Identifying and Addressing the Impacts of Marine Debris on Birds in the Gulf of Maine Region

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ATLANTIC MARINE BIRD
COOPERATIVE

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Cover photo and credit: Abandoned, lost, or otherwise discarded fishing gear on Old Orchard Beach, Maine. NOAA

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The views and conclusions contained in this publication are those of the authors and should not be interpreted as representing opinions or policies of NOAA or the USFWS. Mention of trade names or commercial products does not constitute endorsement by the U.S. government.

EXECUTIVE SUMMARY

Tangle of rope. NOAA

The cumulative impact of marine debris on birds remains understudied, though it is known to affect avian species around the globe. Identifying and Addressing the Impacts of Marine Debris on Birds in the Gulf of Maine Region is a two-part document featuring a synoptic report and an action-oriented 'Implementation Framework'.

PART I: REPORT

The report, which summarizes current research (both published and unpublished) and input from a wide array of regional stakeholders, describes the types of marine debris in the Gulf of Maine region of the United States and Canada and summarizes known impacts on birds. The most prominent types of marine debris in this region include derelict fishing gear and consumer litter (cigarettes, food packaging, miscellaneous plastics). Derelict fishing gear is described as recreational or commercial fishing nets, lines, and traps which are lost, abandoned, or discarded in the environment. The Gulf of Maine and its surrounding waters support several large, successful commercial fisheries (including lobster, finfish, and shellfish), resulting in a substantial amount of gear in the water. This gear risks becoming derelict due to irregular ocean floor topography, adverse weather, interaction with other fishing gear, or misplacement/loss. The Gulf of Maine region also supports a thriving tourist and recreation industry, thanks to its picturesque beaches, rocky coastlines, and abundant inland forests. During months of peak tourism, the increase in human use generates excess amounts of consumer waste, which has the potential of becoming litter and ending up as marine debris if not properly disposed. The impacts of marine debris on birds can be grouped into three general categories: entanglement and entrapment, ingestion, and degradation of nesting habitat.

Additional findings of interest include:

Lobster Traps

- Estimates suggest that commercial lobster fishers actively deployed approximately 3.3 million lobster traps within the Gulf of Maine in 2018 (Atlantic States Marine Fisheries Commission, 2020).
- Around 175,000 traps are estimated to be lost in the region annually, resulting in approximately $16,000,000 of lost revenue and the need to pay for replacement products, including ropes and buoys (Gulf of Maine Lobster Foundation, 2021).

Regulation Challenges

- Regulations exist in Maine (Title 12, Section 6434, Rule 25.05), Massachusetts (MASS. GEN. LAWS Ch. 130, § 31), and New Hampshire (Title XVIII, Chapter 211, Section 211:31) which make it unlawful for anyone except the licensed owner or deputized officer to raise, lift, transfer, possess, or in any manner molest any lobster trap, warp, or buoy, including lost and derelict gear.

Solutions for Fishing Gear

- Since 2008, the Fishing for Energy partnership has provided collection bins at 56 ports in 13 states, offering no-cost solutions to dispose of derelict and retired fishing gear, which has resulted in over 4.5 million pounds collected, including more than 670,000 pounds collected at a site in Wellfleet, MA (National Fish and Wildlife Foundation, 2020).

Engaging Community Scientists

- The Seabird Ecological Assessment Network (SEANET) is a volunteer program which started in 2003 in Buzzards Bay, MA, and now consists of a network of volunteers from Maine to Florida. SEANET is the only coordinated beached bird survey effort on the Atlantic coast of the United States (Tufts Center for Conservation Medicine, 2019).

In spite of these findings, this work determined that there are relatively few Gulf of Maine region-specific publications on marine debris-bird interactions, highlighting the need for additional research and actions. In light of the paucity of region-specific information, information from other parts of the United States and Canada is also incorporated into the report where applicable.

PART II: IMPLEMENTATION FRAMEWORK

The Implementation Framework ("Framework") uses information from the report and extensive partner engagement to recommend, prioritize, and guide implementation of future actions to minimize adverse effects of marine debris on birds and address priority information gaps. The Framework was developed through extensive feedback collected during a facilitated, discussion-based webinar series (three total) hosted by the USFWS in partnership with the NOAA Marine Debris Program (MDP). The webinar series brought together partners with an interest/expertise in marine debris and/or birds that may not regularly interact. During the first webinar, partners agreed upon the most pressing topics for the Gulf of Maine region (two related to filling information gaps, and two related to developing impact reduction strategies) and objectives were developed. The information collected was then reviewed and is incorporated into the Implementation Framework, a document that will allow partners and organizations to begin stepping down recommendations from the report into concrete actions that could lead to future projects. In addition to objectives for each priority topic, the Implementation Framework includes tables with relevant work completed or underway, targeted first steps that could help partners initiate projects, and potential "Barriers to Success", obstacles that may arise when meeting objectives.

Priority Information Gaps:

1. Ingestion - Better understand population & community level impacts of plastic pollution on coastal birds (including sub-lethal effects on health, food web dynamics, and exposure mechanisms)
2. Habitat - Determine significance and sources of plastic pollution and derelict fishing gear at seabird colonies

Priority Strategies:

1. Derelict Fishing Gear - Initiate, expand, and facilitate partner- and stakeholder-driven actions to aid in prevention and clean-up
2. Consumer Litter - Identify effective methods to serve data and other information to inform and/or influence legislation to reduce impacts of balloons, plastic bags, and single-use utensils.

Adult Northern Gannet feeding washed up rope, a common type of derelict fishing gear, to a chick at a Colony. While no gannets nest in the Gulf of Maine region, they are abundant in the non-breeding season. Creative Commons

PART I: REPORT

LITERATURE REVIEW & INFORMATION SYNTHESIS

Washed up debris. NOAA

BACKGROUND AND METHODS

The National Oceanic and Atmospheric Administration (NOAA), defines marine debris as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. Widely recognized as a threat to coastal and marine wildlife, marine debris interactions can potentially lead to entanglement- or entrapment-related mortality and/or adverse effects when ingested (e.g., loss of nutrition, internal injury, intestinal blockage, starvation, and death). However, the severity and magnitude of the impacts of marine debris on birds has not been well quantified in the Gulf of Maine region of the United States and Canada. In recent years, the NOAA Marine Debris Program (MDP) has coordinated the development of the Gulf of Maine Marine Debris Action Plan (MDAP) in its Northeast region, in partnership with the United States Fish and Wildlife Service (USFWS) and dozens of other agencies and organizations (NOAA Marine Debris Program, 2019). A major strategy identified in the five-year plan is, "Assessing marine debris risks to wildlife and habitat." USFWS has regulatory responsibility for all migratory birds protected under the Migratory Bird Treaty Act's (MBTA) 10.13 list, as well as all bird species federally listed under the Endangered Species Act (ESA) (MBTA, 1918; ESA, 1973). As a partner agency, the USFWS aims to conduct work to better understand the effects of marine debris on birds in support of MDAP objectives. As such, this report was compiled throughout 2020-2021 as an internship opportunity supported by the USFWS and the MDP. For the purposes of this report, the Gulf of Maine region is defined as Cape Cod, Massachusetts, to the coasts of New Hampshire, Maine, and the Canadian provinces of New Brunswick to Cape Sable, Nova Scotia. Although the information in this report will be used to assess impacts to birds in this region, core findings including strategy planning and identification of information gaps may be more broadly applicable towards addressing similar issues in other regions.

The information in this report was collected from a combination of analyzed peer-reviewed publications and "gray literature", as well as unpublished data and anecdotal accounts provided by MDAP partners and broader stakeholders.

Literature Review

The literature review included over one hundred published papers, presentations, and government documents. These literary sources were found entering combinations of the following keywords into academic search engines:

- Gulf of Maine
- Plastic
- Seabirds
- Plastic ingestion
- Marine Debris
- Fishing gear
- Marine litter
- Derelict gear
- Microplastics

Expert Inquiry

In addition to a literature review, an inquiry (Appendix II) was created and disseminated through Google Forms to MDAP partners and other topic experts in the U.S. and Canada to solicit unpublished and anecdotal accounts of marine debris and bird interactions in the Gulf of Maine. A first inquiry was sent on July 15th, 2020, and respondents were given two-and-a-half weeks to provide feedback. A second inquiry was sent on November 2nd, 2020, and respondents were given four weeks to provide feedback. In total, over the course of five months, 37 responses were recorded via Google Forms, email, and telephone.

Organizational Representation

To obtain responses and information from a representative set of experts, the inquiry was sent out to partners representing federal agencies, state or provincial departments, non-governmental organizations (NGOs), academia, and other groups. Overall, the inquiry was sent to 69 people, with 37 replying (Appendix I), a 53.6% response rate. The representation of respondents during the inquiry phase of this project can be seen in the following table (Table 1). Information from the expert inquiry is included throughout the document to supplement information summarized from the literature review and used to identify gaps to address in future research and monitoring efforts.

Table 1. Number of people contacted from each type of organization and response rate.

Organization Type	Contacted	Replied	Response Rate
Federal Agency	21	11	52.4 %
State or Provincial Agency	8	3	37.5 %
NGO	25	13	52.0 %
University	12	9	75.0 %
Other	3	1	33.3 %
Total	**69**	**37**	**53.6 %**

Derelict fishing gear and other debris found on a seabird nesting island site. Linda Welch

TYPES OF MARINE DEBRIS

Although the NOAA definition of marine debris encompasses any persistent manufactured solid material, the types and distribution of specific materials vary from region to region depending on prevalent industries, human population sizes, and oceanographic and meteorologic influences (e.g., currents and prevailing winds). Distributions of debris are also influenced by applicable laws and regulations which can restrict types and quantities of debris. In the Gulf of Maine, where the economy relies heavily on the fishing industry, derelict fishing gear is a common form of marine debris. Gear from fishing vessels which has the potential to become derelict (abandoned, lost, or discarded) includes fishing nets (twine and monofilament), fishing lines (rope, monofilament, and dragger cable), fish boxes, bait barrels, crab/lobster traps and all their components, buoys, shellfish nets, shellfish bags, packing straps from boxed bait, and rubber gloves. Although the specific type of gear used by some fisheries has higher potential of becoming derelict due to materials and location deployed, this issue is found across all types of fishing gear.

Consumer litter has widespread impacts and is generally more abundant in areas with high levels of human use (Gössling, 2002; Alessi & Di Carlo, 2018; United Nations Environment Programme, 2020). A substantial amount of the world's marine debris comes in the form of plastics, which have seen drastically increasing usage since their introduction as a major component of consumer packaging. The annual world production of plastics has increased from 1.7 million tons in the 1950s, when mass production of plastics started, to 368 million tons in 2019 (PlasticsEurope, 2020). The U.S. Environmental Protection Agency (EPA) notes that in most parts of the developed world, packaging constitutes as much as one-third of the non-industrial solid waste stream, including just over 28% in the United States (U.S. EPA, 2020); however, at the time of this report (July 2021), the United States has no federal packaging mandates. Despite continuing industrial reliance on plastic packaging and production, the U.S. EPA estimates that less than 9% of plastics are recycled (U.S. EPA, 2020). Increases in production of single use plastics with minimal recycling potential leads to conditions that increases the likelihood that they will enter the marine environment from land-based sources via rivers and streams, or direct discarding from vessels at sea. Once present in the marine environment, plastic marine debris is exposed to degrading forces such as UV-B radiation and physical abrasion by wave action (Andrady, 2011). Plastic marine debris items will progressively fragment into smaller and smaller pieces, until they become microplastics, generally defined as plastics smaller than 5mm in size, though this definition has historically varied amongst scientists (Barnes et al., 2009; Frias & Nash, 2019). Eriksen et al. (2014) estimated that 268,940 tons of macro- and microplastic particles were floating across the world's ocean and seas.

Derelict Fishing Gear

Lobster traps and other debris pulled from the water during a clean up in the Gulf of Maine. Linda Welch

Of the various types of marine debris found in the Gulf of Maine region, derelict fishing gear is one of the most extensive and widespread threats to seabirds and other marine life. Derelict fishing gear is described as recreational or commercial fishing nets, lines, ropes, traps, and buoys which are lost, abandoned, or discarded in the environment. According to reports from the Food and Agriculture Organization of the United Nations, about 640,000 tons of derelict fishing gear is added to the ocean yearly, which is approximately 10% of the world total of marine debris (Macfadyen et al., 2009). Fishing gear can become "derelict" through accidental loss at sea due to gear conflict (when nets or rope from different vessels or fisheries become entangled), misplaced or poorly placed gear, irregular seafloor topography (where nets, traps, and rope become stuck on the seafloor or chaffed on the rocky bottom), and adverse weather (Hammer et al., 2012). Additionally, fishing gear can be intentionally abandoned at sea, which can happen to conceal illegal fishing practices or because of disposal costs. Multiple inquiry respondents and other project partners have reported nets and traps being discarded at sea when damaged because it can be cheaper than proper onshore disposal. With the Gulf of Maine's large lobstering industry, lobster traps are an important category of marine debris in the region. In Maine, the overall value of the lobster fishery was estimated at over $533 million in 2016 (Maine Department of Marine Resources, 2017). Estimates conducted by the Atlantic States Marine Fisheries Commission (2020) suggest that commercial lobster fishers actively deployed approximately 3.3 million lobster traps within the Gulf of Maine in 2018. This substantial trap usage leads to extensive trap loss and associated financial costs; each year around 175,000 traps are estimated to be lost in the region, costing the lobster industry around $16,000,000 annually. (Gulf of Maine Lobster Foundation, 2021). When examining surrounding areas, Macfadyen et al. (2009) also found that Canadian Atlantic gillnet fisheries lose about 2% of nets per boat per year, and Newfoundland cod gillnet fisheries lose 5,000 nets per year. While these areas are outside the boundaries of the Gulf of Maine, they are important to consider in the context of derelict fishing gear, because ocean currents and prevailing winds can cause extensive movement and accumulation of lost gear into adjacent regions (NOAA Marine Debris Program, 2015).

Aquaculture is another seafood industry in the Gulf of Maine region that can produce derelict gear. The Food and Agriculture Organization of the United Nations (2018) identified aquaculture as the fastest growing food production sector in the world. In Maine, the total economic impact of aquaculture is growing rapidly on an annual basis, developing from an estimated $50 million in 2007 to $137 million in 2014, with continued expansion expected over the next several years (Cole et al., 2017). While effects of derelict aquaculture gear on birds are not yet well understood, with rapid industry growth comes the potential for increased equipment from farms entering the marine environment and creating additional floating and sinking debris. Report authors found no studies that quantified marine debris from aquaculture gear loss in the region. However, seabird researchers and public land managers from both the U.S. and Canada have documented washed-up aquaculture netting, cages, and floats across a wide area. Outside the Gulf of Maine region, several publications indicate that aquaculture projects produce marine debris worldwide, causing various detrimental impacts to seabirds and other wildlife (Forrest et al., 2009; Astudillo et al., 2009; Andréfouët et al., 2014).

"Ghost gear", which is uncontrolled derelict fishing gear in submerged habitats, presents its own set of unique issues as it continues to fish, trap, entangle, and potentially kill marine life under the surface. Ghost fishing can impose a variety of harmful impacts, such as killing target and non-target organisms, including endangered and protected species; causing damage to and smothering underwater habitats such as coral reefs and benthic fauna; and act as a hazard to navigation long after it is lost at sea (NOAA Marine Debris Program, 2015). Early research into ghost fishing began in the 1970s (High, 1976; Pecci et al., 1978), shortly after the 1973 prohibition of abandonment or dumping of fishing gear by the International Maritime Organization Convention for the

Prevention of Pollution from Ships (NOAA Marine Debris Program, 2015). In addition to causing trap and entanglement risks at sea, abandoned gear may eventually wash up on beaches, posing threats to birds in coastal areas, and reducing or negatively affecting their coastal nesting habitat. The access to and removal of gear washed up on shore poses its own set of risks to wildlife and land managers. For example, the NOAA Office for Coastal Management reports that the state of Maine has over 3,400 miles of "tidal shoreline", which includes offshore islands, sounds, bays, rivers, and creeks to the head of tidewater or to a point where tidal waters narrow to a width of 100 feet (NOAA Office of Coastal Management, 2021). Most of this shoreline, however, is very rocky and difficult to navigate, making it very challenging to reach areas where derelict gear is accumulating and even harder to remove, extending exposure durations and potential impacts on birds. Synthetic fishing gear is functionally resistant to degradation in the water, and, once discarded or lost, this gear may remain in the marine environment for decades (Good et al., 2010). Butler & Matthews (2015) estimated that a new wooden trap can remain intact for about 16 months, while PVC-coated wire traps, now in common use, can last for at least two years.

Consumer Litter

Cracked bowling ball found during beach cleanup. NOAA

Consumer litter is generally derived from land-based sources (Nelms et al., 2017) but can end up in waterways, and ultimately the ocean, affecting coastal and seabirds in the Gulf of Maine region. Consumer litter, which includes plastic bottles and caps, balloons, plastic bags, cigarettes, food packaging, and various other commercial and industrial items, can accumulate in the marine environment due to improper consumer disposal, faulty recycling management, and industry use of excessive plastic packaging. The tourism industry in the Gulf of Maine attracts huge numbers of visitors every year. Although this provides an economic boom for the region, it also has the potential to add a large amount of consumer waste to coastal and marine ecosystems. In 2018, state offices of tourism for Maine and Massachusetts reported 37.1 million and 30.1 million visitors, respectively. According to the U.S. EPA's Trash Free Waters Program, one-third to two-thirds of the debris cataloged on beaches comes from improperly disposed single-use, disposable plastic packaging from food and beverage-related goods and services (plastic cups, bottles, straws, utensils, and stirrers) (U.S. EPA, 2021). Plastic consumer litter often degrades into meso- and microplastics, which persist in the environment and may be consumed by many seabird species (Gall & Thompson, 2015). This plastic debris occurs in waters and on shorelines worldwide, including far-removed regions of Antarctica, where they are carried by ocean currents (Zarfl & Matthies, 2010). Within Gulf of Maine waters, it has been estimated that the average plastic concentration (any-size pieces) is 1,534 ± 200 pieces km^{-2}, which is relatively low compared to open ocean trawls (Law et al., 2010). However, research implies that seabird ingestion rates scale with plastic exposure, so ingestion rates will likely increase into the future as plastic usage in this region expands (Wilcox et al., 2015).

While this report was being drafted, the COVID-19 global pandemic erupted, becoming an additional source of consumer litter. National health organizations recommended precautionary measures like wearing a mask in public, disinfecting high-activity surfaces multiple times a day with cleaners often in single use containers, and using single-use utensils to avoid transmission. These actions have increased the production and use of plastic products like personal protective equipment (masks and gloves), single-use plastic bags, food and beverage containers, and other single-use plastics (Ocean Conservancy, 2021). During the peak months of the pandemic, an estimated 129 billion face masks and 65 billion gloves were used each month across the world (Prata et al., 2020). Data collected by organizations that host national coastal clean-up efforts (e.g., Ocean Conservancy, Surfrider Foundation) have already shown that the additional plastic products in the waste stream have increased marine debris. Although many actions to reduce consumer litter have been building momentum in recent years in the Gulf of Maine region (see Strategies section), the COVID-19 pandemic's impact on plastic production and consumer usage will almost certainly have detrimental effects on birds via additional marine debris well into the future.

IMPACTS OF MARINE DEBRIS

Sanderling tangled in beach debris. Ingrid Taylor, Creative Commons

The accumulation of marine debris can alter and degrade marine habitats through abrasion, shearing, or smothering, and can change the physical and chemical composition of sediments (NOAA Marine Debris Program, 2016). In addition to physical changes to the landscape or seascape, marine debris can also impact the organisms that it interacts with. The first comprehensive review of the impacts of marine debris on seabirds was done by Laist (1997), which references published reports from as far back as the early 1970s. These impacts can be categorized into three main areas: entanglement and entrapment (both on land and at sea), ingestion of marine debris, and degradation of nests and breeding colonies (i.e., incorporation of marine debris, increased predation, and loss of habitat).

Entanglement and Entrapment

Entanglement and entrapment of coastal birds in marine debris can occur both on land (discarded plastic materials like monofilament line) and at sea (derelict fishing gear), resulting in impacts such as cuts and abrasions to skin, impeded mobility (increasing risk of starvation or predation), and drowning (Laist, 1997; Kühn et al., 2015). Although species-specific risk factors have not been comprehensively described, the literature suggests that foraging behavior and phenological factors may play a role. Diving birds are at risk while pursuing fish underwater, particularly when some forage fish species and their prey aggregate in and under the relative safety of the netting, which results in entanglement of their predators (Good et al., 2009). Observations of entanglement tend to be relatively infrequent or poorly documented in most species, and many entanglements occurring at sea may go unobserved. Therefore, it is likely that more bird species are entangled than are readily observed (Laist, 1997; Kühn et al., 2015). Laist (1997) lists 138 seabird species worldwide with entanglement or ingestion records. In the Continental U.S. and Hawaii, a minimum of 44 species of seabirds have been documented to be entangled in marine debris (Harris et al., 2006; Moore et al., 2009; NOAA Marine Debris Program, 2014a). Ryan (2018) conducted a worldwide search using Google Images and other image search engines to compile entanglement records that had been photographed by residents of the area but had not been published or captured in reviews to date. With this method, a total of 265 bird species were recorded entangled in apparently discarded plastic or other synthetic materials (55.5% were seabirds).

In the Gulf of Maine region, coastal birds and seabirds can become entangled in derelict fishing gear and discarded consumer debris. Report authors were able to find few published accounts of seabird entrapment or entanglement with marine debris in the region. Harris et al. (2006) surveyed beaches in Cape Cod, MA, in 2003 –

2004 and indicated 6.7% of dead seabirds found were caught with hooks, entangled in monofilament line, or trapped in nets, and that 2.2% were entangled in additional types of marine debris. Cline & Hatt (2011) published observations of Blue Jay (Cyanocitta cristata) mortality in idle lobster traps stored on Merepoint Neck in the Town of Brunswick, Maine, showing that land birds are also vulnerable to entrapment.

Guillemot entangled in lobster trap. Stephen Kress

Although very few studies have quantified precise numbers of birds lost due to derelict fishing gear in Gulf of Maine region's waters, studies from other parts of the world may provide insight on the magnitude of potential impacts. Using bottom trawl surveys in Puget Sound and the Northwest Straits, the Washington Department of Fish and Wildlife (WDFW) estimated that up to 117,000 derelict nets and traps weighing approximately 2.6 million pounds lay beneath the waters of that area (Good et al., 2010). A study done by Good et al. (2010) in Puget Sound showed that within the 870 recovered derelict gillnets, over 500 seabirds were found dead, representing at least 15 identifiable species. The actual number was likely higher, but decomposition of older specimens made classification of some individuals impossible.

Ingestion

With an estimated 15 - 51 trillion pieces of plastic currently floating in the world's oceans, the ingestion of plastic and other marine debris poses a serious risk to seabirds (van Sebille et al., 2015). Seabirds can ingest plastic both directly and through secondary consumption via their prey or in regurgitate fed to chicks (Caldwell et al., 2019; Boerger et al., 2010). Ingested debris has been documented in seabirds ranging from pole to pole, and they have been proposed as bioindicators of plastic pollution due to the ease with which such studies can be conducted and the roles they play as top predators in the marine environment (Auman et al., 2004; Nevins et al., 2005). A literature review by Kühn et al. (2015) found that about 50% of the world's seabird species have been affected by marine debris ingestion, and the problem is predicted to grow. Recent models predict that 99% of seabird species, and 95% of individual seabirds, will have ingested plastic by 2050 (Wilcox et al., 2015). The effects of ingestion have been more widely studied than many other impacts of marine debris on birds (NOAA Marine Debris Program, 2014b). Ingestion of marine debris by seabirds can lead to physical damage and blockage of the digestive tract, impairment of foraging efficiency, and absorption of associated toxins (Ryan, 1990). While research is limited, some data on the ingestion of plastic marine debris suggest the transfer of plastic-derived chemicals to the tissues of marine-based organisms like seabirds (Tanaka et al., 2013).

Common Tern in Maine found with balloon string partially ingested. L. Smith

Roman et al. (2019b) examined 1,733 seabird carcasses obtained as fisheries bycatch, from veterinary offices, and that had washed up on shores from Australia and New Zealand. Carcasses were necropsied and debris visible to the naked eye was removed and analyzed. They found that 557 (32.1%) had ingested marine debris, which could be seen as an underestimate due to the size of some microplastics and their difficulty to quantify.

Of all the debris types extracted from carcasses, balloons were the most likely to cause mortality. Once released into the air, balloons deflate or pop and can make their way into waterways, becoming floating debris. Deflated or popped balloons in the ocean can be mistaken for food and ingested, can entangle marine organisms, or can break down into smaller fragments left to impact other sections of the environment. Furthermore, the study found that ingestion of balloons or balloon fragments were the confirmed or suspected cause of death in 18.5% of seabirds that ingested them. In addition, the ingestion of a balloon or balloon fragment was 32 times more likely to result in death than ingestion of a hard-plastic fragment because these soft and pliable items resist peristalsis and become obstructions (Roman et al., 2019b).

In the Gulf of Maine, Caldwell et al. (2019) collected gastrointestinal tracts, regurgitant, and pellet samples from a mixed-species gull colony on Appledore Island, ME, and from a protected tern-gull colony on White/Seavey Island, NH. Of the two gull species investigated, Herring Gulls (Larus argentatus), more generalist scavengers, experienced more frequent exposure to plastic debris in their diets than Great Black-backed Gulls (Larus marinus), which are considered more specialist predators. Their findings supported their hypothesis that generalists experience higher instances of plastic consumption than specialists. Seabirds and other visual foragers may physically accumulate certain types of macroplastics (defined here as greater than 5mm) in higher quantities due to characteristics such as color and shape (Caldwell et al., 2019). Robuck et al. (2021) conducted research on Great Shearwaters (Ardenna gravis) caught as commercial fisheries bycatch in or adjacent to Massachusetts Bay in the southern Gulf of Maine region. During this research, 217 birds were necropsied and assessed for plastic ingestion. Results indicated that most of the birds contained ingested plastic fragments (an average of 8-10 per bird), although one bird contained up to 200 pieces. Juveniles more frequently contained ingested plastics than adults. Two hundred and two sand lances, a primary food source for shearwaters and other seabirds, were also sampled from the areas where shearwaters were collected, and did not contain any plastic items in the same size range as those seen in the shearwaters, suggesting the birds were directly ingesting plastic loads from the environment. Importantly, the study found that Great Shearwaters from the Gulf of Maine contained similar plastic loads to Great Shearwaters sampled in South American waters closer to their breeding range. This suggests that plastic items are being ingested throughout their life cycles in different parts of the species range.

When ingested by birds, plastics can also be offloaded to chicks as a form of secondary consumption. Just outside the boundaries of the Gulf of Maine region, Krug et al. (2021) found that that 87.5% of recently fledged Leach's Storm-petrels from Baccalieu Island (the species' largest colony in the world) in Newfoundland and Labrador contained plastic as a result of adults feeding chicks via regurgitation.

DEGRADATION OF NESTING HABITAT

Herring Gull found at a seabird colony on Appledore Island (ME), fatally entangled in fishing line. The line also wrapped around a shrub, preventing the bird from freeing itself. Sarah Courchesne

Although impacts of incorporating marine debris into breeding colonies and nests are not well studied, such impacts may include both entanglement/entrapment and ingestion (Bond et al., 2012). Some seabirds collect anthropogenic debris to use as nesting material (Hartwig et al., 2007) increasing entanglement probability at breeding sites. The likelihood of birds selecting marine debris for nest construction depends in part on the availability of natural materials close to the nest site (Witteveen et al., 2017). Votier et al. (2011) conducted a study that focused on nest incorporation by observing the third largest colony (approx. 40,000 pairs) of Northern Gannets (Morus bassanus) in the world, located in Grassholm, Wales. They estimated that 18.46 tons of plastic was present in gannet nests in this single colony, with content dominated by rope made from synthetic fibers (83%), followed by fishing nets (15%). In the Gulf of Maine region, there are numerous anecdotal accounts of seabirds incorporating marine debris into nests, though published accounts in the literature are limited. In one published account, 188 of 497 nests (37%) on Double-crested Cormorant (Phalacrocorax auritus) nesting islands in Maine, which were examined over a two-year period, contained plastic debris (Podolsky & Kress, 1989). Sections of lobster trap line, plastic bags and pieces of fishing net dominated the debris, and in most cases, the plastic was woven into the nest to be used as nesting material. In a few cases, plastic debris was on the surface of the nest cup and may have been regurgitated with food for the young.

Nesting sites can also be altered indirectly through the production and presence of consumer litter. When discarded along coastlines and beaches that support seabird colonies, food-related garbage, including packaging, is known to increase density and activity patterns of seabird nest predators, thereby lowering productivity at colonies (USFWS, 1996). Human generated food-related waste can create artificially inflated populations of commensal predators, impacting productivity of seabirds and other coastal species (Hunt et al., 2019). Examples of increases in predator communities associated with increased human waste, such as food wrappers and take-out containers, include a study showing increasing local populations of skunks and raccoons with increased availability of trash at summer homes (Raithel, 1984) and another showing correlations between higher densities of fox tracks and more intensive human use in beach areas (Strauss, 1990).

Marine debris at nesting sites not only increases chances of entanglement, ingestion, and predation, but also takes up significant physical space, resulting in the loss of nesting habitat. As sea levels continue to rise, an already small amount of available nesting habitat space is being reduced even further as marine debris accumulates in these areas. In the Gulf of Maine, seabird colonies can occur on extremely remote islands. However, despite an absence of direct human disturbance, they are regularly subject to large volumes of washed-up fishing gear and other marine debris, requiring managers to expend extensive resources to remove waste prior to each breeding season (Linda Welch, pers comm). In addition, washed up plastic items in marine environments are commonly colonized by a diversity of encrusting and fouling invertebrates, some of which can become invasive in their new habitat (Gregory, 2009) or which may harbor pathogens, such as some members of the genus Vibrio (NOAA Marine Debris Program, 2017).

See Appendix III for a list of seabirds and marine waterfowl species documented to have been affected by marine debris in the Gulf of Maine region.

A two year study of breeding cormorants in Maine found that nearly 40% of nests contained plastic debris (Podolsky & Kress, 1989).

Above: Double-crested Cormorant (Phalacrocorax auritus) nests with marine debris incorporated into them, found at Spectacle Island (Cobscook Bay), Maine Coastal Islands NWR. Linda Welch

Right: Marine plastics floating in the ocean. Heath Alseike, Creative Commons

STRATEGIES

Sorting debris and collecting data. Center for Coastal Studies

Strategies to address marine debris can vary in scale from international policy to local, and scope from mandatory policy to voluntary actions. One of the earliest international regulations adopted to reduce marine waste on a large scale was the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), specifically Annex V. This section, which initiated a volunteer observer program in December 1988, specifies how different types of garbage must be handled in the offshore environment, and sets minimal disposal distance from land that it can be dumped. Most importantly, the Annex imposes a complete ban on at sea disposal of any form of plastic (International Maritime Organization, 1992). In the United States, the Marine Protection, Research, and Sanctuaries Act (MPRSA), often referred to as the Ocean Dumping Act, was also enacted in 1988. This regulation imposes broad prohibitions on the transportation of material from within the United States for the purpose of ocean dumping. It also bans U.S. agencies and/or U.S.-flagged vessels from transporting material from any country for the purpose of ocean disposal (MPRSA, 1988). The NOAA Marine Debris Program was created through the signing of the Marine Debris Research, Prevention, and Reduction Act in 2006. The Act requires the program to "identify, determine sources of, assess, prevent, reduce, and remove marine debris, and address the adverse impacts of marine debris on the economy of the United States, marine environment, and navigation safety" (MDRPR, 2006).

Today, people in many areas of the world are coming up with creative ways to combat the ever-increasing challenges of marine debris. Below, we offer some examples of strategies and actions from the Gulf of Maine and beyond.

ADDRESS DERELICT FISHING GEAR

Over the past 400 years, commercial fisheries have remained an important part of the social and economic fabric of the Gulf of Maine, in spite of both changing ecosystems and regulatory requirements during this period. Fisheries in this region support thousands of jobs and annually contribute hundreds of millions of dollars to the economy (Lapointe, 2013). Given the scale of the industry, it is important to better understand how it contributes to marine debris production in the region so impacts can be addressed. The following section introduces several strategies and examples that could be used to begin addressing derelict fishing gear, including changes to local regulations, improving gear disposal activities, and establishing partnerships which help both the fishers and the region's wildlife. Effective local programs have often been spearheaded by non-governmental organizations; for example, Traps 2 Treasure, which is organized by OceansWide in Gouldsboro, Maine, is a program that collects old gear from fishers as a $2/trap tax write-off and then uses the money to engage students in future projects through research and educational opportunities.

Change Regulations To Facilitate Lobster Trap Cleanups

Although lobster traps remain one of the largest sources of derelict fishing gear in the Gulf of Maine region, in Maine, it is unlawful for anyone except the licensed owner, or a Marine Patrol Officer, to "raise, lift, transfer, possess, or in any manner molest any lobster trap, warp, buoy, or lobster car" under Lobstering Laws ("Molesting Lobster Gear": Title 12, Section 6434, Rule 25.05). Similar laws exist in Massachusetts (MASS. GEN. LAWS Ch. 130, § 31) and New Hampshire (Title XVIII, Chapter 211, Section 211:31). This regulation prevents non-profits and non-governmental organizations that organize and conduct volunteer beach sweeps and cleanups from collecting, discarding, and/or disposing of washed-up derelict fishing gear in a timely manner without specific authorization, regardless of who owns the property (e.g., public vs. private) where the gear washes up (USFWS wildlife refuges are an exception). In addition, regulations also prevent vessel operators from transporting gear that does not belong to them without express permission from the owner or a marine authority; for example, if a scallop dragger encounters derelict lobster gear in a tow, it may only return it to shore with proper authorization. A collaboration between industry, non-governmental organizations, researchers, and state agencies could work to improve the wording of the laws and amend regulations that prevent additional parties from aiding in the clean-up efforts.

Identify And Eliminate Illegal Gear Dumping Zones

Several topic experts responding to the expert inquiry also indicated that illegal "gear dumping" zones exist in the Gulf of Maine region, where both commercial and recreational fishers have abandoned gear because it is cheaper and easier to discard a damaged item at sea than to transfer the gear for onshore disposal. A first step towards addressing this issue would be to locate these zones and understand the timing and extent of gear dumping activities, which could assist managers in documenting these events and aid in regulatory changes. Strengthening license conditions to require harvesters to report lost gear could also increase responsibility of license holders and help reduce marine debris at its source.

Emphasizing open communication between state/provincial and federal agencies, and local fisher organizations can also aid in the recovery efforts for derelict fishing gear. In Canada, the Department of Fisheries and Oceans (DFO) has used their Sustainable Fisheries Solutions & Retrieval Support Contribution Program (known more simply as the "Ghost Gear Fund") to authorize and encourage fishers and other members of the public to report

Above: Taking samples of fishing nets to be recycled. Gulf of Maine Lobster Foundation

Since 2013, the Center for Coastal Studies has worked with fishers and volunteers to remove over 85 tons of derelict fishing gear. Gear is recycled, upcycled, incinerated, or returned to the owners.

Right: Derelict lobster traps being cleaned up at Frenchboro Preserve, Maine. T. Towne

previously lost or recently retrieved gear, and create an associated database. This system does not implicitly identify illegal dumping but can help agency officials distinguish areas with potentially high quantities of derelict gear that may become problematic, including areas with high fishing intensity and/or areas subject to increased loss potential due to seasonal weather extremes. In these areas, partners can work to retrieve the gear promptly to avoid increased risks of detrimental interactions with wildlife. Outside the Gulf of Maine region, the Washington State Department of Fish and Wildlife established a similar "no-fault" reporting mechanism for fishers who lose nets. For the majority of derelict nets, agencies have no way of knowing how long they have been derelict before being detected. No-fault systems encourage reporting of derelict gear by divers, fishers, scientists, and the public without fear that they would be held responsible for the waste (Good et al., 2009). Both programs could be modified and adopted for the entirety of the Gulf of Maine region, benefitted by the development of a centralized reporting system to allow for increased strategizing and coordinated recovery efforts in the U.S. and Canada (see next section for additional solutions related to gear retrieval).

Establish Partnerships To Aid In Prevention

The establishment of partnerships between state agencies and non-governmental organizations, and with local fisher groups has also led to initiation of effective activities that reduce impacts of derelict gear. The Gulf of Maine Lobster Foundation (GOMLF) has led an effort to recover and dispose of derelict fishing gear and marine debris with its three-pronged 'GEAR GRAB' initiative, designed to inform, involve, and improve the lives of fishers and the communities in which they live along the Maine coast (Gulf of Maine Lobster Foundation, 2021). In 2010 – 2011, seventy boat captains volunteered their time, staff, and vessels, in exchange for a small fuel stipend. During this project, the GOMLF collected over 43 tons of derelict gear. This included 3,372 ghost traps (with 1,100 traps being returned to their owners) and 21 tons of recyclable steel salvaged from non-useable traps. It should be noted that this program would not be possible without the GOMLF's work with the Maine Department of Marine Resources to secure special permits to allow the handling and recycling of the gear. GOMLF is currently the only organization in Maine permitted to do at sea recovery work under such authority. The Center for Coastal Studies in Provincetown, Massachusetts, also works with volunteers and fishers to identify, document, and properly dispose of derelict fishing gear from Cape Cod Bay and the Cape Cod National Seashore. Since 2013, over 85 tons of derelict fishing gear has been removed, recycled, upcycled, incinerated, or returned to the owners (Ludwig, pers comm.). All gear is also carefully catalogued to provide an assessment of the type, quantity, and extent of derelict gear in the area. In Canada, the Ghost Gear Fund provides grants to third parties to retrieve gear and report data, which helps track the distribution and density of ghost gear. These programs also facilitate responsible disposal, including the return of gear to owners (if they can be identified by a unique tag number and gear is still in good shape), recycling, and repurposing. In 2020, over 63 tons of gear, which included rope, dragger cable, and traps dating back to 1988, were removed from the waters of Atlantic Canada (Global Ghost Gear Initiative, 2020). The Ghost Gear Fund programs are not as effective for recovery of U.S. lobster traps and fishing nets. Since there is no common system shared by both countries linking gear identification tags to specific fishers, parties that find the traps are generally unable to return them to their owners. As noted in the previous section, the development of a centralized reporting and tracking system would allow for coordinated recovery efforts on both sides of the border.

The U.S. portion of the Gulf of Maine region has a similar program to Canada's Ghost Gear Fund, the Fishing for Energy program. This effort, a partnership between of the National Fish and Wildlife Foundation (NFWF), National Oceanic and Atmospheric Administration Marine Debris Program, Covanta, and Schnitzer Steel, provides commercial fishers with no-cost solutions to dispose of derelict and retired fishing gear and offers competitive grants to reduce the impacts of derelict fishing gear on the environment (National Fish and Wildlife Foundation, 2021). Since 2008, the program has provided collection bins at 56 ports in 13 states, resulting in over 4.5 million pounds of derelict fishing gear collected (as of December 2020). The local communities of Wellfleet, Massachusetts, and Port Judith, Rhode Island, have used this program particularly effectively, collecting more than 670,000 pounds and 410,000 pounds of gear, respectively (National Fish and Wildlife Foundation, 2020; Covanta 2019).

Outside the Gulf of Maine region, effective programs have been developed that reduce derelict fishing gear through both incentives to bring it back to shore for proper disposal, and penalties assessed to gear owners that abandon gear at sea. A state-sponsored retrieval program organized by Florida's Fish and Wildlife Conservation Commission (FWCC) is one such example. Vessel operators are contracted and partnered with an FWCC observer. Observers are responsible for verifying the number of traps collected, recording the license information, and mapping the location data from each trap retrieved. Vessel operators receive compensation for their service. Traps recovered as part of this program are recycled or properly destroyed, and a retrieval fee is assessed to the owner per trap, covering the cost of the program (Florida Fish and

Wildlife Conservation Commission, 2021). Although fisheries are managed differently in Florida than in the Gulf of Maine region (closed area and season depending on the fishery), this type of program could be creatively adapted for use in the Gulf of Maine region.

Teach Proper Gear Handling Techniques And Storage

The simplest way to reduce derelict fishing gear is to prevent it from becoming derelict in the first place. This is especially true for lobster traps. As described by the Center for Coastal Studies, over 5,000 recreational lobster trapping permits are issued annually in the Gulf of Maine (L. Ludwig, pers. comm.), but little to no training is required for these permits, which greatly increases the potential for improper fishing methods and associated gear loss. Many derelict traps that are recovered in Cape Cod Bay are lightweight and small, which suggests they are recreational gear, rather than the heavier and larger commercial traps (Ludwig, 2019). Massachusetts, New Hampshire, and Maine all have comparatively strict permitting requirements for obtaining a commercial lobstering license. However, a non-commercial (recreational) lobster and crab license in Maine can be much more easily obtained by filling out a short application and completing an open-book, online exam. Increasing the number of instructional programs, such as those run by the Massachusetts Division of Marine Fisheries and similar organizations, promoting them to the public, and even making them mandatory for receiving recreational permits can help fishers by preventing loss of their investment in fishing gear, and decrease incidences and impacts of derelict gear on marine habitats and wildlife.

Proper storage of traps and fishing gear, once removed from the water, can also help reduce their impacts on coastal bird species. Cline & Hatt (2011) recommended that thorough removal of bait would prevent luring of birds to traps when they are pulled from the ocean for storage. Elimination of residual bait is especially important if trap storage occurs during periods when food for terrestrial birds is limited. During times of low food availability, birds are more likely to seek out new or additional food sources, including bait, incidental bycatch, or remnant invertebrates that may not have been thoroughly cleaned out of the traps. Because the structure of these piled-up traps may also attract a variety of passerines, storing traps indoors can limit interactions. Traps that need to be stored outdoors should have their entrance funnels obstructed, thus preventing unintended capture of terrestrial birds. Traps could also be covered (e.g., with a tarpaulin) to further protect against inadvertent trapping.

GOMLF working with fishermen to provide proper disposal for end-of-life nets which includes repurposing and recycling. Gulf of Maine Lobster Foundation

REDUCE CONSUMER LITTER

Reducing consumer litter is another strategy that could lessen the impacts of marine debris by minimizing its creation and eliminating improper disposal. Two ways to achieve the goal of reducing consumer litter include enacting more effective legislation and policy, and increasing volunteer engagement and public outreach. Recent studies have shown the effectiveness of legislative changes. Clean Virginia Waterways of Longwood University found that plastic bottles, glass bottles, and aluminum cans are approximately two and half times more frequently littered in Virginia (a state without a bottle bill) than in states with bottle bills (like Massachusetts and Maine) (Register, 2020). Schuyler et al. (2018) also found that state-based Container Deposit Legislation (CDL) has a demonstrable effect on keeping containers out of the environment: states with a CDL had an approximately 40% lower mean proportion of containers found in coastal debris surveys than states without one.

Legislation & Policy

Mylar and rubber balloons have been documented as a major type of consumer litter and are particularly harmful to seabirds when ingested. In July 2021, the State of Maine (LD 618) banned the intentional mass release of balloons in an effort to reduce their environmental impact. The bill prohibits releasing more than 24 balloons at a time and includes fines between $100 and $500. States along the Atlantic Coast, including Rhode Island and New Jersey, are currently considering similar legislation that would deter and eventually stop the intentional release of balloons outdoors. In New Jersey, a 2020 legislative proposal (A4322) was drafted that stated releasing one or many balloons could result in a $500 fine throughout the state. Although this proposal has not been enacted, as of September 2018, fifteen municipalities in New Jersey have passed local bans on the intentional release of balloons. A bill currently proposed in Rhode Island (2020-H 7261) would prohibit any intentional release of balloons except for scientific or meteorological purposes (with government permission), hot air balloon launches (as long as the balloons are recovered), and indoors. At the time of this writing (August 2021), neither proposed bill had been adopted.

Many states are passing legislation to regulate the intentional release of ballons to help protect seabirds and other wildlife. Lisa Sette

Balloons are not the only anthropogenic threat to seabirds that could be reduced through regulatory changes. Across multiple studies, researchers have found that seabirds are especially prone to consuming plastic bags, particularly after they have broken down into smaller pieces of plastic film (O'Brine & Thompson, 2010; Lindborg et al., 2012; Bond et al., 2013). Regional legislation on packaging and plastic containers could slow down the rate they enter the marine ecosystem and become debris. Single-use plastic packaging (including bags) is not only harmful to seabirds, but also impacts coastal foraging habitat shorebirds and other marine life. One study found that, within nine weeks, the presence of plastic debris in the intertidal zone significantly altered the community structure and abundance of sediment infauna, reducing the number of invertebrates living within the sediment (Green et al., 2015). In response to the threat from plastic bags, Maine passed a statewide ban in 2019 on single-use plastic bags from retailers; however, due to the ongoing COVID-19 pandemic, the enforcement of this ban did not go into effect until July 2021 (Maine Department of Environmental Protection, 2021). Massachusetts has 144 cities and towns (as of June 2021), representing over 60% of the state's population, that regulate single-use plastic shopping bags (Massachusetts Sierra Club, 2021). However, Massachusetts currently does not have any state-wide regulation. Neighboring Gulf of Maine state New Hampshire also lacks state-wide regulation and possesses fewer municipal regulations than Massachusetts.

Single-use plastic drinking straws are also a substantial consumer litter concern that are being addressed by both regulatory changes and responsible businesses. A complete plastic straw ban can preclude essential uses (e.g., for customers with disabilities) and can be difficult to establish. However, restaurants and other retailers can institute policies to help reduce straw waste, such as limiting them to customers only upon request, and only

offering straws composed of natural fibers (bamboo, hay, cardboard, etc.). Maine's largest city, Portland, phased in an ordinance in April 2020 which made all types of single-use straws, stirrers and splash sticks available only upon customer request. As of January 1, 2021, distribution of all plastic beverage straws, stirrers and splash sticks will be prohibited, while those made from alternative materials will be available upon request (City of Portland, 2021). New Hampshire and Massachusetts legislators have introduced similar bills (MA Bill S.2450 and NH HB 1472, for example) that would make plastic drinking straws by request only or outright ban them, although these mandates have yet to pass.

Many local entities organize local beach clean ups for people of all ages to participate in. Center for Coastal Studies

Volunteer Engagement And Public Outreach

By partnering with local entities and the public, beach clean-up programs can be an effective way to keep consumer litter from becoming harmful marine debris while engaging members of the public who may be wondering what they can do to help. Ocean Conservancy's International Coastal Cleanup is a global event that leverages volunteers and takes place in all three states in the U.S. portion of the Gulf of Maine region: Maine Coastal Cleanup (organized by Maine Department of Marine Resources), COASTSWEEP (organized by Massachusetts Office of Coastal Zone Management), and the New Hampshire Coastal Cleanup (organized by Blue Ocean Society and other NGOs). From September through November, thousands of people across these states volunteer and receive basic training on how to collect marine debris (trash, fishing line, and any other human-made items) over the course of a two-hour event. With the help of trained staff, the volunteers categorize and tally what they find, and may report their findings in a mobile app called Clean Swell. Similar volunteer clean-up efforts are being organized and implemented by Canadian non-governmental organizations as well (e.g., Huntsman Marine Science Centre and the Clean Foundation's Ocean Summits). Although it can be time consuming to compile data on items collected during volunteer cleanups, these data can help managers and regulators understand the effectiveness of waste management policies, identify hotspots for items that have a large impact on wildlife, and prioritize engagement efforts with industry and consumers (Hardesty et al., 2017).

Elimination of garbage on the beach, including installing waste receptacles with predator-proof lids and working with local businesses to ensure food scraps are safely disposed, can also help keep beaches free from debris (Hunt et al., 2019).

Based on the timing and location of entanglement data in the Gulf of Maine and reports from other parts of the country, it would be beneficial to target recreational fishers and other members of the public with educational outreach and signage that aims to: promote responsible, debris-free fishing practices; reduce debris interaction with seabirds; and minimize anthropogenic waste at the source that could become debris. It is particularly important for stewards to directly interact with beachgoers and other coastal recreationists to help them understand how their decisions impact the quantity of marine debris that ends up in the Gulf of Maine region waters. California has been the site of several effective outreach programs, with ocean literacy organizations (e.g., Seabird Protection Network, Surfrider Foundation, Save Our Shores) educating the public and creating community-supported actions such as beach cleanups, marine debris awareness, and prevention campaigns (Donnelly-Greenan et al., 2019). Some of these examples could be replicated in the Gulf of Maine region, which depends on coastal tourism dollars. Extensive litter and debris associated with increased human use degrades the aesthetics and environmental health of coastal destinations, affecting local economic benefits of a thriving tourism industry.

ENGAGE COMMUNITY SCIENTISTS

When considering ways to catalog the effects of marine debris and understand its impacts on coastal birds, community science projects can be a productive and cost-effective way to collect data and directly engage the public in the topic. The NOAA Marine Debris Program offers and encourages public engagement programs to help document and address marine debris, including the Marine Debris Tracker mobile app and the Marine Debris Monitoring and Assessment Project (MDMAP, 2021). The Marine Debris Tracker mobile app is a joint initiative between the NOAA Marine Debris Program and the Southeast Atlantic Marine Debris Initiative, run out of the University of Georgia College of Engineering. Created in 2010, this free web-based application allows the public to engage in marine debris science and conservation efforts by signing in and categorizing pieces of debris they find along the coast. This app has the added benefit of only requiring a GPS signal (standard in most "smartphones"), rather than cell service or Wi-Fi, as the user can log the location of the debris and later upload their results to the database. The Marine Debris Monitoring and Assessment Project is an initiative to compile a record of the amount and types of debris in the environment. Through regular monitoring, NOAA MDP can track the progress of existing marine debris prevention initiatives and identify targets for future mitigation efforts. Both the mobile app and the shoreline surveys completed by partner organizations and volunteers are easy-to-use, uniform, and readily available. These are all functions that previous programs lacked when trying to engage community scientists with marine debris projects.

Additional efforts, including the Coastal Observation and Seabird Survey Team (COASST) on the Pacific coast, take community science a step further, enabling volunteers to linking debris observations to wildlife impacts such as entanglement (COASST, 2021). In the southeast Atlantic, another effort to document marine debris-wildlife interactions, the Tangled in Trash app, is under development. While no similar programs currently exist for the U.S. portion of the Gulf of Maine region, programs for assessing beached birds along coastal and island habitats exist in some locations within Canada's portion. Birds Canada runs a program along beaches as part of the Beached Bird Survey program, where volunteers are assigned a beach to conduct systematic walks and record beached birds (e.g., entangled, oiled, etc.); although previously conducted across most Canada beaches, this program is now only active in Quebec and British Columbia. Zoe Lucas (Sable Island Environmental Specialist) has conducted systematic beached bird surveys approximately monthly on Sable Island creating a long time series of records on birds affected by oil, entanglement, and other human impacts (Lucas et al., 2012; ExxonMobil, 2018). Engaging the public through mobile applications and websites can be helpful, as Ryan (2018) found during his review of seabird entanglement records. During this review, numerous entanglements were documented by simply searching the internet for images and content related to seabird and marine debris interactions, which were then summarized for publication. The author concluded that setting up a website where members of the public can submit images of entangled birds might prove to be a useful tool to track the problem at broad scales, while also raising awareness of the dangers posed by plastic litter. Since the publication of that paper, the Birds and Debris website was created for the public to submit photos of birds interacting with debris around the globe (see Appendix IV for more information).

The Seabird Ecological Assessment Network (SEANET) is another volunteer program which could be used to track the potential impacts of marine debris on seabirds. Started in 2003 in Buzzards Bay, MA, and now consisting of a network of volunteers from Maine to Florida, SEANET is the only coordinated beached bird survey effort on the Atlantic coast of the United States (Tufts Center for Conservation Medicine, 2019). The creators of SEANET hope to continue to engage community scientists in providing baseline information about bird mortality, help detect mass mortality events due to oil spills, toxins, or disease outbreaks, and examine the spatial and temporal pattern of bird carcass deposition. Community science programs are especially helpful in the collection of this type of data because they do not require expert birding skills, travel to remote locations, or specialized equipment. SEANET volunteers select a section of beach that can be reliably assessed year-round and walk it one or two times per month, recording findings of beached birds, as well as locations and photos of objects of interest, sometimes including marine debris.

Overall, the goals of SEANET and similar programs described above are to bring together researchers and members of the public in a long-term collaborative effort, while highlighting that seabirds can serve as indicators of the health of the marine ecosystem. Additional work is needed to better link efforts of programs like SEANET to those that employ volunteers collecting debris information like the MDMAP.

INFORMATION GAPS

Derelict fishing gear washed up on a Cape Cod beach. Jooke Robbins

Despite widespread evidence that ingestion, entanglement, and entrapment associated with marine debris may pose a threat to birds, very little is understood about the mechanism and extent of these interactions at different scales, how they change over time, and how they may affect bird populations (O'Hanlon et al., 2017). This is particularly true in the Gulf of Maine region where very few studies have been undertaken to examine bird - marine debris interactions. One of the objectives of this report is to identify priority information gaps for the Gulf of Maine region that future work should focus on. The following information gaps were identified through literature review and responses to the Expert Inquiry[1]:

Entanglement and Entrapment

- Number of seabirds lost to in-water entanglements and entrapments in active and ghost gear. (D. Lyons, pers comm.)
- Number of birds lost to entanglement or entrapment in traps or rope located on islands and coastal properties (L. Welch, pers comm.)

Ingestion

- Fine scale environmental concentrations of microplastics in relevant environmental and food web matrices (surface water, sediment, prey species) [A. Robuck, pers comm.]
- Longevity of plastic pieces in seabird digestive tracts (A. Robuck, pers comm.)
- Better understanding of the movement and concentration of microplastics throughout food webs (L. Craig, pers comm.)
- Mechanisms of ingestion; how and from where plastics are coming from (A. Caldwell, pers comm.)
- Individual (lethal and sublethal), population and community level impacts on seabirds in regard to ingestion and chemical interaction (Provencher et al., 2020; A. Barrows, pers comm.)
- Contributions of varying ecological factors (foraging strategy, taxonomy, environmental exposure, diet, etc.) to the incidence of marine debris ingestion (Roman et al., 2019a).

[1]*Also see Provencher et al., 2020 for additional priorities for understanding and addressing impacts of plastic pollution on biota*

Alteration of Nesting Habitat

- Quantification of loss of nesting habitat on Maine coastal islands that experience extensive quantities of washed-up derelict lobster traps (L. Welch, pers comm.)
- Extent of entanglement and subsequent mortality of seabird species that commonly use synthetic fibers as nesting material (Votier et al., 2011)
- Sources of debris items at colonies, especially near nesting sites that may be incorporated into nests (Witteveen et al., 2017)

Cumulative Impact

- Magnitude of cumulative impacts of marine debris on seabirds (e.g., habitat loss, rate and effects of ingestion, rate and effects of entanglement, and identifying and understanding interactions with debris 'sinks'). Inquiry respondents specifically highlighted the need to:
    1) Identify actual sources (both on land and at sea) and exposure hotspots of marine debris
    2) Conduct research to find accurate estimates of birds affected by marine debris, and how they are affected
    3) Elucidate the significance of plastic pollution as a population-level threat (e.g., identify which bird species/populations are most vulnerable to marine debris interactions) [J. Stanton, pers comm.]

Storm petrels fly near a balloon in the Gulf of Maine. Balloons are a widespread and particularly dangerous type of marine debris for birds, who can mistake them for food. Lisa Sette

PART II: IMPLEMENTATION FRAMEWORK

Addressing Information Gaps and Impacts

Taking a GPS point to monitor seabirds. NOAA

BACKGROUND

The preceding report broadly details information gaps in understanding impacts of marine debris on birds and strategies for addressing these impacts. It also conveys the need for additional work, through partner collaboration -- specifically, stepping down gaps and strategies so they can be implemented. An Implementation Framework ("Framework") is presented here to meet this need. The Framework identifies:

- A set of top priority information gaps to focus on, and strategies to develop to address impacts of marine debris on birds in the Gulf of Maine region
- Clear objective(s) for each priority
- First step actions that could be undertaken by partners to begin to meet objectives, including building off any existing materials from work already underway or completed
- Partners that identified specific interest/expertise in taking action on specific priorities, and potential stakeholders that should be involved (Appendices I and V)
- A compilation of potential funding sources that could help facilitate future projects to meet objectives (Appendix VI)

FRAMEWORK DEVELOPMENT AND STRUCTURE

Razorbill. USFWS

From February – April 2021, the U.S. Fish and Wildlife Service (USFWS) in partnership with the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program (MDP), hosted a series of three discussion-based webinars with partners from different professional backgrounds. The purpose of the webinar series was to bring together people with an interest and expertise in marine debris and/or birds that may not regularly interact, to begin stepping down recommendations in the report into concrete actions that could lead to future projects. In order to obtain input from a representative set of experts, an invitation to participate in a first webinar was sent out to over 100 partners, representing federal agencies, state or provincial agencies, non-governmental organizations (NGO), academia, and representatives from the commercial fishing industry. Approximately 50 individuals representing thirty-one agencies, organizations and institutions participated (Appendix I) in the first webinar in February, which included over ninety minutes of presentations and discussion. The webinar began building momentum for future collaborations and set the stage for two additional USFWS-hosted webinars. These webinars focused on identifying and discussing top priorities described in the Strategies and Information Gaps sections of the report. Prior to the second and third webinars, partners that had participated in the first webinar and/or contributed to the report were given an opportunity to select a small subset of their top priorities on which to focus the Framework. Twenty-six individuals selected priorities, which were finalized during the webinars. Participants in the discussion-based webinars provided ideas and information for these priorities that were used to develop the Framework.

The Framework is presented as a set of tables that addresses partners' top two priorities for filling information gaps and top two priorities for identifying strategies to address impacts of marine debris on birds in the Gulf of Maine:

Priority Information Gaps:

(1) Ingestion - Better understand population & community level impacts of plastic pollution on seabirds (including sub-lethal effects on health, food web dynamics, and exposure mechanisms)

(2) Habitat - Determine significance and sources of plastic pollution and derelict fishing gear at seabird colonies

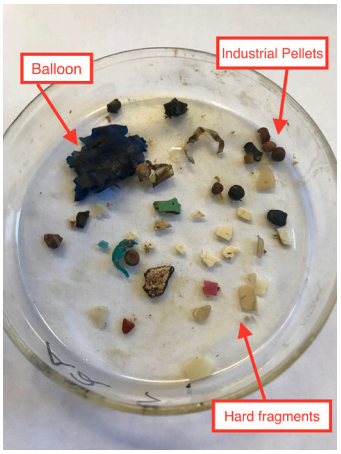
Priority Strategies:

(1) Derelict Fishing Gear - Initiate, expand, and facilitate partner- and stakeholder-driven actions to aid in prevention and clean-up

(2) Consumer Litter - Identify effective methods to serve data and other information to inform and/or influence legislation to reduce impacts of balloons, plastic bags, and single-use utensils

For each priority, tables were developed that identify a set of objectives, present targeted first steps that can help partners initiate projects, and compile relevant work completed or underway. For both the information gaps and strategies priorities, potential obstacles to meeting objectives are also highlighted. In the tables, potential timeframes are suggested for addressing stated objectives and initiating first steps.

A Great Shearwater found dead in the Gulf of Maine region is necropsied by a researcher. Studies have shown that shearwaters and several other seabirds commonly ingest plastics at sea. This blocks digestive tracts and may lead some individuals to starve. Anna Robuck



In response to partner suggestions, additional materials are provided as appendices to help the partnership undertake first step actions and develop future projects to meet stated objectives of the Framework. These include:

- Published documentation of birds in the Gulf of Maine region that have been adversely impacted by entanglement and ingestion (Appendix III)
- Existing databases which house and maintain relevant data on marine debris and wildlife (Appendix IV)
- Useful information on potential funding opportunities in and around the region (Appendix VI)

The Framework is intended to help bring partners together and guide the initiation of priority actions addressing marine debris-bird interactions in the Gulf of Maine. The USFWS Migratory Birds Program and NOAA MDP will help facilitate priority first steps to the greatest extent possible. However, the Framework's utility depends entirely on you, the partners, to keep up the momentum, follow the guidance, and to initiate the work.

MARINE DEBRIS IMPLEMENTATION FRAMEWORK - INFORMATION GAPS

Beach trash. R. Perezosa

INGESTION - Better Understand Population & Community Level Impacts Of Plastic Pollution On Coastal Birds (Including Sub-Lethal Effects On Health, Food Web Dynamics, And Exposure Mechanisms).

Overview:
Population and community level impacts of marine debris (specifically plastic ingestion) on birds are greatly understudied in the Gulf of Maine region. Although some research has been conducted in the last few years to target this information gap, partners have indicated that collaboration across projects is infrequent, and no consistent research methodologies or data management systems exist. Collecting, centralizing, and standardizing existing data on types and occurrences of plastic ingestion in coastal birds (including mortality levels where available) in the Gulf of Maine region would facilitate increased collaboration and communication among research efforts and prompt new work at larger spatial scales. Concerted efforts to expand and promote a collection and analysis network for dead and/or beached coastal bird samples would provide additional data on plastic pollution ingestion across a larger portion of the Gulf of Maine region. This could be achieved through partnerships with government entities collecting specimens at sea (e.g., NOAA Marine Fisheries Observer Program) and airports (USDA APHIS and others performing animal damage control), or with community science groups like Seabird Ecological Assessment Network (SEANET) and Surfrider Foundation.

After streamlining the process for acquiring samples, pursuing and encouraging collaboration within institutions on post-mortem macro- and microplastic analysis (not necessarily seabird-focused), would be a helpful first step in giving partners greater access to share space and cut down the costs associated with expensive analytical tools. Consistent and comparable research methodologies are critical for a thorough understanding of regional impacts (e.g., sub-lethal effects on health, food web dynamics, and exposure mechanisms) of plastics ingestion on coastal bird populations. Adapting and promoting consistent methods and resources, like the ones found in Provencher et al. (2019), for linking macro- and microplastics ingestion to health and toxicity issues in birds will help make research comparable among parties and increase its usefulness. In addition to methodology, consistency among definitions of terminology (e.g., distinguishing “macro-”/”meso-“, “micro-”, and “nano-plastics” (Barnes et al., 2009)) was not well established until relatively recently, and older publications may lack such consistency. Following and encouraging consistent usage of now established definitions among researchers would allow for better collaboration and wider understanding of plastics ingestion.

Identifying the species and local populations that are experiencing potentially dangerous levels / rates of macro-plastic ingestion will require coordinated data collection on a regular basis. As a first step to meet this objective, key partners have agreed to work together to identify non-traditional plastics-related funding sources and collaborate on competitive proposals. Establishing partnerships and pursuing funding opportunities that extend beyond traditional bird conservation is important for long-term success. After creating a centralized data management system, existing data (community science, coastal cleanups, etc.) on ingested macro-plastics could be paired with expert knowledge, allowing researchers to identify potential sources of plastics and perform a gap analysis to see where lapses in sampling coverage exist. Both objectives could result in new tools and products available for habitat managers and seabird conservationists.

Although we anticipate that some of the stated objectives could be met within a two-to-three-year time frame (depending on partner engagement and resources available), some broader and/or more complex objectives identified will require additional time and funding.

OBJECTIVES		
Description - what we'll do	Time frame - when? (6mo, 1y, 3y, etc.)	Associated Metrics - how will we measure progress?
Collect, centralize, and standardize existing data on types and occurrences of plastic ingestion in seabirds (including mortality levels where available) in the Gulf of Maine region from partners	1+ years	Increased number of participating partners and datasets.
Promote efforts to increase collection & analysis of dead / beached bird samples to investigate plastics ingestion (macro/meso/micro).	1 – 2 years	Increased number of collaborative partnerships; Increased samples obtained and analyzed.
Compile and examine existing data (community science, coastal cleanups, etc.) to identify sources of ingested macro-plastics and gaps in sampling coverage.	1 – 3 years	New analyses and products created based on surveys / partner data.
Adopt and promote consistent methods for linking microplastics ingestion to health and toxicity issues in birds.	2+ years	New analysis tools and methodologies available for managers to use in research.
Identify priority species and local populations experiencing potentially harmful levels / rates of ingestion (macro-plastics) through regular and coordinated data collection and analyses.	2+ years	New research completed. New tools and data products available for managers.

FIRST STEPS - SIMPLE, ACHIEVABLE, SHORT TERM		
Action	Key Partners	Time frame to initiate
Meet with Shaw Institute study contacts (see "Relevant Work" project [A] below) to discuss options for incorporating fecal samples from dead birds	Mark Pokras (Tufts University) Paula Shannon and Don Lyons (National Audubon) Gina Shield (National Marine Fisheries Service) Stephanie Ellis (Wild Care, Inc.)	Winter '21/'22 - Fall 2022
Meet with NOAA Observer Program and USDA APHIS/ airports about providing carcasses to researchers for plastics analysis	Caleb Spiegel (USFWS) Mark Pokras (Tufts University) Gina Shield (NMFS) USFWS Migratory Bird Permit Staff	Winter '21/'22 - Summer 2022
Brainstorm a system to collect, organize, and standardize all available recorded data for ingestion of plastic by coastal birds in the Gulf of Maine region (research-level and survey-based)	Linda Welch (USFWS) Bob Houston (USFWS) Aliya Caldwell (University of New Hampshire) Liz Craig (Shoals Marine Laboratory) (Request participation from Robert Ronconi (ECCC) [Canada data])	Winter '21/'22 – Winter '22/'23
Promote implementation of standardized methodology for collecting fecal and pellet samples for analysis	Jennifer Provencher (Environment and Climate Change Canada) Anna Robuck and Dave Wiley (Stellwagen Bank National Marine Sanctuary) Aliya Caldwell (UNH) Liz Craig (Shoals Marine Laboratory)	Winter '21/'22 – Winter '22/'23
Identify organizations and non-traditional funding sources; specifically reach out to plastics-related funding opportunities (also see Appendix VI)	NOAA Marine Debris Program USFWS	Spring 2022 – Winter '22/'23
Encourage and pursue collaboration within institutions on post-mortem plastics analysis (all wildlife, not just bird-focused), especially microplastics using standardized methods	Mark Pokras (Tufts University) Anna Robuck (University of Rhode Island / Stellwagen Bank NMS) Aliya Caldwell (University of New Hampshire) ECCC	Spring 2022 - Spring 2023
Meet to discuss idea of organizing a workshop/ conference on understanding effects of plastics on the health of NW Atlantic seabirds and shorebirds	NOAA MDP USFWS ECCC Mark Pokras (Tufts University)	Spring 2022 – Winter '22/'23
Convene meeting among key volunteer coastal clean-up partners to identify opportunities to integrate research and monitoring efforts related to birds.	Ocean Conservancy Massachusetts Coastal Zone Management Maine Dept. of Marine Resources New Hampshire Coastal Program Other NGOs: Blue Ocean Society, Surfrider Foundation, Huntsman Marine Science Centre, etc. Mark Pokras (Tufts University)	Spring 2022 – Winter '22/'23

RELEVANT WORK UNDERWAY/COMPLETED				
Title	Objective(s)	Project contact(s)	Outcomes / products	Location
[A] Ingestion of Microplastics and Associated Risks to Seabird Colonies [Began Summer 2021]	Measure microplastics in seabird guano and surface water samples collected to assess the health risks of ingestion in seabirds inhabiting eastern Maine's critical nesting islands	Heather Richard (Shaw Institute) Linda Welch (USFWS) Carey Friedman (Maine Maritime Academy) Don Lyons (National Audubon)	Report summarizing results of fecal and seawater analysis; Help seabird conservationists and resource managers identify which species / foraging guild experiences highest exposure to microplastics	Eastern Maine (Seal, Ship, and Petit Manan Islands)
[B] Plastics in guano of Arctic seabirds [Ongoing]	Assess if guano can be used as a non-lethal plastics sampling tool; Assess if/how seabirds are contributing microplastics to their colonies	Jennifer Provencher (ECCC)	Provencher et al. (2018) Hamilton et al. (2021) Bourdages et al. (2021)	Arctic Canada and the Great Lakes region
[C] Seabird Ecological Assessment Network (SEANET) [Ongoing]	Bring together interdisciplinary researchers and members of the public in a long-term collaborative effort to identify and mitigate threats to seabirds	John Stanton (USFWS)	Future collaborations with use of collected data	Occurs throughout the U.S. Atlantic seaboard
[D] Seabird demographics and plastic pollution ingestion of Great Shearwaters in fisheries bycatch [Ongoing]	Collect demographic data on bycaught birds (primarily Great Shearwaters); Identify and quantify the accumulated ingested macro-plastics in these birds	Gina Shield (NMFS) Anna Robuck and Dave Wiley (Stellwagen Bank NMS) Christy Hudak (Center for Coastal Studies)	Robuck et al. (2021); Large necropsy dataset also available.	Birds sampled from Massachusetts Bay, Narragansett Bay, and the Cape Fear River Estuary
[E] Plastic pollution in seabird pellets [2020 – 2021]	Quantify microplastic presence in Common Terns from collected pellets	Aliya Caldwell (UNH) Liz Craig (Shoals Marine Lab)	UNH undergrad poster	White and Seavey Island (NH)
[F] Plastic pollution in seabird guano [2019]	Compare plastic types and load in species with different foraging strategies (Common and Roseate Terns) across the region	Aliya Caldwell (UNH) Liz Craig (Shoals Marine Lab)	Rutgers senior thesis; second publication in prep	White and Seavey Island (NH), Massachusetts, and New Jersey
[G] Establishing techniques for assessing ingested plastic pollution in birds [2019]	Publish peer-reviewed methods that can be applied globally by researchers	Jennifer Provencher (ECCC)	Provencher et al. (2019) Provencher et al. (2017)	International
[H] Plastic pollution in seabird pellets [2018]	Compare incidence of plastic ingestion between species with different foraging strategies	Aliya Caldwell (UNH) Liz Craig and Jennifer Seavey (Shoals Marine Lab)	Caldwell et al. (2019)	Appledore Island (ME)

Additional Project Information (for select projects):

[A] Ingestion of Microplastics and Associated Risks to Seabird Colonies: Target species include Atlantic Puffins, Arctic Terns, Common Terns, Double-crested Cormorants, Herring Gulls, Great Black-backed Gulls, Laughing Gulls, and Common Eiders. Samples will be analyzed for microplastics at the Shaw Institute's Blue Hill Research Center, and polymer identification will be performed using pyrolysis Gas Chromatography/Mass Spectrometry at Maine Maritime Academy. As a pilot study, researchers plan to use the information gathered and the produced report to help identify which seabird species and colonies to focus future sampling efforts.

[C] Seabird Ecological Assessment Network (SEANET): Volunteer-driven program that consolidates information on beached/dead birds. In recent years, participation and data collection has declined in the Gulf of Maine region, so efforts are needed to engage more volunteer participants and create more efficiency in reporting. Additional work needed includes establishing a better link between beached birds and plastics and other debris.

[D] Seabird demographics and plastic pollution ingestion of Great Shearwaters in fisheries bycatch: A collection of observer data on incidental take within New England and Mid-Atlantic fisheries, paired with necropsies of bycaught Great Shearwaters. Continued necropsy and plastic identification are required to monitor longer trends across time. Researchers on this project also hope to expand to additional species at the same scale and sampling effort as Great Shearwaters, and would like to one day host the data in a central, publicly accessible database for others to use.

[E] Plastic pollution in seabird pellets: Analyzed seabird (Common Terns) pellet samples from White and Seavey Island (NH) to determine microplastic presence in seabirds. Additional work of interest includes analytical chemistry and comparing prior methods with analysis of fecal samples, subject to availability of additional resources.

[G] Establishing techniques for assessing ingested plastic pollution in birds: Focused on standardizing techniques for assessing plastics pollution in seabird carcasses, pellets, regurgitation, etc. to ensure results are comparable across studies.

[H] Plastic pollution in seabird pellets: Compared plastic types and loads in species with different foraging strategies (Herring and Black-backed Gulls; Common and Roseate Terns) based on pellet analysis from Appledore Island (ME) samples. Research presented in Caldwell et al. (2019). Also determined which biological sample types to focus future efforts on and analyze.

Roseate Tern. Scott Heron, Creative Commons

HABITAT - Determine Significance And Sources Of Plastic Pollution And Derelict Fishing Gear At Seabird Colonies

Overview:

Determining sources of plastic pollution and derelict fishing gear, and understanding associated impacts on seabird colonies were highlighted by partners as pressing information gaps needing further research. Pulling together seabird colony managers throughout the Gulf of Maine region to coordinate on documenting and understanding effects of plastics and gear on colonies is an attainable first step towards filling this information gap. In order to expand sources of data and efforts to address plastics at seabird colonies, a list of state agencies, seabird managers, and NGOs who currently organize cleanups/surveys should be compiled, as well as those who may be able to help with these efforts in the future.

When conducting cleanups and engaging in other work to help mitigate the impacts of marine debris, seabird managers and conservationists must minimize impacts to colonies. Developing a set of best management practices (BMPs) for cleanups should be prioritized to mitigate impacts on birds during breeding periods. Progress on this objective could begin by working with seabird colony managers and collecting their organization's current management practices for cleaning up debris in a shared document for collaborative discussion.

Methods for collecting, storing, and serving data from clean-up efforts currently lack standardization. A common set of measures to track effort, extent, and associated impacts should be developed and promoted. Large-scale efforts like the Global Ghost Gear Initiative database have been initiated to collect this type of data on an international scale; however, partners in the Gulf of Maine region have not adopted a coordinated reporting system for recording derelict fishing gear on beaches. Implementing an objective that creates a new shared reporting system or adapts an existing system to better document sources of pollution and derelict fishing gear is needed. This reporting system should include consistent methodologies and standardized reporting forms, and offer options for greater communication among partners for collaboration.

We anticipate that some of these objectives can be completed in a one-to-two-year time frame. However, other objectives will require long-term commitments, including regular monitoring to establish baseline data. Longer term objectives include quantifying the loss of breeding habitat from derelict fishing gear (lobster, aquaculture, and other fisheries) and plastic pollution on both shorelines and coastal islands. This can be done by compiling and examining existing records and imagery to establish a baseline dataset and continued through annual or semi-annual surveys. A first step to achieve this objective is having land managers establish communications with partners in industries responsible for generating derelict fishing gear and requesting any available data on bycatch, lost gear, etc. Observer-based surveys of offshore islands are more logistically challenging and costly. Use of aerial imagery collected by drones is being tested as an alternative (or supplement) to observer-based surveys **(see Relevant Work Underway/Completed section, [A] and [B] below)**. Understanding how loss of habitat affects breeding success and mortality of nesting seabirds is another area requiring more data to adequately assess. An important first step for understanding impacts on productivity and mortality is to examine and compile available data on debris quantities at colonies and any observed impacts, in a common location to facilitate broader-scale analyses.

Double-crested Cormorant with disposable plastic cup. Lisa Sette

OBJECTIVES		
Description - what we'll do	Time frame - when? (6mo, 1y, 3y, etc.)	Associated Metrics - how will we measure progress?
Adopt and implement standardized measures and reporting systems (datasheets, shared database) to consistently track extent of debris at colonies (e.g., quantification, location, type, seasonality) and associated impacts (acres affected, impact on breeding species), plus extent and impact of clean-up efforts	1 – 2 years	Guidance created and provided to coastal land managers and NGOs detailing standard practices; New reporting system developed and utilized by stewards, managers, and the public
Develop best management practices (BMP) for cleanups at colonies (both islands and coastal mainland) to minimize impacts to birds during breeding / presence	1 year	BMPs created and provided to coastal land managers, including USFWS Refuges, National Parks, and state land management agencies; and NGOs
Quantify the loss of breeding habitat from derelict fishing gear (lobster, aquaculture, and other fisheries) and plastic pollution	2+ years	New quantitative assessments compiled and disseminated
Better understand how loss of habitat affects productivity and mortality of birds	2+ years	New reports / publications drafted

FIRST STEPS - Simple, Achievable, Short term		
Action	Key Partners	Time frame to initiate
Request access to regional data records on plastic pollution and DFG accumulation / collection from large organizations like the Marine Debris Tracker App and International Coastal Cleanup	NOAA MDP Jennifer Provencher (ECCC) Susanne Kühn (Wageningen Marine Research)	Winter '21/'22 – Fall 2022
Create a list of individuals and organizations who currently conduct cleanups / surveys or could potentially expand effort in the future	NOAA MDP USFWS Terry Towne (Maine Coast Heritage Trust; MCHT) Don Lyons (National Audubon) Request participation from Buzz Scott (OceansWide)	Winter '21/'22 – Summer 2022
Compile a list of seabird colony managers in the Gulf of Maine region and organize a meeting to discuss better documentation and evaluation of the effects of plastics and DFG on colonies	USFWS Linda Welch (USFWS) NOAA MDP Atlantic Marine Bird Cooperative (AMBC) Seabird Colonies and Adjacent Waters Working Group ECCC National Audubon staff	Winter '21/'22 – Summer 2022
Work with seabird colony managers to collect current management practices for cleaning up debris in a shared document for collaborative discussion	Linda Welch (USFWS) AMBC Seabird Colonies and Adjacent Waters Working Group ECCC National Audubon staff	Winter '21/'22 – Fall 2022
Identify partners and brainstorm a system to collect and organize available clean-up and accumulation data from Gulf of Maine region organizations; also compile documented impacts on birds	Linda Welch (USFWS) Paula Shannon (National Audubon) Cynthia Loftin (USGS Maine Cooperative Fish and Wildlife Research Unit)	Spring 2022 – Winter '22/'23
Begin communication with partners in the lobster industry to investigate any data available on bycatch, lost gear, etc.	Laura Ludwig (Center for Coastal Studies) Linda Welch (USFWS) Demi Fox (NOAA MDP) Theresa Torrent (Maine Dept. of Marine Resources; DMR)	Spring 2022 – Winter '22/'23

RELEVANT WORK UNDERWAY/COMPLETED				
Title	Objective(s)	Project contact(s)	Outcomes / products	Location
[A] Drone-based Debris Surveys [Summer 2021 - Winter 2022]	Better document where gear is accumulating on coastal islands and sensitive areas via remote aerial drones	Buzz Scott (OceansWide) Laura Ludwig (Center for Coastal Studies)	Produce visual survey data for future use to quantify the issue and faciliate removals.	Maine Islands Outer Cape Cod
[B] Using Technology in Colonial Waterbird Research [Ongoing]	Identify strategies that increase nesting bird survey accuracy and efficiency, while reducing costs and disturbance; Adapt strategies to quantify marine debris in these bird colonies	Logan Kline and Meredith Lewis (University of Maine) Cynthia Loftin (USGS Maine Cooperative Fish and Wildlife Research Unit)	Map products identifying highest debris concentrations on Maine seabird nesting islands	Maine Islands
[C] Marine Debris Tracker App [Ongoing]	With the help of community scientists, categorize and document marine litter along coastlines and waterways on an open data platform	Jenna Jambeck (University of Georgia) Jason Rolfe (NOAA Marine Debris Program)	Database for statistics and images	International
[D] Marine Debris Removal from Maine Seabird-Nesting Islands & Surrounding Waters [Sept. 2018 – Dec. 2021]	Remove marine debris from eight Maine islands; Study the accumulation of debris on the islands	Paula Shannon (National Audubon) Demi Fox (NOAA MDP)	Project results will be posted on NOAA MDP Clearinghouse	Matinicus Rock, Eastern Egg Rock, Stratton, Bluff, Jenny, Outer Green Islands; Pond and Seal Island NWRs
[E] Quantifying plastic debris in cormorant nests [2020]	Determine prevalence and type of plastics incorporated into Double-crested Cormorant nests; Monitor negative impacts on reproductive success	Liz Craig (UNH) Lisa Sette (Center for Coastal Studies) Trevor Lloyd-Evans and Evan Dalton (Manomet)	None to date	Cape Cod and Isles of Shoals (ME/NH)
[F] Expedition Remote Island Cleanup [2014, 2015, 2019, and 2022 (planned)]	Perform large scale marine debris removal in communities on remote islands; create partnerships with local community members	Ashley Sullivan (Rozalia Project) Terry Towne (MCHT)	Update existing datasets on collection and re-accumulation of marine debris on islands	Maine Islands

Additional Project Information (for select projects):

[B] Using Technology in Colonial Waterbird Research: Originally focused on surveying seabirds, project now incorporates objectives that relate to identifying and quantifying accumulation of marine debris on coastal islands. Using high-resolution aerial photography, researchers are hoping to identify where the highest concentrations of debris are distributed on Maine islands. Additional future work includes developing community science opportunities, artificial intelligence/machine learning to aid the process and potentially scale it up to larger scales.

[C] Marine Debris Tracker App: Collaborative effort between the NOAA Marine Debris Program, the University of Georgia and the Southeast Atlantic Marine Debris Initiative. Created in 2010, this free application allows the public to engage in marine debris science and conservation efforts by locating, logging, and categorizing pieces of debris they find along the coast. Program has the added benefit of only needing a GPS signal, rather than cell service or Wi-Fi, as the user can log the location of the debris and later upload their results to the database.

[D] Marine Debris Removal from Maine Seabird-Nesting Islands & Surrounding Waters: Funded through NOAA MDP Community Based Removal grant, project is a partnership with the National Audubon Society, Gulf of Maine Lobster Foundation, and local lobster fishermen. Aims to reduce the rate of accumulation through at sea removal of derelict fishing gear.

[F] Expedition Remote Island Cleanup: Crews aboard American Promise conducted expeditions in 2014, 2015, and 2019 that cleaned remote islands and collected data. Expedition in 2022 (originally planned for 2020 but delayed due to COVID-19 pandemic) is planned to return to the same areas to update existing datasets, track re-accumulation rates, and engage in partnerships with local community members.

INFORMATION GAPS – POTENTIAL BARRIERS TO SUCCESS

When working towards a set of objectives, it is important to plan for challenges that may occur during associated actions. These “Barriers to Success” can arise because of funding limitations, ingrained societal norms that are difficult to change, or slow-moving processes associated with legislative changes.

The most substantial barriers identified by partners that might impede progress towards filling Information Gaps included the lack of consistent communication and centralized data management among researchers and securing funding to undertake research-level studies or survey-based clean-up efforts. Bringing together partners through the webinar series and planning meetings through a variety of first steps will ideally create new networks for communication. In addition, funding is often a major influence on whether projects are implemented. We have created a Funding Table (Appendix VI) with this document that contains several grant opportunities for funding removal, research, and education projects, which could help partners address some financial challenges when planning. The following additional Barriers to Success were also identified during the webinar process:

Ingestion

- Not enough data (dead and live birds, and other samples) being collected
- Not enough analysis of samples being done (expense of equipment; lack of well-equipped labs)
- Not enough partnerships between interested research parties and labs for analysis
- Hard to identify sources of microplastics based on chemical and spectral levels - requires new technology, methodological advancements, and new multi-disciplinary partnerships

Habitat

- Minimal opportunities for regular communication between the lobster industry, seabird conservationists, and public land managers
- Inadequate number of coordinated surveys for debris (boats, aircraft/drones, etc.)
- Sources of island-based derelict fishing gear and pollution can be challenging to identify
- Several logistical challenges impede better understanding and quantification of debris on islands

MARINE DEBRIS IMPLEMENTATION FRAMEWORK - STRATEGIES

Snowy Owl resting near debris. Peter Trull

DERELICT FISHING GEAR (DFG) - Initiate, Expand, And Facilitate Partner- And Stakeholder-Driven Actions To Aid In Prevention And Clean-Up

Overview:

In order to address impacts related to derelict fishing gear (DFG) on birds, partners identified the need to initiate, expand, and/or facilitate partner- and stakeholder-driven actions across a diverse set of organizations and industries to aid in prevention and clean-up. Project-related webinars, which focused on creating objectives and first steps for impact-reduction strategies, involved partners with different professional expertise, including researchers, conservationists, managers, and the private sector. Partner-developed objectives for this priority largely focus on the debris created by the lobster and aquaculture industries, which are prevalent in the region, so establishing a stable line of communication between seabird managers, policymakers, and contacts in these key fishing industries is imperative. As a first step, key partners (including seabird colony and public land managers) should meet to develop strategies for reaching out to those industries that contribute the most debris and request more assistance. Part of this strategy should include a plan to compile best available information (data, photos, case studies, talking points, graphics, etc.) on the extent, quantity, and clean-up costs of DFG, and quantitative and qualitative measure of impacts to birds across sites. This information should be summarized in a presentation(s) for commercial fishing industries to highlight the issue, indicate to the industries that partners are organizing to document impacts, and facilitate increased engagement and financial support of clean-up and prevention efforts.

Partners indicated that no centralized, cooperative repository currently exists for compiling information on extent, quantity, clean-up costs of DFG, and associated impacts to birds, but that it would be of great use. Projects like the Global Ghost Gear Initiative database (see Relevant Work Underway/Completed Table below and Appendix IV), which tracks some of these types of data on an international scale, could be used as a model to create such a coordinated information sharing and reporting system. A shared information repository should be developed that would include a standard way for engaged partners to regularly record and report the extent of debris (estimates for size, cost, location) throughout the Gulf of Maine region (both at islands and along mainland coasts). To begin populating such a repository with existing information across sites, it is important to reach out to partners and initiate efforts to identify, obtain, and compile all available information and data, photos, and observations of bird entanglements and mortalities. Compiling data for analysis will be

key to planning and prioritizing future clean-up efforts, and supplemental information such as photos and cost estimates will be important for engagement with the industry, agencies, and the public.

Longer-term objectives for this priority include working with legislators to facilitate regulatory changes to mitigate gear loss or abandonment and aid in clean-up efforts in the Gulf of Maine region. Providing data and information to regulators of the fishing, lobster, and aquaculture industries would provide stronger justification for changes. Some changes proposed by partners include allowing cleanup of lobster traps and other DFG on private property by public groups, initiating tag fees and mandatory gear labeling (aquaculture), and creating a reporting system (similar to the one used in Canada) for lost and found gear to increase both public and industry engagement in the removal process. To help partners engage in larger clean-up efforts, expanding and promoting the scope of gear disposal and recycling options for regional fishers and lobstermen is another important action, although it may take some time to fund and establish such expansion. Working with partners to identify organizations and individuals that have gear disposal programs, and organizing a meeting to discuss current capacity, outreach efforts, and expansion possibilities, however, is a possible first step in building momentum.

Lastly, partners identified that several strategies and actions present in the "Derelict Fishing Gear" section of the Gulf of Maine Marine Debris Action Plan may help address impacts to birds. We recommend better engagement with Action Plan lead partners to better incorporate benefits to birds into objectives, and suggest that partners involved in the Implementation Framework offer assistance and expertise pertaining to birds.

OBJECTIVES		
Description - what we'll do	Time frame - when? (6mo, 1y, 3y, etc.)	Associated Metrics - how will we measure progress?
Improve and facilitate regular communication between seabird managers, policymakers, and key fishing and lobster industry stakeholders.	6 months – 1 year	List of key partners developed; Forum or working group formed
Compile and present best available information (photos, clean-up cost estimates, etc.) and data (tonnage recovered, number of birds affected, habitat lost) to the commercial fishing and lobster industries, highlighting the issue and asking for more assistance / partnership on cleanup.	6 months – 1 year	Presentations given at regularly held fishing industry meetings (e.g., Zone Council meetings, the Maine Fishermen's Forum, etc.)
Work with regulators of aquaculture industry to ensure that gear labeling is mandatory to facilitate reporting and industry involvement in cleanup.	1 year	System in place that includes gear labeling requirement as part of permits (similar to lobster industry)
Collect and centralize existing data, photos, and other information (case studies, talking points, graphics, etc.) throughout the Gulf of Maine region on: 1) Impacts of DFG to seabirds; 2) extent of DFG on shore and offshore; 3) quantity of DFG on shore and offshore; 4) costs of cleanup on shore and offshore	1 – 2 years	Centralized repository created, or existing one expanded, to meet objective; Increased number of participating partners supplying and accessing information
Incorporate bird information and objectives into relevant strategies identified in the Gulf of Maine Marine Debris Action Plan, "Derelict Fishing Gear" section Goals	1 – 2 years	Increased number of MDAP strategies and actions incorporating bird-related objectives
Create a standard mechanism for partners to annually record and report the extent of DFG (estimates for size, cost, and location) annually throughout the Gulf of Maine and islands.	1 – 2 years	Common reporting system and associated database in place
Provide data and summary information to regulators to consider regulatory changes including: allowing the cleanup of lobster traps and other DFG on private property; tag fees; responsibility for gear loss; etc.	1 – 3 years	Increased sharing of data and information with regulators; Increased number of regulatory changes implemented
Expand scope of gear disposal and recycling options for regional fishers & lobstermen, and promote to industry	1 – 3 years	Increased tonnage of gear properly recycled or disposed of; Reduced amount of DFG

FIRST STEPS - Simple, Achievable, Short term		
Action	Key Partners	Time frame to initiate
Organize a meeting between USFWS, state agencies (ME, NH, MA, CT, RI), and U.S. Army Corps of Engineers (USACE) to discuss potential gear tagging requirements under aquaculture permitting	Susi vonOettingen (USFWS) Kate O'Brien (USFWS) Laura Ludwig (CCS) Theresa Torrent (Maine DMR)	Fall 2021 (initiated) – Fall 2022
Work with partners to identify organizations and individuals that have gear disposal programs, and organize meeting to discuss current capacity, outreach efforts, and expansion possibilities	Terry Towne (MCHT) Jim Fortier (USFWS) Buzz Scott (OceansWide) Laura Ludwig (CCS)	Winter '21/'22 – Fall 2022
Reach out to partners to initiate effort to identify, obtain, and compile all available information/data on: 1) extent quantity/cost of removal of washed-up DFG 2) photos of extent of DFG and entanglement/impacts. 3) bird entanglements/mortalities observed	Linda Welch (USFWS) Caleb Spiegel (USFWS) Terry Towne (MCHT) Laura Ludwig (CCS) Buzz Scott (OceansWide) Stephanie Ellis (Wild Care, Inc.) Don Lyons and Paula Shannon (National Audubon) Request participation from Erin Pelletier, Gulf of Maine Lobster Foundation)	Fall 2021 (initiated) - Fall 2022
Identify relevant strategies and actions in the Gulf of Maine Action Plan and reach out to leads about better linking bird information and objectives from this Framework	Demi Fox (NOAA MDP) Caleb Spiegel (USFWS) Linda Welch (USFWS) Joan LeBlanc (Gulf of Maine Council) Don Lyons and Paula Shannon (National Audubon)	Winter '21/'22 - Fall 2022
Pursue options for bringing on a part-time grad student, honors student, or USFWS intern to work with partners to compile existing data on tonnage recovered, number of birds affected, habitat lost (also see Consumer Litter priority below)	Mark Pokras (Tufts University) Caleb Spiegel (USFWS)	Fall 2021 (initiated) - Spring 2022
Establish a "Bird Impacts" section of the NE Marine Debris Collaborative Portal for compiling and storing data, info, and photos (see prior two actions); promote the resource among partners	Demi Fox (NOAA MDP) Caleb Spiegel (USFWS) Linda Welch (USFWS) John Stanton (USFWS) Don Lyons and Paula Shannon (National Audubon)	Fall 2021 (initiated) - Summer 2022
Outline components for an annual reporting method for the extent of DFG debris[1] and establish ideas for engaging participants at annual Gulf of Maine Seabird Working Group meetings	Linda Welch (USFWS) Brian Benedict (USFWS) Terry Towne (MCHT) Don Lyons and Paula Shannon (National Audubon)	Fall 2021 (initiated) - Summer 2022
Organize a meeting of partners to develop a strategy and next steps for reaching out to Lobster Industry to request more assistance/come up with solutions[2]	Terry Towne (MCHT) Linda Welch (USFWS) Jim Fortier (USFWS) Brian Benedict (USFWS) Laura Ludwig (CCS) Demi Fox (NOAA MDP) Buzz Scott (OceansWide) Theresa Torrent (Maine DMR) (Request participation from MA/NH/ME SeaGrant program)	Fall 2021 (initiated) - Summer 2022

[1]Potential components to consider:
i) Extent of coverage? Opportunistic reporting form, or coordinated survey? How to survey (e.g., Use of drones? – UMaine / Shaw Institute work)
ii) Where to store and serve info?
iii) Link to community science -- guide to Marine Debris (Laura Ludwig/Heather Richard) - link to SEANET (John Stanton)? Link to Ocean Conservancy International Coastal Cleanup team and datasets (Sarah Kollar)?

[2]Planning considerations to work out:
i) Identify venue (Zone meetings? Maine Fishermen's Forum? Lobster Association meetings?)
ii) Identify who will be involved in presenting info
iii) Identify what info is available and what is needed
iv) Identify timeline

[3]Planning considerations to work out:
i) who will be involved?
ii) what data are needed to really show impact?
iii) what other info would be useful to serve (e.g., definition of a 'derelict' trap - lacking 6 sides) timeline,
iv) what solutions/regs would group like to see to help?
v) what other programs exist which could provide a model for the GOM region?

RELEVANT WORK UNDERWAY/COMPLETED				
Title	Objective(s)	Project contact(s)	Outcomes / products	Location
[A] Traps 2 Treasure [Ongoing]	Incentivize the proper disposal of unwanted / no longer needed lobster traps, rope, and buoys	Buzz Scott (OceansWide)	Location for proper disposal of old/unwanted gear	Gouldsboro, ME
[B] Gulf of Maine Derelict Fishing Gear At Sea Removal Database [Ongoing]	Document DFG recovered at sea; Provide data to managers and industry	Laura Ludwig (CCS) Erin Pelletier (Gulf of Maine Lobster Foundation)	Database for partners containing statistics on abandoned, lost, or derelict fishing gear and bycatch (available upon request)	Gulf of Maine
[C] Sustainable Fisheries Solutions & Retrieval Support Contribution Program ("Ghost Gear Fund") [Ongoing]	Provide funding for projects that examine methods of improving disposal and recycling of abandoned, lost, and derelict fishing gear (ALDFG) and end-of-life fishing gear (see Additional Project Information below)	Department of Fisheries and Oceans Canada	Supported 26 projects over two years (2020-2022) within one of four themes: - ALDFG retrieval - Responsible disposal - Acquisition and piloting of currently available innovative technologies - International leadership	Canada
[D] Rope Recycling Program [Ongoing]	Educate commercial fishers on general recycling and waste disposal options available locally; Providing collection bins to prevent rope from becoming DFG	Chris Bridger (Huntsman Marine Science Centre)	Twenty-six collection bins located at 20 wharf locations and maintained by Huntsman staff and partners (as of Dec. 2020)	Bay of Fundy
[E] Center for Coastal Studies At Sea Cleanup [Ongoing]	Conduct surveys of the ocean floor for lost lobster traps and other gear; Collaborate with other stakeholders to conduct lost fishing gear recovery	Laura Ludwig (CCS)	Information and data used to investigate by-catch, habitat impacts, and gear modification ideas; Database and images available	Cape Cod Bay

[F] Global Ghost Gear Initiative [Ongoing]	Improve the health of marine ecosystems; Safeguard human health and livelihoods; Protect marine animals from harm	Jaclyn McGary and Ingrid Giskes (Ocean Conservancy)	Database which contains active and completed projects; Data and statistics available online	International
[G] Fishing for Energy Partnership [Ongoing]	Provide funding for projects that give coastal communities and fishers a way to dispose of old and unusable fishing gear to reduce the amount of derelict fishing gear in and near coastal waterways	Erika Feller and Kaity Goldsmith (National Fish and Wildlife Foundation)	Support projects that work towards four priorities: - Disposal Opportunities - Regulation - Technological Innovation - Outreach and Education	17 U.S. states, Washington, D.C., and Puerto Rico
[H] Collaborative Remediation of Abandoned, Lost, and Discarded Fishing Gear [July 2020 – March 2022]	Implement waste management systems for responsible disposal of end-of-life gear; Retrieve DFG from targeted areas; Conduct an impact assessment of DFG	Jessie McIntyre (Coastal Action)	Project accomplishments will be listed and updated on the Coastal Action website after each year	Southwestern Nova Scotia
[I] Partnering with Local Fishers to Remove Derelict Fishing Gear in the Gulf of Maine [Oct. 2020 – Oct. 2022]	Remove derelict fishing gear and large debris from identified hotspots; Build capacity and encourage fishers, lobstermen, and other stakeholders to implement best practices for managing gear and preventing / reporting gear loss.	Jackie McGary (Ocean Conservancy) Erin Pelletier (GOMLF) Demi Fox (NOAA MDP)	Two workshops with fishers, policymakers, conservation advocates and other stakeholders and present collected data and information; An event at the Maine Fishermen's Forum to share best practices for gear removal	Maine: the Portland area of Casco Bay, the Harpswell / Orrs Island area, and the Southwest Harbor / Cranberry Islands area.
[J] Lobster Trap Recovery and Recycling in Gulf of Maine [2018]	Conduct at sea gear removal in an area where heavy lobster fishing occurs; Take recovered gear to appropriate recycling facility	Jackie McGary (Ocean Conservancy) Erin Pelletier (GOMLF) Demi Fox (NOAA MDP)	Data about by-catch, escape vent functionality, and age of traps, which will be stored and used by the GGGI Best Practice Working Group.	Casco Bay, ME
[K] Engaging Commercial and Recreational Shellfish Partners in Gear Cleanup [Ongoing]	Identify hot spots or legacy gear removal sites to improve habitat; Work with town officials and shellfish fishers to clean up these areas collaboratively	Laura Ludwig (CCS)	Educates shellfish industry on impacts of debris; removal of debris from shellfish areas; data for all cleanups available upon request	Cape Cod

Additional Project Information (for select projects):

[A] Traps 2 Treasure: All traps are collected at the processing site and $2 tax deductions are given for each unwanted trap. Provides local fishers with a place to dispose of gear properly but is currently very small effort, existing only at a single site in Gouldsboro, Maine. Future additional work to consider related to this effort includes promoting increased awareness of the program and expanding / scaling up the number of processing sites.

[B] Gulf of Maine Derelict Fishing Gear At Sea Removal Database: Database for at sea DFG removal projects in Maine and Massachusetts, updated annually or semi-annually. This project provides data to managers and industry, while also ensuring that the data can be housed for long-term objectives.

[C] Sustainable Fisheries Solutions & Retrieval Support Contribution Program ("Ghost Gear Fund"): Has contributed funding and support for twenty-six projects over two years (2020-2022), including some that take place in the Gulf of Maine region. Some example projects include the Maliseet Nation Conservation Council, which focuses on using SCUBA and surface-supply diving as an effective ghost-gear recovery method in the Bay of Fundy, and Fundy North Fisherman's Association, which looks to expand the repurposing capacity and address the gap around responsible disposal by building recycling capacity to manage end-of-life lobster traps in southwestern New Brunswick.

Atlantic Puffin are one of nearly two dozen species documented to have been affected by marine debris in the Gulf of Maine Region. Kendrick Hang

[H] Collaborative Remediation of Abandoned, Lost, and Discarded Fishing Gear: Collaborative effort between Canadian government, fishing industry, and academic researchers. Will result in impact assessment that focuses on economic and environmental impacts of ghost gear in Southwestern Nova Scotia.

[K] Engaging Commercial and Recreational Shellfish Partners in Gear Cleanup: A collaboration between the Center for Coastal Studies, Cape Cod town officials, and commercial/recreational fishers. Program partners hope to expand to all Cape Cod towns in near future and encourage all coastal towns to host similar scheduled events.

Not a healthy snack for a bird! I. Taylor

CONSUMER LITTER - Identify Effective Methods To Serve Data And Other Information To Inform And/Or Influence Legislation To Reduce Impacts Of Balloons, Plastic Bags, And Single-Use Utensils

Overview:
Tourism is a major economic driver of the Gulf of Maine region's economy. This industry also increases consumer litter that reaches the marine environment, including balloons, plastic bags, and single-use utensils. Although identified as one of four top priorities by project partners, it was acknowledged that the group may have fewer options to address the issue directly. Instead, partners should identify effective methods to better provide data and other information to quantify and highlight the issue. This information can be used to influence legislation to reduce impacts of consumer litter. Meeting many of the objectives identified by partners for this priority may therefore take several years, though initial actions could be undertaken much sooner.

As with the derelict fishing gear issue, partners indicated that it was essential to establish and/or expand partnerships and increase communication among stakeholders to address impacts of consumer litter on birds. One related objective is to collect and centralize any existing data and photos from partners showing impacts of consumer litter on seabirds. Collecting and centralizing this information will differ from how information is collected in previous priorities (e.g., DFG) because partners anticipate that many of these images may come from NGOs and non-profits already conducting extensive (and often volunteer-driven) shoreline cleanups, rather than bird researchers at a fixed site. Photo-documentation is sometimes part of these established community-science protocols or could be incorporated via outreach to sponsoring organizations.

Another objective emphasizes creation of a network of partners for sharing opportunities to link bird-debris information to legislative efforts for reducing consumer debris. Creation of a notice board on the NOAA Marine Debris Program's Northeast Marine Debris Collaborative Portal that identifies relevant legislative proceedings (e.g., hearings, testimonies, etc.) would enable partners to stay up to date on the latest opportunities to provide supporting data, talking points, photos, and other documentation of the impacts of consumer litter on birds. Better coordination between researchers and NGOs could lead to synergies that facilitate legislative changes.

With proper planning and coordination, data and other information can also be served to the public to elicit support for reducing sources of consumer litter. Partners suggested that USFWS Refuge staff and other public land managers could design and implement a campaign for emphasizing the link between bird mortality and consumer litter (signage) on those lands they manage. Partners could also work to incorporate data and photos into a set of presentations and educational materials (photos, videos, case studies, information, talking points) for schools, community organizations, and tourist-related industries highlighting consumer litter-bird interactions. These materials would also be useful for informing legislative decisions. Some of these objectives will likely take time and funding to accomplish, but coordination among interested land managers and NGOs could begin in the near future, with the initiation of an effort to develop signage and messaging strategies based on other successful conservation campaigns.

The Consumer Litter priority can be directly linked to work identified as objectives for filling information gaps (see Information Gaps, Habitat section). In order to standardize the data collected during beach and island clean-up efforts, a Gulf of Maine-focused guide on consumer litter collection, identification, and data recording/processing could be created to aid NGOs and land managers. By combining the efforts of these partners with researchers who are identifying and studying ingestion-related issues (see Information Gaps, Ingestion section), research and data can be translated into outreach products to be used to meet objectives related to addressing consumer litter impacts.

Similar to the DFG-related priority, partners recognized that several strategies and actions identified in the "Consumer Debris" section of Gulf of Maine Marine Debris Action Plan may help address impacts to birds. We recommend better engagement with Action Plan lead partners to better incorporate benefits to birds into objectives, and suggest that partners involved in the Implementation Framework offer assistance and expertise pertaining to birds.

One-third to two-thirds of the debris cataloged on beaches comes from improperly disposed single-use, disposable plastic packaging from food and beverage-related goods and services (plastic cups, bottles, straws, utensils, and stirrers). Roberta Youmans

OBJECTIVES		
Description - what we'll do	Time frame - when? (6mo, 1y, 3y, etc.)	Associated Metrics - how will we measure progress?
Create network of existing partners (NOAA MDAP, this effort) to share opportunities for linking bird information to legislative opportunities for reducing consumer debris (e.g., hearings, testimonies, etc.)	1 year	Working partnership formed; Common objectives developed; Increased number of meetings attended / presented at by partnership
Collect and centralize existing data, photos, and other information from partners (case studies, talking points, graphics, etc.) throughout the Gulf of Maine region showing impacts of consumer litter on seabirds	1 – 2 years	Centralized repository created / or existing one expanded to meet objective; Increased number of participating partners supplying and accessing information
Incorporate bird information and objectives into relevant strategies identified in the Gulf of Maine Action Plan, "Consumer Debris" section Goals	1 – 2 years	Increased number of MDAP strategies and actions incorporating bird-related objectives
Work with researchers identifying and studying information gaps on plastic pollution ingestion to translate research / data into outreach products	1 – 3+ years	Increased number of outreach products developed based on ingestion research results
Develop a set of presentations and other educational materials (infographics, videos, case studies, talking points) for schools, community organizations, tourist-related industries, and legislative officials showing the impacts of consumer litter on birds	1 – 3 years	Information created and stored/ served in centralized repository; Increased number of participating partners supplying and accessing information; Increased number of educational programs incorporating information; Information used to help inform additional legislation
Design outreach campaign for USFWS Refuges and other public lands in the Gulf of Maine region that highlights the link between bird mortality and consumer litter (e.g., signage; outreach and education)	1 – 3 years	Signage and outreach materials created and utilized at federal, state, local managed lands across region

Restaurants and other retailers can institute policies to help reduce straw waste, such as limiting them to customers only upon request, and only offering straws composed of natural fibers (bamboo, hay, cardboard, etc.). Creative Commons

FIRST STEPS - Simple, Achievable, Short term		
Action	Key Partners	Time frame to initiate
Create a notice board on the Marine Debris Collaborative Portal that identifies legislative opportunities (e.g., hearings, testimonies, etc.)	Jennifer Kennedy (Blue Ocean Society) Demi Fox (NOAA MDP) (Request participation from Melissa Gates (Surfrider Foundation))	Winter '21/'22 – Summer 2022
Organize a call to identify data sources for examining abundance and distribution of balloons at sea, and documenting their impacts	Iain Stenhouse (Biodiversity Research Institute) Stephanie Ellis (Wild Care, Inc.) Jennifer Kennedy (Blue Ocean Society) Laura Ludwig (CCS) Theresa Torrent (Maine DMR) (Request participation from the Rozalia Project)	Winter '21/'22 – Summer 2022
Establish a section of the Northeast Marine Debris Collaborative Portal for compiling and storing data, info, and photos documenting impacts of consumer litter on birds; promote with partners	Demi Fox (NOAA MDP) Caleb Spiegel (USFWS) Linda Welch (USFWS) John Stanton (USFWS)	Fall 2021 (initiated) – Fall 2022
Coordinate with interested land managers to initiate an effort to develop signage, messaging, and other strategies to emphasize debris impacts on birds and reduce litter on public lands – use examples of other successful conservation campaigns	Susi von Oettingen (USFWS) Kate O'Brien (USFWS) Deb Reynolds (USFWS) Jennifer Kennedy (Blue Ocean Society) Theresa Torrent (Maine DMR) (Request participation from select town and state managers)	Spring 2022 – Fall 2022
Identify relevant strategies and actions in the Gulf of Maine Marine Debris Action Plan and reach out to leads about better linking bird information and objectives from this Framework	Demi Fox (NOAA MDP) Caleb Spiegel (USFWS) Linda Welch (USFWS) Joan LeBlanc (Gulf of Maine Council)	Winter '21/'22 - Fall 2022
Create a Gulf of Maine-focused guide on consumer litter collection and identification to aid NGOs and land managers in cleanups and data collection/processing	Laura Ludwig (CCS) Jennifer Kennedy (Blue Ocean Society) Sarah Kollar (Ocean Conservancy)	Winter '21/'22 – Fall 2022
Organize a call with NGOs and research partners to brainstorm development of multimedia outreach products to highlight the impacts of consumer litter on birds	Jennifer Kennedy (Blue Ocean Society) Stephanie Ellis (Wild Care, Inc.) Caleb Spiegel (USFWS) Demi Fox (NOAA MDP) Rónán Selby (Earth ECHO) Theresa Torrent (Maine DMR) Don Lyons and Paula Shannon (National Audubon) (Request participation from Cornell Media Lab)	Winter 2022 - Fall 2022

RELEVANT WORK UNDERWAY/COMPLETED				
Title	Objective(s)	Project contact(s)	Outcomes / products	Location
[A] Efforts to influence new legislation on use of balloons and straws [Ongoing]	Increase awareness of impacts to protect marine life in the Gulf of Maine	Jennifer Kennedy (Blue Ocean Society for Marine Conservation)	Changes in legislation on single-use plastics, balloons, etc.	Gulf of Maine region
[B] Database of images of hooked / debris-entangled birds [Ongoing]	Reduce the amount of recreational DFG and decrease impacts on birds through public education	Stephanie Ellis (Wild Care Inc.)	Database of images and documented interactions that could be used for future research	Chatham and Eastham, Cape Cod, MA
[C] COASTSWEEP [Sept. – Nov., annually]	Engage volunteers to collect land-based debris on coastlines; Sort debris and log data on types found, volume, animal impacts, etc.	Robin Lacey (MA Office of Coastal Zone Management)	Summaries and statistics of past efforts can be found on the CZM website	Coastal Massachusetts
[D] International Coastal Cleanup Database (TIDES) [Annual]	Collect and store data from the world's largest volunteer effort of its kind; Data includes type of debris, amount of debris, and any injured/deceased animals that are visibly entangled in debris or litter	Sarah Kollar (Ocean Conservancy)	Database and accompanying annual reports containing statistics and images (35+ years)	International
[E] Center for Coastal Studies Beach Cleanups [Seasonal]	Organize volunteers and conduct cleanups of consumer litter during spring, fall, and winter; Sort and document items recovered	Laura Ludwig (CCS)	Public data cards and app to track litter independently; Datasets from past years for future research	Long Point, Herring Cove and other public beaches (Provincetown, MA)

Additional Project Information (For Select Projects):

[A] Efforts to influence new legislation on use of balloons and straws: NGOs like Blue Ocean Society help increase awareness of impacts of consumer litter by providing testimony at municipal hearings about regulating balloons, straws, etc. One area of need for these efforts is specific expertise, talking points, and data about birds, which is currently lacking in presentations.

[B] Database of images of hooked / debris-entangled birds: Partners at Wild Care Inc. have collected anecdotal reports and images on impacts of recreational fishing gear (monofilament line, hook, sinkers, etc.). Additional future work includes bringing this community science-based effort to other towns on Cape Cod, and inspiring other coastal towns/states to implement similar model.

STRATEGIES – POTENTIAL BARRIERS TO SUCCESS

When working towards a set of objectives, it is important to plan for challenges that may occur during associated actions. These "Barriers to Success" can arise because of funding limitations for projects, ingrained societal norms that are difficult to change, or slow-moving processes associated with legislative changes.

The most substantial barrier identified by partners that might impede progress towards implementing impact-reduction strategies was difficulty changing established habits of fishers and the public involved in use and disposal of derelict fishing gear and consumer litter. Insufficient or ineffective legislation, weak or nonexistent enforcement, and lack of available resources can lead to improper (often illegal) dumping of old gear to save money and time. Public consumers may have a difficult time changing daily plastic usage habits. Incorporating objectives and first steps that increase disposal opportunities for derelict fishing gear and consumer litter, while also creating and strengthening education programs directed at these groups, should aid in increasing awareness, and ideally overcoming established habits that impact birds. Partners also discussed the lack of time and opportunities for effective collaborations. This Implementation Framework provides achievable, momentum-building first steps towards better focused collaboration, as well as resources like partner contacts (Appendix I), a list of key stakeholders (Appendix V), and a table featuring several potential funding opportunities (Appendix VI). While the Framework will require continued partner engagement to be effective, we hope that it will serve as a solid first step to better coordinate collective actions to address impacts of marine debris on birds. The following barriers to success were also identified during the webinar process:

(I) Derelict Fishing Gear

- Not enough data collection on interactions with birds (entanglement, entrapment, and mortality) when collecting and disposing of derelict fishing gear
- Limited opportunities to engage lobstermen, fishers, and aquaculture producers in clean-up efforts with other partners
- Current regulations do not permit cleanup of derelict lobster traps, except by gear owners or by state or federal permit
- Insufficient funding available to aid in clean-up efforts and program expansion
- No centralized/standardized way to collect or share information on impacts of DFG on birds or associated clean-up burden (e.g., tonnage and quantity estimates, clean-up costs, pictures of entangled birds)

(II) Consumer Litter

- Difficult to provide adequate supporting information to influence legislative changes
- Impacts on birds not always considered when discussing consumer litter
- Single use plastic increases due to COVID pandemic
- Lack of effective communication across projects working on addressing impacts
- Potential data sources scattered across region and interests, and not well cataloged, organized, or compiled
- Lack of support or objection from packaging and disposables industry to efforts to reduce waste that can become marine debris

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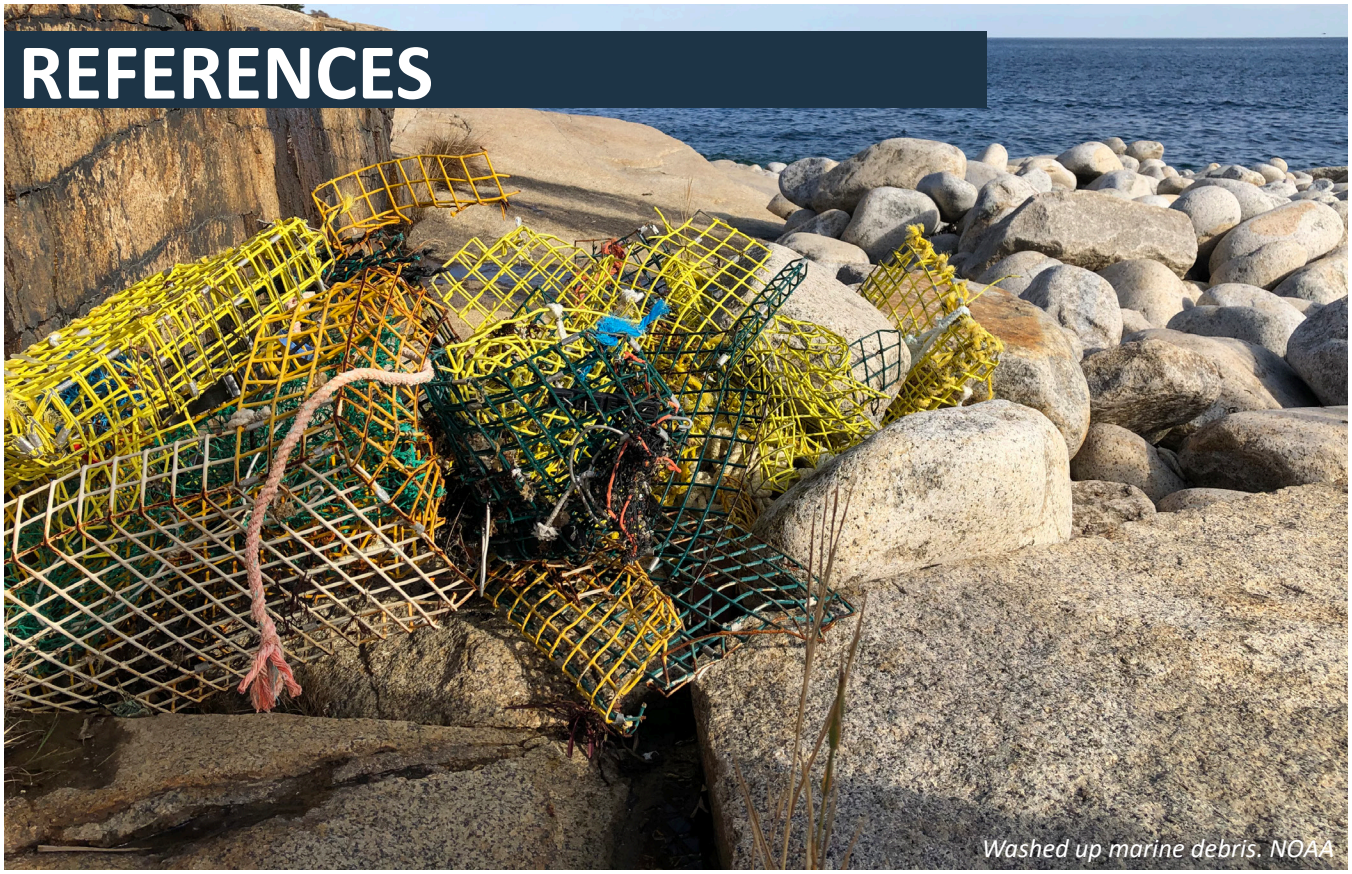

Washed up marine debris. NOAA

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COMMON ACRONYMS

Monofilament recycling bin in Boston, MA. NOAA

Acronym	Organization
APHIS	Animal and Plant Health Inspection Service
BMP	Best Management Practice
DFG	Derelict Fishing Gear
DMR	Department of Marine Resources
ECCC	Environment and Climate Change Canada
GOMLF	Gulf of Maine Lobster Foundation
MCHT	Maine Coast Heritage Trust
MDAP	Marine Debris Action Plan
MDP	Marine Debris Program
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
SEANET	Seabird Ecological Assessment Network
UNH	University of New Hampshire
US EPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

Volunteers remove debris in Maine. Terry Towne, Maine Coast Heritage Trust

APPENDIX I

PROJECT COLLABORATORS, AND KEY AND RECOMMENDED PARTNERS (IMPLEMENTATION FRAMEWORK)

Key partners are those identified in specific first step actions within the Implementation Framework. Most participated in at least one planning webinar and/or offered substantial input during the project, and expressed an interest in helping initiate actions they are associated with (see Priorities Engagement column). Key partner e-mail addresses are provided to facilitate collaboration on those first step actions they have agreed to help initiate.

Webinar Participants and Key Partners						
Name	Affiliation	Inquiry Respondent	Key Partner	Webinar Participant	Priorities Engagement	Key Partner Email Address
Brad Allen	Maine Dept. of Inland Fisheries & Wildlife	No	No	Yes	--	--
Jane Arbuckle	Maine Coast Heritage Trust	No	No	Yes	--	--
Magdalena Ayed	The Harborkeepers (MA)	No	No	Yes	--	--
Julia Baak	McGill University	No	No	Yes	--	--
Mark Baran	Univerisity of New Brunswick	No	No	Yes	--	--
Brian Benedict	USFWS	No	Yes	Yes	Derelict Fishing Gear	brian_benedict@fws.gov
Aliya Caldwell	University of New Hampshire	No	Yes	No	Ingestion	aliyaeverestcaldwell@gmail.com
Sarah Courchesne	Northern Essex Community College	Yes	No	Yes	--	--
Elizabeth Craig	University of New Hampshire	Yes	Yes	Yes	Ingestion	ecc79@cornell.edu

Webinar Participants and Key Partners						
Name	Affiliation	Inquiry Respondent	Key Partner	Webinar Participant	Priorities Engagement	Key Partner Email Address
Danielle D'Auria	Maine Dept. of Inland Fisheries & Wildlife	No	No	Yes	--	--
Eddie Edwards	USFWS	No	No	Yes	--	--
Stephanie Ellis	Wild Care Inc.	No	Yes	Yes	Derelict Fishing Gear; Consumer Litter	stephanie@wildcarecapecod.org
Jim Fortier	USFWS	No	Yes	Yes	Derelict Fishing Gear	james_fortier@fws.gov
Demi Fox	NOAA MDP / Lynker	No	Yes	Yes	Habitat; Derelict Fishing Gear; Consumer Litter	demi.fox@noaa.gov
Carina Gjerdrum	Environment and Climate Change Canada	No	No	Yes	--	--
Matthew Hillman	USFWS	No	No	Yes	--	--
Robert Houston	USFWS	No	No	Yes	--	--
Pamela Hunt	New Hampshire Audubon	No	No	Yes	--	--
Lynn Jackson	Seaside Sustainability	No	No	Yes	--	--
Scott Johnston	USFWS	No	No	Yes	--	--
Christy Kehoe	NOAA MDP	No	No	Yes	--	--
Jennifer Kennedy	Blue Ocean Society	No	Yes	Yes	Consumer Litter	jen@blueoceansociety.org
Logan Kline	University of Maine	No	No	Yes	--	--
Sarah Kollar	Ocean Conservancy	No	Yes	No	Consumer Litter	skollar@oceanconservancy.org
Michael Langlois	USFWS	No	No	Yes	--	--
Joan LeBlanc	Gulf of Maine Council on the Marine Environment	No	Yes	No	Derelict Fishing Gear; Consumer Litter	jleblanc@gulfofmaine.org
Adrienne Leppold	Maine Dept. of Inland Fisheries & Wildlife	No	No	Yes	--	--
Meredith Lewis	University of Maine	No	No	Yes	--	--
Cynthia Loftin	University of Maine; USGS Coop Unit	Yes	Yes	No	Habitat	cynthia.loftin@maine.edu
Pamela Loring	USFWS	No	Yes	Yes	Ingestion; Habitat; Derelict Fishing Gear; Consumer Litter	pamela_loring@fws.gov
Laura Ludwig	Center for Coastal Studies	Yes	Yes	Yes	Habitat; Derelict Fishing Gear; Consumer Litter	lludwig@coastalstudies.org
Don Lyons	National Audubon	Yes	Yes	Yes	Ingestion; Habitat	donald.lyons@audubon.org

Webinar Participants and Key Partners						
Name	Affiliation	Inquiry Respondent	Key Partner	Webinar Participant	Priorities Engagement	Key Partner Email Address
Heather Major	University of New Brunswick	Yes	No	Yes	--	--
Mark McCollough	USFWS	No	No	Yes	--	--
Wayne McFee	NOAA	No	No	Yes	--	--
Jessie McIntyre	Coastal Action	No	No	Yes	--	--
Aly McKnight	Unity College	No	No	Yes	--	--
Carolyn Mostello	Massachusetts Division of Fisheries & Wildlife	Yes	No	Yes	--	--
Kate O'Brien	USFWS	No	Yes	Yes	Derelict Fishing Gear; Consumer Litter	kate_obrien@fws.gov
Tessa Pfeifer	College of Charleston	No	No	Yes	--	--
Mark Pokras	Tufts University	No	Yes	Yes	Ingestion; Derelict Fishing Gear	mark.pokras@tufts.edu
Jennifer Provencher	Environment and Climate Change Canada	No	Yes	No	Ingestion; Habitat	jennifer.provencher@ec.gc.ca
Debra Reynolds	USFWS	No	Yes	Yes	Consumer Litter	debra_reynolds@fws.gov
Heather Richard	Shaw Institute	No	No	Yes	--	--
Anna Robuck	University of Rhode Island / Stellwagen Bank NMS	Yes	Yes	Yes	Ingestion	anna_robuck@uri.edu
Amy Russell	Not Specified	No	No	Yes	--	--
Jake Russell-Mercier	Environment and Climate Change Canada	No	Yes	Yes	Ingestion; Habitat	jake.russell-mercier@ec.gc.ca
Susan Schubel	National Audubon	No	No	Yes	--	--
Buzz Scott	OceansWide	No	Yes	Yes	Derelict Fishing Gear	buzz@oceanswide.org
Rónán Selby	Earth ECHO	No	Yes	Yes	Consumer Litter	rodmsel@gmail.com
Lisa Sette	Center for Coastal Studies	No	No	Yes	--	--
Paula Shannon	National Audubon	No	Yes	Yes	Ingestion; Habitat	paula.shannon@audubon.org
Gina Shield	NOAA National Marine Fisheries Service	Yes	Yes	No	Ingestion	gina.shield@noaa.gov
Caleb Spiegel	USFWS	No	Yes	Yes	Ingestion; Habitat; Derelict Fishing Gear; Consumer Litter	caleb_spiegel@fws.gov
John Stanton	USFWS	Yes	Yes	Yes	Ingestion; Derelict Fishing Gear	john_stanton@fws.gov
Kim Starbuck	Urban Harbors Institute	No	No	Yes	--	--

Webinar Participants and Key Partners						
Name	Affiliation	Inquiry Respondent	Key Partner	Webinar Participant	Priorities Engagement	Key Partner Email Address
Iain Stenhouse	Biodiversity Research Institute	No	Yes	Yes	Consumer Litter	iain.stenhouse@briloon.org
Theresa Torrent	Maine Dept. of Marine Resources (Coastal Program)	Yes	Yes	Yes	Habitat; Derelict Fishing Gear; Consumer Litter	theresa.torrent@maine.gov
Terry Towne	Maine Coast Heritage Trust	No	Yes	Yes	Habitat; Derelict Fishing Gear	ttowne@mcht.org
Susi vonOettingen	USFWS	No	Yes	Yes	Derelict Fishing Gear; Consumer Litter	susi_vonoettingen@fws.gov
Kiah Walker	USFWS	Yes	No	Yes	--	--
Linda Welch	USFWS	Yes	Yes	Yes	Ingestion; Habitat; Derelict Fishing Gear; Consumer Litter	linda_welch@fws.gov
Audrey White	Duke University Marine Lab	No	No	Yes	--	--
Becky Whittam	Environment and Climate Change Canada	No	No	Yes	--	--
Dave Wiley	Stellwagen Bank NMS	Yes	Yes	No	Ingestion	david.wiley@noaa.gov
Sarah Wong	Environment and Climate Change Canada	No	Yes	Yes	Ingestion; Habitat	sarah.wong2@ec.gc.ca

The following partners did not participate in the webinar series, but were recommended by peers	
Name	Affiliation
Chris Bridger	Huntsman Marine Science Center
Kristian Curran	Canada Dept. of Fisheries and Oceans
Ivy Frignoca	Friends of Casco Bay
Carey Friedman	Maine Maritime Academy
Melissa Gates	Surfrider Foundation
Larissa Goshulak	Canada Dept. of Fisheries and Oceans
Dick Hilmer	Town of Orleans, MA
Patricia Jones	Bowdoin College
Zoe Lucas	Sable Island Institute
Mark Mallory	Environment and Climate Change Canada
Mike Marchand	NH Fish and Game Department
Jaclyn McGarry	Ocean Conservancy
Marina Petrovic	Canada Dept. of Fisheries and Oceans
Jen Rock	Environment and Climate Change Canada
Geoff Sanders	Cape Cod National Seashore
Ashley Sullivan	Rozalia Project
Sabina Wilhelm	Environment and Climate Change Canada

APPENDIX II

Removing derelict traps off Cape Cod.
Center for Coastal Studies

APPENDIX II – EXPERT INQUIRY FORM

GoME Marine Debris Action Plan (MDAP)

* Required

Name: *

_____

Entity / Agency: *

_____

Primary Geographic Location of your Work: *
Check all that apply.

[ ] Maine
[ ] New Hampshire
[ ] Massachusetts
[ ] Rhode Island
[ ] Other: _____

Email Address: *

_____

Impacts of Marine Debris:

For the purposes of this inquiry, marine debris can be defined as:
1) Derelict fishing gear - lost or abandoned recreational or commercial fishing nets, lines, pots and traps
2) Consumer litter - some examples include plastic bottles and caps, balloons, household garbage, cigarettes
3) Industrial litter - some examples include plastic strappings, industrial pellets, buoys, rope, oil, etc.
4) Any other persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes.

THREATS: *

Threats of marine debris to birds include: entanglement, ingestion, and impacts to nesting habitat. Do you have anecdotal information, data, or photos on the following?
Check all that apply.

[ ] Entanglement at sea
[ ] Entanglement on land
[ ] Ingestion
[ ] Impacts to nesting habitat
[ ] Other:

STRATEGIES:

List any partnerships or programs you are involved with that are working towards reducing impacts of marine debris to birds. Please provide a contact name and email, if possible.

_____

_____

_____

_____

_____

INFORMATION GAPS:

What do you see as the biggest information gaps on marine debris and birds in the Gulf of Maine and beyond? Please list in order of importance, if possible.

_____

_____

_____

_____

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_____

DATA ACQUISITION:

Please let us know if you have any information to contribute to a summary report, including unpublished documents, photos or anecdotal accounts documenting impacts of marine debris to birds. If at all easier, you can email this information directly to: mandranovich@uri.edu.

_____

_____

_____

_____

_____

_____

Would you be willing to participate in a follow-up call to discuss details to include in the MDAP report? *

[ ] Yes
[ ] No

Thank you for taking time to complete this inquiry, and we look forward to adding your contributions to the final report!

APPENDIX III

Common Eider. Fyn Kynd, Creative Commons

SEABIRDS AND MARINE WATERFOWL AFFECTED BY MARINE DEBRIS IN THE GULF OF MAINE REGION

This table lists seabird and marine waterfowl species (n = 21) documented in the literature to have experienced adverse effects from marine debris interactions. The table draws on information compiled by Susanne Kühn (Wageningen Marine Research) as part of a comprehensive literature database documenting ingestion and entanglement of marine biota worldwide (see associated publication for more details). This database contains numerous attributes, including source publications, work conducted, location, and results. Data in this appendix are filtered to provide relevant information for species interactions in the Gulf of Maine region. Please contact Susanne Kühn at susanne.kuehn@wur.nl for more information on the database or if you are interested in sharing information.

Common Name	Genus / Species	Marine Debris Interaction	Location	Publication
Arctic Herring Gull	*Larus sargentatus smithsonianus*	Entanglement and Entrapment Ingestion	Massachusetts, United States Maine United States	Harris et al. (2006) Day et al. (1985)
Atlantic Puffin	*Fratercula arctica*	Ingestion	North Atlantic, Canada	Provencher et al. (2014)
Black-legged Kittiwake	*Rissa tridactyla*	Ingestion	North Atlantic, Canada	Day et al. (1985)
Bonaparte's Gull	*Chroicocephalus philadelphia*	Ingestion	Eastern Canada	Braune and Gaskin (1982)
Common Eider	*Somateria mollissima*	Entanglement and Entrapment Ingestion	Massachusetts, United States North Atlantic, Canada	Harris et al. (2006) English et al. (2015)
Common Murre	*Uria aalge*	Ingestion	Newfoundland, Canada	Bond et al. (2013)

Common Name	Genus / Species	Marine Debris Interaction	Location	Publication
Common Tern	*Sterna hirundo*	Ingestion	Eastern Canada	Braune and Gaskin (1982)
Double-crested Cormorant	*Nannopterum auritum*	Incorporation into Nests	Gulf of Maine, United States	Podolsky and Kress (1989)
Dovekie (Little Auk)	*Alle alle*	Ingestion	Newfoundland, Canada	Avery-Gomm et al. (2016)
European Herring Gull	*Larus argentatus*	Ingestion Incorporation into Nests	Newfoundland, Canada North Atlantic, United States	Bond (2016) Lato et al. (2021)
Great Black-backed Gull	*Larus marinus*	Entanglement and Entrapment Ingestion	Maine, United States Maine, United States	Laist (1997) Day et al. (1985)
Great Shearwater	*Ardenna gravis*	Ingestion	Sable Island, Canada	Bond et al. (2014)
Iceland Gull	*Larus glaucoides*	Ingestion	Newfoundland, Canada	Seif et al. (2018)
Leach's Storm-petrel	*Hydrobates leucorhous*	Entanglement and Entrapment Ingestion	Newfoundland, Canada Nova Scotia, Canada	Laist (1997) Frith et al. (2020)
Lesser Black-backed Gull	*Larus fuscus*	Ingestion Incorporation into Nests	Maine, United States North Atlantic, United States	Caldwell et al. (2019) Lato et al. (2021)
Northern Fulmar	*Fulmarus glacialis*	Ingestion	Labrador Sea, Canada	Avery-Gomm et al. (2018)
Northern Gannet	*Morus bassanus*	Entanglement and Entrapment Ingestion Incorporation into Nests	Nova Scotia, Canada Massachusetts, United States Newfoundland, Canada	Lucas (1992) Pierce et al. (2004) Bond et al. (2012)
Sooty Shearwater	*Ardenna grisea*	Ingestion	Sable Island, Canada	Bond et al. (2014)
Thick-billed Murre	*Uria lomvia*	Entanglement and Entrapment Ingestion	Nova Scotia, Canada Newfoundland, Canada	Lucas (1992) Bond et al. (2013)
White-winged Scoter	*Melanitta deglandi*	Entanglement and Entrapment Ingestion	Massachusetts, United States North Atlantic, Canada	Harris et al. (2006) Holland et al. (2016)
Yellow-billed Loon	*Gavia adamsii*	Ingestion	North Atlantic, Canada	Holland et al. (2016)

APPENDIX IV

Cormorants nesting on breakwater, Provincetown, MA. Elise Cozzi

DATABASES AND INFORMATION REPOSITORIES RELEVANT TO DOCUMENTING THE IMPACTS OF MARINE DEBRIS ON BIRDS

Several project partners indicated that there is no shared, standardized repository or database for data, photos, and other relevant information on marine debris - wildlife interactions in the Gulf of Maine region. This table provides a list of databases and other repositories which maintain relevant information on marine debris and/or the impacts of marine debris on wildlife. The databases range in scope and scale from the Gulf of Maine region to multiple countries. Databases and repositories listed in this appendix may be of direct interest to current and future projects and research, or could be used as a model for Gulf of Maine region partners to create and adopt in their own collaborative way of sharing information. These projects are listed alphabetically, thus order does not indicate importance or relevance.

Project Name	Maintaining Organization	Geographic Focus	Description
Beach Cleanups and Marine Debris Research Database	Blue Ocean Society for Marine Conservation	Gulf of Maine region (US only)	Maintains statistics from yearly beach cleanups in MA, NH, and ME. Includes anecdotal reports of animal interactions with marine debris which are submitted by the public.
Birds & Debris Database	Environmental Research Institute (North Highland College UHI, and the University of the Highlands and Islands)	International	Contains user-submitted images of entangled birds or bird nests with debris incorporated. Created to better understand and highlight the extent of bird-debris interactions.
Duke University's Plastic Policy Inventory	Nicholas Institute at Duke University	International	Updateable and searchable database consisting of public policy documents targeting plastic pollution in several languages. Contains policies from Jan. 1, 2000, to Aug. 30, 2020.

Project Name	Maintaining Organization	Geographic Focus	Description
Global Ghost Gear Initiative (GGGI) database	Global Ghost Gear Initiative	International	Maintains a collective database of ghost gear found at sea, as part of an effort to tackle the issue at a global scale.
Marine Debris Collaborative Portal (Northeast)	NOAA	Northeast United States	Provides a common location for sharing data, funding opportunities, and other marine debris related materials among partners and the general public.
Marine Debris Tracker App Database	University of Georgia and National Geographic Society	International (primarily Atlantic US states)	Logs user-submitted forms that contain descriptions of litter, associated photos, and GPS coordinates, along the coast and at sea. Can be used to track litter in any body of water (streams, lakes, oceans, etc.).
Marine Plastic Pollution Working Group	North Pacific Marine Science Organization (PICES)	North Pacific region and its marginal seas	Collaboration by topic experts to identify what species should be promoted for monitoring of plastic pollution monitoring across the North Pacific region
Database of marine biota experiencing debris ingestion and entanglement	Susanne Kühn and Jan Andries van Franeker	International (can be queried by attribute. See Appendix III)	Developed for a recent research review, which updates the Kühn et al. (2015) list on records of entanglement and ingestion.
Trash Information and Data for Education and Solutions (TIDES)	Ocean Conservancy	International	The world's largest database for documenting washed up debris. Collected by volunteers during beach cleanups
Wildlife Health Information Sharing Partnership Event Reporting System (WHISPers)	United States Geological Survey National Wildlife Health Center	United States	Web-based repository for sharing basic information about historic and ongoing wildlife mortality (death) and morbidity (illness) events.

APPENDIX V

Getting ready to clean up the beach.
Center for Coastal Studies

STAKEHOLDERS IDENTIFIED

This list identifies groups (both general and specific) in the Gulf of Maine region that partners indicated should be engaged in order to meet objectives identified in the Implementation Framework. Stakeholders are grouped by the Framework priority(s) they have a stake in. The order listed does not necessarily indicate importance or relevance.

STAKEHOLDERS IDENTIFIED
Information Gaps – Ingestion
Forensics labs (micro-plastics and toxicity analysis)
Lab partners / testing organizations
Researchers investigating plastic ingestion in other types of wildlife
Students engaged in plastics/seabird research
Volunteer groups interested in seabird carcass collection
Information Gaps – Habitat
Gulf of Maine Lobster Foundation
Lobster and aquaculture industry partners
Maine Lobstermen's Association
Maine Fishermen's Forum
Partners with expertise in aerial mapping
State/provincial and Federal agencies

STAKEHOLDERS IDENTIFIED
Strategies – Derelict Fishing Gear
Commercial lobster and fishing industry in both the US and Canada
Gulf of Maine Marine Debris Action Plan – “Derelict Fishing Gear” section leads
Gulf of Maine Lobster Foundation
Maine Lobstermen’s Association
Maine Fishermen’s Forum
National Park System
National Wildlife Refuge managers
Native tribes and First Nations
Organizations participating in coastal and island cleanups
Outdoor recreation and fishing gear stores
Recreational fishers
Restaurants that sell seafood / shellfish
State/provincial and municipal agencies
US Army Corps of Engineers
Strategies – Consumer Litter
Gulf of Maine Marine Debris Action Plan – “Consumer Debris” section leads
Nature centers, zoos, and aquariums
NGOs who advocate for legislation and/or participate in administrative meetings
Organizations participating in coastal and island cleanups
Public land managers
Researchers examining impacts of consumer litter on wildlife
Schools
State/provincial and town managers
Towns that rely on tourism revenue

APPENDIX VI

Purple Sandpiper. Fyn Kynd, Creative Commons

FUNDING OPPORTUNITY TABLE

It is anticipated that funding will be required to implement projects that address some of the objectives identified in the Implementation Framework. In order to help partners identify potential funding sources, this table provides a list of grant opportunities that may be relevant to gear removal and prevention, research, public outreach, and/or other marine debris issues. Funding opportunities are broken up by category and summarize useful information about each grant program (application deadline, RFP cycle, example of successful proposals, etc.) to help partners navigate application processes. This list is not exhaustive, but rather a compilation by the authors of some best available opportunities which have previously funded marine debris work, or could be viable candidates for advancing work toward meeting objectives in the Framework.

REMOVAL + PREVENTION OPPORTUNITIES											
Funding Opportunity	Source (Fed, State, NGO, commercial, academic)	Last proposal deadline	RFP Frequency	Total Funds available	Award ceiling $	Match Requirement	Stated objectives / target	Covers	Weblink	Contact e-mail	Example successful proposal
NFWF Fishing for Energy	Federal, Commercial	30-Mar-21	Annual	$500,000	Bin Host: $15,000; Bin Event: $10,000; Capacity/ Logistics: $75,000-100,000	1:1	Facilitate collection and proper disposal of retired and derelict commercial fishing gear for recycling and for energy conversion by supporting the placement of disposal bins at select ports across the U.S.	Collection of old fishing gear; Outreach & Education	https://www.nfwf.org/programs/fishing-energy/fishing-energy-2021-request-proposals	kaitlin.goldsmith@nfwf.org	https://www.nfwf.org/media-center/press-releases/fishing-energy-reaches-45-million-pound-milestone-marine-debris-collection
North America Marine Debris Prevention and Removal Grants	Federal	29-Jan-21	Special Funding Opportunity	$5,000,000	$150,000 -- $750, 000	1:1	Fund projects that address marine debris issues in the U.S.-Mexico and U.S.-Canada border areas. Projects that include collaboration with partners in Mexico and/or Canada will be prioritized.	Projects that prevent or reduce the occurrence of marine debris, and projects that remove marine debris from the environment.	https://www.grants.gov/web/grants/view-opportunity.html?oppId=329765	tom.barry@noaa.gov	First-time grant opportunity
Marine Debris Removal Grants	Federal	4-Sep-20	Annual (Alternating Years w/ Prevention)	$2,500,000	$50,000 -- $250, 000	1:1	Develop impactful, community-driven and cost-effective projects that remove threats to living marine resources and improve habitats through the removal of marine debris. Priority given to the detection and removal of derelict fishing gear and abandoned vessels.	New projects or ongoing work, although priority given to ongoing work (see weblink)	https://www.grants.gov/web/grants/view-opportunity.html?oppId=328110	tom.barry@noaa.gov	https://marinedebris.noaa.gov/noaa-marine-debris-program-awards-funding-new-projects-remove-marine-debris
Marine Debris Prevention Grants	Federal	7-Feb-20	Annual (Alternating Years w/ Removal)	$2,000,000	$50,000 -- $150, 000	1:1	Fund projects that provide creative, practical approaches to preventing or reducing a type or category of marine debris, or address a specific marine debris issue within the coastal United States and Territories (e.g., derelict fishing gear, abandoned and derelict vessels, land-based litter, microplastics, etc.)	New projects or ongoing work, although priority given to ongoing work (see weblink)	https://www.grants.gov/web/grants/view-opportunity.html?oppId=320683	tom.barry@noaa.gov	https://marinedebris.noaa.gov/noaa-marine-debris-program-awards-funding-new-projects-prevent-marine-debris
Joanna Toole GloLitter Partnerships Grant (Global Ghost Gear Initiative / Ocean Conservancy)	NGO	19-Jul-21	First time grant opportunity	Unknown	Up to $20,000	None listed	Applicants must be women-led organizations. Projects should focus on preventing negative impacts from ALDFG to species and habitat; developing systematic approaches to prevent/mitigate occurences of ALDFG; and recovery of ALDFG from sensitive habitats.	New projects or ongoing work	https://www.ghostgear.org/news/2021/6/4/joanna-toole-glolitter-partnerships-glp-grant-launched	GGGIproposals@oceanconservancy.org	First-time grant opportunity

REMOVAL + PREVENTION OPPORTUNITIES											
Funding Opportunity	Source (Fed, State, NGO, commercial, academic)	Last proposal deadline	RFP Frequency	Total Funds available	Award ceiling $	Match Requirement	Stated objectives / target	Covers	Weblink	Contact e-mail	Example successful proposal
Massachuetts Reduce, Reuse, Repair Micro-Grants	State	Rolling basis	N/A	Unknown	Up to $5,000	None listed	Fund projects focused on the reduction, reuse, or repair of one or more of the materials listed in the MA Solid Waste Master Plan (2030). Some of these priority materials include single-use packaging and food service products, building materials, transportation and distribution packaging, and textiles.	Research costs, materials, equipment, signage, outreach / education, event space rental fees, event marketing / promotion, professional services, and new personnel	https://www.mass.gov/doc/reduce-reuse-repair-micro-grant-guidelines	erin.victor@mass.gov	https://www.mass.gov/doc/2020-micro-grant-recipients/download https://www.mass.gov/doc/2019-micro-grant-recipients/download
NOAA New England Bay Watershed Education and Training (New England B-WET) Program	Federal	19-Apr-21	Bienniel	$300,000	$50,000 -- $100, 000	Not required	Fund projects that advance ocean, climate, and other environmental literacy goals and incorporate the goals of the NOAA Education Strategic Plan through educational programs and professional devleopment.	All costs related to program proposal	https://www.grants.gov/web/grants/view-opportunity.html?oppId=331533	Deirdre Kimball, deirdre.kimball@noaa.gov	https://www.noaa.gov/office-education/bwet/awards
Maine Community Foundation	Private donor-advised funds	Varies	Varies	Varies	Varies	Varies	All competitive grant programs only support work being done in Maine and benefiting people and communities in Maine.	Entrepreneurship Downeast; environmental conservation	https://www.mainecf.org/apply-for-a-grant/available-grants-deadlines/	Amy Pollien, apollien@mainecf.org	https://www.mainecf.org/apply-for-a-grant/recent-grants/conservation-for-all/ https://www.mainecf.org/apply-for-a-grant/recent-grants/downeast-innovation/
Aquatic Animal Conservation Grantmaking Program (Massachusetts Environmental Trust)	State	5/21/2021	Annual	$300,000	$30,000	Not required	MET is soliciting proposals for projects that proactively support aquatic animal species ranging from invertebrates to marine animals, with emphasis on endangered marine animals including NARW, sea turtles and seabirds, and coldwater fish species. MET is a catalyst for grassroots organizations that are working toward the completion of large-scale projects where federal, state, and local agencies and organizations work together to further implement conservation and restoration initiatives.	Provides reimbursement funding to projects that support the advancement of marine animal conservation efforts and restoration and enhancement of aquatic ecosystems within Massachusetts.	https://www.commbuys.com/bso/external/bidDetail.sdo?bidId=BD-21-1042-ENV-ENV01-58341&parentUrl=activeBids	Kathleen.McDermott@mass.gov	https://www.mass.gov/service-details/past-met-grant-awards

RESEARCH OPPORTUNITIES											
Funding Opportunity	Source (Fed, State, NGO, commercial, academic)	Last proposal deadline	RFP Frequency	Total Funds available	Award ceiling $	Match Requirement	Stated objectives / target	Covers	Weblink	Contact e-mail	Example successful proposal
Marine Debris Research Grants	Federal	5-Nov-20	Alternating years	$2,000,000	$75,000 -- $350, 000	1:1	Research that investigates and identifies the critical input pathways for marine debris introduction into the coastal zone (shoreline or nearshore), including evaluation of appropriate simultaneous pathways of riverine transport downstream, surface runoff, stormwater discharge, and wind-driven transport.	Research directly related to marine debris through field, laboratory, and modeling experiments.	https://marinedebris.noaa.gov/sites/default/files/NOAA-NOS-ORR-2021-2006620_NOFO_Report_0.pdf	tom.barry@noaa.gov	https://marinedebris.noaa.gov/funding-opportunities/noaa-marine-debris-program-awards-funding-4-new-projects-research-marine
Critical Aspects of Sustainability (CAS): Micro- and Nanoplastics [National Science Foundation]	Federal	Rolling basis, depending on program	Rolling basis, depending on program	Depends on program division (most greater than $100,000,000)	Most average $150,000 per year for three years ($450,000 total)	Unknown	Proposals that focus on fundamental scientific questions underlying micro- and nanoplastic characterization, behavior, and reactivity in the environment (including animal and human health), as well as their elimination from land and water systems.	Depends on program/ divison	https://www.nsf.gov/pubs/2020/nsf20050/nsf20050.jsp	Depends on program/ divison	Successful projects and research available for each division.
National Estuary Program – Coastal Watershed Grants	Federal	7-Jun-21	Annual	Not listed	$75,000 -- $250,000	33%	Designed to support projects that address urgent and challenging issues threatening the well-being of coastal and estuarine areas within determined estuaries of national significance.	Priorities: Loss of Habitat. Contaminants of emerging concern found in coastal and estuarine waters such as microplastics.	https://estuaries.org/initiatives/watershedgrants/	Suzanne Simon, Restore America's Estuaries, ssimon@estuaries.org	https://estuaries.org/initiatives/watershedgrants/2020-nep-cwg/
Massachusetts, MIT Sea Grant	Federal	19-Feb-21	Annual	Not listed	$100,000 per year (max 2 years)	50%	Priority objectives change with each new funding cycle.	Priority objectives change with each new funding cycle.	https://seagrant.mit.edu/funding/	Mary Newton Lima, Research Program Coordinator, mnewlim@mit.edu	https://seagrant.mit.edu/all-projects/
Massachusetts, Woods Hole Sea Grant	Federal	19-Feb-21	Bienniel	$1,000,000	Not listed	50%	Priority objectives change with each new funding cycle.	Priority objectives change with each new funding cycle.	https://seagrant.whoi.edu/funding-2/funding/biennial-request-for-proposals/	Jennie Rheuban, Research Coordinator, seagrant-research@whoi.edu	https://seagrant.whoi.edu/funding-2/all-funded-projects-2010-2020/
New Hampshire Sea Grant	Federal	19-Feb-21	Bienniel	Not listed	$100,000	50%	Priority objectives change with each new funding cycle.	Priority objectives change with each new funding cycle.	https://seagrant.unh.edu/biennial-request-proposals	Steve Jones, Assistant Director for Research, stephen.jones@unh.edu	https://seagrant.unh.edu/current-research
Maine Sea Grant	Federal	24-Feb-21	Bienniel	$600,000	$150,000	50%	Priority objectives change with each new funding cycle.	Priority objectives change with each new funding cycle.	https://seagrant.umaine.edu/funding-opportunities/maine-sea-grant-biennial-request-for-proposals/	sgresearch@maine.edu	https://seagrant.umaine.edu/research-program-development-projects/

ONE-TIME OPPORTUNITIES											
Funding Opportunity	Source (Fed, State, NGO, commercial, academic)	Last proposal deadline	RFP Frequency	Total Funds available	Award ceiling $	Match Requirement	Stated objectives / target	Covers	Weblink	Contact e-mail	Example successful proposal
Algalita's Stay Stoked Award (for young people)	NGO	14-Jul-21	Annual(?)	$15,000	$500 minimum	Not required	Continuing work to prevent plastic pollution through furthering education or conducting projects on a local, regional, national, or international scale. Recipients must be under the age of 25.		https://algalita.org/wayfinder/stay-stoked-award/	Michael Doshi, Director of Partnerships doshi@algalita.org	First time opportunity
BoatUS Foundation: Recast & Recycle Contest	NGO	14-May-21	One-time	$30,000	Three prizes ($15,000; $10,000; $5,000)	Not required	Funding the best ideas on how to make recycling of fishing line and soft bait more efficient, more attractive and more accessible.		https://www.boatus.org/contest/	akeating@boatus.com	First time opportunity