties while imposing only the modest burden of installing an inexpensive device on each funnel.

Petitioners propose that NJDEP amend N.J.A.C. 7:25-14 and any related provisions substantially as follows:

Terrapin Bycatch Reduction Devices

- (a) No person shall set, tend, fish, or otherwise use a commercial-style blue crab pot in any waters of this State unless each entrance funnel of the pot is equipped with a securely installed rectangular bycatch reduction device.
- (b) Each bycatch reduction device shall restrict the entrance opening to no greater than 4.5 centimeters (1.75 inches) in height and 12.0 centimeters (4.75 inches) in width.
- (c) The device shall be constructed and installed so that a terrapin cannot pass around, beneath, above, or between the device and the entrance funnel.
- (d) The requirements of this section shall apply to commercial and non-commercial crab pots.
- (e) The Department may approve an alternative device only upon a scientifically supported determination that the alternative provides protection to diamondback terrapins equal to or greater than the device specified in subsection (b), without materially increasing bycatch mortality.

Terrapin Protection Areas

- (f) The Department shall identify waters presenting a heightened risk of diamondback terrapin mortality from crab pots and prohibit the deployment or use of crab pots within such waters during periods of significant terrapin activity.
- (g) In identifying such areas and periods, the Department shall consider diamondback terrapin occurrence and abundance, crab-pot density, documented bycatch and mortality, water depth, habitat characteristics, nesting activity, seasonal movements, and other relevant scientific information.

Derelict Crab Pots

- (h) The Department shall establish a program for identifying, reporting, retrieving, and documenting abandoned, lost, and derelict crab pots from New Jersey coastal and estuarine waters, with priority given to diamondback terrapin habitat.

Education and Licensing

- (i) The Department shall provide information concerning diamondback terrapin conservation and applicable bycatch-reduction requirements to each person obtaining or renewing a commercial or non-commercial crab-pot license.

Compliance Monitoring

- (j) The Department shall periodically assess compliance with this section and monitor diamondback terrapin bycatch in the blue crab pot fishery. The Department shall use monitoring results to evaluate whether additional spatial, seasonal, gear, or enforcement measures are necessary to reduce preventable terrapin mortality.

X. Statutory and Regulatory Authority

The Department has ample authority to adopt the requested measures. Relevant authority includes, but is not necessarily limited to:

- the New Jersey Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq., including N.J.S.A. 52:14B-4(f);
- New Jersey's fish and wildlife laws under Title 23;
- the Marine Fisheries Management and Commercial Fisheries Act, N.J.S.A. 23:2B-1 et seq.;
- the Endangered and Nongame Species Conservation Act, N.J.S.A. 23:2A-1 et seq.;
- N.J.A.C. 7:25-14, governing crab and lobster management;
- N.J.A.C. 7:25-21, governing diamondback terrapins; and
- N.J.A.C. 7:1D-1.1, governing petitions for rulemaking submitted to NJDEP.

The requested measures fall squarely within NJDEP's responsibility to manage marine fisheries while conserving New Jersey's wildlife resources.

XI. Conclusion

Petitioners request that NJDEP eliminate the current narrow-waterway limitation and require compliant BRDs on all commercial-style blue crab pots. This would protect terrapins rather than merely a subset of their habitat. It would also be substantially easier for crabbers to understand and Conservation Police Officers to enforce. A crabber should not have to determine whether a creek is 145 or 155 feet wide at mean low water before knowing whether a device intended to prevent the drowning of protected native wildlife is required. This would increase both protection and compliance.

The requested BRD requirement is a particularly practical conservation measure because it does not require elimination of New Jersey's blue crab pot fishery. BRDs are simple, inexpensive pieces of equipment. They do not require fundamental changes to crab-pot design or fishing practices. Scientific experiments have demonstrated that appropriately designed BRDs can substantially reduce terrapin captures, while maintaining the large majority of legal blue crab catch.

Indeed, New Jersey has required terrapin excluders in certain crab pots for decades. The principal questions presented by this Petition therefore are not whether BRDs work or whether crabbers can use them; the issue is whether the State should continue limiting this proven conservation measure to only a subset of the waters occupied by terrapins and continue using a larger opening when scientific evidence supports a more protective design.

For the foregoing reasons, Petitioners respectfully requests that NJDEP:

1. Grant this Petition and initiate rulemaking to require 4.5×12 cm BRDs in every entrance funnel of commercial-style blue crab pots used for commercial and recreational crabbing deployed in New Jersey waters, effectively eliminating the existing geographic restriction that limits mandatory terrapin excluders primarily to narrow waterways and man-made lagoons;

2. Establish seasonal crab-pot closures in documented high-risk diamondback terrapin habitats;
3. Establish and fund a recurring statewide ghost crab-pot identification, reporting, and retrieval program;
4. Develop an enforcement and compliance-monitoring program for BRD and other crab-pot requirements;
5. Provide diamondback terrapin conservation and BRD materials with every recreational and commercial crab-pot license and through other appropriate fishing-registration and outreach channels; and
6. Establish monitoring and reporting sufficient to evaluate terrapin bycatch, compliance, ghost-pot mortality, and the effectiveness of the adopted conservation measures.

These measures would address a known and preventable source of mortality using inexpensive, tested conservation tools, while allowing New Jersey's recreational and commercial blue crab fisheries to continue.

If the Department or staff has any questions, please contact Tara Zuardo at tzuardo@biologicaldiversity.org or 415-419-4210. The Center can provide copies of the literature cited in this petition upon request.

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ATTACHMENTS

Appendix A: Scientific literature concerning diamondback terrapin population vulnerability, crab-pot mortality, BRD effectiveness, and derelict crab pots.

Exhibits A and B: Educational materials developed by Project Terrapin addressing bycatch reduction devices, proper crab-pot rigging, and prevention of diamondback terrapin mortality.

APPENDIX A

EXECUTIVE SUMMARY

The diamondback terrapin (*Malaclemys terrapin*) is the only turtle species in the world that lives exclusively in brackish coastal habitats (Wood 1995). It occurs in the United States along the coasts of the Atlantic Ocean and Gulf of Mexico, and in Bermuda. The species is currently in decline (Roosenburg et al., 2019).

Wild turtle populations are characterized by a suite of life history characteristics that predispose them to rapid declines when subjected to unnatural levels of adult mortality (Colteaux and Johnson, 2017 at 17; Heppell, 1998; Galbraith et al., 1997; Congdon et al., 1993, 1994). Among these characteristics are delayed maturity, low fecundity, high annual survivorship of adults, and high natural levels of nest mortality (Reed and Gibbons, 2003). Similarly, terrapins' life history traits prevent them from withstanding chronic sub-adult and adult mortality (Hoyle and Gibbons, 2000 at 736). Removing even a few diamondback terrapins from a population can have detrimental effects on the population as a whole (Hoyle and Gibbons, 2000). For this reason, experts rank crab pot mortality as the greatest threat to the diamondback terrapin (Butler et. al., 2006 at 332) and have emphasized that modifying pots to reduce terrapin mortality is of utmost importance (Baker et al., 2013 at 676).

A fleet of active blue crab pots is capable of steadily removing individual terrapins from a population until it can no longer sustain itself (Roosenburg et al., 1997; Butler and Heinrich, 2007), while just one or two inactive or “ghost” pots are capable of killing large numbers of individuals in a population over a single crabbing season (<1 year) (Grosse et al., 2009). Because the terrapin's life history traits prevent it from absorbing chronic increases in adult mortality, crab pots can rapidly cause reduction in population size (Roosenburg, 1991 at 231–232; Hoyle and Gibbons 2000 at 736). Roosenburg et al. (1997) estimated that mortality rates caused by the recreational use of crab pots in Maryland alone could increase annual terrapin mortality rates up to 78%, which can cause decline and rapid extirpation of local populations. Similarly, Hart (1999) modeled the impacts of terrapin bycatch and mortality in crab pots in Massachusetts, finding that even a low harvest rate (15%) could reduce a population by 49% after 15 years. Moderate (30%) and intense (75%) harvest rates produced 77% and 92% population reductions, respectively, over the same time period (Hart 1999 at 46).

Bycatch reduction devices (also known as “BRDs” or terrapin excluder devices) can prevent most terrapins from drowning in crab pots, while having little to no effect on the number or size of crabs captured (reviewed in Chambers and Maerz 2018; Roosenburg 2004; Butler and Heinrich 2007). Recognizing the significant threat crab pot mortality poses to terrapins, several states require blue crab pots to have BRDs, and even more states are now considering similar measures.

BACKGROUND

The Diamondback Terrapin

Named for the concentric, diamond-shaped rings on their shells, diamondback terrapins are among the most beautiful and charismatic turtles in the United States. Though their colors may vary between light gray, dark gray, brown, and nearly black, diamondback terrapins are easily identifiable by their diamond-patterned shells and flecked or spotted heads and legs.

Diamondback terrapins are the only turtles that live exclusively in coastal brackish water ecosystems, where freshwater meets the sea. There are seven traditionally recognized subspecies of diamondback terrapin: the Carolina diamondback terrapin (*M. t. centrata*), eastern Florida diamondback terrapin (*M. t. tequesta*), mangrove diamondback terrapin (*M. t. rhizophorarum*), ornate diamondback terrapin (*M. t. macrospilota*), and Mississippi diamondback terrapin (*M. t. pileata*). Experts now recommend recognizing four discrete populations or management units: Northeast Atlantic, Coastal mid-Atlantic, Florida, and Texas/Louisiana (Hart et al. 2014; Lovich and Hart 2018). Coastal Mid-Atlantic Terrapins are significant because their extirpation would result in a large gap in the Diamondback Terrapin's range; with the noted site fidelity and slow recolonization times in the species, it would be extremely difficult for Diamondback Terrapins to rebound from the loss of this genetic cluster (Gibbons et al., 2001).

Diamondback terrapins are keystone species in the salt marshes they inhabit, which means they help maintain the ecological health of their associated ecosystems. Among the prey of diamondback terrapins are salt marsh snails (*Littorina spp.*) (Tucker et al., 1985), which, in high numbers, contribute to loss and erosion of salt marshes by grazing on the epiphytes that live on stems of grasses and thereby killing the grasses (Silliman and Bertness, 2002). Because terrapins feed on the snails, they likely reduce salt marsh erosion and loss (See Brennessel, 2007). Terrapins also move substantial quantities of nutrients and calories from the water to land in the form of eggs, which are then eaten by a variety of terrestrial and avian predators (Seigel, 1980a; Clark, 1982; Cechala et al., 2008).

Life cycle and natural history

Diamondback terrapins spend most of their lives in nearshore habitat (Roosenburg et al. 1999). Their diets include snails, clams, mussels, small crabs, fish, and annelid worms (Tucker et al. 1985; Butler et al. 2012). Male terrapins mature around 2 to 7 years of age, while female terrapins become reproductively mature between 4 and 8 years of age (Seigel 1984; Lovich et al. 2018 at 65–66). In Florida, one study found female terrapins mature at 4 to 5 years, while male terrapins mature at 2 to 3 years (Seigel 1984; Lovich et al. 2018 at 66).

In the spring, terrapins form courtship and mating aggregations for several days to weeks; and beginning in late spring and continuing into the summer, female terrapins come to land to dig nests and lay their eggs (Butler et al., 2018). Wild female terrapins produce one or two clutches of eggs per year, though triple clutches have been reported in Florida (Lovich et al., 2018 at 66–

67; Heinrich, pers. comm., 2019). Clutch sizes range from 1 to 23 eggs, though clutch sizes tend to be smaller in Florida based on studies of the Florida east coast diamondback terrapin (6.7 eggs) and the Carolina diamondback terrapin (6.7 eggs) (Seigel 1980b; Butler 2000; Lovich et al. 2018 at 66–67).

Status and threats

The International Union for the Conservation of Nature (IUCN) Red List ranks the diamondback terrapin's global status as Vulnerable and describes its population trend as decreasing (Roosenburg et al., 2019). Of 54 researchers surveyed across the terrapin's range in 2006, 29.6% said the diamondback terrapin was declining in their state, 14.8% said populations were stable, and 55.6% said the status was unknown (Butler et al., 2006). No one considered populations to be increasing (Butler et al., 2006).

A primary threat to diamondback terrapins is the presence of these derelict crab pots, with incidental capture and drowning in blue crab pots is a common threat with commercial and recreational pots. Crab pots have been known to eliminate local populations of terrapins - depending on the extent of the fishery and the assumed mortality rates, between 15% and 78% of a local terrapin population may be removed annually (Roosenburg et al. 1997). For example, one ghost crab pot can contain almost 100 dead terrapins (Grosse et. al., 2009; Bishop, 1983).

Anthropogenic threats to terrapins remain, making the species' future survival tenuous in some locales (Butler and Roosenburg, 2018). Threats to the diamondback terrapin include habitat destruction and degradation (Butler et al., 2006; Hart and Lee, 2007 at 211); road mortality (Wood and Herlands, 1997; Butler et al. 2006; Szerlag and McRobert, 2006; Maerz et al., 2018); sea-level rise caused by global climate change (Hunter et al., 2015; Woodland et al., 2017); pollution (Butler et al., 2006; Blanvillain et al., 2007; Drabeck et al., 2014 at 132–133; Roosenburg et al. 2019); boat strikes (Lester et al., 2013); predation (Butler et al., 2004; Draud et al., 2004; Butler et al., 2006); collection for personal and commercial purposes, including the effects of large-scale historic commercial harvesting and current poaching (Hart and Lee, 2007 at 207), and inadequate regulatory measures to address these threats (Roosenburg et al., 2019).

Crab Pot Mortality

Terrapin mortality in crab pots has been and continues to be one of the major threats to terrapins, and it has been studied in nearly every state in the species' range (Butler and Roosenburg, 2018). When surveyed, experts ranked crab pot mortality as the greatest threat to terrapins.

Crab pots essentially cause two “levels” of terrapin mortality: (1) a “constant background mortality” from many crab pots that are regularly fished over a long period of time; and (2) acute mortality events from individual crab pots that have been lost or abandoned (“ghost” or “derelict” pots) (Roosenburg et al., 1997 at 1167; Roosenburg, 2004). In other words, regularly fished crab pots have the potential to consistently capture smaller numbers of terrapins over time, while ghost pots can capture more terrapins in one pot over a relatively shorter time

(Roosenburg, et al., 1997 at 1167). Mortality due to entrapment in crab pots would have the potential to contribute to local extirpation of terrapin populations.

Both commercial and recreational crab pots pose a serious threat to diamondback terrapins at the individual, population, and species level (Roosenburg et al., 1997; Crowder et al., 2000 at 1; Roosenburg, 2004; Chamber and Maerz, 2018). Terrapins enter submerged crab pots and die when they cannot escape to breathe at the water's surface. This can occur in a short period of time — less than five hours (Crowder et al., 2000 at 1). The problem is often compounded when these gregarious turtles follow one another into pots (Bishop, 1983 at 428; Butler and Heinrich, 2007). Experts posit that terrapins have an innate curiosity to investigate things and that the presence of a terrapin in a crab pot may attract additional turtles, thus increasing the likelihood of large kills in crab pots (Roosenburg, 1991 at 231). They also find that crab pots attract terrapins whether or not they are baited (Chambers and Maerz, 2018).

Blue crab pots are present throughout the terrapin's range, as commercial and recreational crab fisheries are active to varying degrees in nearly every coastal state along the Atlantic and Gulf coasts (Chambers and Maerz, 2018). Even when crabbing potential may be small in a state, it can have a severe effect on a local scale (Roosenburg et al., 1997; Tucker et al., 2001; Grosse et al., 2009; Chambers and Maerz, 2018). While commercial crabbing is generally distributed broadly across open water, it also is allowed in tidal creeks associated with large river systems that intersect with coastal salt marsh habitat (Chambers and Maerz, 2018; VMRC, 2023).

Commercial harvest of peeler crabs occurs seasonally in small tidal creeks when crabs are molting, which places crab pots in critical terrapin habitat (Chambers and Maerz, 2018). Furthermore, a large percentage of recreational crabbing occurs in shallow creeks and other areas that intersect with terrapin habitat (*Id.*). Both commercial and recreational crab pots can end up as derelict or “ghost” pots in terrapin habitat (*Id.*). Crab pots fished in deeper waters may be lost and carried into terrapin habitat by tides or storms, thereby affecting terrapins in shallow water (*Id.*).

Crab pot mortality affects terrapin populations by removing mature males and subadult and adult females and hindering the population's reproductive capabilities. While in some places female terrapins may grow too large to enter pots, male terrapins never grow larger than the opening of a crab pot entrance and are susceptible to crab pot mortality throughout their lives (Roosenburg et al., 1997; Chambers and Maerz, 2018). In the southeast, female terrapins do not grow as large as more northern populations, and therefore do not grow large enough to avoid crab pot mortality (Chambers and Maerz, 2018). For example, in one Alabama population, 85% of female terrapins sampled were susceptible to crab pot mortality (Coleman et al., 2014; Chambers and Maerz, 2018).



These 4 diamondback terrapins drowned after being trapped in a crab pot.
(Source: Virginia Institute of Marine Science/Diane Tulipani)

Crab pot mortality is a long-documented threat to diamondback terrapins across their range, with dozens of studies published over the last 75⁺ years (Davis, 1942; Bishop, 1983; Marion, 1986; Burger, 1989; Mazzarella, 1994; Mann, 1995; Wood and Herlands, 1996; Roosenburg et al., 1997; Wood, 1997; Guillory and Prejean, 1998; Hoyle and Gibbons, 2000; Roosenburg and Green, 2000; Cole and Helser, 2001; Butler, 2002, 2000; Roosenburg, 2004; Butler and Heinrich, 2007; Grosse et al., 2009).

Experts agree that the capture and drowning of terrapins in crab pots is a major threat to terrapin populations throughout their range (Burger, 1989; Siegel and Gibbons, 1995; Wood, 1997; Roosenburg, 2004; Butler et al., 2006; Butler and Heinrich, 2007). This is because crab pots can eliminate local terrapin populations (Roosenburg et al., 1997 at 1171). Population-level impacts also include rapid, large-scale declines (Roosenburg et al., 1997 at 1170; Cole and Helser, 2001; Roosenburg, 2004 at 24; Grosse et al., 2009 at 99); skewed sex ratios (Bishop, 1983 at 427; Roosenburg, 1991 at 231; Roosenburg et al., 1997 at 1170; Hoyle and Gibbons, 2000 at 735; Dorcas et al., 2007 at 336–337; Butler and Heinrich, 2007 at 183; Grosse et al., 2009 at 99; Grosse et al., 2011 at 765); skewed age distribution (Dorcas et al., 2007 at 338–339); and skewed size distribution (Dorcas et al., 2007 at 3336–337; Grosse et al., 2011 at 763, 766; Lovich et al., 2018 at 71). Because terrapins' life history traits prevent them from absorbing chronic adult mortality, crab pots can cause localized extirpation of populations (Roosenburg, 1991 at 231–232; Hoyle and Gibbons, 2000 at 736).

Active pots

As early as the 1940s, scientists observed the harmful effects of crab fishing gear on terrapins. The following is a survey of published studies documenting terrapin mortality in active crab pots.

Davis (1942) studied crab pot bycatch in Maryland waters and “definitely established that pots will capture terrapin” (Davis, 1942 at 16). Although the results were limited, Davis found that three large diamondback terrapins were taken, and two drowned (Davis, 1942 at 16–17). The third would have drowned, had the pot not been partially protruding from the water so the turtle could obtain air (Davis, 1942 at 17).

Bishop (1983) studied crab pot mortality from two South Carolina estuaries over three years and recorded 281 diamondback terrapins (195 male and 86 female) captured in baited and unbaited crab pots.¹ Based on 1982 records that there were 458 licensed crabbers fishing from 50–100 crab pots, and assuming an average number of 60 pots per crabber, with 40% of those pots being fished in near-shore shallow waters where terrapins live, Bishop estimated that 2,853 terrapins were captured daily during April and May, with mortality estimated at 285 terrapins (Bishop, 1983 at 428). This estimate fails to account for mortalities resulting from ghost pots.

Wood (1997) investigated the effect of crabbing on terrapins in New Jersey, including the extent of terrapin bycatch in commercial crab pots and the mortality levels of terrapins caught in those pots. He found that 19 terrapins (8 male, 11 female) were caught at a capture rate of 15 terrapins per 100 trap-days (Wood, 1997 at 23). Although Wood checked pots twice daily to minimize drowning of terrapins, four were drowned, causing a slightly greater than 20% mortality rate (Wood, 1997 at 23). Wood observed that commercial crabbers check pots no more than once per day, and that the terrapin mortality may have approached 100% (Wood, 1997 at 23).

Roosenburg et al. (1997) studied the rate of capture, size, sex, and age of terrapins captured in crab pots and determined the potential effect of crab pot mortality on local populations in the shallow water areas of Chesapeake Bay, Maryland. They estimated terrapin capture rates of 0.17 terrapins per pot per day (Roosenburg et al., 1997 at 1168). Based on these numbers, the scientists estimated that 15–78% of a local population may be captured in a single year (Roosenburg et al., 1997 at 1169). Based on these results, they estimated that local terrapin populations could be extirpated in 3 to 4 years (Roosenburg et al., 1997 at 1170).

Hoyle and Gibbons (2000) studied twenty recreational crab pots in South Carolina (Hoyle and Gibbons, 2000 at 735). During the 760 days the crab pots were deployed, 21 captures were made of 19 individual terrapins (Hoyle and Gibbons, 2000 at 735). Based on an estimated population size of 168 to 299 terrapins, and an estimated annual recruitment of 12 to 17 terrapins, the scientists estimated that 6–11% of the population would potentially be removed from the local population² (Hoyle and Gibbons, 2000 at 735–736). Because terrapins’ life history traits prevent

¹ Because the traps were checked daily during the study, less than 10% of captured terrapins died (Bishop, 1983 at 427–428).

² The two recaptures were excluded from the study (Hoyle and Gibbons, 2000 at 735).

them from absorbing chronic adult mortality, the scientists concluded that crab pots could cause “significant localized consequences” for local populations (Hoyle and Gibbons, 2000 at 736). Hoyle and Gibbons also found that recreational pots could be a greater threat to terrapins than commercial pots because local crabbers are able to access smaller creeks than commercial crabbers, where terrapins are more populated (Hoyle and Gibbons, 2000 at 736). Recreational crabbers are also more likely to leave their pots in the water for a longer period of time without checking them, and even unintentionally abandon them (Hoyle and Gibbons, 2000 at 736).

Dorcas et al. (2007) studied 21 years of mark-recapture data (more than 2,800 captures of 1,399 individuals) from a declining diamondback terrapin population in Kiawah Island, South Carolina, to determine whether a population decline there was the result of mortality in crab pots. They found that, since the 1980s, the modal size of both male and female terrapins had increased substantially and that the proportion of females was higher than earlier samples (Dorcas et al., 2007 at 336–337). They also noted that the studied population contained more old and fewer young terrapins than before (Dorcas et al., 2007 at 336). This change in the age of the population is also reflected in the size of individual terrapins (*Id.*). Based on their observations of changes in demography and sex ratio, the scientists suggested that the terrapin population declined as a result of selective mortality of smaller terrapins in crab pots (*Id.* at 338–339). Another later study in South Carolina showed that in a creek where bycatch mortality was high, terrapins rarely survived to reproduce (Tucker et al., 2001).

Grosse et al. (2011) contemporaneously studied two of the primary conservation concerns for diamondback terrapins: road mortality from coastal traffic and bycatch mortality in crab pots. They captured 1,547 individual terrapins among 29 tidal creeks in Georgia and used mark-recapture estimates of terrapin density and sex ratio to identify crab pot effects (Grosse et al., 2011 at 764–765). They observed that 153 terrapins—approximately 10% of all live terrapins they observed in the study creeks—drowned in 5 crab pots within study creeks, 83% of which were males (Grosse et al., 2011 at 765). Among all sites, terrapin density declined with increasing crabbing activity within the creek, whereas population density was not related to proximity of roads (Grosse et al., 2001 at 765–766). The scientists also found that there was a significantly larger proportion of smaller-sized terrapins in creeks with no crabbing activity (Grosse et al., 2011 at 763, 766). Thus, they concluded that crabbing activities are linked to terrapin population declines in Georgia and recommended that states focus on reducing bycatch risk by regulating fishing times, requiring the use of BRDs, and removing lost or abandoned crab pots from coastal habitats (Grosse et al., 2011 at 766–769).

Hart and Crowder (2011) estimated that if each of the approximately 7,500 crab fishers in North Carolina catches a number of terrapins similar to those observed in their study, and roughly 50% of that catch is removed from terrapin populations due to mortality (consistent with their study), then tens of thousands of terrapins could be removed from populations each year (Hart and Crowder, 2011 at 269). Thus, terrapin capture and mortality in actively fished commercial crab pots may represent an extremely large collective effect on local terrapin populations (*Id.*).

Coleman et al. (2014) found that although it is generally accepted that male and juvenile female terrapins are more vulnerable to crab pot mortality than adult females, fully mature females in some parts of the terrapin's range may be smaller and equally capable of entering crab pots (Coleman et al., 2014 at 142). Because loss of female terrapins means the loss of greater long-term reproductive potential, crab pot mortality could be more devastating to terrapin populations in some areas than previously considered (Coleman et al., 2014 at 143–144).

Two important conclusions can be drawn from these many studies that document terrapin capture and mortality rates in crab pots. First, the high rates of removal of terrapins by crabs will rapidly result in the local terrapin decline and, within 15-20 years, complete extirpation of the population. Second, given that crab pots have been used since the 1940s, many terrapin populations are now extirpated, leading to the false interpretation that the current lack of terrapin captures in crab pots in a particular area suggests that they do not occur there. They may well have occurred there in the past, but their population has already been wiped out, suggesting to the modern day crabber that terrapins do not occur there.

Ghost and derelict pots

For the purposes of this petition, the term “ghost pot” includes crab pots that are accidentally lost or intentionally abandoned, as well as derelict crab pots that are irresponsibly left in the water for long periods of time without regular supervision. Ghost pots may result from permanent abandonment of fishable pots by crabbers who leave the fishery seasonally or permanently when it is logistically difficult to transport the pots for either temporary storage or permanent disposal, temporary storage sites are not available, or it is difficult or expensive to dispose of them (Guillory et al., 2001 at 2). Crab pots may also be inadvertently lost due to uncontrollable weather or hydrological factors, such as tides, currents, and storm surges; deterioration of buoys, lines, or knots; negligent assembly or maintenance of buoys and lines; unintentional clipping of lines by boat propellers; or intentional cutting of buoy lines by vandals (Guillory et al., 2001 at 2). Because commercial crabbers use large numbers of durable pots, ghost pots can persist for long periods of time (Guillory et al., 2001 at 1).

Ghost pots are considered to be even more detrimental to terrapin populations than actively fished pots³ (Bishop, 1983 at 428; Guillory et al., 2001 at 4; Rook et al., 2010 at 172). This is because ghost pots are ongoing threats and have the capacity to capture great numbers of terrapins if they remain abandoned or lost (Rook et al., 2010 at 172). For example, Bishop (1983) found one ghost pot with 28 dead, decomposing terrapins in South Carolina (Bishop, 1983 at 429), and Roosenburg (1991) found a ghost pot with 49 terrapin shells, and remains of even more terrapins in Maryland (Roosenburg, 1991 at 231). The number of dead terrapins in that single crab pot represented an estimated 1.6–2.8% of the local population (Roosenburg, 1991 at 231).

³ Ghost pots are also known to capture other vertebrates such as river otters (*Lontra canadensis*) and raccoons (*Procyon lotor*) (Guillory et al. 2001 at 4).



Terrapin carcasses found in abandoned crab pot in Georgia
(Source: Grosse et al. 2009)

During Hoyle and Gibbons' (2000) study in South Carolina, the scientists inadvertently created a ghost pot scenario when two of their test pots became entangled during a high spring tide when they were not monitored (Hoyle and Gibbons, 2000 at 735). Four terrapins entered those pots and died (*Id.*). The scientists estimated that those two lost pots could account for more terrapin captures than all 20 pots set during the study year (*Id.* at 736).

The number of terrapins lost to ghost pots is exponentially amplified by the number of ghost pots present in terrapin habitat. The commercial fishery generates many ghost pots each year (Chambers and Maerz, 2018). These abandoned pots are abundant, and every year more become marine debris in shallow estuaries, sometimes directly in terrapin habitat (Chambers and Maerz, 2018; Bishop, 1983 at 429). Though the numbers and location of ghost pots are unknown, scientists believe they are frequently abandoned or lost (Roosenburg, 1991 at 231). Guillory et al. (2001) estimated that approximately 250,000 derelict crab pots are added to the Gulf of Mexico annually (Guillory et al., 2001 at 2–3).

Bycatch Reduction Devices

Bycatch Reduction Devices (also called “BRDs” or “terrapin excluder devices”) prevent terrapins of a certain size from entering the pot (Roosenburg, 2004 at 23). They are designed specifically to prevent terrapin bycatch. Designed in the early 1990s (Wood, 1997 at 23), experts

now recognize the BRD as the “best and most feasible solution to reducing terrapin mortality in crab pots” (Roosenburg, 2004 at 27).



An example of a plastic terrapin excluder device
(Source: South Carolina Department of Natural Resources)

A large number of studies have been conducted on BRD efficiency including a study by MAREX in Georgia. The effectiveness of BRDs at preventing terrapin death with little to no impact on blue crab capture has been well-studied (Roosenburg, 2004 at 26). There is a general consensus that 4.5 x 12-centimeter (cm) BRDs are effective at reducing terrapin entrapment (Roosenburg, 2004 at 26). Likewise, studies have found that both the 4.5 x 12 cm and the 5 x 10 cm BRD have a minimal effect on crab catch (Roosenburg, 2004 at 26).

Effect on terrapin mortality

Experts have studied BRDs of various sizes in several geographic regions within the terrapin’s range. All studies found that crab pots with BRDs successfully limited terrapin bycatch to some degree, ranging from 12-100% effectiveness, with smaller BRDs generally being more effective than larger BRDs. The studies widely found that BRDs measuring 4.5 x 12 cm are sufficiently effective at reducing crab pot mortality without significantly affecting the size or number of crabs caught.⁴ Table 1 summarizes the findings from studies that evaluated the ability of BRDs to reduce terrapin bycatch in blue crab pots. More detailed summaries of the studies are provided in Appendix A.

⁴ See Section(ii), *Effect on Crab Haul*.

Table 1: Survey of Publications Evaluating the Ability of BRDs to Reduce Diamondback Terrapin Mortality in Blue Crab Pots

Article	State	BRD size (cm)	% terrapins excluded
Butler and Heinrich (2007)	FL	4.5 x 12	73.2%
Cole and Helser (2001)	DE	3.8 x 12	100%
		4.5 x 12	*67%
		5 x 10	59%
		5 x 12	12%
Crowder et al. (2000)	NC	4 x 16	100%
		4.5 x 16	100%
		5 x 16	100%
Hart and Crowder (2011)	NC	4.5 x 16	77%
		5 x 16	28%
Mazzarella (1994)	NJ	5 x 10	**90.5%
Morris et al. (2011)	VA	4.5 x 12	100%
Rook et al. (2010)	VA	4.5 x 12	95.7%
Roosenburg and Green (2000)	MD	4 x 10	100%
		4.5 x 12	82%
		5 x 10	47%
Wnek (2019)	NJ	4.5 x 12	100%
		5 x 15	100%
		5.1–6.4 × 7.3 (curved)	100%
*averaged percentages for male terrapins and female terrapins			
**averaged numbers from two separate seasons			

Notably, BRDs have successfully reduced terrapin mortality in crab pots in North Carolina waters. Dr. Amanda Southwood Willard and her team at University of North Carolina Wilmington studied the effectiveness of fisheries-sourced bycatch reduction solutions for excluding Diamond-backed Terrapins from crab pots. They conducted trials with captive Diamond-backed Terrapins to compare the number of entries into standard crab pots, crab pots with oval BRDs inserted in entrance funnels, and crab pots manufactured with an NFD design, and found that pots with smaller entrance funnel dimensions, either through insertion of oval BRDs or the NFD design, had significantly fewer Diamond-backed Terrapin entries compared with standard crab pots. Their results illustrate the effectiveness of fisheries-sourced gear

modifications for preventing bycatch of Diamond-backed Terrapins in crab pots (Williard et. al., 2022).

Similar studies have found the same: Reinsel, Gibson, Klesch, and Chambers tested four replicates of each of the five trap treatments (1.75-inch oval BRD, 2-inch oval BRD, 1.75-inch rectangular BRD, 2-inch rectangular BRD, and a control trap without a BRD) in each tidal creek, for a total of 20 traps per creek and 40 traps total. They fitted traps with wire chimneys that extended above the high low water line to allow trapped terrapins to surface for air. For eight weeks during summer 2021, they baited traps with Atlantic Menhaden *Brevoortia tyrannus* each day, beginning on Monday. Tuesday–Friday, they emptied traps of any animals inside, and recorded terrapin sex, terrapin carapace length, terrapin carapace width, and terrapin shell height, as well as blue crab carapace length. They found that all four BRD designs were highly effective at excluding terrapins and maintaining crab catch, when compared to control traps. They also found a significant difference ($p = 0.003$) in catch per unit effort (CPUE) of diamondback terrapins among treatments, with the control group (those without BRDs) having the highest CPUE (0.97 ± 0.18). All traps fitted with BRDs decreased terrapin capture significantly compared to the control group. Oval BRDs excluded more terrapins than their rectangular counterparts, with the same height dimension, although these differences were not significant. They also found no significant difference in CPUE of blue crabs among treatments ($p = 0.392$), or in the size of legal crabs caught in each treatment ($p = 0.216$). Accordingly, they pointed out that the study provides evidence of the effectiveness of both rectangular and oval-shaped BRDs to exclude terrapins and maintain crab catch.

Effect on crab haul

Many studies also assess the effect of BRDs on the size and number of crabs captured, with the goal of identifying a BRD design that successfully minimizes terrapin captures, while having minimal effect on crab haul. Nearly every study found at least one BRD size that had little to no effect on crab haul, and they generally agree that a 4.5 x 12 cm BRD can successfully prevent terrapin deaths while having insignificant impacts on crab haul.

Table 2: Survey of Publications Evaluating the Effect of BRDs on Crab Haul

Article	State	BRD size (cm)	Finding
Butler and Heinrich (2007)	FL	4.5 x 12	no significant effect on sex, size, or number of crabs captured
Cole and Helser (2001)	DE	3.8 x 12	substantial loss of legal-size blue crabs (26% decrease with BRDs)
		4.5 x 12	nominal loss of legal-size blue crabs (12% total decrease, with 6% of most desirable crabs with BRDs)
		5 x 10	no statistical difference in blue crab catches (2.4% increase with BRDs)
		5 x 12	no substantial change in total blue crab catch rates (0.2% increase with BRDs)
Cuevas et al. (2000)	MS	5 x 10	similar daily catch rates (mean 19.5 for traps with BRDs and without) and crab size frequency
Guillory and Prejean (1998)	LA	5 x 10	overall catch per trap day of sublegal, legal, and total crabs was 14.5%, 37.9%, and 25.7% greater, respectively, than in standard pots
Hart and Crowder (2011)	NC	4.5 x 16	BRD did not have a significant effect on catch of either large male blue crabs or peelers
		5 x 16	
Lukacovic et al. (2005)	MD	4.5 x 12	all categories of crab catch were significantly lower in crab pots fitted with BRDs; in traps without BRDs, overall crab catch was 35% greater and catch of legal crabs was 28.5% greater
Mazzarella (1994)	NJ	5 x 10	no significant difference in number of crabs or size of crabs captured

Morris et al. (2011)	VA	4.5 x 12	no statistical difference between either the number or size of legal-size crabs in crab pots with and without BRDs on the first day after baiting; significant difference in total catch per unit effort and size across all other days after; more legal-size crabs were caught in pots without terrapin bycatch, but the difference was not significant
Rook et al. (2010)	VA	4.5 x 12	crab catch equivalent between crab pots with and without BRDs; slight increase (marginal) in number, size, and biomass of both legal-size and sublegal-size crabs in pots with BRDs
Roosenburg and Green (2000)	MD	4 x 10	reduced the size and number of large and mature female crabs
		4.5 x 12	no effect on size or number of crabs caught
		5 x 10	no effect on size or number of crabs caught
Wnek (2019)	NJ	4.5 x 12	no significant difference in number of crabs caught; similar mean length, width, height
		5 x 15	no significant difference in number of crabs caught; similar mean length; smaller mean width and height
		5.1–6.4 × 7.3 (curved)	no significant difference in number of crabs caught; similar mean length, width, height

Butler and Heinrich (2007) tested whether bycatch mortality of diamondback terrapins in commercial crab pots is reduced by using 4.5 x 12 cm galvanized steel BRDs and whether those devices limit blue crab catch. They captured 2,753 legal-sized crabs and found no significant difference between the sex, measurements, or number of crabs captured in standard crab pots versus crab pots with BRDs (Butler and Heinrich, 2007 at 182).

Although BRDs have not been studied in large-scale commercial operations that fish more than 100 pots, anecdotal reports from crabbers who use BRDs in large-scale operations claim that they see no effect—or maybe an improvement—in their crab catch (Roosenburg, 2004 at 27).

BRDs may offer additional benefits to crabbers as well. For instance, BRDs reduce the rate of entry of many large vertebrate bycatch including fish, turtles, and otters (Guillory and Prejean, 1998 at 39). This frees up additional space in pots, which would otherwise be occupied by nontarget species, to capture more crabs. The presence of terrapins in crab pots may cause crabs to avoid crab pots. Morris et al. (2011) found that crab pots with terrapin bycatch in them had, on average, fewer crabs per unit effort (Morris et al., 2011 at 388). Likewise, more legal-size crabs were caught in pots without terrapin bycatch (*Id.*). Thus, keeping terrapins out of crab pots may lead to the capture of more and larger crabs. Guillory and Prejean (1998) have also suggested that increased crab catch in traps with BRDs could be due to increased ingress and/or decreased egress through the entrance funnels (Guillory and Prejean, 1998 at 39).

Keeping terrapins out of crab pots may help also keep crabs in marketable condition. Davenport et al. (1992) studied terrapin feeding behavior on crabs by providing hungry male terrapins crabs of different size classes and observing the terrapins' behavior (Davenport et al., 1992 at 837–846). The size classes for crabs were small (10–25 mm carapace width), medium (30–50 mm), and large (52–75 mm) (*Id.* at 837). They observed that although terrapins are not specialized anatomically for a diet of hard-shelled animals, they will still exploit such food sources if they are hungry and do not have other options. Specifically, they will eat crabs (*Id.* at 846). Small crabs were eaten whole, while medium and large crabs were “cropped”—that is, their walking legs were eaten without killing the crab (*Id.* at 847). Applying their findings to diamondback terrapins in the field, the scientists predicted that terrapins might eat blue crabs through a “cropping” technique (*Id.*). Generally, terrapins will attack smaller crabs before medium crabs, and medium crabs before larger crabs (*Id.*). Because terrapins captured in crab pots are in closed conditions without access to their preferred prey, it is possible that they will shear crabs, thus making them less marketable.

Dr. Amanda Southwood Williard and her team and UNC have had success studying the use of crab pots manufactured with narrowed funnel dimensions (NFD). Their results illustrate the effectiveness of fisheries-sourced gear modifications for preventing bycatch of diamond-backed Terrapins in crab pots. Additional field studies to assess the effects on crab catch will determine the feasibility of incorporating these gear modifications into commercial crab fisheries (Williard et. al, 2022).

The Diamondback Terrapin is Imperiled and Cannot Sustain Effects from Crab Pot Mortality

Wild turtle populations are characterized by a suite of life history characteristics that predispose them to rapid declines when subjected to unnatural levels of adult mortality (Colteaux and Johnson, 2017 at 17; Heppell, 1998; Galbraith et al., 1997; Congdon et al., 1993, 1994). Among these characteristics are delayed maturity, low fecundity, high annual survivorship of adults, and high natural levels of nest mortality (Reed and Gibbons, 2003). Similarly, terrapins' life history traits prevent them from absorbing chronic adult mortality (Hoyle and Gibbons, 2000 at 736). Removing even a few diamondback terrapins from a population can have detrimental effects on the population as a whole (Hoyle and Gibbons, 2000). For this reason, experts rank crab pot

mortality as the greatest threat to the diamondback terrapin (Butler et. al., 2006 at 332) and have emphasized that modifying pots to reduce terrapin mortality is of utmost importance (Baker et al., 2013 at 676).

Studies and anecdotal evidence demonstrate that blue crab pots can have devastating population-level impacts on diamondback terrapins (Davis, 1942; Bishop, 1983; Marion, 1986; Burger, 1989; Mazzearella, 1994; Mann, 1995; Wood and Herlands, 1996; Roosenburg et al., 1997; Wood, 1997; Guillory and Prejean, 1998; Crowder et al., 2000; Hoyle and Gibbons, 2000; Roosenburg and Green, 2000; Cole and Helser, 2001; Butler, 2002, 2000; Roosenburg, 2004; Butler and Heinrich, 2007; Dorcas et al., 2007; Coleman et al., 2014; Chambers and Maerz, 2018). A fleet of active crab pots can significantly reduce a terrapin population over time by periodically removing a few terrapins at a time (Hart and Crowder 2011 at 269). A single ghost pot—which can capture dozens of terrapins at once—can wipe out an entire population in a relatively shorter period of time (Grosse et al., 2009 at 99).

BRDs Protect Diamondback Terrapins While Boosting Marketability of Crabs

BRDs provide a simple and inexpensive method to reduce terrapin deaths in crab pots and increase marketability of crabs caught in state waters. A rule requiring BRDs is justified because BRDs protect most mature diamondback terrapins from drowning in pots, BRDs have little to no effect on crab haul, BRDs are inexpensive, and using BRDs increases the marketability of crabs fished from state waters.

Research shows that rules simply requiring crabbers to check pots once per day—even if stringently followed—are not enough to combat terrapin mortality (Wood, 1997).

BRDs protect terrapins from needless drowning deaths

Extensive studies show that BRDs effectively prevent most large, mature terrapins from entering crab pots by restricting the pot entrances to a size that precludes a terrapin's carapace from fitting through (Reviewed in Roosenburg, 2004; Chambers and Maerz, 2018). Studies demonstrate that on average, 70% of terrapins are unable to enter pots equipped with BRDs, while blue crabs can still enter easily (Mazzearella, 1994; Crowder, 2000; Roosenburg and Green, 2000; Cole and Helser, 2001; Rook et al., 2010; Hart and Crowder, 2011; Morris et al., 2011).

Studies have shown that while BRDs are effective at preventing terrapins and other animals from entering pots, they have little impact on the size and number of blue crabs found in crab pots. Specifically, a 2021 study tested the effectiveness of oval BRDs, and preliminary results show a large reduction in terrapin mortality, while maintaining crab catch (Reinsel, Gibson, Klesch, and Chambers, 2021). Most BRDs used in these studies have been either 5x15cm or 4.5x12cm, and all have been plastic. Some BRD sizes showed small or no change in crab catch. Studies using 4.5x12cm BRDs often showed large decreases in crab catch, but some of these studies did not use bait. Other studies conducted by Southwood Williard and her team at UNC have also

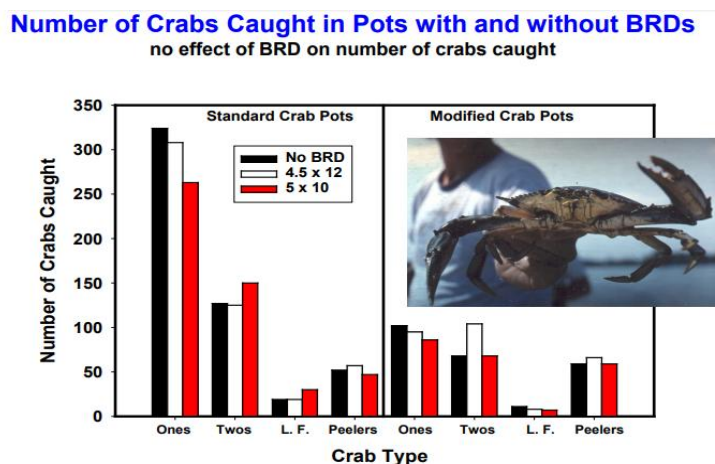
demonstrated that gear modifications, including Narrow Funnel Design (NFD), have had similar success.

This significant reduction in terrapin mortality achieved by BRDs and similar gear modifications will slow terrapin declines attributed to crab pot mortality and provide South Carolina's terrapins with a level of resiliency against myriad other threats it currently faces and will face as climate change and sea-level rise continue and accelerate.

BRDs have little to no effect on crab haul

Extensive scientific study also demonstrates that BRDs have little to no effect on the number and size of marketable crabs harvested (Mazzarella, 1994; Guillory and Prejean, 1998; Cuevas et al., 2000; Roosenburg and Green, 2000; Cole and Helser, 2001; Butler and Heinrich, 2007; Rook et al., 2010; Hart and Crowder, 2011; Morris et al., 2011). Some studies have even suggested that BRD use can result in an increase in catch of marketable crabs (Rook et al., 2010; Roosenburg and Green, 2000; Guillory and Prejean, 1998).

The following chart reflecting a survey of all BRD studies demonstrates that crab haul is relatively the same in crab pots with no BRDs and crab pots with 4.5 x 12 cm BRDs (Roosenburg, 2017).



(Source: modified from Roosenburg and Green, 2000).

BRDs are inexpensive

BRDs are small and inexpensive. Some companies in states like Maine sell BRDs for as little as \$0.45 each, while other programs will distribute BRDs for free or demonstrate how crabbers can make them themselves. There are also free resources that teach fishermen how to build and install their own BRDs.⁵

⁵ [Make Your Own BRDs | Virginia Institute of Marine Science.](#)

BRDs will likely become even less expensive over time as they are integrated into the crab pot fishery. As more states adopt rules and regulations requiring the use of BRDs, manufacturers will embrace the opportunity to design pots that already include BRDs. As these pot designs become more common, the cost of making them will also decrease.

Some States in the Diamondback Terrapin's Range Require Bycatch Reduction Devices.

Several states already require or incentivize crabbers to use BRDs on their pots. New Jersey requires crabbers to use BRDs in waters of less than 150 feet across at mean low water mark,⁶ and New York recently implemented regulations requiring crabbers to use BRDs on pots set in creeks, coves, rivers, tributaries, and near-shore harbors of the Marine and Coastal District.⁷ In Maryland and Delaware, all recreational crab pots must have BRDs.⁸ BRDs are also required in North Carolina's two Designated Management Areas.⁹

Table 3: Survey of State Laws Governing Bycatch		
State	Terrapin Conservation Status	BRD required on crab pots?
MA	Threatened	N/A; Traditional funnel-style crab pots are banned
RI	Endangered	N/A; Traditional funnel-style crab pots are banned
CT	Species of Special Concern	N/A; Traditional funnel-style crab pots are banned
NY	None	yes
NJ	Species of Special Concern	yes
DE	Species of Conservation Concern	yes (recreational only)
MD	None	yes (recreational only)
VA	Species of Greatest Conservation Need	no
SC	High Priority species for conservation	no
GA	Protected species ("unusual")	no
FL	Species of Greatest Conservation Need	yes (recreational only)
AL	Highest Conservation Concern/ Nongame species	no
MS	Species of Greatest Conservation Need	no
LA	Species of Special Concern	no
TX	Nongame/ Species of Greatest Conservation Need	no

⁶ N.J. Admin. Code § 7:25-14.6(c) (Lexis Advance through the New Jersey Register, Vol. 51 No. 13, July 1, 2019)

⁷ N.Y. Comp. Codes R. & Regs. tit. 6, § 44.2(d) (Lexis Advance through June 28, 2019).

⁸ Md. Code Regs. 08.02.03.07(B)(5); 7-3000-3700 Del. Code Regs. § 1.0.

⁹ Blue Crab Fishery Management Plan (FMP) Amendment 3.

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Survey of Scientific Literature Evaluating the Effect of BRDs on Terrapin Mortality

Butler and Heinrich (2007) tested whether bycatch mortality of diamondback terrapins in Florida in commercial crab pots is reduced by using 4.5 x 12 cm galvanized steel BRDs. They fished 15 pots without BRDs and 15 outfitted with BRDs at eight sites along the Atlantic and Gulf coasts (including the Florida panhandle) during the summers of 2002-2005. Thirty-seven terrapins were caught in standard pots and four in those with BRDs. They found that 73.2% of trapped terrapins would have been excluded from pots with BRDs (Butler and Heinrich 2007 at 183–184). These researchers recommended that the Florida Fish and Wildlife Conservation Commission devise and adopt regulations that require the use of 4.5 x 12 cm BRDs on all commercial and recreational crab pots used in Florida waters.

Cole and Helser (2001) conducted a 4-year study between 1997 and 2000 in the Delaware Bay estuary to investigate four sizes of wire, rectangular BRDs measuring 5 x 10 cm, 5 x 12 cm, 4.5 x 12 cm, and 3.8 x 12 cm to determine their impacts on terrapin bycatch mortality. During the study, 372 diamondback terrapins were captured (Cole and Helser 2001 at 828–831). Crab pots fitted with 5 x 10 cm BRDs demonstrated statistically significant reduction in terrapin captures (59%) (Cole and Helser 2001 at 828), as did crab pots fitted with 4.5 cm x 12 cm BRDs (38% male and 96% female) (Cole and Helser 2001 at 831). Crab pots fitted with the smallest BRD, 3.8 x 12 cm, prevented all diamondback terrapins from entering the pot (Cole and Helser 2001 at 831). They found that the 5 x 12 cm BRD was the only treatment for which the reduction in overall diamondback terrapin catches was not statistically significant (12%) (Cole and Helser 2001 at 832). Based on the study, Cole and Helser recommended using 4.5 x 12 cm BRDs (Cole and Helser 2001 at 831).

Crowder et al. (2000) studied the extent of terrapin mortality in actively fished crab pots in Jarrett Bay, North Carolina, to evaluate the effect of several different BRDs on both terrapin and crab catch rates (Crowder et al. 2000 at 1). They studied BRD-equipped crab pots for three seasons, testing a 5 x 16 cm BRD the first season (Spring 2000), a 4 x 16 cm BRD the second season (Fall 2000), and a 4.5 x 16 cm BRD the third season (Spring 2001) (Crowder et al. 2000 at 1). All BRDs were made from galvanized fencing (Crowder et al. 2000 at 1). During the course of the three-season study, they captured 12 diamondback terrapins, none of which were captured in pots fitted with excluder devices. (Crowder et al. 2000 at 3).

Hart and Crowder (2011) tested BRDs in North Carolina's year-round blue crab fishery from 2000 to 2004 and found that BRDs successfully prevent terrapin capture and mortality (Hart and Crowder 268–269). The smaller the BRD was, the fewer terrapins were captured (Hart and Crowder 2011 at 268–269). Specifically, they found that a 4.5 cm tall BRD excluded approximately 77% of terrapins captured, while a 5 cm tall BRD excluded approximately 28% of terrapins (Hart and Crowder 2011 at 269). They also found that longer soak times and closer distances to shore increased the risk of terrapin captures (Hart and Crowder 2011 at 268–269). As a result of the study, Hart and Crowder suggested three complementary and economically feasible tools to prevent terrapin mortality in the blue crab fishery: 1) gear modifications such as BRDs; 2) distance-to-shore restrictions; and 3) time-of-year regulations (Hart and Crowder 2011

at 270–271). They estimated that by using all three measures combined, a reduction in terrapin bycatch of up to 95% could be achieved without significant reduction in target crab catch (Hart and Crowder 2011 at 264).

Mazzarella (1994) studied crab pots with 5 x 10 cm rectangular wire BRDs and crab pots without BRDs in New Jersey's Great Bay estuary for 116 days from July 6 to August 31, 1993, and from May 1 to June 30, 1994 (Mazzarella 1994 at 1, 3–4). In 1993, crab pots with BRDs captured no terrapins, and crab pots without BRDs captured 3 terrapins; and in 1994, crab pots with BRDs captured 3 terrapins, and crab pots without BRDs captured 37 terrapins (Mazzarella 1994 at 1, 3–4).

Morris et al. (2011) studied the effectiveness of BRDs measuring 4.5 x 12 cm on commercial blue-crab pots in the York River, Virginia, by fishing 10 pots with BRDs and 10 pots without BRDs from June 4 to July 31, 2009 (Morris et al. 2011 at 387). All 51 terrapins captured during the study were captured in crab pots without BRDs; no terrapins were captured in crab pots with BRDs (Morris et al. 2011 at 388, 389). Based on local population estimates, Morris and co-workers concluded that the total number of terrapins caught in non-BRD pots during the 46-day study (51 terrapins) represented a potential reduction in population size from 27–50% (Morris et al. 2011 at 389). Given that the crab pots were in the water only 46 days, the terrapin population in the study creek would have experienced significant mortality of juvenile and adult male terrapins over a full, 8-month season of commercial crabbing, likely resulting in skewed population dynamics (Morris et al. 2011 at 389). Thus, the terrapin mortality prevented by the BRDs was significant.

Roosenburg and Green (2000) tested three sizes of wire BRDs in the Chesapeake Bay in Maryland: 4 x 10 cm, 4.5 x 12 cm, and 5 x 10 cm (Roosenburg and Green 2000 at 883–884). They caught no terrapins in crab pots with 4 x 10 cm BRDs, 19 terrapins in crab pots with 4.5 x 12 cm BRD, and 56 terrapins in crab pots with 5 x 10 cm BRDs (Roosenburg and Green 2000 at 884). They caught 126 terrapins in the crab pots without BRDs (Roosenburg and Green 2000 at 884). Thus, the 5 x 10 cm BRDs reduced terrapin bycatch by 47%, the 4.5 x 12 cm BRDs reduced bycatch by 82%, and the 4 x 10 cm BRDs reduced bycatch by 100% (Roosenburg and Green 2000 at 884). This study resulted in the requirement of a 4.5 x 12 cm BRD in the Maryland recreational crab pot fishery.¹⁰

Rook et al. (2010) tested a 4.5 x 12 cm plastic BRD in the lower Chesapeake Bay during summer 2008. They tested 10 sets of unbaited crab pots, one pot in each set with BRDs and one without (Rook et al. 2010 at 173–174). In a separate experiment they did the same with baited crab pots (Rook et al. 2010 at 173–174). Of 48 terrapin captures in crab pots, only 2 were from pots with BRDs (Rook et al. 2010 at 175). The BRDs diminished terrapin bycatch in crab pots by 95.7% (Rook et al. 2010 at 177). Thus, Rook et al. “recommend[ed] the use of BRDs on all crab traps

¹⁰ See Md. Code Regs. 08.02.03.07(B)(5); Maryland Department of Natural Resources, Attention Maryland Crabbers: you can help save our state reptile! Publication #03-1282009-430, available at <https://dnr.maryland.gov/wildlife/Documents/TerrapinBrochure.pdf>.

placed in diamondback terrapin habitat of the North American coastline, particularly for crab traps in the shallow waters fringing coastal marshes, estuaries, and lagoons” (Rook et al. 2010 at 178).

Wnek (2019) studied the effectiveness of various BRD designs in reducing terrapin bycatch and compared the amounts and sizes of blue crabs captured in crab pots fitted with BRDs in Barnegat Bay, New Jersey. He studied four sizes of BRD (5 x 15 cm, 4.5 x 12 cm, South Carolina prototype in red, South Carolina prototype in white) against control pots without BRDs (Wnek 2019 at 2). No terrapins were trapped in crab pots with BRDs, and two terrapins were captured in control pots without BRDs (Wnek 2019 at 10).

Survey of Scientific Literature Evaluating the Effect of BRDs on Crab Haul

Butler and Heinrich (2007) tested whether bycatch mortality of diamondback terrapins in commercial crab pots is reduced by using 4.5 x 12 cm galvanized steel BRDs and whether those devices limit blue crab catch. They captured 2,753 legal-sized crabs and found no significant difference between the sex, measurements, or number of crabs captured in standard crab pots versus crab pots with BRDs (Butler and Heinrich 2007 at 182).

Cole and Helser (2001) found that crab pots fitted with 5 x 10 cm BRDs demonstrated statistically significant reduction in terrapin captures (59%) with no statistical difference in blue crab catches (Cole and Helser 2001 at 828). Crab pots fitted with 4.5 x 12 cm BRDs demonstrated statistically significant reduction in terrapin captures (38% male and 96% female) with only a nominal loss of legal-size blue crabs (12% total, 6% of most desirable crabs) (Cole and Helser 2001 at 831). Crab pots fitted with the smallest BRD, 3.8 x 12 cm, prevented all diamondback terrapins from entering the trap, but incurred substantial loss of legal-size blue crabs (-26%) (Cole and Helser 2001 at 831). Based on the study, Cole and Helser recommended using 4.5 x 12 cm BRDs, which effectively protect subadult and reproductively mature female terrapins with minimal loss of legal blue crabs (Cole and Helser 2001 at 831).

Cuevas et al. (2000) studied and compared the catch rate and sizes of blue crab and terrapin bycatch taken in Mississippi Sound with crab pots equipped with and without BRDs. The BRDs were made of welding rods shaped into a 5 x 10 cm rectangle and fitted into the funnel entrances of crab pots (Cuevas et al. 2000 at 223). A total of 740 blue crabs were captured, 370 in pots without BRDs and 370 in pots with BRDs (Cuevas et al. 2000 at 224). Pots with BRDs captured 160 female crabs and 210 male crabs, while control pots caught 125 females and 245 males (Cuevas et al. 2000 at 224). Daily catch rates and crab size frequency were similar for crab pots with and without BRDs (Cuevas et al. 2000 at 224, 225). However, the scientists noted that there was a detectable difference in size distribution, resulting in a slight decrease in numbers of larger crabs observed in pots with BRDs (Cuevas et al. 2000 at 225). This difference could have been attributable to the small sample size in the study (Cuevas et al. 2000 at 225).

Guillory and Prejean (1998) studied the effects of BRDs on blue crab catches in estuarine Louisiana waters. To do this, they fished five standard crab pots and five crab pots with BRDs constructed of stainless-steel wire and measuring 5 x 10 cm (Guillory and Prejean 1998 at 38). They found that overall catch per trap day of sublegal, legal, and total crabs was 14.5%, 37.9%, and 25.7% greater, respectively, than in standard pots (Guillory and Prejean 1998 at 39). The scientists attributed the increased crab catch in pots with BRDs to increased ingress or decreased egress through the entrance funnels (Guillory and Prejean 1998 at 39).

Hart and Crowder (2011) studied various sizes of galvanized steel BRDs in North Carolina. Although they found a positive correlation between the size of the BRD and effect on crab haul (compared with non-BRD crab pots), they concluded that a 5 cm tall BRD did not have a significant effect on catch of either large male blue crabs or peelers (Hart and Crowder 2011 at 269).

Lukacovic et al. (2005) investigated the effect of BRDs on crab catch and terrapin bycatch in crab pots in Maryland's Assawoman Bay. They studied 16 crab pots, 8 with BRDs and 8 without BRDs, which were fished for 24 and 48 hours twice each month from mid-May through October 2004. The BRDs were rectangular and met Maryland's regulatory requirement that they not exceed 1.75 x 4.75 inches (approximately 4.5 x 12 cm) in length (Lukacovic et al. 2005 at *3). The crab pots were set for a total of 1029 pot-days in water depths ranging from 0.6–2.8 meters (2–8 feet), and 3,412 blue crabs and 1 diamondback terrapin were captured (Lukacovic et al. 2005 at *4). The terrapin was captured in a pot without a BRD, making the rate of terrapin bycatch in non-BRD crab pots 0.002 terrapins/pot per day (Lukacovic et al. 2005 at *4). They also found that crab catch for unmodified pots was greater than pots modified with BRDs (Lukacovic et al. 2005 at 4). The overall crab catch was 35% greater, the catch of legal crabs was 28.5% greater, the catch of legal male crabs was 25.6% greater, the catch of mature females was 23.7% greater, and the catch of peelers was 104.2% greater (Lukacovic et al. 2005 at *4). Following inferential analyses, Lukacovic et al. concluded that all categories of crab catch were significantly lower in crab pots fitted with BRDs (Lukacovic et al. 2005 at *5).

Mazzarella (1994) observed no significant difference between crabs caught in crab pots with 5 x 10 cm rectangular BRDs and crab pots without BRDs. In the first study year, crab pots with BRDs caught 6,139 crabs (mean size 13.2), while crab pots without BRDs caught 5,288 crabs (mean size 13.3) (Mazzarella 1994 at 1, 3–4). In the second study year, crab pots with BRDs caught 5,703 crabs (mean size 12.3), and crab pots without BRDs caught 5,851 (mean size 12.2) (Mazzarella 1994 at 1, 3–4).

Morris et al. (2011) studied the effectiveness of BRDs on commercial blue-crab pots in the York River, Virginia, by fishing 10 pots with BRDs and 10 pots without BRDs (Morris et al. 2011 at 387). More than 25% of total crabs were caught on the first day after baiting, and on the first day after baiting they found no statistical difference between either the number or size of legal-size crabs in crab pots with and without BRDs (Morris et al. 2011 at 388). Across all other days after baiting, there was a significant difference in total catch per unit effort of legal-size crabs; however, there was no significant difference in size of legal-sized crabs in BRD pots and non-BRD pots (Morris et al. 2011 at 388). These results indicate that in the absence of fresh bait, crabs do not enter crab pots with BRDs as frequently as non-BRD pots (Morris et al. 2011 at 389). Morris et al. also found that crab pots with terrapin bycatch in them had, on average, fewer crabs per unit effort (Morris et al. 2011 at 388). Likewise, more legal-size crabs were caught in pots without terrapin bycatch, but the difference was not significant (Morris et al. 2011 at 388).

Rook et al. (2010) tested a 4.5 x 12 cm BRD in the lower Chesapeake Bay and found that the BRDs had little effect on crab catch (Rook et al. 2010 at 173–178). Crab catch was equivalent between crab pots with and without BRDs (Rook et al. 2010 at 178). In fact, crab pots with BRDs had slight increases in number, size, and biomass of both legal-size and sublegal-size crabs, though the difference was considered marginal (Rook et al. 2010 at 178).

Roosenburg and Green (2000) tested three sizes of wire BRDs in a tributary to the Chesapeake Bay in Maryland: 4 x 10 cm, 4.5 x 12 cm, and 5 x 10 cm (Roosenburg and Green 2000 at 883–

884). Neither the 5 x 10 cm BRD nor the 4.5 x 12 cm BRD affected crab size or the number of crabs caught in the crab pots (Roosenburg and Green 2000 at 885). In fact, crab pots with 4.5 x 12 cm BRDs had the highest catch per unit effort (2.69 crabs per pot per day), followed by crab pots without BRDs (2.55 crabs per pot per day), and then crab pots with 5 x 10 cm BRDs (2.39 crabs per pot per day) (Roosenburg and Green 2000 at 885). In the second year of study, the largest crab was caught in a crab pot with a 4.5 x 12 cm BRD (Roosenburg and Green 2000 at 885, 886). The 4 x 10 cm BRD reduced the size and number of large and mature female crabs (Roosenburg and Green 2000 at 884–885). Catch rate for standard crab pots with 4 x 10 cm BRDs was 2 crabs per pot per day lower than standard crab pots fished without BRDs (Roosenburg and Green 2000 at 885). The 4 x 10 cm BRD also had a significant effect on the width and height of crabs caught, excluding larger Number Ones and large females (Roosenburg and Green 2000 at 885). The scientists found that height of the BRD was the limiting factor rather than width (Roosenburg and Green 2000 at 885). Based on their study, Roosenburg and Green stressed the importance of using 4.5 x 12 cm BRDs on commercial and recreational crab pots because they do not affect crab haul but significantly reduce terrapin capture (82% reduction) (Roosenburg and Green 2000 at 886).¹¹

Wnek (2019) studied the effectiveness of various BRD designs in reducing terrapin bycatch and compared the amounts and sizes of blue crabs captured in crab pots fitted with BRDs in Barnegat Bay, New Jersey. He studied three sizes of BRD (5 x 15 cm, 4.5 x 12 cm, South Carolina prototype (half white, half red) against control pots without BRDs (Wnek 2019 at 2). There was no significant difference in the number of blue crabs captured in traps with BRDs and traps without BRDs (Wnek 2019 at 4). In terms of measurement, there was no difference in the total mean length of blue crab captures (Wnek 2019 at 4). The control pots had significantly wider blue crabs than the pots with 5 x 15 cm and South Carolina style BRDs; however, the control pots were similar to those fitted with 4.5 x 12 cm BRDs (Wnek 2019 at 4). While mean blue crab height was significantly lower in pots with 5 x 15 cm BRDs, there was no difference in mean blue crab height between control pots and those with 4.5 x 12 cm and South Carolina style BRDs (Wnek 2019 at 4).

¹¹ Roosenburg and Green (2000) found that the 4 x 10 cm BRDs were not a suitable solution for commercial fisheries because they reduced the number of crabs caught by nearly half (Roosenburg and Green 2000 at 887). However, they could be considered for recreational crabbers, who often place their traps in areas with more terrapins, because the 4 x 10 cm BRDs excluded 100% of terrapins (Roosenburg and Green 2000 at 887).

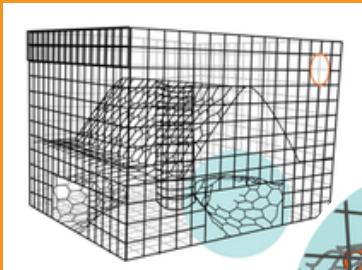
Using BRDs



Photo by Melanie Thorn

- + Little effect on crab catch.
- + Reduces bycatch.
- + Reduces terrapin mortality.
- + Conserves marine species.

Attaching a BRD



Illustrations: (c) 2009 Kelly Finan/National Aquarium.



Insert BRDs into all funnels (openings) on commercial-style crab pots. The placement of the BRD inside the funnel is the crabber's choice, whether it is deep inside the pot's funnel or towards the outside. Secure with cable ties on each corner.

How Can You Help?

- Always use BRDs.
- Follow state regulations regarding licenses, usages, and crabbing methods.
- Check pots regularly and remove promptly.
- Rig your pots properly using a sinkable line, commercial float, weighted bottom, and biodegradable escape panel.
- Tell friends, family, and other crabbers about BRDs and the benefits for conservation.
- Sign our pledge and learn more at BRD-Zone.net.



Photo by Melanie Thorn

This brochure was made possible by our partners. Funding provided by the Marine Debris Foundation. Visit our website BRD-Zone.net for more information.



Photo by Project Terrapin

Bycatch Reduction Devices (BRDs)

Drowning in crab pots is a major threat to Diamondback Terrapin populations. Bycatch Reduction Devices (BRDs) are inserted on crab pot funnels to prevent large terrapins from entering & drowning.



Check out
BRD-Zone.net
for more info

What Are BRDs?

BRDs are preventative tools that help to protect adult terrapins from drowning. When attached to crab pot funnels (openings), they help reduce bycatch or non-targeted species from being caught in the pots, like terrapins. Due to their slow life history and late maturity for males at 3-5 years old and females at 6-10 years old, the drowning of adult terrapins in pots affects the overall population.



Photo by Melanie Thorn

Due to differences in size, shape, and behavior of terrapins and crabs, BRDs prevent large terrapins from entering a pot while still allowing legal sized crabs to enter.

BRD Facts

Studies confirm that BRDs are effective tools for saving marine species and do not discourage blue crabs from entering pots. BRDs have little effect on the size and number of blue crabs found in crab pots. Just by reducing the funnel size, there is a reduction in bycatch with continued crab captures.



Photo by wpopp via Wikimedia Commons

Many crab pots are set in areas where terrapins reside. Terrapins are attracted to crab pots because of bait and curiosity. This increases the risk of accidental bycatch. Crab pots with BRDs prevent large terrapins from being captured and drowning.



Photo by Melanie Thorn

Marine Debris (Ghost Pots)

Marine Debris is trash in our oceans and waterways. Plastics, textiles, rubber, and derelict fishing gear are examples of marine debris. These discarded items can affect marine life, habitats, and people.



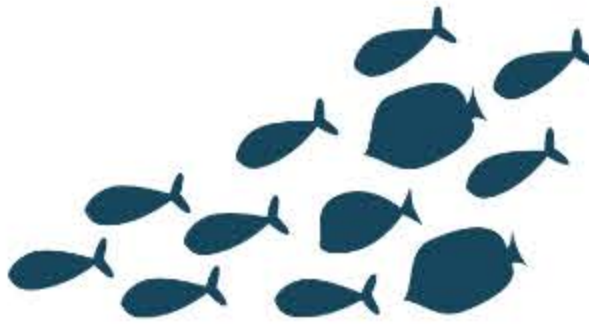
Photo by Project Terrapin

When crab pots are lost in our waterways, they become known as ghost pots. These ghost pots continue to catch crabs and other bycatch. This can negatively affect crab and terrapin populations. Lost pots will happen, but you can take extra precautions like rigging your pot properly using a sinkable line, commercial float, and sufficient weight.

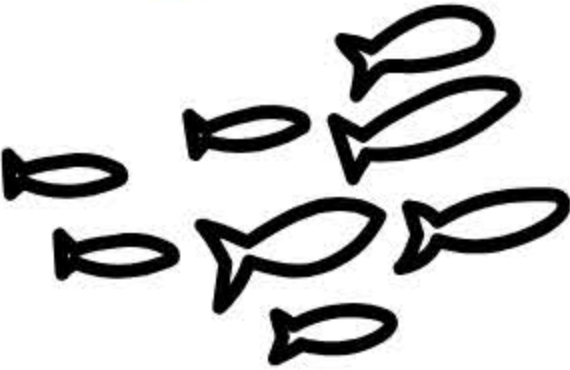


Rig-It-Right!

Photo by Project Terrapin



HOW TO REDUCE



BYCATCH

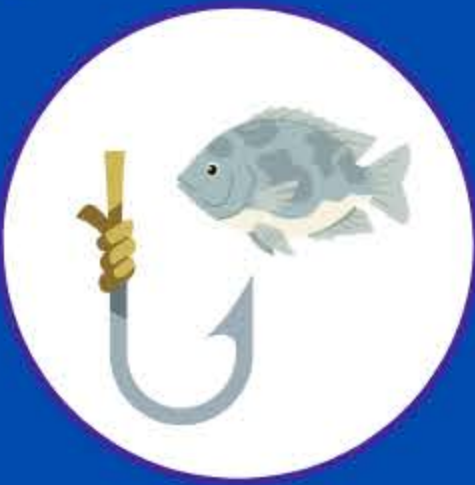


RESPONSIBLE CRABBING

IF CATCHING BLUE CRABS USING A COMMERCIAL-STYLE CRAB POT, PLEASE USE A SINKABLE LINE, PROPER FLOAT AND ESCAPE PANEL.

BYCATCH REDUCTION DEVICES (BRDS)

USE BRDS IN THE FUNNELS OF CRAB POTS TO REDUCE BYCATCH AND PREVENT MASS MORTALITIES IF THE CRAB POT BECOMES LOST.



FISH RESPONSIBLY

FOLLOW REGULATIONS FOR CAPTURE LIMITS, SIZES, AND LEGAL SEASONS FOR TARGETED SPECIES.

BE THE DIFFERENCE

MARINE DEBRIS SUCH AS CRAB POTS CAN NEGATIVELY AFFECT SPECIES AND ALTER THE NECESSARY BALANCE TO SUSTAIN HEALTHY HABITATS. PROPERLY RIG YOUR TRAPS TO LOWER THE CHANCE OF TRAP LOSS!



WWW.BRD-ZONE.COM

