

# A Call for Intervention

## The Decline of South Carolina's Horseshoe Crab Population





**D**efenders of Wildlife is a national, nonprofit membership organization dedicated to the protection of all native wild animals and plants in their natural communities.

Defenders has worked to conserve migratory shorebirds and the resources they rely on for decades, including in South Carolina. We played a major role in securing Endangered Species Act listing as threatened for the rufa red knot, a subspecies (*rufa*) that relies on horseshoe crab egg availability to survive its northbound migration. We also compelled the U.S. Fish and Wildlife Service to propose critical habitat for the red knot and successfully litigated over the illicit harvesting of horseshoe crabs from Cape Romain National Wildlife Refuge, near Charleston, South Carolina. Defenders is an active member of the Horseshoe Crab Recovery Coalition and advocates before state and federal agencies for expanded protections for horseshoe crabs.

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Cover Photo: Horseshoe Crabs on Beach © Ariane Mueller

# Overview

The American horseshoe crab (*Limulus polyphemus*) is a unique, primordial animal. Having evolved little over hundreds of millions of years, this “living fossil” is more closely related to spiders and scorpions than crabs (Walls et al., 2002).

The horseshoe crab can be found from Maine to the Yucatan Peninsula in Mexico (South Carolina Department of Natural Resources [SCDNR], 2019b) and spends most of the year dwelling on the ocean bottom until changes in temperature draw adults to spawning beaches in early spring (Walls et al., 2002). Female crabs deposit their eggs among males in excavated nests within the intertidal zone (Brockmann & Penn, 1992).

In an ancient synchrony, migratory shorebirds time their arrival to coincide with horseshoe crab spawning events. In one of the country’s most anticipated wildlife spectacles, red knots and other migrant species converge to feed on horseshoe crab eggs before continuing the journey to their Arctic breeding grounds (Botton et al., 1994). Red knots rely on horseshoe crab eggs in Delaware Bay, South Carolina and Georgia (Botton et al., 1994; Smith et al., 2019; SCDNR, 2013).

Like the bison or passenger pigeon before it, the horseshoe crab was once considered an inexhaustible resource, with spawning aggregations so dense they could be “shovelled up and collected by the wagon load” (New Jersey Geological Survey, 1857, p. 106). Millions were annually harvested from Delaware Bay, site of the country’s largest population, to feed the livestock and fertilizer industries (Cramer, 2016). Factories were established near prime spawning beaches, with crabs speared, stacked and ground into fertilizer paste (*The Great King*

*Crab Invasion*, 1871). By the early 1900s, the Delaware Bay population had been depleted (Cramer, 2016; *Knot Then, Knot Now, Knot Later*, 2012).

Today, the species is still managed as a commodity. The horseshoe crab is harvested and bled by the biomedical industry and used as bait by eel and whelk fishermen (Atlantic States Marine Fisheries Commission [ASMFC], 2019). The ASMFC, a compact of state wildlife agencies

and industry interests, oversees the management of horseshoe crabs. By developing horseshoe crab benchmark stock assessments, implementing restrictions on the number of crabs harvested for bait and imposing state quotas, the ASMFC has taken important steps to redress historical overharvesting.

Such regulations, however, are applied to bait fishermen only (ASMFC, 2019) and have failed to recover mature female horseshoe crabs, the preferred target of industry (Bi et al., 2020). At roughly 8,000 per square meter, horseshoe crab egg densities in Delaware Bay have shrunk by roughly 80% in the past three decades (Niles, 2021). Similar declines have followed in South

Carolina (Niles, 2021; Niles et al., 2021).

Unlike bait fishermen, the biomedical industry has largely avoided regulation, and harvesters are uniquely unencumbered by time, place or quota restrictions (ASMFC, 2019). Despite annually exceeding coastwide kill thresholds meant to trigger intervention, no actions have followed (ASMFC, 2019). Best management practices are suggested but not enforced. Harvesters are generally monitored no more than once per year (SCDNR, 2019c). Little data is publicly shared, moreover, with harvest locations and kill rates kept confidential.

It is within this context that horseshoe crab poaching



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has occurred on private lands and national wildlife refuges in South Carolina, where as many as 150,000 crabs are harvested annually (Kinnard, 2021). With nearly a third of harvested female crabs potentially killed per year (Leschen & Correia, 2010), unregulated harvesting has set the stage for declines in horseshoe crab abundance, particularly among smaller, less resilient populations.

This report offers SCDNR<sup>1</sup>—the agency overseeing the state's horseshoe crab harvest—a set of management suggestions necessary to restore oversight and accountability, mitigate the continued decline of the species and foreclose potential conflicts of interest.

Specifically, we recommend that SCDNR:<sup>2</sup>

1. Restrict the timing and manner of harvest practices.
2. Explicitly articulate all relevant closures in the hand harvest permit.
3. Create and implement a horseshoe crab-specific trawl survey.
4. Prohibit the use of horseshoe crab containment ponds, where crabs are held for weeks or months without food before bleeding.
5. Sever financial ties to Charles River Laboratories, the Charleston-based company that produces the pharmaceutical product derived from horseshoe crab blood.

1 For purposes of this report, SCDNR can be stratified into three groups: management or leadership; crustacean researchers; and shorebird biologists.

2 While these actions are far from comprehensive, they provide the first step toward recovering horseshoe crabs and migratory shorebirds in South Carolina.

Red knots fuel up on horseshoe crab eggs before continuing the journey to their Arctic breeding grounds.



# The Keystone Crab

Once considered a “trash fish” (Walls et al., 2002, p. 41), the horseshoe crab has enjoyed a scientific renaissance and is now recognized as a keystone species essential to the survival of many other species.

The horseshoe crab’s importance to shorebirds is well-established. Each spring, red knots, ruddy turnstones, semipalmated sandpipers and other notable shorebirds descend on eastern coastal foraging areas to feed on horseshoe crab eggs before resuming their journeys to Arctic breeding grounds (Clark et al., 1993). Horseshoe crab eggs constitute the majority of the gut contents of these birds (Tsipoura & Burger, 1999).

Horseshoe crab eggs are the favored food source for the federally listed red knot and provide the highest energy accumulation rates in the birds worldwide (Piersma et al., 2005). Each knot must consume roughly 400,000 eggs to fuel the second leg of its journey (Cramer, 2018). With breeding season performance, recruitment, and population dynamics correlated to body condition, the birds that fail to acquire such reserves are less likely to survive and reproduce (Duijns et al., 2017).

Horseshoe crabs lay their eggs 10 to 20 centimeters underground (Botton et al., 2010), making them generally out of reach to shorebirds. Only with repeated spawning by multiple crabs are their eggs distributed onto or just below the surface where they are accessible to the birds (Smith et al., 2002; Smith, 2007). Areas supporting higher densities of horseshoe crabs attract more birds because eggs are likelier to be within their reach (Niles, 2021).

During the 2000s, the overharvest of horseshoe crabs in Delaware Bay was considered the “key causal factor” in the population decline of the red knot (U.S. Fish and Wildlife Service [USFWS], 2021a, p. 9).

Red knots also rely on horseshoe crab eggs in South Carolina and Georgia (Smith et al., 2019; SCDNR, 2013). One of the single largest flocks—as many as 8,000—has been documented in South Carolina (SCDNR, 2013; SCDNR, 2018c; Smith et al., 2019).

While there, red knots feed on less energy rich coquina clams until the horseshoe crab spawn occurs, at which point they switch diet and disperse to priority crab spawning areas, such as Harbor Island and Deveaux



GREGORY BREESE/USFWS

Horseshoe crab eggs are a food source for many species, but an indispensable one for red knots.

Bank (SCDNR, 2013; SCDNR, 2018c).

In Cape Romain National Wildlife Refuge, the foraging distribution of migratory shorebirds, including the red knot, is spatially correlated to horseshoe crab egg abundance (Takahashi, 2016). The eggs produced in Cape Romain provide sustenance to not only the red knot, but also to the ruddy turnstone, short-billed dowitcher, semipalmated sandpiper, sanderling and dunlin, with 95% of tested shorebird fecal samples showing traces of eggs (Takahashi, 2016).

Two-thirds of the red knots that forage on South Carolina resources bypass Delaware Bay altogether (SCDNR, 2018c), underpinning the state’s unique importance as a staging area for long-distance migrants (Smith et al., 2019).

A wide diversity of marine species also relies on horseshoe crab eggs and larvae, including Atlantic silverside, flounder, striped bass, perch and eel (Shuster, 1982a; Antonucci et al., n.d.). Adult crabs are preyed on by hammerhead and tiger sharks (Cramer, 2016). The species is also considered the preferred prey of the loggerhead sea turtle, with the management of the stock directly tied to alterations in loggerhead foraging patterns (Seney & Musick, 2007).

Following the depletion of the horseshoe crab in Virginia, the loggerhead shifted its diet to secondary prey such as blue crab. After blue crab abundance declined, the loggerhead then resorted to scavenging on net-entangled or discarded fish (Seney & Musick, 2007).

# South Carolina's Biomedical Industry

Roughly 700,000 horseshoe crabs are annually harvested and live bled by the biomedical industry (ASMFC, 2020). Limulus Amebocyte Lysate (LAL), the product derived from the horseshoe crab, is manufactured by a handful of companies including Charles River Laboratories operating in Charleston, South Carolina (ASMFC, 2019).

The production of LAL ensures medical devices, such as implants and other intravenous devices, are free of bacterial contaminants (Burgenson, 2020) and supports a multi-million-dollar industry, even though synthetic alternatives are available.

The biomedical industry's annual kill rate can vary according to external stressors such as handling practices, transport, time out of water, etc. (Hurton & Berkson,

2006; Leschen & Correia, 2010).

Bleeding can result in decreased activity levels, failure to respond to tidal rhythms and reduced hemocyanin counts, which could diminish immune function (Anderson et al., 2013). Bleeding can impair mating behaviors (Owings et al., 2019), decreasing the survival of the species. Stress caused by exposure to high temperatures can impact quality and overall health (Coates et al., 2012). Mortality rates can be as high as 30% among bled females (Leschen & Correia, 2010).

The ASMFC adopted a 15% intermediate mortality rate for bled and released crabs (ASMFC, 2019). Best management practices—a set of handling guidelines designed by industry—are assumed to reduce the negative costs of bleeding (ASMFC, 2019).

## A Humane Alternative to LAL

### Synthetic substitute spares horseshoe crabs

By virtue of its extreme sensitivity, the horseshoe crab derivative LAL has long been considered the most reliable method for bacterial testing to ensure the safety of various pharmaceutical products (Burgenson, 2020).

In recent years, the demand for endotoxin testing has increased (ASMFC, 2020), and so too has the pressure on the wild horseshoe crab stock, inspiring the use of alternative technologies (Burgenson, 2020; Eli Lilly, 2018).

A synthetic alternative—recombinant Factor C (rFC)—precludes the need for LAL and the industry's reliance on wild crab populations. In 2012, the U.S. Food and Drug Administration approved its use if testing methods provide equivalent or better results (U.S. Food and Drug Administration, 2012).

For its equal if not superior reliability, rFC promises an eventual industry-wide transition (Piehler et al., 2020; Bolden & Smith, 2017; Abate et al., 2017). The pharmaceutical giant, Eli Lilly, has already shifted roughly 90% of its testing to the synthetic (Eli Lilly, 2018). The U.S. government contracted to purchase at least 100,000 doses of two COVID-19 drugs tested using rFC (Eisner, 2021b). The synthetic has also been deemed safe for use in Europe (Balfour, 2020).

By discouraging authorities from streamlining its adoption, however, Charles River has obstructed the synthetic's implementation (O'Hare, 2019), while casting doubt on its efficacy (Baldwin, 2021; O'Hare, 2019; Jordan, 2021).

A major European journal recently published an Expression of Concern, chastising Charles River's employees for inappropriately generalizing about the synthetic in 2021 (Brandl, 2021; Eisner, 2021b).

Today, Charles River relies on cartridge technology designed to reduce, but not yet replace, the use of horseshoe crab blood. That technology requires 5% of the LAL (Collins, 2017), yet is purportedly sold for significantly more than the traditional cost, incentivizing continued bleeding (Undisclosed, 2021).

# Harvest Numbers

From 2004 to 2020, the East Coast biomedical harvest increased by 138% (ASMFC, 2020; ASMFC, 2005). Based on existing records, much of this growth has been concentrated in South Carolina.

When South Carolina reporting requirements began in 1991, fewer than 5,000 crabs were removed from spawning beaches (Thompson, 1999). Two years later, the number had spiked to roughly 30,000 animals and had nearly doubled again by 1996 (Thompson, 1999). By 2001, 90,000 crabs were being harvested annually (Wenner et al., 2002). Two decades later, that number had further ballooned to an astounding 150,000 animals (Kinnard, 2021). Roughly 25% of the entire biomedical take now occurs in South Carolina (ASMFC, 2019).

In South Carolina, best management practices are generally monitored no more than once per year and rarely

practically applied (SCDNR, 2019c). Horseshoe crabs are regularly retrieved by the telson (tail) (Crolley, 2019; Horan, 2019; SCDNR, 2019a) in a manner known to harm the animals (SCDNR, 2019b); indelicately stacked to capacity in uncovered boats (Horan, 2019; Eisner, 2022); and harvested from beaches over 100 miles from the bleeding facility (Smith et al., 2019; Horan, 2019), confounding the true kill rate of the overall bleeding process.

Thousands of crabs are held in man-made ponds for weeks or months before bleeding, without food or regulated pond conditions, exacerbating the negative impacts of bleeding (Linesch, 2017; Hamilton et al., 2019).

Under the most careful of handling conditions, roughly 22,000 crabs are likely killed per harvest season in South Carolina (ASMFC, 2019). Under a 30%



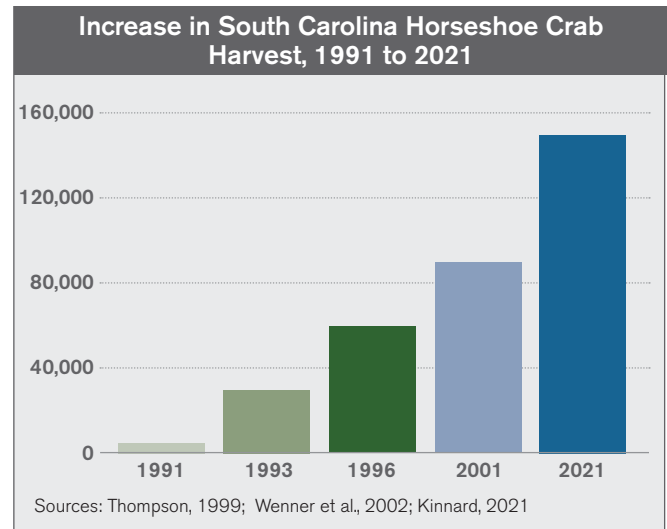
Technicians bleed horseshoe crabs at a Charles River Laboratories bleeding facility.

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mortality threshold, the kill rate could reach nearly 50,000 per year.

In the early days of harvesting, the impacts on horseshoe crab survival were largely unknown, although the basic principles of precautionary wildlife management were well-established. According to a 1999 study, the exploitation of breeding stocks, without a management plan, could lead to abrupt and significant declines in South Carolina's horseshoe crab population, meriting the crab's listing as a threatened or endangered species (Thompson, 1999). Effective management would therefore require "knowledge of population fitness, distribution, [and] critical habitat requirements" (Thompson, 1999, p. 6), as well as active management on the part of SCDNR (Thompson, 1999).

Similar sentiments were expressed years later, when SCDNR scientists warned that an "unchecked" harvest could result in population declines that would not be apparent for nearly a decade (Wenner et al., 2002, p. 3). The magnitude of the take at that time—over 90,000 animals in 2001—was "of great concern" (Wenner, et al., p. 3) and conducted in a manner uncondusive to successful spawning, with crabs removed from beaches during their most sensitive life stage (Wenner at al., 2002).



Over the next decade, research intensified but ultimately yielded few substantive insights into the health of localized horseshoe crab populations. By 2012, SCDNR compliance reports tied "worrisome" sampling declines to increases in harvesting (SCDNR, 2012b, p. 3).

Three years later, researchers again noted the potential for "profound" long-term impacts (SCDNR, 2015a, p. 2), with upwards of as many as 150,000 animals removed from spawning beaches per year (Kinnard, 2021).



A harvester adds a horseshoe crab grabbed by the telson (tail)—a practice that can harm the crabs—to his haul.



After the federal listing of the red knot, SCDNR biologists, among others, expressed the need for horseshoe crab protections (Sanders et al., 2019) and mitigation of human disturbances (SCDNR, 2019e).

Rather than acting on these warnings, SCDNR leadership encouraged the phenomenal growth of industry, while conceding that its surveys were unreliable<sup>3</sup> (SCDNR, 2015b; ASMFC, 1998), and the status of the population structure largely unclear (SCDNR, 2015a).

Today, the male-to-female ratio and locations of juveniles, among other basic data, remain largely unknown.

Even so, *every* crab, regardless of gender, can be harvested in the midst of spawning events, on virtually all South Carolina properties. No caps are imposed on the

number killed, and as many as 50,000 are potentially lost each year. Thousands are detained in ponds (Kingsley-Smith, 2017) precluding reproduction. Management decisions are rarely if ever subject to public comment or input. Even harvest data—locations, year-by-year trends, etc.—are withheld from the public.

Between 1993 and 2021, this harvest pressure increased by roughly 400% (Thompson, 1999; Wenner et al., 2002; Kinnard, 2021). Relative to population size, South Carolina’s stock may suffer today from the greatest biomedical harvest pressure coastwide (Kinnard, 2021; ASMFC, 2019).

Reports of declines and/or nonexistent spawning have since become commonplace.

## Purported Declines

The American horseshoe crab is currently listed by the International Union for Conservation of Nature as “Vulnerable” to extinction (Smith et al., 2016). The IUCN also listed *Tachypleus tridentatus*, a once abundant Asian horseshoe crab, as “Endangered” (Laurie et al., 2019).

With the Asian population on the decline, increased harvest pressure may shift to North America (Burgenson, 2020), putting added pressure on South Carolina. Whether the population can sustain increased harvesting is unknown.

According to a recent study, the horseshoe crab appears genetically stable (Cushman et al., 2019) and presumably in little need of intervention in South Carolina. Because that study was the first of its kind, it could not quantify the impact that bleeding may have had on the species (Eisner, 2021b).

On-the-ground SCDNR staff, however, are now seeing fewer crabs on spawning beaches (SCDNR, 2019e). In 2018, SCDNR surveys yielded few sightings on priority spawning grounds such as Marsh Island and Hilton Head Island (SCDNR, 2018a), both heavily harvested habitats (SCDNR, 2015a; USFWS, 2019). For two years straight (2017-2018), South Carolina altogether failed to produce a meaningful spawn (SCDNR, 2018b).

On Harbor Island, crabs have been “drastically dropping in numbers,” according to local experts (Albert, 2019). Since 2004, the “crabs tagged numbered in the hundreds until 2018 when we only found three individuals. This year we only found two. This sudden decline in crabs has affected the number of migratory birds arriving to refuel for the final stages of their migrations. Birds such as the red knot, once numerous, have been seldom seen.... Having observed both species for the past 10 years it is easy to see a serious problem” (Albert, 2019).

In Cape Romain National Wildlife Refuge, knots have declined and are rarely, if ever, able to feed on horseshoe crab eggs (Niles, 2021), which were once found in suitable quantities on several islands, including Marsh, Bulls and Little Bulls (Takahashi, 2016), depriving them of a critical food source. Once seen in abundance, few if any crabs have been documented in Cape Romain in recent years (Crolley, 2021).

According to a commercial boatman who has spent two days a week on the water since 2009, there has been “a distinct decline in all wildlife in Beaufort County, South Carolina, but especially shorebirds, dolphin [sic] and horseshoe crabs. The latter being especially concern-

<sup>3</sup> The same surveys were used by the ASMFC in the development of the latest benchmark stock assessment, which described the trend of the Southeast population as “good.” The ASMFC historically discounted nontargeted survey methods of this nature for their inherent shortcomings and potential biases (ASMFC, 1998). See p. 19 for more information.

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ing because the horseshoe crab eggs have been the main food source for many migrating shorebirds” (Horan, 2021).

Where hundreds of crabs used to be tagged on important spawning beaches, a former SCDNR biologist now claims to see only four or five at any given point (Eisner, 2022).

Finally, harvesting on Turtle Island Wildlife Management Area, a once-prolific spawning beach, has depleted the local population, according to USFWS (2021c). No spawning has been documented since intensive harvest-

ing occurred in 2019 (USFWS, 2021c), whereas spawning just across the state line in Georgia has remained consistent (Eisner, 2022).

Such declines, reported throughout virtually the entire range in South Carolina, may force red knots to relocate from the state (Niles, 2021), with only Delaware Bay now capable of supporting meaningful egg densities (Niles et al., 2021).

According to biologists with the Georgia Department of Natural Resources (GDNR), “we may be witnessing a collapse” in South Carolina (Eisner, 2022).

## Harvest Locations

Generally operating within informal territories, fishermen repeatedly harvest the same population throughout the summer. To prevent recapture, crabs are generally returned to the same focal region, but not

the discrete habitat from which they were harvested (SCDNR, 2019d).

Dozens of state-permitted fishermen gather crabs on behalf of Charles River (Rhodes, 2012). Some of these



harvested crabs must be transported roughly 30 miles, others far more, to reach the Charleston-based bleeding facility. A handful of harvesters hold crabs in earthen ponds for bleeding at a later date (Hamilton et al., 2019).

Harvesting generally occurs in three focal regions in South Carolina: Beaufort, Edisto and Cape Romain (Egger, 2021). Of the specific harvest locations in these regions, the seven singled out below are notable for either their critical importance to shorebirds, documentation of poaching or a combination thereof.

Poaching has likely occurred on at least five of these

properties and potentially more areas in South Carolina. (Horseshoe crabs are also harvested on Hilton Head Island, Daufuskie Island, St. Helena Island, the beach adjacent to the South Carolina Aquarium and James Island, among other places [SCDNR, 2015a; USFWS, 2021d]).

Curtailling harvesting on all of these areas can be achieved through various procedural and substantive mechanisms, such as state-enacted closures, revisions to the horseshoe crab hand harvest permit and active oversight and policing. (See section on management suggestions, page 17).



Horseshoe crab poachers work Marsh Island in Cape Romain National Wildlife Refuge.

## Cape Romain National Wildlife Refuge

Renowned for its world-class shorebird habitat, Cape Romain is among the most important wintering and migration areas on the Atlantic Coast, supporting hundreds of thousands of birds (Dodd & Spinks, 2001). The refuge has a higher critical value than both Delaware Bay and all other Pacific, Atlantic and Gulf Coast Western Hemisphere Shorebird Reserve Network sites once overall species richness and presence of declining species are considered (Dodd & Spinks, 2001).

Cape Romain's Marsh Island is the state's only site with documented brown pelican nesting every year since recording began (USFWS, 2019). Over five decades,

Marsh Island has supported 18 nesting species of seabirds, shorebirds and wading birds (USFWS, 2019). The island also supports the highest number of red knots on the refuge (Wallover et al., 2015), as well as the state's largest assemblage of roosting and foraging marbled godwits (USFWS, 2019).

Human disturbance is considered a significant cause of shorebird declines, impacting their ability to successfully breed, roost and forage (Pfister et al., 1992; Burger, 1994). Disturbance causes increased flushing from nests and decreased chick survival (USFWS, 2010). Even occupying boats and kayaks *near* nesting islands poses a

threat (USFWS, 2010). Mitigating human disturbance is thus of critical conservation importance (USFWS, 2010).

To that end, USFWS closes Marsh Island, White Banks and Sandy Point to all entry annually from February 15 to September 15, with the closed area extending down to the low mean water mark (50 CFR 26.34(mm) (1)(v); USFWS, 2019).

Notwithstanding these restrictions, a state-licensed fisherman and his crew bypassed island closure signs for roughly a decade, harvesting tens of thousands of crabs in violation of federal law (USFWS, 2019; Dawsey, 2014).

In 2013, SCDNR was “in agreement” that the Marsh Island harvest was not in compliance with federal regulations (USFWS, 2019, p. 3). USFWS also notified Charles River of its violations (USFWS, 2019; Eisner, 2021a). While closures were temporarily honored (Wagner, 2014), poaching resumed shortly thereafter

(USFWS, 2019; Boyles, 2018).

During that time, USFWS pled for help from SCDNR in protecting the refuge, meeting with leaders on six occasions (Boyles, 2018). Ultimately, SCDNR denied additional meeting requests (Boyles, 2018); refused to explicitly incorporate the closures into hand harvest permits (Bell, 2014; Bell, 2020; SCDNR, 2019c); and issued continued permits, later claiming USFWS could not close any areas of the refuge to human entry (SCDNR, 2021b).

Defenders of Wildlife and the Southern Environmental Law Center sued USFWS over the unregulated harvesting in Cape Romain, but voluntarily dismissed their case after USFWS announced its intention to regulate the harvest in accordance with federal law.

SCDNR, meanwhile, appears poised to reissue permits to the same poacher (SCDNR, 2021b; Bell, 2020), setting the stage for continued conflict.

## Tybee National Wildlife Refuge

Located near the Georgia-South Carolina state line, Tybee National Wildlife Refuge sits at the southern end of Charles River's operating range. Managed primarily for nesting shorebirds (USFWS, 2011), Tybee has supported thousands of red knots and suffers from heavy human disturbance (Smith et al., 2019).

While protected on paper, high levels of harvest have been documented in the refuge (Smith et al., 2019). Ac-

cording to biologists from multiple agencies and states, the magnitude of the horseshoe crab take was “unexpected” and likely “unsustainable” (Smith et al., 2019, p. 15, 18), with thousands taken during peak migration events.

With the refuge closed to public use (USFWS, 2011), the state-permitted harvest on Tybee occurs in violation of federal law, degrading a key foraging area for red knots and other shorebirds.

## Turtle Island Wildlife Management Area

In 2019, thousands of red knots were documented on Turtle Island Wildlife Management Area (Smith et al., 2019). Ruddy turnstones, long-distance migrants like red knots, were also seen consuming horseshoe crab eggs before departing to fly straight to the Arctic (SCDNR, 2020a). Various imperiled species such as American oystercatchers and piping plovers use the island as well (*Turtle Island*, 2018).

The migratory birds that visit Turtle Island also rely on Georgia resources in places such as Tybee Bar and Little

Tybee Island, apparently utilizing the larger area as one staging site (Smith et al., 2019; SCDNR, 2018c). Conservation actions (or lack thereof) on Turtle Island can thus reinforce or undermine conservation efforts in Georgia.

With that in mind, multiple agencies, including USFWS and GDNR, attempted to mitigate the impacts of the Turtle Island harvest (Smith et al., 2019). Since 2019, however, spawning has not been documented on Turtle Island (USFWS, 2021c), irreparably diminishing a once-prolific South Carolina habitat.



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A harvester collects horseshoe crabs on Turtle Island Wildlife Management Area. Despite efforts to mitigate the impacts of harvesting on the area, no horseshoe crab spawning has been documented on Turtle Island since 2019, the year this scene was recorded.

## Bay Point Island

One of the last undeveloped barrier islands in South Carolina, Bay Point Island is considered an Important Bird Area by Audubon (*Morse Creek Inlet/Bay Point Island*, 2018). Hundreds of knots have regularly been documented during migration (Sanders, 2020; SCDNR, 2021b), with as many as 8,000 other birds recorded during winter (*Morse Creek Inlet/Bay Point Island*, 2018).

Despite being privately owned, thousands of crabs

are harvested from Bay Point Island and confined to a Beaufort-area containment pond (*Morse Creek Inlet/Bay Point Island*, 2018; Parker, 2021).<sup>4</sup> According to Charles River’s agents, development proposed by the island’s owner threatens the continued viability of their harvest (Parker, 2021).

In the absence of an agreement otherwise, the harvest on Bay Point Island may occur illicitly.

## Deveaux Bank Seabird Sanctuary

Of the 187 miles of South Carolina coastline, Deveaux Bank, a state-managed seabird sanctuary, constitutes less than 1 mile, yet attracts tens of thousands of birds, including red knots, black skimmers and virtually every coastal bird species of “greatest conservation need” in South Carolina (*Deveaux Bank*, 2017; Cramer, 2021).

Deveaux Bank is considered by some without equal, supporting almost 20,000 roosting whimbrels (Sand-

ers et al., 2021), the east’s largest brown pelican colony (*Deveaux Bank*, 2017; Cramer, 2021) and thousands of red knots (Smith et al., 2019). Few sites anywhere in the region support the diversity or abundance found on Deveaux.

Many of Deveaux’s iconic species—piping plover, whimbrel, red knot—are vulnerable to human disturbance (Gibson et al., 2018; Wilke & Johnston González,

<sup>4</sup> The harvester’s name has been intentionally withheld. While it is argued that harvesters operate in the intertidal zone on properties restricted above high tide, such as Bay Point Island, SCDNR correspondences indicate that harvesters move above high tide, then beneath it, depending on the presence of observers.



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2010; USFWS, 2021a). Full intertidal closures are considered necessary to protect Deveaux's peerless wildlife (Eggert, 2012).

With limited restrictions, boaters, recreationists and anglers nonetheless make regular incursions onto Deveaux (Cramer, 2021; *Deveaux Bank*, 2017). Horseshoe crab

harvesting also occurs on an annual basis (SCDNR, 2015a), often at night when birds are most easily disturbed.

Because horseshoe crabs spawn over months, harvesters return to Deveaux, repeatedly disturbing birds throughout early summer, diminishing its already limited protections.

## Morgan Island

Located within the ACE Basin National Estuarine Research Reserve, Morgan Island hosts a population of monkeys used for medical research purposes. The property itself is leased by SCDNR to Charles River for roughly \$1.5 million per year (Beaufort County, South Carolina, 2017; Eisner, 2022).

By virtue of the lease agreement, the taking of wildlife is strictly prohibited (Beaufort County, South Carolina, 2017; Eisner, 2022). Former SCDNR staff have nonetheless documented harvesters on Morgan Island, operating above low tide and beyond no entry signs (Eisner, 2022).

## Parris Island Marine Corps Recruit Depot

Owned and operated by the U.S. Marine Corps (USMC), Parris Island serves as a recruit depot for marine training purposes. Although federal ownership extends to the channel (Presidential Proclamation, 1918; Redacted Author, 2021), harvesters have operated on Parris Island for years (SCDNR, 2015a; Horton, 2021), boating to the island and removing crabs without permission. At least one poacher has been

intercepted by Parris Island law enforcement, though harvesting has largely continued unabated (Redacted Author, 2021; Horton, 2021).

USMC has discussed changes to the hand harvest permit with SCDNR (Redacted Author, 2021; Horton, 2021)—namely, the specific inclusion of Parris Island as a restricted area—but, as of December 2021, the agency had yet to commit (Horton, 2021).

## Case Study: Carl N. Shuster Jr. Horseshoe Crab Reserve

In 2001, the National Marine Fisheries Service established 30 nautical miles off the mouth of Delaware Bay from south of Atlantic City, New Jersey, to just north of Ocean City, Maryland, as a horseshoe crab sanctuary. Named for pioneering horseshoe crab researcher Carl Shuster, the reserve limited possession and prohibited fishing of horseshoe crabs adjacent the bay (Restricted Gear Areas, 2001).

Shortly after the designation of the reserve, however, a biomedical company received an exemption, allowing the harvest of up to 10,000 crabs per year (Atlantic Coastal Fisheries Cooperative Management Act Provisions, 2016). In turn, harvesters tagged 15% of crabs and provided morphological data on the catch. The exemption was reissued on multiple occasions (Atlantic Coastal Fisheries Cooperative Management Act Provisions, 2016), arguably undermining the reserve's founding purposes.

In a similar vein, Charles River has requested access to the ACE<sup>1</sup> Basin National Estuarine Research Reserve in South Carolina. As one of the last potential viable spawning sites, the reserve's islands were set aside to monitor spawning, larval abundance, and survival (Jenkins, 2016), providing a control similar to the Carl Shuster Reserve.

SCDNR met with Charles River to discuss the prospect in July 2021 (Kinnard, 2021; SCDNR, 2021a). Shortly thereafter, the company requested universal access to all crabs under the state's jurisdiction, "*in exchange*" for \$500,000 of cash resources and added data gathering (Flynn, 2021, p. 2; Eisner, 2022) (emphasis added).

Potential changes of this nature would be enshrined in the SCDNR horseshoe crab hand harvest permit.



<sup>1</sup> ACE stands for the Ashepoo, Combahee and Edisto rivers.



South Carolina Gov. Henry McMaster watches a video of the bleeding of horseshoe crabs during a visit to Charles River Laboratories in Charleston on August 6, 2021.

## A Conflict of Management

When Charles River began harvesting operations, the company successfully advocated for legislation that prohibited the use of horseshoe crabs as bait. The resulting bill, drafted by Jim Cooper of Charles River, effectively privatized the use of a public trust resource, banning other commercial uses (Cooper, 2019). Since then, Charles River assumed a key role on the advisory panel of the ASMFC, regularly downplaying the impacts of the bleeding process (Cooper, 2019; ASMFC, 2019) and guiding the management of the species.

The horseshoe crab is listed today by SCDNR as one of two marine invertebrates of the highest conservation priority (SCDNR, 2014).

While various research efforts have followed (SCDNR, 2015a; SCDNR, 2015b), often with Charles River's funding (Eisner, 2020b), few if any tangible restrictions designed to prevent declines have been implemented (SCDNR, 2019c). Management suggestions from shorebird biologists have also gone largely unheeded.

According to SCDNR biologists, "efforts should be made to identify and protect foraging areas" in South Carolina (SCDNR, 2013, p. 6), since red knots often

bypass Delaware Bay altogether (SCDNR, 2018c). One of the "first steps" toward that end must be the safeguarding of horseshoe crabs and coquina clams (Sanders et al., 2019, p. 1). Because red knots are unable to habituate to human presence, disturbances must also be mitigated (SCDNR, 2012a).

Today, most *if not all* priority red knot foraging areas suffer from heavy harvest disturbance, with fisherman and birds now vying for the same resources, at the same time of year, often during the agency's own monitoring efforts (Smith et al., 2019; SCDNR, 2015a). These interactions, according to SCDNR, reduce the number of red knots and the time they spend consuming prey (2012a).

Such conflicts in management—encouraging unencumbered harvesting, while trying to protect shorebird resources—have degraded even the most high-value habitats in South Carolina

For instance, Cape Romain supports 70% of South Carolina's royal and sandwich tern nests alone, as well as half the American oystercatcher population (*Cape Romain Bird Steward*, n.d.). In 2020, DNR hired a shorebird steward to work with the federal government



in protecting the refuge from human disturbance (*Cape Romain Bird Steward*, n.d.).

Three days after Charles River met with the state, however, South Carolina intervened in litigation (Moore, 2021), arguing that USFWS could not close any portions of the refuge. The same areas patrolled by the shorebird steward were those DNR leadership refused to protect from harvesting (*Cape Romain Bird Steward*, n.d.; Boyles, 2018; SCDNR, 2021b).

The state also encouraged the designation of critical habitat—a framework meant to facilitate the red knot’s recovery—while demanding that some of those same priority areas be opened to commercial harvesting

(SCDNR, 2021b).

In some cases, efforts to limit recreational disturbance have succeeded. Specific calls for reform to horseshoe crab harvesting practices have been rebuffed, however (Smith et al., 2019; Hunt et al., 2020; Bell, 2020). Federal efforts to mitigate its impacts have also failed (Boyles, 2018; USFWS, 2019).

Shorebird biologists from multiple states now consider runaway horseshoe crab harvesting in South Carolina the “*most significant shorebird conservation issue moving forward in the region*” for its inherent disturbances and potential to deprive shorebirds of sustenance (Smith et al., 2019, p. 17) (emphasis added).

## Recommended Management Actions

To address the issues raised in this report, we recommend SCDNR commit to the following precautionary management actions.

### 1. Restrict the timing and manner of harvest practices.

Horseshoe crabs are harvested by hand during tidal events before they have an opportunity to spawn, potentially impeding reproduction of the species (Wenner et al., 2002). To mitigate these dangers, SCDNR studied alternative collection methods in the early 2000s. The resulting data cautioned against harvesting during the high tide (Wenner et al., 2002).

While enforcement challenges would preclude the effective implementation of hourly restrictions, the principle applies: To ensure continued spawning, SCDNR must enact a series of full-day closures to prevent the interception of the crabs before they arrive on spawning beaches.

Enacting five-day closures around the new and full moons of April, May and June, for instance, could yield significant conservation gains.<sup>5</sup> The success of such an approach, however, would require the closing of containment ponds, where crabs are held throughout summer.

Harvesting should furthermore be prohibited on *all*

known foraging red knot locations during the months of migration. State biologists have repeatedly called for the protection of crab eggs (SCDNR, 2013), the shielding of knots from human disturbance (SCDNR, 2012a), and the maintenance of inviolate habitats (Sanders et al., 2019). Without such measures, continued declines—in potential violation of the Endangered Species Act—are expected.

These foraging locations include, but are not limited to (see USFWS, 2021b, for additional locations):

- ACE Basin National Estuarine Research Reserve (various islands)
- Bay Point Island
- Bird Key-Stono
- Cape Romain National Wildlife Refuge
- Capers Island
- Daufuskie Island
- Deveaux Bank
- Fripp Island

<sup>5</sup> In Massachusetts, harvesting is prohibited on spawning beaches two days before the new and full moon and two days after, from April through June (2021 horseshoe crab lunar spawning closure dates, 2021).

- Harbor Island
- Hilton Head Island
- Seabrook Island
- Turtle Island Wildlife Management Area
- Tybee National Wildlife Refuge

Finally, crustacean researchers and shorebird biologists should collaboratively design a joint management framework focused on maintaining adequate spawns, providing undisturbed foraging for migratory birds and protecting additional priority roosting and nesting habitats. Publicly available records indicate that such collaboration has been lacking, with SCDNR researchers and biologists operating within their respective siloes and communicating little about these issues.

## 2. Explicitly articulate all relevant closures in the hand harvest permit.

Before the harvest season commences each year, SCDNR reissues saltwater fishing permits, articulating handling, transportation and return-to-water requirements. The permit generally covers a three-to-four-month window and must be renewed annually (SCDNR, 2019c).

The current permit explicitly notes closures within the ACE Basin National Estuarine Research Reserve but falls short of describing closures elsewhere (SCDNR, 2019c). Although SCDNR has the authority to list closures in the permit (SC Code § 50-5-1330, 2019), the onus is on harvesters to determine, on a property-by-property basis, which habitats are off-limits (SCDNR, 2019c). The practical effect is that few if any areas are considered restricted.

Federal land managers and nonprofits have advocated to no avail for explicit permit revisions (Hunt et al., 2020; Bell, 2014; Boyles, 2018). Nevertheless, we are persisting and encouraging the listing of *all* closed areas (national wildlife refuges, state parks, etc.), particularly those where poaching is known to occur.

We further suggest that harvest privileges be withheld from at least two poachers, whose names we can provide, to restore a sense of competitive equity for those operat-



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ing within the law. Doing so would foreclose poaching on at least three, and possibly more, properties.

Finally, in place of the permit's suggested handling practices, the vagueness of which precludes effective guidance (SCDNR, 2019c), the hand harvest permit should:

- Require the use of refrigerated trucks for transporting crabs, which are uniquely vulnerable to temperature-related impacts in South Carolina (Coates et al., 2012).
- Impose a 24-hour window in which to harvest, bleed and return crabs to water.
- Prohibit the handling of crabs by the telson.
- Mandate the marking of bled crabs to prevent recapture.

### 3. Create and implement a horseshoe crab-specific trawl survey.

By virtue of their passive, incidental nature, surveys used to assess horseshoe crab population trends in South Carolina are fundamentally limited (SCDNR 2015b) and of questionable reliability. None of SCDNR's surveys are designed solely for horseshoe crabs.

The ASMFC has long discounted coastwide trawl, dredge and other surveys of this kind, noting that while useful for general trends within specific areas, “each is complicated by factors that may bias the data, such as sampling error, inappropriate equipment or incomplete sampling effort” (ASMFC, 1998, p. 22).

Only one survey—the horseshoe crab-specific Virginia Tech trawl survey—has been considered fully reliable by the ASMFC (ASMFC, 2013; Niles et al., 2021), although it has yet to be replicated elsewhere.

In 2019, the ASMFC nonetheless developed a regional benchmark stock assessment utilizing state surveys of various methodologies. The ASMFC was unable to

estimate male-to-female ratios or determine the structure or spawning success of discrete populations in South Carolina (ASMFC, 2019). Despite these shortcomings, the ASMFC's assessment is used by industry to justify unregulated harvesting in South Carolina (Jordan, 2021), while anecdotal reports of declines are dismissed.

In place of these surveys, SCDNR should design its own horseshoe crab-specific survey, with support from university, state and nonprofit partners.

Robust egg monitoring programs should also be consistently implemented. Horseshoe crab egg densities offer a clear connection to recovery trends for crabs and birds alike, while providing a backstop against which to examine trawl surveys (i.e., trends in trawl survey results should be closely mirrored by egg densities [buried egg clusters and surface eggs]).

In the absence of such data, SCDNR cannot defensibly condone harvesting on the scale seen today.

### 4. Prohibit the use of horseshoe crab containment ponds.

Crabs harvested from the Beaufort area are often deposited in earthen containment ponds, where they are stored for later bleeding. Unique to South Carolina, the practice deprives shorebirds of eggs, with crabs often stored for the entire summer when they would otherwise be spawning on beaches (SCDNR, 2020b).<sup>6</sup>

With numerous operators (Bell, 2015), containment ponds can encompass nearly 50 acres, holding anywhere from 10,000 to 15,000 crabs, according to Charles River (Egger, 2021).

SCDNR does not limit the number of crabs held in ponds or the duration held (SCDNR, 2020b). Crabs are not fed during detention, nor are specific habitat conditions required of operators (SCDNR, 2020b). Every year, thousands spawn in vain and die, trapped in the unsanitary, overcrowded conditions (Hamilton et al., 2019).

Because females produce upwards of 80,000 eggs per season (Taft, 2016), *billions* of eggs can be lost in ponds, endangering the long-term survival of the species.

Twenty years ago, roughly 10% of harvested crabs were held in containment ponds (Wenner et al., 2002). Today,



Horseshoe crabs waiting to be bled are held in containment ponds like this, a practice only South Carolina permits.

<sup>6</sup> In January 2022, Defenders of Wildlife and the South Carolina Coastal Conservation League, represented by the Southern Environmental Law Center, sued SCDNR and Charles River Laboratories for violating the Endangered Species Act over the practice of detaining horseshoe crabs in containment ponds.



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the majority of crabs are detained, with 75% of all harvested crabs held before bleeding (Kingsley-Smith, 2017).

Only South Carolina allows such plainly unsustainable

practices, and SCDNR should forgo possession permits and instead require that harvesters transport crabs for bleeding *immediately* after removal.

## 5. Sever financial ties with Charles River Laboratories.

By leasing Morgan Island, a SCDNR-managed property, to Charles River, in exchange for as much as 20% of the horseshoe crab division's revenue (Eisner, 2021a), an incentive exists to allow unregulated harvesting in South Carolina. SCDNR is expected to receive roughly \$1.5 million from Charles River in 2022 alone, with continued options for renewal (Beaufort County, South Carolina, 2017)

Charles River has further ingratiated itself with SCDNR by paying for research, sponsoring NGO conservation events (Eisner, 2022) and funding the agency's educational partners—including the South Carolina Aquarium (Thill, 2017).

Presumably for these reasons, the “horseshoe crab fishery in South Carolina is [considered] a sensitive one” (Kingsley-Smith, 2017, p. 1) that stands apart as uniquely politicized, according to SCDNR researchers (Kingsley-Smith, 2017, p. 1). New SCDNR staff are

told to “keep at the front of your mind” internal political dynamics before unfavorably describing biomedical operations (Kingsley-Smith, 2017, p. 1). Implicitly, public acknowledgements of declines are prohibited. Public management decisions are also potentially influenced through corporate offers of cash resources (Eisner, 2022; Flynn, 2021).

SCDNR cannot manage the horseshoe crab fishery in the public interest if it is financially entangled with the industry it is charged with regulating. To address the appearance, if not reality, of impropriety, SCDNR must forego all financial ties (leases, research funding, sponsorships, etc.) with Charles River and pursue funding for the Marine Resources Division through other public mechanisms. Management proposals submitted by Charles River to SCDNR should also be disclosed for public comment in a manner that solicits and welcomes public input.

## Conclusion: Commit to Recovery

**O**n average, shorebird populations have shrunk by an estimated 70% across North America in the past 50 years, with Arctic-breeding species the most severely diminished (Munro, 2017). Among these species is the rufa red knot, a bird once considered abundantly common in the Lowcountry (Bent, 1928). That abundance, according to USFWS, “remains depleted” (2021c, p. 24).

South Carolina nonetheless remains a critically important stopover. While the management suggestions offered in this report are not exhaustive, they could slow the continued degradation of this vital habitat.

To that end, SCDNR’s leadership must impose *enforceable* management restrictions and faithfully enforce

them, depoliticize and implement staff suggestions, engage the public in management decisions and uphold legal protections, while establishing distance between the agency and industry.

Most fundamental to this effort is the reconciling of nearly unregulated harvesting and shorebird conservation. By fighting for both, SCDNR staff are burdened with incompatible management goals, the tension of which is manifested on the most studied and high priority habitats.

Without these interventions, the red knot and horseshoe crab are likely to continue their decline, undermining South Carolina’s conservation legacy.



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