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## Protecting Beaches from Bites: Shark Management Programs in New England

Grayson P. Szczepaniak  
*University of Maine School of Law*

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# PROTECTING BEACHES FROM BITES: SHARK MANAGEMENT PROGRAMS IN NEW ENGLAND

*Grayson P. Szczepaniak\**

ABSTRACT

INTRODUCTION

I. BACKGROUND

II. THE CONNECTION BETWEEN PUBLIC PERCEPTION AND LEGISLATIVE  
RESPONSE

*A. The Evolution of Society's Perceptions*

*B. The Role of the Media*

*C. The Legislative Response*

III. CONTROL STRATEGIES

*A. Shark Culling*

*B. Meshing*

*C. Baited Drumlines*

*D. Electromagnetic Interference*

*E. Volunteer and Other Control Measures*

IV. IMPLEMENTING SHARK MANAGEMENT POLICIES

V. NEXT STEPS: POLICY RECOMMENDATIONS FOR NEW ENGLAND

CONCLUSION

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\* J.D. Candidate, Class of 2022, University of Maine School of Law; B.S. Marine Biology 2017, University of New England.

## ABSTRACT

*With shark encounters on the rise along the New England coast, state officials have the perfect opportunity to implement the United States' first large-scale shark management program similar to that enacted in KwaZulu-Natal, South Africa. Management programs are comprised of control measures that prevent sharks from swimming too close to beachgoers, and thus reduce the number of human-shark interactions. Sharks have long been portrayed by the media as man-eating monsters, and this negative image is deeply intertwined with lethal control measures taken by local governments in response to shark bites. However, such lethal action can cause a decrease in shark populations which can be detrimental to the delicate ocean ecosystem. This comment seeks to utilize available scientific research to recommend a viable shark control program to be implemented via state legislation. This comment culminates in the recommendation that New England states should establish a shark council comprised of various stakeholders with two central goals: (1) to research and implement the SharkSafe Barrier™, an electromagnetic deterrence mechanism, on public beaches; and (2) enact a public education campaign focused on the conservation of sharks in the hopes of changing the public narrative surrounding sharks.*

## INTRODUCTION

In July 2020, Maine experienced its first-ever fatal shark attack.<sup>1</sup> Such encounters are extremely rare; since 1837, Massachusetts has recorded only six unprovoked shark bites, and New Hampshire has recorded none.<sup>2</sup> Including this tragic event, Maine now has two.<sup>3</sup> Although such up-close encounters are uncommon, shark sightings have been increasing off the coast of New England in recent years.<sup>4</sup> Understandably, locals and tourists alike are more apprehensive about going in the water,<sup>5</sup> but this apprehension stems from a long history of negative and inaccurate portrayals of sharks. These negative perceptions hinder the implementation of shark control measures that will protect beachgoers without diminishing current shark populations.

This comment utilizes available scientific research to propose shark management strategies for New England beaches and corresponding implementation legislation. Part I will provide a background on sharks and their prevalence in New England. Part II will then explore the evolution of society's perceptions of sharks from the 1900s until now, followed by an analysis of why a positive public perception is vital to informing actions taken by legislatures. Part III will then provide a short survey of feasible control measures, and Part IV will discuss the various policy mechanisms for implementing such control measures. This paper will culminate in a recommendation that New England states form an interstate council dedicated to shark education and policy, with the ultimate goal of researching and implementing the SharkSafe Barrier™ to protect New England beaches most susceptible to shark encounters.

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1. Kathryn Miles, *Shark Attacks in Maine were Unthinkable – Until Last Summer*, DOWNEAST MAGAZINE (June 2021), <https://downeast.com/land-wildlife/shark-attacks-in-maine-were-unthinkable-until-last-summer/> [<https://perma.cc/D6F5-5YSU>].

2. International Shark Attack File, *United States: Confirmed Unprovoked Shark Attacks (1837 - Present)*, FLORIDA MUSEUM OF NATURAL HISTORY, <https://www.florida-museum.ufl.edu/shark-attacks/maps/na/usa/usa-all/> [<https://perma.cc/6ERQ-GBRG>] (last visited Feb. 20, 2022).

3. *Id.*

4. See, e.g., Caitlyn Francis & Andrew Masse, *Scientists Seeing an Increase in Shark Sightings off the New England Coast*, WFSB (July 13, 2021), <https://ktvz.com/cnn-regional/2021/07/13/scientists-seeing-an-increase-in-shark-sightings-off-the-new-england-coast/> [<https://perma.cc/E7EK-Y2V7>].

5. See, e.g., Mike Beaudet, *With No Signs of Sharks Abating, Frustration Continues Over Massachusetts Response*, WCVB (Sept. 30, 2021), <https://www.wcvb.com/article/frustration-massachusetts-response-to-sharks-ocearch-cape-cod-ocean-community/37810765> [<https://perma.cc/N7NR-UYQY>].

## I. BACKGROUND

Sharks have been present on Earth for over 450 million years,<sup>6</sup> meaning they have been resilient enough to survive multiple mass extinctions.<sup>7</sup> Although their ancestry can be traced back further, sharks as we see them today, with “torpedo-shaped bodies, forked tails, and dorsal fins,”<sup>8</sup> appeared about 380 million years ago, and their mighty jaws evolved about 195 million years ago.<sup>9</sup> Throughout their evolution, changes in average shark size coincided with mass extinction events such as the large asteroid strike at the end of the Cretaceous period.<sup>10</sup> Following that extinction event, shark species began to branch off, giving us the diverse array of species present in the ocean today.<sup>11</sup>

At one time, sharks existed in large numbers because they sit at the top of the food chain with very few natural predators.<sup>12</sup> The greatest threat to their existence today is humans. As a result of targeted culling campaigns, shark finning, and fisheries bycatch, shark population numbers have dwindled over the years.<sup>13</sup> These practices have led the International Union for Conservation and Nature (IUCN) to designate seventy-nine shark species as “threatened,”<sup>14</sup> including the great white shark. Human interference continues to threaten shark populations despite scientific research that shows sharks are vital to a healthy ecosystem.

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6. Josh Davis, *Shark Evolution: A 450 Million Year Timeline*, NAT. HIST. MUSEUM, <https://www.nhm.ac.uk/discover/shark-evolution-a-450-million-year-timeline.html> [<https://perma.cc/U96R-U6CT>] (last visited Mar. 6, 2022).

7. Lucas Joel, *The Secrets of how Sharks Survived so Many of Earth's Mass Extinctions*, NEW SCIENTIST (June 26, 2019), <https://www.newscientist.com/article/mg24232360-900-the-secrets-of-how-sharks-survived-so-many-of-earths-mass-extinctions/> [<https://perma.cc/L8NC-ZG7R>].

8. Davis, *supra* note 6.

9. *Id.*

10. *Id.*

11. *Id.*

12. E. GRIFFIN ET AL., OCEANA, PREDATORS AS PREY: WHY HEALTHY OCEANS NEED SHARKS 1 (July 2008); *see also* Ed Yong, *The Predator that Makes Sharks Flee in Fear*, THE ATLANTIC (April 19, 2019), <https://www.theatlantic.com/science/archive/2019/04/great-white-sharks-flee-killer-whales/587563/> [<https://perma.cc/RS93-U54A>]. Aside from other shark species, sharks only fear certain whale species.

13. E. GRIFFIN ET AL., *supra* note 12, at 5 (“Surveys show that the abundance of the 11 great sharks (sharks more than two meters in length) along the eastern coast of the United States has declined to levels of functional elimination.”).

14. Shark Specialist Group, *Frequently Asked Questions: Sharks, Rays, and Chimaeras*, IUCN, <https://www.iucnssg.org/faqs.html> [<https://perma.cc/32SY-C5GG>] (last visited Mar. 6, 2022).

The urgency behind shark conservation is driven by the drastic changes in the ocean ecosystem that result from a decline in the populations of apex predators, such as an abundance of prey, the collapse of fisheries, and changes to feeding patterns of other species.<sup>15</sup> For example, one study suggested that a decline in large shark populations led to the collapse of the North Carolina scallop fishery in 2004.<sup>16</sup> Without top predators, mid-level predators, specifically cownose rays, increased dramatically and depleted the scallop stock to a point where the fishery had to be shut down.<sup>17</sup> This example illustrates the vital role sharks play in the trophic system, as commercial fisheries are clearly subject to indirect impacts resulting from dwindling shark populations that may ultimately lead to their failure if not abated. Such failure would be detrimental to New England, where commercial fisheries are a valuable source of revenue and economic prosperity.<sup>18</sup>

Another study from 2019 looked at the decline of the great white shark population at Seal Island in South Africa, which “coincided with the unprecedented appearance of sevengill sharks” in the area.<sup>19</sup> Although they are not yet certain, researchers hypothesized that the absence of great white sharks led to “reduced competition for shared prey and as well as lowered predation,”<sup>20</sup> as both species eat seals, and white sharks are one of the few natural predators of sevengill sharks.<sup>21</sup> As demonstrated by this population shift at Seal Island, changes in biodiversity are likely to occur when there is a decline in apex predators.

In response to declining shark numbers, and to take action to protect ocean ecosystems, various tactics have been adopted on an international level to protect sharks. Numerous countries, including the United States, have enacted bans on shark finning.<sup>22</sup> As a result of these bans, many

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15. E. GRIFFIN ET AL., *supra* note 12, at 5, 8.

16. Ransom A. Myers et al., *Cascading Effects of the Loss of Apex Predatory Sharks from a Coastal Ocean*, 315 *Science* 1846, 1848-50 (2007).

17. *Id.*

18. See generally *Northeast Socioeconomic Data Products*, NOAA FISHERIES, <https://www.fisheries.noaa.gov/new-england-mid-atlantic/socioeconomics/northeast-socioeconomic-data-products> [<https://perma.cc/J6A8-H7YF>] (last visited Feb. 20, 2022).

19. Neil Hammerschlag et al., *Disappearance of White Sharks Leads to the Novel Emergence of an Allopatric Apex Predator, the Sevengill Shark*, 9 *SCI. REP.* 1, 1 (2019).

20. *Id.* at 4.

21. *Notorynchus cepedianus*, FLA. MUSEUM OF NAT. HIST., <https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/notorynchus-cepedianus/> [<https://perma.cc/AS4K-XDMD>] (last visited Apr. 26, 2021). Aside from cannibalism within the species, the only other predators of sevengill sharks are large sharks. *Id.*

22. *International Shark Finning Bans and Policies*, ANIMAL WELFARE INSTITUTE, <https://awionline.org/content/international-shark-finning-bans-and-policies>

companies have stopped transporting and selling fins altogether, and restaurants have taken shark fin soup off their menus permanently.<sup>23</sup> Beyond these, new measures of protection are constantly being explored. For example, in 2019, new protections for eighteen threatened species of sharks and rays were passed at the Convention on International Trade in Endangered Species (CITES).<sup>24</sup>

Protections for species other than sharks have also had an indirect impact on shark populations. For example, in 1972, the Marine Mammal Protection Act<sup>25</sup> was passed by the United States Congress, making “it illegal to harass, feed, hunt, capture, or kill any marine mammal,”<sup>26</sup> including seals. Since the passage of the Act, seal populations have rebounded and are found in abundance, especially in the Northwest Atlantic Ocean.<sup>27</sup> Because seals are a staple in the diet of the great white shark,<sup>28</sup> scientists have hypothesized that the increase in seal populations is correlated with the increase in the great white shark population off the coast of New England.<sup>29</sup> Many locals have called for the removal of seals through a cull, or massive slaughter, to control the shark population; however, researchers claim such dire action is unnecessary as the seal populations will eventually stabilize as a result of “[d]isease, predation . . .

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[<https://perma.cc/YZ6W-9RRL>] (last visited Apr. 26, 2021). Shark finning is the practice of cutting the fins off live sharks and throwing the shark back into the water, leaving it to drown because it is unable to swim. The fins are then sold for use in shark fin soup, a popular delicacy in Chinese culture. Katy Fairclough, *Shark Finning: Sharks Turned Prey*, SMITHSONIAN (August 2013), <https://ocean.si.edu/ocean-life/sharks-rays/shark-finning-sharks-turned-prey> [<https://perma.cc/S4YK-56QH>].

23. Fairclough, *supra* note 22.

24. *Sharks and Rays to be Given New International Protections*, BBC News (Aug. 25, 2019), <https://www.bbc.com/news/world-49466717> [<https://perma.cc/SZV7-KDAR>].

25. 16 U.S.C. § 1361 (1972).

26. *Marine Animals and the Marine Mammal Protection Act*, THE MARINE MAMMAL CENTER, <https://www.marinemammalcenter.org/marine-mammal-protection-act> [<https://perma.cc/VT5V-SEW9>] (last visited Apr. 26, 2021).

27. Patrick Whittle & Michael Casey, *Conservation Success or Pests? Seals Spark Passionate Debate*, ABC NEWS (Oct. 5, 2020, 10:09 AM), <https://abcnews.go.com/Technology/wireStory/conservation-success-pests-seals-spark-passionate-debate-73424513> [<https://perma.cc/X5T9-M4TG>].

28. *Sharks in Atlantic Coastal Waters*, NOAA FISHERIES, <https://www.fisheries.noaa.gov/national/atlantic-highly-migratory-species/sharks-atlantic-coastal-waters> [<https://perma.cc/HMG2-HW9A>] (last visited Apr. 26, 2021).

29. Doug Fraser, *Sharks and Seals: A Success Story on Cape Cod*, CAPE COD TIMES (June 29, 2019, 6:39 PM), <https://www.capecodtimes.com/story/news/local/2019/06/29/sharks-seals-success-story-on/4790264007/> [<https://perma.cc/ZRS8-CGMS>].

and limited food availability.”<sup>30</sup> Further, similar to the studies mentioned above, “[s]eals play important roles in the coastal ecosystem, and their large numbers are a sign of a healthy environment.”<sup>31</sup> Therefore, intentionally manipulating the trophic system could have detrimental effects on biodiversity across multiple species.

The rebounding seal population has been described as “both a conservation success story and an emerging public safety concern,”<sup>32</sup> as the increase in great white shark populations in the Atlantic Ocean is likely a result of the abundance of prey. However, scientists have been unable to point to a definitive cause and have other hypotheses as well.<sup>33</sup> In addition to the increasing seal population, warmer ocean waters could be playing a role. Previously, it was not uncommon for great whites’ migration patterns to extend all the way up to Nova Scotia.<sup>34</sup> Inconsistent with prior patterns, however, is that the same sharks are spending more time in these areas, most likely due to warming waters as a result of climate change.<sup>35</sup> Sharks are ectothermic creatures, meaning they cannot generate their own body heat.<sup>36</sup> Thus, as waters closer to the poles warm, new areas are reaching an acceptable temperature for habitation and migration patterns are changing as a result.

As great white shark populations continue to rise, an increase in human-shark interactions is inevitable. In addition, the changes in their migration patterns will result in human-shark interactions in areas which have historically not had shark concerns. After Maine’s most recent shark fatality, residents were sent into various stages of caution and panic.<sup>37</sup>

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30. Sophie Ruehr, *Culling Seals is Wrong Answer to Shark Threat, Scientists Say*, THE PROVINCETOWN INDEPENDENT (Aug. 23, 2019), <https://provincetownindependent.org/top-stories/2019/08/23/culling-seals-is-wrong-answer-to-shark-threat-say-scientists/> [<https://perma.cc/W6NP-EBVW>].

31. *Id.*

32. Ret Talbot, *Great White Sharks Have Returned to New England*, NAT’L GEOGRAPHIC (July 29, 2020), <https://www.nationalgeographic.com/animals/article/maine-shark-attack-public-safety-issue-conservation-success> [<https://perma.cc/FS5V-VS9C>].

33. *See, e.g.*, Paul Withers, *Why More Great White Sharks are Showing up in Atlantic Canada*, CBC (July 8, 2020 6:00 AM), <https://www.cbc.ca/news/canada/nova-scotia/great-white-sharks-atlantic-canada-1.5641078> [<https://perma.cc/9GR6-VWEL>].

34. Sarah Gibbens, *New Englanders May Soon See More Great White Sharks*, NAT’L GEOGRAPHIC (Dec. 6, 2017), <https://www.nationalgeographic.com/news/2017/12/great-white-shark-populations-rising-maine-new-england-spd/> [<https://perma.cc/E9ED-ZJ24>].

35. *Id.*

36. R.A. Skubel et al., *Patterns of Long-Term Climate Variability and Predation Rates by a Marine Apex Predator, the White Shark *Carcharodon Carcharias**, 587 *Marine Ecology Progress Series* 129, 130 (2018).

37. Reuben Schafir & Edward D. Murphy, *Fatal Shark Attack Shakes Sense of Security Along Maine Coast*, PORTLAND PRESS HERALD (August 2, 2020),

News outlets were regularly reporting shark sightings off the coasts of Maine and Massachusetts.<sup>38</sup> As summer turned into fall and less people were spending time on the water, the reports died down and the excitement faded. However, it is likely that both Maine and Massachusetts will continue seeing sharks, and more frequently, in the coming years. Therefore, government action is necessary to prevent further offshore encounters and help beachgoers feel safe going in the water. New England states have a unique opportunity to learn from management systems currently being utilized by other countries and to make informed decisions to implement shark-human interaction measures, and further, to be the first states to implement such measures in the United States. But first, the public perception must be shifted to a more favorable view of sharks to elicit a positive response from legislatures and other policy-makers.

## II. THE CONNECTION BETWEEN PUBLIC PERCEPTION AND LEGISLATIVE RESPONSE

The general public's perception of sharks is closely associated with public policies implemented to protect beaches, and therefore it is a crucial consideration in determining which control strategies will be most effective. As shark bite incidents were on the rise in the 1900s, so were public panic and uneasiness about swimming at beaches. This called for local governments to take action to protect its beaches, usually in the form of shark culls or other lethal strategies. However, in recent years, the public has been exposed to ocean conservation campaigns, including ones aimed at protecting sharks. This increase in knowledge has led to a deeper understanding of sharks and a pushback against lethal methods of shark management.

### *A. The Evolution of Society's Perceptions*

Prior to the 1900s, people generally knew little about sharks and very few were concerned with the possibility of confronting one in the water.<sup>39</sup> Early in the twentieth century, however, swimming slowly became a popular recreational activity and "the average bather knew or cared little about sharks and the tales became accepted as simply sailors' lore and

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<https://www.pressherald.com/2020/08/02/fatal-shark-attack-shakes-sense-of-security-along-maine-coast/> [<https://perma.cc/G9RQ-Z3T5>].

38. See, e.g., Francis & Masse, *supra* note 4.

39. Beryl Francis, *Before and After "Jaws": Changing Representations of Shark Attacks*, 34 THE GREAT CIRCLE 44, 45 (2012).

legends.”<sup>40</sup> However, just a few generations later, sharks were thrust into the spotlight, ultimately becoming the stars of a sub-genre of movies and receiving an entire week of television programming dedicated only to them. Despite the fact that there is only a slim probability of ever seeing a shark in the wild when going to the beach, the public has become paranoid of attacks. How could a public so enamored by these giant fish still be so frightened of the slim possibility of seeing one in the wild? For over 100 years, the media has been depicting sharks as ruthless, man-eating monsters, leaving beachgoers with the lingering fear that something unseen may be lurking below the surface.

For a long time, it was widely believed that sharks did not attack people. In 1916, the United States experienced a travesty when four people were killed in a span of two weeks off the coast of New Jersey.<sup>41</sup> Even then, many people refused to believe that a shark could have been the culprit.<sup>42</sup> We now know otherwise, but this event spawned the first stage of a cycle that would later become a pattern after shark encounters: “fear, followed by denial, followed by revenge, and then followed by some rational or scientific approach to the problem.”<sup>43</sup> Newspapers “headlined the terror of the shark attacks across their front pages, spreading hysteria and fear.”<sup>44</sup> The public responded by issuing a bounty on the shark responsible for the deaths and President Woodrow Wilson organized a “war on sharks.”<sup>45</sup> The excitement was not long-lived, however, and within a year sharks were no longer on peoples’ minds.<sup>46</sup>

Then, in the 1920s, surfing became popular in Australia. As the number of people in the water increased, so did the number of shark encounters.<sup>47</sup> When four fatal bites occurred in the span of four years along a one-mile stretch of beach, Australia’s public had a similar response to that of the United States.<sup>48</sup> But, instead of waiting for the excitement to fade, Australian authorities took action to protect and ease the fear of its

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40. *Id.*

41. Vivian McCall, *How America’s First Shark Panic Spurred a Century of Fear*, NAT’L GEOGRAPHIC (June 12, 2019), <https://www.nationalgeographic.com/news/2015/07/150702-shark-attack-jersey-shore-1916-great-white/> [https://perma.cc/6EPF-2WWA].

42. *Id.*

43. *Id.*

44. Francis, *supra* note 39, at 46.

45. Christopher Klein, *The Real-Life “Jaws” that Terrorized the Jersey Shore*, HISTORY (last updated Sept. 1, 2018), <https://www.history.com/news/the-real-life-jaws-that-terrorized-the-jersey-shore> [https://perma.cc/Z7A4-JETC].

46. Francis, *supra* note 39, at 46.

47. *Id.*

48. *Id.*

residents by implementing the first-ever protective measures, including look-out towers, surf lifesaving clubs, shark watches, and alarm bells.<sup>49</sup> However, this was not enough to prevent attacks and the government took further action, signaling the first implementation of a meshing system (which will be more fully discussed below in Part IV of this comment) off of New South Wales beaches.<sup>50</sup>

Although these attacks brought sharks to the public's attention, many remained unafraid and continued going in the water. That is, until *Jaws* was released in 1975, serving as a catalyst for the modern perception of sharks. Based on Peter Benchley's novel inspired by the 1916 New Jersey attacks, the film followed a small beach town's experience with a rogue shark.<sup>51</sup> The immediate response was overwhelming terror and captivation as "[c]inemas everywhere had audiences in thrall at the thought of an oversized great white shark with a bad attitude coming to a beach near you."<sup>52</sup> Shark fishing tournaments became popular, which contributed to the decline of shark populations<sup>53</sup> and were justified by sentiments that "the same shark might be responsible for more than one incident and return to harm beachgoers,"<sup>54</sup> as was the situation in *Jaws*.

The idea that the same shark may be responsible for multiple incidents stems from the "rogue shark theory," initially put forth by researchers in the mid-1900s.<sup>55</sup> A "rogue shark" refers to an individual shark that consciously hunts humans as part of its diet.<sup>56</sup> The theory formed because places that were usually free from shark attacks had suddenly become "the scene of two, three, or even more attacks within a short interval and within distances varying from no more than a few hundred meters to [fifteen]

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49. *Id.*

50. *Id.*

51. *JAWS* (Universal Pictures 1975).

52. *How Jaws Misrepresented the Great White*, BBC NEWS (June 8, 2015), <https://www.bbc.com/news/magazine-33049099> [<https://perma.cc/C5XD-RM8T>].

53. Francis, *supra* note 39, at 47-48.

54. Christopher L. Pepin-Neff & Thomas Wynter, *Reducing Fear to Influence Policy Preferences: An Experiment with Sharks and Beach Safety*, 88 MARINE POL'Y 222, 222 (2018).

55. See, e.g. Tyler Rudick, "Jaws" of Controversy: The "One Rogue Man-Eating Shark" Theory Doesn't Hold Water, Expert Says, CULTURE MAP HOUS. (Oct. 29, 2011, 11:30 AM), <https://houston.culturemap.com/news/travel/10-29-11-man-eating-shark-theory-doesnt-hold-water-jaws/#slide=0> [<https://perma.cc/TS7G-7E4Z>].

56. Eric E.G. Clua, et al., *Selective Removal of Problem Individuals as an Environmentally Responsible Approach for Managing Shark Bites on Humans*, 194 OCEAN AND COASTAL MANAGEMENT 1, 2 (2020).

kilometers.”<sup>57</sup> However, the rogue shark theory gained little traction among mainstream scientists and was refuted by later research.<sup>58</sup> Occasions where one shark is responsible for a cluster of attacks still exist, but are credited to food deprivation as opposed to the desire for human flesh.<sup>59</sup> Thanks to an evolution in shark research, most shark bites are attributed to the shark’s curiosity, territoriality, or cases of mistaken identity (in which sharks mistake humans for seals or sometimes sea turtles).<sup>60</sup>

Since the release of *Jaws*, sharks have become regulars on the big and small screens, perpetuating the rogue shark stereotype that leaves viewers both terrified and curious.<sup>61</sup> An entire sub-genre of movies has emerged with sharks at the center of them, produced by major cinema companies as well as television networks such as Syfy.<sup>62</sup> Films released in theaters are often box-office hits that bring in major money while targeting humans’ irrational fears.<sup>63</sup> The “bad shark films” are usually released directly to television yet have a cult following.<sup>64</sup> While the bad acting and horrible CGI renderings are part of the joke, the popularity of these films stems from the fact that “sharks are an increasingly large part of popular culture in general.”<sup>65</sup>

The Discovery Channel took advantage of this media sensation and, in 1988, launched its first iteration of Shark Week. The station saw an opportunity to capitalize on humans’ fascination with these potentially aggressive animals, recognizing that “[h]umans love animals, and humans

57. Victor Coppelson & Peter Goadby, *SHARK ATTACK: HOW, WHY, WHEN & WHERE SHARKS ATTACK HUMANS* 67 (1988).

58. Melissa Cristina Márquez, *Why Everything You ‘Know’ About ‘Rogue Sharks’ is a Lie*, FORBES (Oct. 13, 2018, 8:26 PM), <https://www.forbes.com/sites/melissacristinamarquez/2018/10/13/why-everything-you-know-about-rogue-sharks-is-a-lie> [<https://perma.cc/9A3G-ZF6K>].

59. *Id.*

60. International Shark Attack File, *How, Where, & When Sharks Attack*, FLORIDA MUSEUM, <https://www.floridamuseum.ufl.edu/shark-attacks/odds/how-where-when/> (last updated July 19, 2021) [<https://perma.cc/F99T-3ACD>].

61. *See, e.g., Best Shark Movies (and Worst) Ranked by Tomatometer*, ROTTEN TOMATOES, <https://editorial.rottentomatoes.com/guide/best-shark-movies-ranked-by-tomatometer/> [<https://perma.cc/EVP6-WPYV>] (last visited Apr. 17, 2022).

62. *Id.*

63. Brandon Katz, *Why Shark Movies are Such Reliable Box Office Bets: A Deep Dive*, OBSERVER (July 6, 2019), <https://observer.com/2019/07/shark-movies-box-office-the-meg-the-shallows-47-meters-down-jaws/> [<https://perma.cc/RSB6-PWBJ>].

64. David Shiffman, *Sharknado and Sharktopus and Megalodon, Oh My!*, SCUBA DIVING (Aug. 23, 2019), <https://www.scubadiving.com/rise-of-the-bad-shark-movie> [<https://perma.cc/Y749-E4PW>].

65. *Id.*

love being scared, so potentially scary animals are popular.”<sup>66</sup> It initially started with only ten programs in the lineup, but today there is enough material to cover the span of an entire week and more.<sup>67</sup> Although Shark Week satisfies the public’s curiosity about sharks, it has been characterized as “a million-dollar marketing ploy masquerading as educational programming.”<sup>68</sup> Despite active efforts to promote conservation and correct misconceptions of sharks, Shark Week has taken on heavy criticism from shark scientists and conservationists alike, arguing that it “perpetuates fear and misunderstanding.”<sup>69</sup> This perception is evidenced in the evolution of Shark Week programming. The first ever Shark Week special, *Caged in Fear*, “explored the science of creating and testing motorized shark cages,”<sup>70</sup> clearly focusing on the efforts that scientists go through to study these elusive creatures. Arguably, Shark Week peaked when it premiered *Air Jaws*, a program devoted to successfully capturing a great white shark breaching from the water for the first time.<sup>71</sup> *Air Jaws* and subsequent spinoffs have been immensely successful, capturing some of the most incredible available footage of great white sharks leaping from the water and garnering respect for these graceful, powerful predators from viewers.

Unfortunately, not all Shark Week programming receives the same positive response. During Shark Week in 2013, the Discovery Channel aired *Megalodon: The Monster Shark Lives*, a mockumentary that speculated the continued existence of a seventy-foot shark closely related to great whites. While it is a well-known fact that the megalodon has long been extinct, many viewers of the mockumentary missed that memo, and the Discovery Channel received much criticism for airing the fictitious

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66. *Id.*

67. Matt Cohen, *The History of Shark Week: How the Discovery Channel Both Elevated and Degraded Sharks*, THE WEEK (Aug. 14, 2014), <https://theweek.com/articles/444542/history-shark-week-how-discovery-channel-both-elevated-degraded-sharks> [<https://perma.cc/Q9HQ-K3CL>].

68. Sarah Kaplan, *Shark Week is a Sham, but Sharks are Still Super Cool*, WASH. POST (July 26, 2017, 8:00 AM), <https://www.washingtonpost.com/news/speaking-of-science/wp/2017/07/26/shark-week-is-a-sham-but-sharks-are-still-super-cool/> [<https://perma.cc/6LCG-36VV>].

69. Cohen, *supra* note 67.

70. *Id.*

71. Alexis C. Madrigal, *The Physics of Great White Sharks Leaping Out of the Water to Catch Seals*, THE ATL. (Dec. 9, 2011), <https://www.theatlantic.com/technology/archive/2011/12/the-physics-of-great-white-sharks-leaping-out-of-the-water-to-catch-seals/249799/> [<https://perma.cc/G222-EYSH>] (explaining that “Breaching” occurs when a shark ambushes its prey by attacking from below at an incredible speed and subsequently launches itself out of the water).

narrative instead of the usual science-based material.<sup>72</sup> Since then, additional phony programs have been aired misrepresenting sharks, including other fantasy-based specials and numerous episodes that emphasize the fear factor of sharks.<sup>73</sup>

Public perceptions of sharks have gone through an immense evolution, from the ignorant bliss of the 1900s to the fear-based narrative that exists today. Despite the attention sharks have garnered and curiosity they have inspired, the negative image of sharks is perpetuated by damaging representation in the media. Media representation of sharks must be altered to elicit a positive, conservation-based response.

### *B. The Role of the Media*

The media takes a large part in influencing our day-to-day lives because it “not only plays a powerful, intermediary role in communicating facts, ideas, and concepts between policy makers, scientists, and the public, [but] it can also reflect current cultural and political paradigms.”<sup>74</sup> This combination of factual and cultural aspects allows consumers to view the media as a credible informer.<sup>75</sup> Although people view the media as reliable, it is still possible that people could be exposed to inaccurate portrayals with various consequences to public perception.<sup>76</sup>

For decades, sharks have been the victims of highly inaccurate portrayals through grisly accounts of human encounters with them that serve as top news stories, which leads individuals to believe that shark bites are extremely common.<sup>77</sup> This fear-based discourse is achieved by targeting the emotions of consumers<sup>78</sup> through the utilization of “alarmist imagery”<sup>79</sup> to scare us and target our curiosity. For example, recent attack

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72. Alexander Abad-Santos, *Shark Week Fans Furious at Discovery Channel for Megalodon Mockumentary*, THE ATL. (Aug. 6, 2013), <https://www.theatlantic.com/culture/archive/2013/08/shark-week-fans-deserve-better-what-discovery-feeding-them/312471/> [https://perma.cc/9QYC-L9WX].

73. *Id.*

74. Christine McCagh et al., *Killing Sharks: The Media’s Role in Public and Political Response to Fatal Human-Shark Interactions*, 62 MARINE POL’Y 271, 272 (2015).

75. Yarviv Tsafiti & Johnathon Cohen, *The Third-Person Effect, Trust in Media, and Hostile Media Perceptions*, 1 THE INT’L ENCYCLOPEDIA OF MEDIA STUDIES: MEDIA EFFECTS/MEDIA PSYCH. 1, 2 (2013).

76. *Id.* at 3.

77. Serena Lucrezi et al., *A Test of Causative and Moderator Effects in Human Perceptions of Sharks, Their Control, and Framing*, 109 MARINE POL’Y 1, 2 (2019).

78. *Id.*

79. McCagh, *supra* note 74, at 272; see also David Ropeik, *If it Scares, it Airts: How Alarmist News Coverage Does Real Harm*, BIG THINK (April 29, 2015),

headlines have included “Witnesses to Harpswell Shark Attack Heard Laughter, then Screams,”<sup>80</sup> and “Diver Savaged to Death by Shark as Wife Tried to Save Him but Gave up When ‘His Eyes were Open but He was Unresponsive.’”<sup>81</sup> The use of alarmist imagery in news reports puts the media and subsequent public reaction at odds with scientists and environmentalists pushing for a conservationist approach to shark control measures.

Some researchers argue that the phrase “shark attack” is inherently negative and constitutes criminalization of sharks, and therefore, should not be utilized to describe human-shark interactions.<sup>82</sup> Not only is the phrase used to describe actual shark-bite incidents, but it is also used to describe interactions that do not involve any contact with sharks such as when a shark inadvertently collides with a kayak on the ocean.<sup>83</sup> Further, the word “attack” implies motivation and intentionality on the part of the shark, providing “an exaggerated account of the real frequency of shark encounters.”<sup>84</sup> However, humans are not a part of sharks’ natural diet and, as noted above, theories of “rogue sharks” have been consistently disproved.<sup>85</sup> Despite the firm science, “personifying [sharks] as villains with human characteristics”<sup>86</sup> perpetuates the *Jaws*-era stereotype.

Media outlets should shift away from “alarmist imagery” and instead utilize language that more accurately reflects the nature of shark-human

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<https://bigthink.com/risk-reason-and-reality/if-it-scares-it-airs-the-risk-of-alarmist-news-coverage-of-risk> [<https://perma.cc/DLS7-WDEZ>] (“We have been frightened by an ‘If it Scares It Airls’ news media into a number of fears that are now completely accepted as truth, but which are unwarranted by the evidence, and public and environmental health are suffering as a result.”).

80. Christopher Burns, *Witnesses to Harpswell Shark Attack Heard Laughter, then Screams*, BANGOR DAILY NEWS (July 28, 2020), <https://bangordailynews.com/2020/07/28/news/midcoast/great-white-shark-blamed-for-fatal-harpswell-attack/> [<https://perma.cc/7TBF-NQTN>].

81. Ben Hill, *Diver Savaged to Death by Shark as Wife Tried to Save him but Gave up when his Eyes were Open but he was Unresponsive*, THE U.S. SUN (Nov. 17, 2020), <https://www.the-sun.com/news/1813469/shark-attack-diver-killed-western-australia-wife/> [<https://perma.cc/58BW-24CP>].

82. Christopher Neff & Robert Hueter, *Science, Policy, and the Public Discourse of Shark “Attack,”* 3 J. OF ENV’T STUD. AND SCI. 65, 67, 70 (2013) [hereinafter Neff, *Public Discourse*] (noting that the term “attack” should only be used when the motivation and intent of a shark can be established as a result of predation or defense, which is often difficult to do based on our limited knowledge of shark behavior).

83. Lucrezi, *supra* note 77, at 2.

84. *Id.*

85. Neff, *Public Discourse*, *supra* note 82, at 68-69.

86. McCagh, *supra* note 74, at 272-73.

interactions.<sup>87</sup> Such language would include substituting “shark bite” for “shark attack,” as well as other less malicious words such as “sightings” and “encounters.”<sup>88</sup> Additionally, numerous studies have shown that inclusion of expert testimony and consideration of human factors in news reports can help individuals harmonize their contrasting feelings about shark bites and shark conservation and further provide authorities with numerous policy options to consider.<sup>89</sup> Therefore, not only do news reports have the power to perpetuate the fear-narrative, but they also carry the ability to rewrite the narrative through “intent-based counter framing.”<sup>90</sup> Describing human-shark interactions in this way will give viewers a different image of sharks: one that allows the public to recognize that humans are not being targeted by sharks, interactions are not as common as the media portrays them to be, and sharks are valuable to our ecosystem and need to be conserved. This change in attitude is vital for implementing public policies that protect both bathers and sharks.

### C. The Legislative Response

The public’s perception of sharks, including responses to shark encounters, directly informs legislative decisions regarding the subsequent implementation of shark control measures. When the public perceives a high risk of shark attacks based on news reporting, authorities often make immediate, ill-considered decisions regarding beach safety. For example, an analysis of articles from Australian newspapers “identified a correlation between the public’s panicked response to fatal shark bites, and the government’s decision to implement the shark culling program.”<sup>91</sup> On the other hand, however, the study also noted that the public rarely supported the government’s decision to implement shark culls.<sup>92</sup> This difference between government response and public support can be reconciled by considering the pressure the government is placed under during these “something must be done” moments.<sup>93</sup> Government officials are under immense pressure because “[s]hark bites are representative of highly

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87. Neff, *Public Discourse*, *supra* note 82, at 70.

88. *Id.*

89. Christopher Neff, *Human Perceptions and Attitudes Towards Sharks*, in SHARKS: CONSERVATION, GOVERNANCE, AND MANAGEMENT 107, 125 (Erika Techera & Natalie Klein eds. 2014) [hereinafter Neff, *Human Perceptions*].

90. Pepin-Neff & Wynter, *supra* note 54, at 228.

91. McCagh et al., *supra* note 74, at 276.

92. *Id.*

93. Pepin-Neff & Wynter, *supra* note 54, at 222.

emotional events that can be politically penalizing for elected officials,”<sup>94</sup> and therefore they may take immediate, responsive actions in an attempt to appeal to their constituents. As Christopher Neff, expert on the intersection of public policy and shark perceptions, explained,

[A] more recent trend of international policymaking suggests that man is the referent object that needs to be secured and nature is the threat. Nature has a wrath. Storms have fury. And animals get a taste for human flesh. Such rhetorical framing devices influence public perceptions of nature, which in turn shapes both the tolerable thresholds for their occurrence and the types of policies enacted to counter the perceived threat to humans.<sup>95</sup>

On the other hand, precautionary action can minimize the already low chance of a human-shark interaction while promoting conservation of these awesome beings and further educating the public. The case for alternatives to lethal control measures is further reinforced by constituents who are supportive of shark conservation, leading to public support and engagement.

### III. CONTROL STRATEGIES

Shark control strategies were a response to the frenzy induced by *Jaws*, subsequent shark attacks, and the image of sharks portrayed by the media. At the time, the overwhelming public opinion was that the only safe shark was a dead shark,<sup>96</sup> and thus, legislatures implemented lethal control programs. Today, there are three existing shark control programs: KwaZulu-Natal, South Africa; New South Wales, Australia; and Queensland, Australia. These three areas have implemented their programs as a response to high numbers of shark-human interactions. The large majority of fatal shark encounters can be attributed to bull sharks, tiger sharks, and great white sharks and, therefore, control programs typically identify these three species as their “target species.”<sup>97</sup> This article

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94. *Id.* at 223-24.

95. *Id.* at 223.

96. Jeremy Cliff & Sheldon F. J. Dudley, *Reducing the Environmental Impact of Shark-Control Programs: A Case Study from KwaZulu-Natal, South Africa*, 62 MARINE AND FRESHWATER RESEARCH 700, 700 (2011) (quoting J. L. B. Smith, *Are we on the right road with sharks?*, Field & Tide 29 (May 18-20)).

97. S. F. J. Dudley, *A Comparison of the Shark Control Programs of New South Wales and Queensland (Australia) and KwaZulu-Natal (South Africa)*, 34 OCEAN & COASTAL MGMT. 1, 6 (1997) [hereinafter Dudley, *Shark Control Programs*].

mainly focuses on interactions with great white sharks, as those can be found all the way through northern New England.<sup>98</sup>

Shark control programs have not changed much since their inception, and today they are still mostly comprised of lethal measures. However, positive media exposure and conservation efforts surrounding sharks have elicited negative responses from the public regarding lethal control measures. Therefore, shark control programs have begun to implement less-lethal measures and scientists are exploring non-lethal alternatives for shark control, including electromagnetic interference.

With the increased sightings and encounters of great white sharks off the coasts of multiple New England states, now is a great time for these state governments to be proactive and begin considering implementation of bather protection programs. This Part of the article examines the methods currently being utilized or studied throughout the world to recommend strategies for use in New England states.

### A. Shark Culling

Governments have been known to issue shark culls for certain species after repetitive attacks over a relatively short period of time. A cull is “the selective killing of wild sharks in order to reduce their population size in an attempt to decrease the likelihood of a shark bite on a human.”<sup>99</sup> For example, from 1959 to 1976, Hawaii issued multiple shark culls that resulted in the deaths of over 4,000 sharks.<sup>100</sup> However, studies have shown that these are not effective in reducing attack rates<sup>101</sup> and, in fact, may fail at actually capturing the shark responsible for the bites.<sup>102</sup> Further, because sharks experience late sexual maturity, do not have many offspring and grow slowly, it is extremely difficult for populations to

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98. Bull sharks and tiger sharks have both been spotted as far north as Massachusetts. *Carcharhinus leucas* – *Bull Shark*, FLORIDA MUSEUM OF NAT. HIST., <https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/carcharhinus-leucas/> [<https://perma.cc/H6RM-LD2T>] (last visited Apr. 26, 2021); *Tiger Shark* – *Galeocerdo cuvier*, GOV'T OF CAN., <https://www.dfo-mpo.gc.ca/species-especes/profiles-profiles/tigershark-requintigre-eng.html> (last updated Nov. 23, 2018) [<https://perma.cc/Y922-ZYV5>].

99. *SOS Campaign: Stop the Cull*, SUPPORT OUR SHARKS, [http://www.supportoursharks.com/en/Conservation/SOS\\_Campaigns/Stop\\_The\\_Cull/Abo ut.htm](http://www.supportoursharks.com/en/Conservation/SOS_Campaigns/Stop_The_Cull/Abo ut.htm) [<https://perma.cc/QA8W-A2EN>] (last visited Dec. 2, 2020).

100. Bradley M. Wetherbee et al., *A Review of Shark Control in Hawaii with Recommendations for Future Research*, 48 *Pacific Science* 95, 100 (1994).

101. Clua et al., *supra* note 56, at 2.

102. *Id.*

recover from mass culling campaigns.<sup>103</sup> These devastating effects on shark populations outweigh any potential benefit to beachgoers and, therefore, should not be relied on as a shark management technique.

### B. Meshing

Meshing was first introduced in 1937 in New South Wales, Australia (NSW) as a response to an increase in shark attacks in the early 1900s.<sup>104</sup> This program is still in place today, and Queensland, Australia (QLD) and KwaZulu-Natal, Africa (KZN) have both implemented similar programs.<sup>105</sup> Meshing is the systematic netting of popular beaches in areas likely to see shark activity.<sup>106</sup> The nets are placed parallel to the beach and thus do not section off an entire area for swimmers, but instead aim to reduce the chances of a shark interaction based on the possibility that a shark will become entangled in the net.<sup>107</sup> Meshing is considered a passive method of capture, as it does not utilize any sort of bait to attract sharks.<sup>108</sup>

There has been evidence that implementation of the nets does lead to a decrease in the number of shark interactions,<sup>109</sup> but that result comes at a high cost. Up until 2019, the QLD shark control program euthanized any target sharks caught in their nets.<sup>110</sup> That practice was ended by a challenge

103. Hiroki Yokoi et al., *Impact of Biology Knowledge on the Conservation and Management of Large Pelagic Sharks*, 7 *Scientific Reports* 1, 1 (2017).

104. Francis, *supra* note 39, at 46.

105. See, e.g., *Protected Beaches on the KZN Coastline*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/BatherProtection> [<https://perma.cc/T4RZ-NNKS>] (last visited Apr. 17, 2022); *Shark Control Program*, QUEENSL. GOV'T, <https://www.daf.qld.gov.au/business-priorities/fisheries/shark-control-program> [<https://perma.cc/3NEM-YCTR>] (last visited Apr. 17, 2022).

106. Dudley, *Shark Control Programs*, *supra* note 97, at 3. Meshing nets come in a variety of lengths and widths. See, e.g., *Management Plan for the NSW Shark Meshing Program 2017* (NSW) pt 3 § 21 (Austl.); *How We Catch and Detect Sharks*, QUEENSL. GOV'T, <https://www.daf.qld.gov.au/business-priorities/fisheries/shark-control-program/shark-control-equipment> [<https://perma.cc/FZN8-UBR8>] (last visited Apr. 17, 2022) [hereinafter *NSW Program 2017*]; *Shark Nets, Drumlins, and Safe Swimming*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/ProtectionSharks-NetsDrumlins> [<https://perma.cc/DDQ3-XL8F>] (last visited Apr. 26, 2021).

107. *NSW Program 2017*, *supra* note 106, at pt 2 § 10.1.

108. *Id.* at pt 3 § 22.2.

109. Dudley, *Shark Control Programs*, *supra* note 97, at 22.

110. *Public Information Package*, THE GREAT BARRIER REEF MARINE PARKS SHARK CONTROL PROGRAM at 16, [https://www.daf.qld.gov.au/\\_data/assets/pdf\\_file/0007/310939/public-information-package-shark-control-program.pdf](https://www.daf.qld.gov.au/_data/assets/pdf_file/0007/310939/public-information-package-shark-control-program.pdf) [<https://perma.cc/2XTC-UMTH>]. Up until 1989, the KZN shark control program also killed all large sharks entangled in their nets. Cliff, *supra* note 96, at 702.

brought by Humane Society International in the Australian Federal Court, and now sharks caught in nets can only be killed as a humane practice for severely injured sharks.<sup>111</sup> Other programs operate with the goal of tagging and releasing target species; however, sharks often do not survive net entanglement despite being regularly checked.<sup>112</sup> Studies have generally posited that “shark control measures achieve their protective function through reducing the populations of large sharks and hence the probability of an encounter between a shark and bather.”<sup>113</sup> While minimizing the risk of shark bites is important for bather safety, this provides a challenge for shark conservation.

Meshing programs do not only affect shark population numbers, but they also impact the populations of numerous other species. Non-target species, called “bycatch,” regularly become entangled in the nets, and like sharks, often do not survive.<sup>114</sup> There may be additional impacts incurred by these species; however, the “long term survival and effects of catch and release are largely unknown”<sup>115</sup> and require further research. Governments, recognizing the negative environmental impacts of shark control programs, have started incorporating considerations of biodiversity in their plans. The KwaZulu-Natal Sharks Board Act, enacted in 2008, specifically stated a goal “to reduce negative impact on all

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111. *Queensland v. Humane Society International* (2019) FCAFC 163 (Austl.); see also *Shark Drumline Case*, ENVIRONMENTAL LAW AUSTRALIA, <http://envlaw.com.au/sharks/> [<https://perma.cc/78MT-6VTC>] (last visited Apr. 26, 2021); Kym Agius and Kate McKenna, *Queensland Forced to Stop Marine Park Shark Cull for Now, but Government Wants Laws Changed*, ABC News (Sept. 17, 2019, 11:04 PM), <https://www.abc.net.au/news/2019-09-18/shark-attack-drum-lines-great-barrier-reef/11523902> [<https://perma.cc/7M4A-3MKH>].

112. For example, during the 2019-2020 meshing season in NSW, fifty target species were found entangled in nets but only nineteen were released alive. *NSW Bather Protection Annual Performance Report 2019/2020*, NSW DEP'T OF PRIMARY INDUS. at 31, [https://www.sharksmart.nsw.gov.au/\\_data/assets/pdf\\_file/0009/1246275/smp-2019-2020-annual-performance-report.pdf](https://www.sharksmart.nsw.gov.au/_data/assets/pdf_file/0009/1246275/smp-2019-2020-annual-performance-report.pdf) [<https://perma.cc/N8FN-C7YC>] [hereinafter Annual Report].

113. Dudley, *Shark Control Programs*, *supra* note 96, at 2.

114. The 2019-2020 NSW meshing season saw the entanglement of 430 non-target species, with ninety-five of those individuals being threatened or protected species. Annual Report, *supra* note 112, at 29.

115. Leah Gibbs et al., *Effects and Effectiveness of Lethal Shark Hazard Management: The Shark Meshing (Bather Protection) Program*, NSW, Australia, 2 PEOPLE & NATURE 189, 196 (2020).

biodiversity and enhance the survival of caught sharks and other marine animals.”<sup>116</sup> Other plans have vocalized similar goals.<sup>117</sup>

After shark culls, meshing was the first method introduced to reduce the likelihood of a human-shark interaction at popular beaches. Numerous studies have shown that implementation of nets has led to a reduction in bites and encounters; however, some researchers still have their doubts and further research is needed. In addition to declining shark populations, meshing has a negative impact on the populations of other species. In conclusion, the negative environmental impacts outweigh the protections provided to bathers and, therefore, meshing is not the best method to reduce human-shark interactions in New England states.

### C. Baited Drumlines

Drumlines are often utilized in conjunction with shark nets to maximize swimmer safety. A drumline consists of a large, anchored float connected to a hook baited with fresh fish,<sup>118</sup> marking this control measure as an active fishing operation.<sup>119</sup> The fishing line allows sharks to continue swimming while hooked, which leads to higher survival rates. However, sharks are subjected to intense physical trauma when hooked that may result in death if they are not quickly released.<sup>120</sup> Thus, “[b]oth the duration and intensity of this ‘fight time’ can be critical for the survival of the animal.”<sup>121</sup> It’s entirely possible that a shark may be hooked for over twenty-four hours, as drums are typically checked less than once per day, with the result of high mortality rates.<sup>122</sup>

Drumlines were instituted as an alternative to meshing in the attempt to decrease impacts on bycatch species. Overall, the method was successful, as studies have noted that drumlines are “far more selective

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116. Cliff, *supra* note 96, at 701.

117. “The aim of the [Shark Management Program] is to reduce the chances of shark interactions within the area of operation of the program whilst minimising [sic] impacts on non-target species.” NSW Program 2017, *supra* note 106, at 5.

118. Cliff, *supra* note 96, at 700-01.

119. S.F.J. Dudley & N.A. Gribble, *Management of Shark Control Programs in CASE STUDIES OF THE MANAGEMENT OF ELASMOBRANCH FISHERIES* (Ross Shotten, ed., 1999), <http://www.fao.org/3/x2098e/X2098E15.htm#ch26> [<https://perma.cc/3XRF-W4TA>] (last visited Apr. 26, 2021) [hereinafter Dudley, *Elasmobranch Fisheries*].

120. See, e.g., David Guyomard et al., *An Innovative Fishing Gear to Enhance the Release of Non-Target Species in Coastal Shark-Control Programs: The SMART (Shark Management Alert in Real-Time) Drumline*, 216 *FISHERIES RESEARCH* 6, 14 (2019).

121. *Id.*

122. *Id.* at 7.

shark-control measures than nets.”<sup>123</sup> However, there are still numerous concerns. First, implementation did not reduce all bycatch. In some locations, there have been documented instances of non-target species being hooked, such as dolphins and sea turtles.<sup>124</sup> Dolphins and other species have an additional impact on drumlines: they scavenge the bait.<sup>125</sup> Drumlines are only effective as long as they are baited. In an attempt to reduce dolphin bycatch and avoid scavenging, scientists have attached dolphin pingers to alert dolphins of the presence of drumlines.<sup>126</sup> Studies on whether or not this method is effective have been inconclusive so far. Regardless of whether drumlines are effective at reducing bycatch, it is still considered a lethal measure as it results in the deaths of both target and non-target species.

The goal to reduce deaths of target and non-target species has led to the innovation of new technology in the form of Shark-Management-Alert-in-Real-Time (SMART) drumlines.<sup>127</sup> The SMART drumline is similar to the conventional drumline with one improvement: installation of the “Catch-A-Live” system.<sup>128</sup> When an animal gets hooked, an alert signal is emitted to a predetermined list of people in the fishing industry with the expectation that one will respond to the call, collect data on the encounter, and release the animal or humanely kill it if it is too injured for release.<sup>129</sup> This alert system allowed for a rapid response from operators, decreasing the time animals were fighting the buoy, which in turn led to a decrease in mortality rates of hooked animals.<sup>130</sup> Studies concerning the effectiveness of SMART drumlines are on-going with promising results,<sup>131</sup> but the costs associated with this control measure are high: Western Australia spent upwards of five million dollars on a trial study that lasted slightly longer than two years.<sup>132</sup>

Drumlines were introduced as an alternative to meshing with the goal of decreasing the impact on non-target species. Although drumlines are

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123. Cliff, *supra* note 96, at 707.

124. *Id.* at 707-08.

125. *Id.* at 708.

126. *Id.* at 707.

127. Guyomard, *supra* note 120, at 7-8.

128. *Id.* at 8.

129. *Id.* at 8-9.

130. *Id.* at 14.

131. *Scientific Non-Lethal SMART Drumline Trial*, GOV'T OF W. AUSTR., <https://www.sharksmart.com.au/research/smart-drumline-trial/> [https://perma.cc/3Q2A-T44F] (last visited Apr. 26, 2021).

132. *SMART Drumline Trial Extended in WA*, NATIONAL INDIGENOUS TELEVISION (Apr. 26, 2020), <https://www.sbs.com.au/nitv/article/2020/04/26/smart-drumline-trial-extended-wa> [https://perma.cc/NXU7-4AQE].

considered a lethal method of control, SMART drumlines lower mortality rates while reducing shark encounters and therefore it may be an effective option for New England states. However, the price tag associated with this measure is high, and, as this article will explain, it is not the best option.

#### *D. Electromagnetic Interference*

Thus far, this article has discussed lethal means of shark bite prevention. It now turns to the non-lethal method of electromagnetic interference, which has proven to be one of the most effective and least invasive protection mechanisms.

Electromagnetic interference (EMI) is described as “an electromagnetic emission that causes a disturbance in another piece of electrical equipment.”<sup>133</sup> However, EMI is also an effective shark deterrent because it interferes with the senses of sharks.<sup>134</sup> On the bottom of their snout, sharks have small pores known as the ampullae of Lorenzini.<sup>135</sup> The ampullae are electrosensory organs that detect electric field gradients,<sup>136</sup> alerting sharks to nearby prey and assisting with navigation.<sup>137</sup> However, scientists have discovered that the ampullae can be manipulated by generating a man-made electric current to deter sharks from certain areas.<sup>138</sup> There is a high energetic cost associated with the discomfort experienced when crossing an electric gradient, and “if a food item requires a lot of energy to obtain, it may be more efficient to seek out another, less energetically-expensive food item.”<sup>139</sup>

This process has been tested on both large- and small-scales. Initially, shark deterrent products were released on a personalized scale and focused on the protection of individual divers and surfers.<sup>140</sup> Such devices are designed to be worn on a person’s ankle while diving or on the bottom of

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133. Mike Santora, *What is EMI and How Can You Prevent It?*, WIRE AND CABLE TIPS (April 10, 2015), <https://www.wireandcabletips.com/what-is-emi-and-how-can-you-prevent-it/> [https://perma.cc/542C-DZUG].

134. Ryan M. Kempster et al., *How Close is too Close? The Effect of a Non-Lethal Electric Shark Deterrent on White Shark Behavior*, PLoS ONE 1, 2 (2016).

135. *Id.*

136. *Id.*

137. Charlie Huvneers et al., *Effects of an Electric Field on White Sharks: In Situ Testing of an Electric Deterrent*, 8 PLoS ONE 1, 1 (2013).

138. Daryl P. McPhee, *A Comparison of Alternative Systems to Catch and Kill for Mitigating Unprovoked Shark Bite on Bathers or Surfers at Ocean Beaches*, 201 OCEAN AND COASTAL MANAGEMENT 1, 5 (2021).

139. Kempster, *supra* note 134, at 16.

140. Huvneers, *supra* note 137, at 2.

a surfboard and create an electric field around the wearer.<sup>141</sup> One experiment investigated whether a personal deterrent apparatus could keep a great white shark away from static bait.<sup>142</sup> The scientists used chum<sup>143</sup> to attract sharks to the test area, concluding that “such heightened predatory conditions would simulate a ‘worst-case scenario’ for the divers.”<sup>144</sup> The results of that study revealed that personal shark deterrent devices can reduce the already low chances of a shark bite by almost eighty percent.<sup>145</sup> Once electrical shark deterrent devices were proven to be effective on a small scale, inventors and researchers turned their attention to larger devices such as those that can be attached to boats<sup>146</sup> and, relevant to this article, cables that create an exclusion area to protect beaches.<sup>147</sup>

Aside from the discomfort experienced by sharks,<sup>148</sup> which is similar to the changes in human sensitivity as one gets closer to a heat source,<sup>149</sup> there are no major negative impacts to other organisms. Marine mammals and bony fishes do not have the same electrosensory organs and thus will

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141. See, e.g., FREEDOM7, OCEAN GUARDIAN, <https://ocean-guardian.com/collections/dive-series/products/freedom7> [<https://perma.cc/K74J-B79H>] (last visited Mar. 4, 2022); FREEDOM+ Surf, OCEAN GUARDIAN, <https://ocean-guardian.com/collections/surf/products/freedom-surf> [<https://perma.cc/9X7Y-BGTR>] (last visited Mar. 4, 2022).

142. C.F. Smit & V. Peddemors, *Estimating the Probability of a Shark Attach When Using an Electric Repellant*, 37 S. AFR. STAT. J. 59, 61 (2003).

143. Chum is a mixture of blood, bones, and other fish and animal parts deployed in the water to attract sharks to a specific area. It is often used for shark fishing, shark diving, and other tourism needs. See, e.g., Mary Bates, *Is Chumming Leading to More Shark Attacks*, AM. ASS'N FOR THE ADVANCEMENT OF SCIENCE (April 26, 2012), <https://www.aaas.org/chumming-leading-more-shark-attacks> [<https://perma.cc/6QUE-M78Y>].

144. Smit, *supra* note 142, at 77.

145. *Id.* at 76.

146. See, e.g., BOAT01, OCEAN GUARDIAN, <https://ocean-guardian.com/collections/boat/products/boat01> [<https://perma.cc/2M67-RVB3>] (last visited Mar. 4, 2022); LR1000, OCEAN GUARDIAN, <https://ocean-guardian.com/pages/beach-series> [<https://perma.cc/R3AL-NXRV>] (last visited Mar. 4, 2022).

147. See, e.g., Corinne Iozzio, *An Electric Fence Wards Off Sharks*, SMITHSONIAN MAGAZINE (Nov. 25, 2014), <https://smithsonianmag.com/innovation/electric-fence-wards-sharks-180953380/> [<https://perma.cc/52YB-U8LD>].

148. This comment is focused on the impacts of management methods for sharks; however, it is important to note that this particular method would have a similar impact on other elasmobranchs (skates and rays). See, e.g., Jennifer Langston, *Proton-conducting Material Found in Jelly that Fills Organs of Sharks, Skates, and Rays*, UNIV. OF WASH. NEWS (May 13, 2016), <https://www.washington.edu/news/2016/05/13/proton-conducting-material-found-in-jelly-that-fills-organs-of-sharks-skates-and-rays/> [<https://perma.cc/28J8-6N8F>].

149. Iozzio, *supra* note 147.

not be affected by the electromagnetic field created by such cables,<sup>150</sup> and further, will not be restricted in movement nor at risk as bycatch. Additionally, there is little danger to humans, although it is cautioned that they may feel a slight tingle if they touch the exposed electrodes.<sup>151</sup> Overall, the benefits of the electric field as a deterrent, namely marine conservation and minimization of shark interactions, outweigh the potential disadvantages to humans.

Static magnets are an alternative to active electric fields with similar effects that offer additional ecological benefits and protection from shark interactions. The SharkSafe Barrier™ (SSB) is one example of an apparatus that may successfully bar sharks from designated areas using magnets combined with visual stimuli and minimal ecological impact.<sup>152</sup> The SSB is composed of magnets inside rows of low density plastic pipes anchored to the ocean floor.<sup>153</sup> The pipes imitate high density kelp forests which tend to be avoided by great white sharks, likely because kelp impedes white shark hunting behaviors.<sup>154</sup> Numerous studies have been conducted to determine the SSB's effectiveness at keeping sharks out of designated areas with extremely positive results.

One study conducted in South Africa tested the ability to keep sharks away from an area designed to be appealing to sharks.<sup>155</sup> The researchers set up six regions (two regions for each of the three different designs): a "control" area with no barrier whatsoever; a "procedural control" area that utilized the kelp-like pipes but no magnets, and a "magnetic" area that utilized a combination of kelp-like pipes and magnets placed at one-meter intervals.<sup>156</sup> Researchers deployed chum in the water to attract sharks to their location, and observed sharks' behavior as they attempted to get through the barriers to the chum.<sup>157</sup> The researchers observed a total of sixty-three great white sharks during the experiment, with 256 entrances

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150. See, e.g., McPhee, *supra* note 138, at 5; Iozzio, *supra* note 147.

151. *Shark Repellent Cable*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/SharkRepellentTechnology> [https://perma.cc/SM63-3CAW] (last visited Apr. 26, 2021). However, those who are pregnant or have pacemakers should use caution and keep their distance from cables, as the electric field may have an impact on their condition. McPhee, *supra* note 138, at 5.

152. Craig P. O'Connell, et al., *Effects of the Sharksafe Barrier on White Shark (Carcharodon carcharias) behavior and its Implications for Future Conservation Technologies*, 460 J. EXPERIMENTAL MARINE BIOLOGY & ECOLOGY 37, 44 (2014).

153. *Our Product*, SHARKSAFE BARRIER, <https://www.sharksafesolution.com/our-product/> [https://perma.cc/4BLL-MSLY] (last visited Apr. 26, 2021).

154. Hammerschlag, *supra* note 19, at 4.

155. O'Connell, *supra* note 152, at 38.

156. *Id.* at 39.

157. *Id.* at 40.

into the control area.<sup>158</sup> However, none of the sharks entered the procedural control nor the magnetic regions, signaling that “both visual and magnetic stimuli were effective at manipulating the swimming patterns of interacting [great white sharks].”<sup>159</sup> The avoidance behaviors exhibited suggest that the SSB is a feasible option for the protection of beaches, both with and without the inclusion of magnets. However, researchers suggested continuing the inclusion of the magnets in the barriers because the combination provides the most protection from various shark species.<sup>160</sup> Overall, the successful deterrence of sharks by the SSB makes it a strong contender for implementation in Maine and Massachusetts.

The SharkSafe Barrier™ has numerous other benefits that further support its use to protect beaches. First, the SSB is designed for longevity; it is a maintenance-free apparatus that can withstand rough seas.<sup>161</sup> As part of a test, the SSB has been successfully deployed in South Africa for a period of two years without any upkeep or damage.<sup>162</sup> A device such as the SSB, that requires minimal effort to maintain, will likely be enticing to cities with tourism-heavy beaches because additional resources could still be allocated to additional management strategies, such as volunteer shark-spotting programs. Furthermore, the SSB has ecological benefits as an artificial reef structure.<sup>163</sup> During the experiments in South Africa, the Cape sea urchin, dwarf cushion star, African turban snail, and the black sea cucumber were all observed dwelling in the SSB, proving it is a viable habitat for numerous species.<sup>164</sup> Cape fur seals were also seen around the barrier with “no indications of attraction, irritation, or avoidance.”<sup>165</sup> Finally, the cost of the barrier is fairly low, at about thirty-five dollars per square meter.<sup>166</sup> In terms of long-term investment, the SSB is estimated to be twenty times cheaper to maintain than meshing programs due to its low

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158. *Id.* at 44.

159. *Id.*

160. *Id.*

161. SHARKSAFE BARRIER, *supra* note 153.

162. *Id.*

163. O’Connell, *supra* note 152, at 43.

164. *Id.*

165. *Id.* at 44.

166. Rich Saltzberg, *SharkSafe Barrier could protect local swimmers*, MV TIMES (Oct. 12, 2018) <https://www.mvtimes.com/2018/10/12/shark-safe-barrier-protect-local-swimmers/> [https://perma.cc/TN47-9TST].

maintenance design.<sup>167</sup> Implementation is also relatively short-lived and simple, as it took four divers only nine days to install 200 units.<sup>168</sup>

In conclusion, the SharkSafe Barrier™ is a favorable option to protect beachgoers from possible interactions with sharks. The SSB has been highly successful in deterring sharks from entering designated areas. Its non-lethal nature sets it apart from meshing and drumlines because the SSB promotes shark conservation and has a minimal impact on other species. Additionally, reliance on static magnets instead of an active power source make it more enticing than the use of electric currents to generate a field. Finally, the SSB's low cost and low maintenance highlight the benefits of the long-term investment. Overall, the benefits of the SharkSafe Barrier™, and lack of drawbacks, make it the best option for implementation in Maine and Massachusetts.

#### *E. Volunteer and Other Control Measures*

As analyzed earlier in this article, the public's perception of sharks directly informs policies implemented for shark management. There is also a direct correlation between one's perceived view of sharks and that person's knowledge of sharks. By implementing volunteer measures and corresponding educational programs, individuals within a community who are directly involved with beach protection will have a better opportunity to increase their understanding of the biology and behaviors of sharks, which could result in a shift of the overall public perception.

Volunteer measures have a long history in beach protection programs, as they were one of the first mechanisms implemented to protect beaches from shark attacks. After the shark incidents in Australia during the early 1900s, individuals stood watch from lookout towers and participated in surf lifesaving clubs.<sup>169</sup> These volunteer measures are still implemented today and are highly effective at preventing immediate shark-human interactions. For example, shark spotting programs are still active in Cape

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167. *Sharksafe Barrier™*, SOLAR IMPULSE FOUNDATION, <https://solarimpulse.com/efficient-solutions/sharksafe-barrier#> [<https://perma.cc/9537-PB2M>] (last visited Apr. 26, 2021); see also Elsbé Brits, *Eco-friendly Magnetic Shark Barrier Developed in South Africa Could be Boost for Tourism and Jobs* (Oct. 9, 2020), <https://www.dailymaverick.co.za/article/2020-10-09-eco-friendly-magnetic-shark-barrier-developed-in-south-africa-could-be-boost-for-tourism-and-jobs/> [<https://perma.cc/D8HS-Q4A2>].

168. Brits, *supra* note 167.

169. Francis, *supra* note 39, at 14.

Town<sup>170</sup> and there is a push to implement drone surveillance at beaches prone to shark interactions.<sup>171</sup> Similarly, locals in Massachusetts have started a non-profit organization to test different types of shark surveillance measures on Cape Cod beaches.<sup>172</sup>

Aside from official volunteer measures, there are other ways to keep the general population involved with and informed about shark science. For example, the Atlantic White Shark Conservancy (AWSC), which is based in Massachusetts, launched its Sharktivity app in 2016.<sup>173</sup> The app allows users, including the public, researchers, and safety officials, to upload sightings of great white sharks in real time.<sup>174</sup> The app provides both confirmed and unconfirmed sightings, as well as detections of sharks tagged with acoustic transmitters.<sup>175</sup> By allowing the general public to upload their own sightings as well as access information regarding recent sightings, the AWSC is “effectively crowdsourcing critical data points on where sharks are spotted so as to reduce encounters and promote safety.”<sup>176</sup> Aside from the Sharktivity app, the AWSC is involved with other bather protection research in conjunction with The Woods Hole Group to identify effective technologies for the coast of Massachusetts.

One last important aspect of shark management is public education. As one study noted, “[a] well-informed public that understands an issue and its potential solutions is in a stronger position to exert pressure on

170. See, e.g., *About*, SHARK SPOTTERS, <https://sharkspotters.org.za/page/about/> [<https://perma.cc/F67A-4EY6>] (last visited Apr. 27, 2021).

171. See, e.g., Andrew Colefax et al., *Lifeguards with Drones Keep Us (and Sharks) Safe, and Beach-goers Agree*, THE CONVERSATION (July 22, 2021, 1:28 AM), <https://theconversation.com/lifeguards-with-drones-keep-us-and-sharks-safe-and-beach-goers-agree-142721> [<https://perma.cc/DPF9-UXRV>].

172. See CAPE COD OCEAN COMMUNITY, INC., <https://www.capecodoceancommunity.org> [<https://perma.cc/GQG5-HEGJ>] (last visited Feb. 20, 2022).

173. Steve Annear, *Shark Experts Launch ‘Sharktivity’ App for Beachgoers*, BOSTON GLOBE (July 1, 2016), <https://www.bostonglobe.com/metro/2016/07/01/shark-experts-launch-sharktivity-app-for-beachgoers/d03RERXDOAG4M2KMZQYMIP/story.html> [<https://perma.cc/LT8L-GV6M>].

174. *Meet Sharktivity – Atlantic White Shark Sighting and Resource App*, ATLANTIC WHITE SHARK CONSERVANCY, <https://www.atlanticwhiteshark.org/sharktivity-app> [<https://perma.cc/6YBK-B932>] (last visited Apr. 27, 2021) [hereinafter, *Sharktivity*].

175. *Id.* The Atlantic White Shark Conservancy has identified about 300 great white sharks in the North Atlantic, however studies are still being conducted to obtain an official population estimate. *FAQs*, ATLANTIC WHITE SHARK CONSERVANCY, <https://www.atlanticwhiteshark.org/white-shark-faqs> [<https://perma.cc/QFU5-QH2D>] (last visited Apr. 27, 2021).

176. *Sharktivity*, *supra* note 174.

policymakers to address environmental concerns.”<sup>177</sup> Therefore, a comprehensive understanding of shark behavior directly correlates with positive perceptions of sharks and implementation of the least intrusive means of management. Additionally, a public properly informed about the risks of ocean swimming and shark encounters can make their own assessment of whether they feel safe going in the water. Public education can come from outreach efforts, such as those utilized by the AWSC,<sup>178</sup> or be government backed. For example, “Shark Smart” is a program implemented by the Western Australian government that runs a campaign called “Switch on Your Sea Sense.”<sup>179</sup> The campaign focuses on shark bite prevention by providing tips and actions that individual beachgoers can take to feel safer in the water.<sup>180</sup>

There are countless ways for local governments to provide protection to their beaches. However, many of these methods are lethal to sharks and other species, which can lead to reductions in local species populations. As discussed in Part II, a loss of apex predators can cause the collapse of entire fisheries and other instabilities throughout the ecosystem. Therefore, the best strategies for shark control are non-lethal and non-intrusive, leaving beachgoers protected without significantly impacting sharks or the rest of the environment. Electromagnetic interference, such as that provided by the SharkSafe Barrier™, paired with volunteer work and public education would achieve these goals. Thus, these are the actions New England states should seek to use for beach protection.

#### IV. IMPLEMENTING SHARK MANAGEMENT POLICIES

As evidenced by this article, there are a variety of management options available to minimize shark interactions at New England beaches. The challenge that New England faces comes from the need for widespread implementation and cooperation. To effectively manage the North Atlantic great white shark population, New England states will have to

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177. Laura A. Friedrich et al., *Public Perceptions of Sharks: Gathering Support for Shark Conservation*, 47 MARINE POL’Y 1, 1 (2014).

178. The AWSC provides free school curriculums focused on shark science, as well as general community education opportunities. *White Shark Education, Programs, and Resources*. ATLANTIC WHITE SHARK CONSERVANCY, <https://www.atlanticwhiteshark.org/shark-educational-programs> [https://perma.cc/6MR6-N2JJ] (last visited Apr. 27, 2021).

179. Shark Smart, *Switch on Your Sea Sense*, GOV’T OF W. AUSTRALIA. (Sep. 20, 2018), <https://www.sharksmart.com.au/staying-safe/sea-sense/> [https://perma.cc/MBS9-AX2M] (last visited Apr. 27, 2021).

180. *Id.*

cooperate due to sharks' highly migratory nature.<sup>181</sup> Therefore, the best way to implement a shark interaction management team in New England would be through a multi-state policy. Statutory implementation of a large-scale shark research team has been successful elsewhere in the world. The Sharks Board in KwaZulu-Natal, South Africa, is the perfect example.

The KwaZulu-Natal Sharks Board Maritime Centre of Excellence (KZNSB) was initially established in 1962 to supervise the implementation of shark control measures to protect the province's beaches.<sup>182</sup> In 1974, the organization took over the service and installation of its meshing programs.<sup>183</sup> In 2008, the province of KwaZulu-Natal passed legislation to expand the KZNSB to its current capacity.<sup>184</sup>

The statute implementing the KZNSB is a very in-depth document with three central pieces that could serve as an outline for New England states. First, the statute establishes the objectives and responsibilities of the KZNSB, including the research, development, and installation of measures against shark encounters<sup>185</sup> while minimizing the economic impact of such measures.<sup>186</sup> Second, the KZNSB provides educational opportunities to the general public regarding shark awareness and the importance of sharks to the ecosystem, as well as various tourism opportunities for the region.<sup>187</sup> Finally, the statute identifies funding prospects for the organization.<sup>188</sup>

The endeavors of the KZNSB have been largely successful. There are currently thirty-seven beaches along the coast of KZN that are protected by meshing nets and drumlines.<sup>189</sup> Although these methods do not provide absolute protections to beachgoers, only twenty-seven shark bites have been recorded off the KZN coast since nets were first installed in the 1960s.<sup>190</sup> Additional measures implemented at protected beaches include

181. Clua, *supra* note 56, at 2.

182. *History of Protection Against Shark Attack in KZN*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/ProtectionSharks-History> [<https://perma.cc/5DHW-C7W8>] (last visited Apr. 27, 2021) [hereinafter, KZNSB History].

183. *Id.*

184. KwaZulu-Natal Sharks Board Act 05 of 2008 (S. Afr.).

185. *Id.* § 5(1)(a).

186. *Id.* §§ 4-5.

187. *Overview*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/AboutUs-Overview> [<https://perma.cc/GU9T-R6EN>] (last visited Apr. 27, 2021) [hereinafter, KZNSB Overview].

188. KwaZulu-Natal Sharks Board Act 05 of 2008 § 22 (S. Afr.).

189. *Operations*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/BatherProtection/> [<https://perma.cc/AG9Z-Y8K8>] (last visited Apr. 27, 2021) [hereinafter, KZNSB Operations].

190. *Id.*

prohibiting swimming when a large shark is sighted in the immediate area, as well as allowing individuals to participate in “discretionary bathing” instead of seasonal swimming bans when the nets are removed from the water.<sup>191</sup> As a result, a shark bite has not occurred at a KZN protected beach since 1999.<sup>192</sup> These successes signal that a similar regime could be effective in New England and other regions of the United States.

The United States is no stranger to regional ocean management. The Magnuson-Stevens Act (MSA), a statutory regime originally passed in 1976 and later amended in 1996 and 2007, served two functions: (1) to establish an Exclusive Economic Zone (EEZ) between three and 200 miles off the coast of each State,<sup>193</sup> and (2) develop fisheries management plans to “foster[] the long-term biological and economic sustainability of marine fisheries.”<sup>194</sup> To accomplish the latter goal, the MSA established eight regional fisheries management councils across the U.S.,<sup>195</sup> each with the responsibility of establishing a fishery management plan for species harvested in its region, including setting catch limits, establishing accountability measures, and developing research priorities.<sup>196</sup> Although each council is responsible for its own EEZ, there is some overlap between regions that fish from the same stock; for example, the New England Council and the Mid-Atlantic Council work together to manage the spiny dogfish and monkfish fisheries.<sup>197</sup> Fisheries management plans, implemented in accordance with the MSA, have been largely successful

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191. *Id.*

192. *FAQ*, KWAZULU-NATAL SHARKS BOARD, <https://www.shark.co.za/Pages/FAQ> [<https://perma.cc/PEN9-TJEF>] (last visited Apr. 27, 2021).

193. 16 U.S.C. § 1802(40) (2007). “Within the EEZ, the U.S. has sovereign rights for the purpose of exploring, exploiting, conserving, and managing natural resources, whether living and nonliving, of the seabed and subsoil and the superjacent waters with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents, and winds.” *What is the EEZ?*, NOAA, <https://oceanservice.noaa.gov/facts/eez.html> [<https://perma.cc/294J-JAVW>] (last visited Apr. 27, 2021).

194. *Laws & Policies: Magnuson-Stevens Act*, NOAA FISHERIES, <https://www.fisheries.noaa.gov/topic/laws-policies> [<https://perma.cc/J3ZY-D8AL>] (last visited Apr. 27, 2021).

195. 16 U.S.C. § 1852(a)(1) (2007). The eight councils exist in: New England, Mid-Atlantic, South Atlantic, Caribbean, Gulf of Mexico, Pacific, North Pacific, and Western Pacific.

196. *U.S. Regional Fishery Management Councils*, at 1, [https://s3.amazonaws.com/nefmc.org/2019-05-15\\_RFMC-Overview\\_UPDATED\\_FINAL.pdf](https://s3.amazonaws.com/nefmc.org/2019-05-15_RFMC-Overview_UPDATED_FINAL.pdf) [<https://perma.cc/Q78T-X9HN>].

197. *Mid-Atlantic Fishery Management Council*, U.S. REG’L FISHERY MGMT COUNCILS, <http://www.fisherycouncils.org/mid-atlantic> [<https://perma.cc/56A6-FPDV>] (last visited Apr. 27, 2021).

with “ending and preventing overfishing in federally-managed fisheries, actively rebuilding stocks, and providing fishing opportunities and economic benefits for both commercial and recreational fishermen as well as fishing communities and shoreside businesses that support fishing and use fish products.”<sup>198</sup>

The efforts by the KZNSB to protect beaches from shark interactions, as well as the management of natural resources located in the EEZ through the MSA, signal that regional regimes are a successful mechanism for large scale cooperation and conservation. A regional-based statute, whether enacted federally or amongst a group of states, could be highly effective in protecting the public on a large scale while conserving shark populations.

Aside from the success exemplified by other regimes, another rationale for supporting the implementation of such policies is the protection of local governments from people injured in shark encounters. Although there are statutes in place to protect public entities from personal injury torts,<sup>199</sup> liability is a determination for the fact-finder and, therefore, such cases could make their way into court. Previous cases indicate that prior knowledge of a possible shark interaction could provide a basis for recovery. For example, in one case, a court ruled that there was no duty to warn or guard beachgoers from a shark attack when “there was nothing to indicate that the city had knowledge of a shark hazard.”<sup>200</sup> In *Wamser v. City of St. Petersburg*, a young boy was bitten by a shark at a beach operated by the city of St. Petersburg, Florida.<sup>201</sup> The boy and his father brought suit against the city seeking tort damages for a failure to warn, indicating that they knew sharks inhabited the Gulf of Mexico, but were not warned that sharks inhabited that beach area itself.<sup>202</sup> The court ruled that “[i]n the absence of reasonable foreseeability of the danger, there was no duty on the part of the city to guard an invitee against an attack by an animal *Ferae naturae*, or to warn of such an occurrence.”<sup>203</sup> Additionally,

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198. *About the Magnuson-Stevens Act (MSA)*, U.S. REG’L FISHERY MGMT COUNCILS <http://www.fisherycouncils.org/about-the-msa> [<https://perma.cc/G5EH-E7AY>] (last visited Apr. 27, 2021).

199. *See, e.g.*, 14 M.R.S.A. § 8103 (2020) (“Except as expressly authorized by statute, all governmental entities shall be immune from suit on any and all tort claims seeking recovery of damages.”).

200. *Wamser v. City of St. Petersburg*, 339 So.2d 244, 246 (1976).

201. *Id.* at 245.

202. *Id.*

203. *Id.* at 246.

because its beach did not have a history of attacks, the city did not have a duty to inquire into the frequency of shark sightings into the area.<sup>204</sup>

That court announced a rule “that generally the law does not require the owner or possessor of land to anticipate the presence of or guard an invitee against harm from animals *Ferae naturae* unless such owner or possessor has reduced the animals to possession, harbors such animals, or has introduced onto his premises wild animals not indigenous to the locality.”<sup>205</sup> While the amount of litigation surrounding shark bites is scarce, this rule provides some insight into what New England courts may face if such a case arises. A plaintiff could argue that shark bites in the New England area were foreseeable, based on recent sightings as well as fatal and non-fatal interactions, and therefore a city should be held liable for resulting injuries. However, implementing shark management equipment would provide an extra layer of protection, as public entities could argue that they have taken the maximum number of acceptable precautions. As noted above, shark management programs are not always one-hundred percent effective, and therefore beachgoers would still be assuming a certain level of risk by entering the water.

#### V. NEXT STEPS: POLICY RECOMMENDATIONS FOR NEW ENGLAND

Thus far, this article has explored the relationship between shark perceptions and policy implementations, various technologies used in shark management around the world, and statutory regimes used to manage oceanic resources. Now, the article uses that cumulative information to make recommendations for action to be taken in the New England area.

The first and most effective step would be to adopt a statutory regime that establishes a council, board, or committee and includes representatives from each New England state. To achieve the highest level of involvement and the widest array of opinions, the council should include politicians, citizens, fishermen, and scientists. The focus of the council should be the research and long-term implementation of shark management technologies on public beaches. Based on the review of some possible strategies, New England’s best course of action is to invest in an electromagnetic deterrence system. More specifically, New England states should implement the SharkSafe Barrier™ at highly trafficked beaches. There are numerous reasons why this method is superior to others.

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204. *Id.*

205. *Id.*

First, electromagnetic deterrence is a non-lethal strategy, making it the least invasive method of control. Because sharks are vital to a balanced ecosystem, any technologies used should cause the least harm to the shark population. Electromagnetic deterrence achieves this goal as a non-lethal measure and, in turn, promotes shark conservation. Second, electromagnetic interference has the lowest ecological impact. Because it mimics a kelp forest, it can be a suitable habitat for numerous species. Additionally, the magnetic field would not negatively affect ocean mammals commonly found in New England waters, such as seals, because the ampullae of Lorenzini are unique to sharks and other elasmobranchs. Finally, the SharkSafe Barrier™ presents the most financially feasible option, with a low price tag, little manual labor, and minimal future maintenance.

The second goal of the established council should be widespread shark education for the public. This education initiative could be established several ways. For example, adequate signage should be posted at beaches explaining when swimmers should avoid the water and why. Small groups of volunteers can be sent out to beaches to educate the public on shark behavior and serve as shark spotters. Finally, shark bite response trainings can be implemented into first aid classes for lifeguards or other interested members of the public, increasing the chances of survival in the event a shark bite occurs.

However, should states fail to pass legislation implementing a council dedicated to shark control, states should still establish a council or pass other legislation that makes shark education a central value for New Englanders. Investing in a well-informed public will lead to a positive perception of sharks, which in turn will promote shark conservation, which could result in positive shark policies in the future.

#### CONCLUSION

With great white shark sightings and encounters on the rise, it is the perfect time for New England states to implement methods of shark management along their beaches. Throughout history, fear of sharks and subsequent lethal control measures have been positively correlated. However, the loss of apex predators in our ocean ecosystem has detrimental effects. Promoting volunteer involvement and establishing extensive public education campaigns could potentially shift New Englanders to a conservation-based mindset, thus pressuring local policy-makers to implement non-lethal and non-intrusive control measures. Legislatures should invest in electromagnetic interference technology, such as the SharkSafe Barrier™, which prevents sharks from entering

beach areas without any resulting shark deaths or unintended bycatch, thereby making it the most eco-friendly solution. Further, this mechanism is financially efficient and does not require long-term maintenance. These benefits, along with a decrease in shark encounters and the protection of swimmers, make electromagnetic deterrence the best practice in shark control management strategies.