BUSINESS PLAN FOR ADDRESSING & REDUCING MARINE BIRD BYCATCH IN U.S. ATLANTIC FISHERIES

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Final, June 2011

I. INTRODUCTION & OBJECTIVES:

Marine bird bycatch in commercial fishing operations is recognized as a substantial conservation issue that has contributed to the decline of several species. Many marine birds have low reproductive rates, undergo long and strenuous migrations, face multiple threats over their large geographic ranges, and associate with fishing vessels while foraging, making their populations particularly vulnerable to mortality from fishing gear. Under international law (United Nations Convention on the Law of the Sea 1982), nations are responsible for managing all marine resources within their own exclusive economic zone, including species at risk of fisheries bycatch, and are expected to implement best management practices to minimize mortality of birds in fishing gear (Food and Agriculture Organization of the United Nations, FAO 2008). In the United States, laws such as the Endangered Species Act and the Migratory Bird Treaty Act mandate the minimization of bycatch of most marine bird species, and the Magnusson-Stevens Fishery Conservation and Management Reauthorization Act authorizes federal departments to reduce marine bird bycatch in fisheries. Regulatory agencies such as the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) have addressed bycatch of some marine birds within specific fisheries, leading to mitigation that has successfully reduced mortality of those species (e.g., albatross in Pacific longline fisheries). However, despite federal mandates, most actions to understand and reduce marine bird bycatch in the U.S. have occurred in Pacific waters, with little attention focused on Atlantic fisheries.

The North American Waterbird Conservation Plan identifies fisheries bycatch as a serious threat to at least 17 species of marine birds in the Mid-Atlantic/New England/Maritimes, and Southeastern regions, an area including all U.S. Atlantic waters. Several of these birds are also considered Species of Conservation Concern by the USFWS and are on National Audubon Society and American Bird Conservancy watch lists. Bycatch estimates are available for some of these species within certain U.S. Atlantic fisheries, primarily based on ship-board monitoring data collected each year by the NMFS Observer Program. However, bycatch evaluation is unequal among fisheries, with observer rates below 10% in most fisheries, and completely lacking in others. Despite the large gaps in observer data, bycatch estimates for the best-monitored U.S. Atlantic fisheries indicate that an average of slightly over 4,000 marine birds are killed in these fisheries each year (Table 1), though much variation exists in bycatch numbers among years. Annual bycatch estimates based on observer data are particularly high for some species such as Greater Shearwater (*Puffinus gravis*; > 1,500 birds/year) and Red-throated Loon (*Gavia stellata*; ~ 900 birds/year). Studies examining fisheries that are not monitored by the NMFS observer program have suggested that total annual bycatch of marine birds in U.S. Atlantic fisheries is likely much greater than what is indicated by NMFS data. For example, a USFWS study of gillnet fisheries in nearshore waters between Virginia to New Jersey estimated that over 2,300 marine birds were killed within three months of 1998 alone. Immediate actions are required to reduce marine bird bycatch in U.S. Atlantic fisheries that are known to kill large numbers of birds based on extant information, and additional actions are needed to better address marine bird bycatch in underevaluated fisheries.

The Northwestern Atlantic Marine Bird Cooperative, formed by experienced scientists, managers, and conservationists in 2005 to address marine bird issues, has recommended bycatch reduction as a major conservation priority for marine birds in the U.S. Atlantic. Based on this recommendation our primary goal is to address and reduce marine bird bycatch in U.S. Atlantic Fisheries. We propose to initiate two levels (or "tiers") of actions to meet this goal in descending priority:

Tier 1 Actions: Focal Targets

OBJECTIVES: Determine methods for reducing bycatch of marine bird species with the highest known bycatch rates in U.S. Atlantic fisheries, without reducing associated fishing yields. Outreach workshops, fishing practice management trials, and gear modification trials will be conducted with industry participation, targeting the following marine bird-fisheries interactions:

1) **Greater Shearwaters in the New England groundfish fishery**
2) **Red-throated Loons in mid-Atlantic gillnet fisheries**

ANTICIPATED RESULT: With these actions, we anticipate reducing direct mortality of Greater Shearwaters and Red-throated Loons by tens of thousands.

Tier 2 Actions: Additional Priorities

OBJECTIVES: Better understand the severity of marine bird bycatch in underevaluated U.S. Atlantic fisheries and develop a broad strategy for implementing additional bycatch research, outreach, and reduction efforts.

1) **Identify additional focal targets** with enough existing information to initiate bycatch reduction actions.

2) **Conduct research** to better determine where bycatch is occurring (fisheries, gear types, bird species, etc.) and what reduction actions are needed to reduce bycatch.

3) **Develop an outreach strategy** to increase public knowledge about fisheries bycatch of marine birds, educate fishers about best management practices, identify fishers willing to collaborate on identifying bycatch reduction actions, and obtain support for voluntary implementation of actions.

ANTICIPATED RESULT: Targeted mortality reduction of thousands of birds

II. PLAN OF ACTION:

1. Tier 1 Actions - Focal Targets

Tier 1 actions address specific marine bird-fishery interactions in U.S. Atlantic waters for which sufficient information has been obtained to warrant immediate attention and implement a timely and effective bycatch reduction strategy.

1.1. Bycatch of Greater Shearwaters in the New England Groundfish Fishery. -

1.1.1. BACKGROUND & JUSTIFCATION:

Greater Shearwaters (*Puffinus gravis*) are among the world's longest distance migrants, breeding on remote islands in the southern Atlantic Ocean, and migrating to the northwest Atlantic for the austral

winter. The total population of Greater Shearwaters is thought to exceed 5 million breeding pairs. However, as the species nests in cliff burrows on extremely remote islands, populations are nearly impossible to accurately census and monitor, thus a decline may not be readily apparent. Despite the large population estimate, Greater Shearwaters are considered a Species of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS) and are on National Audubon Society and American Bird Conservancy watch lists. As with many marine birds, Greater Shearwaters are long-lived with a low productivity. Thus, the cumulative impact of human threats could cause rapid declines in Greater Shearwater numbers that would be difficult or impossible to recover. Human threats include introduction of nest predators to one of only three extant nesting colonies, introduction or artificial population inflation of foraging competitors, oil spills in foraging and breeding areas, changes in timing of resource availability associated with climate change, and especially commercial fishing, which occurs throughout their range, including waters of the U.S. Atlantic.

During migration and 'wintering' periods (northern hemisphere summer), most of the world's Greater Shearwaters utilize offshore waters of the northern U.S. Atlantic coastline for feeding and resting. Individuals are attracted by concentrations of fish, frequently interacting with commercial fishing operations. Such interactions can lead to direct mortality as birds become ensnared by fishing gear while diving in pursuit of the same fish targeted by fishing vessels. Data from the NMFS Fisheries Observer Program indicates that Greater Shearwaters make up the vast majority of marine bird bycatch in northern U.S. Atlantic waters, particularly within the New England groundfish fishery (federal waters, Rhode Island to Maine). In 2010, 565 Greater Shearwater mortalities were documented in this fishery (mostly in sink gillnet gear), though observer coverage was < 15%. The Greater Shearwater bycatch rate was an order of magnitude greater than that of the next most frequently caught marine bird. Despite considerable interannual variation in bycatch recorded since the New England groundfish fishery observer program was initiated in 1989, estimates from NMFS data indicate that > 1,500 Greater Shearwaters are killed each year. However, 1,500 mortalities per year is a large underestimate, since observer coverage of the New England groundfish fishery was ≤ 5% for most of the program's history, and even today it is likely that some marine bird mortality is not detected on vessels stationed with observers. We believe that actions are warranted to minimize bycatch of Greater Shearwaters in U.S. fisheries, thereby reducing the cumulative impact of human activity on the species.

1.1.2. TARGETED OUTREACH WORKSHOPS:

Prior work in U.S. Pacific Northwest and Alaskan fisheries has demonstrated that effective bycatch reduction strategies require successful collaborations with commercial fishers, throughout the planning, testing/trials, and implementation process (Melvin and Parrish 2003). Fishers have the most comprehensive knowledge of field conditions and the strongest clout within fisheries. Relationships with fishers can best be facilitated through industry leaders. In order to identify partners within the fishing industry, we will hold a series of targeted outreach workshops in coastal New England states to discuss the importance of marine bird-fishery interactions and solicit ideas and participation from fishers. During these meetings we will stress potential incentives provided by participation in marine bird bycatch reduction work including: 1) monetary awards for developing innovative bycatch reduction technologies and helping to design bycatch reduction trials and/or participate in them, 2) pre-season or extra-sector access to fishing grounds during bycatch reduction trials, 3) public attention directed toward participating fisheries as environmentally sustainable/"green", 4) reduced effects of bycatch on productivity (fouled gear, increased fish processing time, lowered yield), and 5) avoidance of possible future litigation hassles from environmental/public interest groups. We aim to identify venues for these workshops by contacting fishing industry associations that include marine

sustainability as part of their mission statements, and through coordination with science/protected species subcommittees of Regional Fisheries Management Councils and the Atlantic States Marine Fisheries Commission. We will also tap contacts within federal and state agencies (e.g., NMFS) and academic institutions (e.g., university SeaGrant programs) for assistance with planning or facilitating workshops.

1.1.3. FISHING PRACTICE MANAGEMENT TRIALS:

As part of a broad marine bird bycatch reduction strategy for U.S. Atlantic waters, we propose to initiate a series of fishing practice management trials within the New England groundfish fishery (Figure 1) in collaboration with willing commercial fishers. Our objective is to identify practical and inexpensive ways to reduce Greater Shearwater bycatch with a minimal effect on efficiency, yield, and profitability of the commercial fishery. This information will ultimately be incorporated into standard operating procedures throughout the fishery, and may inform fishing practices in other regions, leading to a reduction in bycatch of Greater Shearwaters, and many other marine bird species.

1.1.3.1. Fishing Practice Management Trial Descriptions: Initial trials will focus on gillnets and trawls, which have the highest shearwater bycatch rates in the fishery. Trials may later be expanded to other gear types, such as demersal long lines.

a) Waste management, and gear setting/hauling practices trial - Shearwater species are widely known to associate with fishing vessels during gear setting, hauling, and dumping of unsalable waste fish (discards) and fish parts (offal). As a result, Greater Shearwaters are among the most commonly captured marine birds in fishery operations throughout their range (e.g., Argentinian hake trawl, Brazilian pelagic longline, New England bottom gillnet). Gear setting and retrieval and waste management practices have been developed which can minimize the association of shearwaters and other closely related marine birds with fishing vessels, and consequently reduce bycatch. However, such practices have not been tested in U.S. Atlantic waters. We propose to test the following management techniques for effectiveness in reducing shearwater bycatch and for ease of implementation into fishing practices:

• *Alternative Setting and Hauling:*
Test whether fishers can reduce shearwater bycatch by relocating their vessels from sites where discards or offal have been dumped before re-setting and hauling nets. This trial shows promise based on preliminary observations of bycatch patterns by fishers within the New England groundfish fishery, and has been suggested by NMFS.

• *Alternative Fish Waste Dumping:*
Test whether changes in dumping practices and retention of discards and offal can reduce shearwater bycatch.

(i) Holding waste fish and offal aboard before dumping at sea --
A study of a trawl fishery in New Zealand showed that holding fish discards aboard for ≥ 4 hours after hauling led to approximately 40% fewer marine birds attending vessels during dumping, and an associated decrease in bycatch when gear was re-set and hauled again. Another study of pelagic longline fisheries in Hawaii found that retention of fish wastes during line setting and hauling led to a two- to three-fold reduction in marine bird dives upon fishing gear.

(ii) Rendering fish waste into fish byproducts --
Studies of trawl fisheries in the Bering Sea and off New Zealand showed that up to 95% fewer marine birds attended vessels that rendered portions of fish discards and offal into fishmeal and oil before dumping the remaining waste at sea. Successful implementation of this strategy would require fishers to devote processing time and boat space to rendering fish discards into useable byproducts. However, such byproducts could be sold for a profit, potentially offsetting lost time and space. Part of testing the feasibility of this strategy would involve working with fishers to identify a market for fish byproducts.

b) Gear setting timing and location management trial - Large concentrations of Greater Shearwaters only occur in U.S. Atlantic waters during a few months of the year. Within these months, abundance varies among localities and with time of day. Studies of different fisheries (coastal gillnets, pelagic longlines, etc.) have found that determination of timings of peak abundance, identification of local "hot spots", and quantification of daily activity patterns of a marine bird species can be used to strategically plan fishing activities to avoid bycatch, while having a minimal effect on yield. For example, a study conducted in Puget Sound, WA estimated that restricting salmon fishing to periods of high salmon abundance, which had a low affect on fishery yield, resulted in a 43% reduction in marine bird bycatch. We propose trials to slightly modify locations and timing (within season and/or time of day) of fishing efforts during times of high shearwater concentrations, in an effort to reduce bycatch with a minimal effect on fishing yield. NMFS observer records, at-sea survey information, and movement data (> 50 Greater Shearwaters have been tracked using satellite telemetry, with more work planned) will be used to determine abundance and distribution patterns to inform effective location and timing trial design. Fishery haul records will also be examined to minimize the effects of trials on fishing yield.

c) Olfactory deterrent trial - Prior research demonstrated that shark liver and pollock oils deployed by fishing vessels reduced the frequency with which marine birds dove upon fishing gear by up to 11 times, and lowered the concentrations of marine birds attending vessels by up to 10 times. While oil deterrents have not been tested with Greater Shearwaters, or by gillnet vessels, the technique has been particularly effective for deterring other shearwater species in trawl fisheries. It is hypothesized that fish oil discourages marine birds via olfactory mechanisms, and thus could be broadly applicable to many marine birds and gear types. Thus, we propose to test the efficacy of different fish oils to deter Greater Shearwaters from interacting with gillnets and trawling gear in the New England groundfish fishery, thereby reducing bycatch.

1.1.3.2. Fisher Participation in Management Trials: Successful implementation of management trials will require the partnership and cooperation of fishers who are needed to help design and implement management practices aboard their vessels. In order to locate potential participants within the New England groundfish fishery, we have identified a fishing organization called the Cape Cod Commercial Hook Fishermen's Association (CCCHFA; http://www.ccchfa.org/), which represents the interests of many of Cape Cod's commercial fishers. The CCCHFA values sustainable marine resource management, describing its primary objective as "align(ing) protection of the oceans with the interests of our historic fishing community", while supporting "stewardship of coastal ecosystems through education, research, and policy programs". The CCCHFA represents a sector of the New England groundfish fishery with one of the highest bycatch rates of Greater Shearwaters (despite the moniker, the CCCHFA manages gillnet and trawl vessels, as well as longliners). With the aid of existing fisheries contacts we have begun to reach out to the CCCHFA. Based on their stated primary objective

and reputation, we believe that CCCHFA will be supportive of our efforts, and will link us to vessels that will take part in management trials. We intend to offer financial incentives to fishers for participating in our work, and will also stress the benefit of finding workable marine bird bycatch reduction strategies for the fishing industry - bycatch fouls gear, increases fish processing time, and lowers yield.

1.1.3.3. International Collaboration in Management Trials: Greater Shearwaters make up a substantial proportion of marine bird bycatch in Atlantic Canada's fisheries, as well as those in the U.S. Atlantic. During a meeting of the Northwestern Atlantic Marinebird Cooperative in February 2011, wildlife managers from the Canadian Wildlife Service (CWS) expressed a desire to collaborate with USFWS on implementing strategies to reduce marine bird bycatch across international boundaries. We welcome this effort and believe that collaboration with CWS on Greater Shearwater management trials will greatly enhance our effort to reduce bycatch of the species in the northwest Atlantic as a whole. The value of CWS efforts would be measurable as in-kind support for our efforts in the US.

1.2. Bycatch of Red-throated Loons in Mid-Atlantic Gillnet Fisheries. -

1.2.1. BACKGROUND & JUSTIFCATION:

Red-throated Loons (*Gavia stellata*) breed in the arctic and subarctic tundra and winter in temperate coastal and marine waters throughout the northern hemisphere. The species occurs off the U.S. Atlantic coast during winter, primarily in nearshore waters and inlets from Florida to Maine. Despite worldwide population estimates of over 500,000 individuals, the Red-throated Loon is considered a Species of Conservation Concern by the USFWS, due to substantial declines (up to 52%) in many parts of their North American range. While a comprehensive census of Red-throated Loons has not been conducted in eastern U.S., the current population is thought to be 50,000 to 100,000, based on migration counts. Potential population declines have led Red-throated Loon to be included in several state bird conservation plans in the eastern U.S. and considered "in urgent need of conservation action" by the Mid-Atlantic/New England/Maritimes Waterbird Conservation Plan.

The cause of Red-throated Loon population declines in North America is unclear. However, the species faces a number of cumulative threats from anthropogenic sources including oil spills, offshore energy development, degradation of nesting habitat, introduced predators, contaminants, and particularly commercial fishing operations. In U.S. Atlantic waters Red-throated Loons are regularly killed in fishing gear, particularly gillnets used in nearshore and inshore commercial fisheries of the mid Atlantic (North Carolina to New York). Some data have indicated that >70% of these bycatch mortalities are adult birds. High adult mortality can have a strong adverse impact on populations of species with low reproductive capacities and slow maturation, such as Red-throated Loons. A peer-reviewed analysis of bycatch data from the NMFS Fishery Observer Program found an average of nearly 900 Red-throated Loons killed by commercial mid Atlantic gillnet fisheries each year (Warden 2010). The study concluded that such bycatch is 62 to 83% of the "potential biological removal level (PBR)" for the U.S. Atlantic Red-throated Loon population (i.e. the maximum level of individuals that could be removed from a population before having a reductive effect; 100% PBR would indicate an unsustainable impact on a population).

Despite Warden's (2010) high annual bycatch estimate, there are several indications that the actual bycatch rate of Red-thorated Loons in mid Atlantic gillnet fisheries may be even higher. During the 12

years of data collection included in the analysis, NMFS fishery observers witnessed fewer than 3% of hauls of the gillnet fisheries they were monitoring, and were unable to monitor many other gillnet operations within inshore waters and inlets. Additionally, Warden (2010) had to drop 70 bycaught loons from the analysis that could not be identified to species. As Red-throated Loon was the most commonly caught species in gillnets during the study, it is possible that several of the dropped birds were Red-throated Loons, which, if included in analysis, would have resulted in a far higher annual bycatch estimate. The assumption that Warden's (2010) bycatch estimates are low is corroborated by a USFWS study of gillnet fisheries in nearshore waters from Virginia to New Jersey that estimated that over 2,300 diving birds (mostly loons) were killed within just a three month period. Even slightly higher bycatch rates than those reported by Warden (2010) would approach or exceed her estimate of 100% PBR for Red-throated Loons in mid Atlantic gillnet bycatch. Thus, we believe that immediate actions are required to preserve a sustainable population of Red-throated Loons in U.S. Atlantic by reducing bycatch in gillnet fisheries. As mid Atlantic gillnet fisheries are also known to kill Common Loons and other diving birds, our actions will also have a positive effect on multiple species.

1.2.2. TARGETED OUTREACH WORKSHOPS:

Prior work in U.S. Pacific Northwest and Alaskan fisheries has demonstrated that effective bycatch reduction strategies require successful collaborations with commercial fishers, throughout the planning, testing/trials, and implementation process (Melvin and Parrish 2003). Fishers have the most comprehensive knowledge of field conditions and the strongest clout within fisheries. Relationships with fishers can best be facilitated through industry leaders. In order to identify partners within the fishing industry, we will hold a series of targeted outreach workshops in coastal mid Atlantic states to discuss the importance of marine bird-fishery interactions and solicit ideas and participation from fishers. During these meetings we will stress potential incentives provided by participation in marine bird bycatch reduction work including: 1) monetary awards for developing innovative bycatch reduction technologies and helping to design or participate in bycatch reduction trials, 2) pre-season or extra-sector access to fishing grounds during bycatch reduction trials, 3) public attention directed toward participating fisheries as environmentally sustainable/"green", 4) reduced effects of bycatch on productivity (fouled gear, increased fish processing time, lowered yield), and 5) avoidance of possible future litigation hassles from environmental/public interest groups. We aim to identify venues for these workshops by contacting fishing industry associations that include marine sustainability as part of their mission statements, and through coordination with science/protected species subcommittees of Regional Fisheries Management Councils and the Atlantic States Marine Fisheries Commission. We will also tap contacts within federal and state agencies (e.g., NMFS) and academic institutions (e.g., SeaGrants) for assistance with planning or facilitating workshops.

1.2.3. FISHING PRACTICE MANAGEMENT & GEAR MODIFICATION TRIALS:

As part of a broad marine bird bycatch reduction strategy for U.S. Atlantic waters, we propose to initiate a series of fishing practice management and gear modification trials within mid Atlantic gillnet fisheries (Figure 1) in collaboration with willing commercial fishers. Our objective is to identify practical and inexpensive ways to reduce Red-throated Loon bycatch with a minimal effect on efficiency, yield, and profitability of the commercial fisheries. This information will ultimately be incorporated into standard operating procedures throughout the fishery, and may inform fishing practices and gear use in other regions, leading to a reduction in bycatch of Red-throated Loons, and other marine bird species.

1.2.3.1. Fishing Practice Management Trial Descriptions:

a) Gear setting/hauling practices trial - Several methods of setting, maintaining, and hauling gillnets have shown promise for reducing the number of loons and other diving marine birds (e.g., sea ducks and alcids) that become entangled in the gear during commercial fishing operations. We propose to test the following management techniques for effectiveness in reducing loon bycatch and ease of implementation into fishing practices:

• *Soak Duration & Hauling Rate:*
Analysis of NMFS observer data indicated that bycatch of Common Loons was significantly lower in New England and mid Atlantic gillnet fisheries (cod, pollack, hake, dogfish, monkfish, bass, etc.) that **(1)** set nets for under 24 hours**,** and **(2)** hauled nets in at a slower rate after setting (> 30 minutes). Shorter duration net sets minimized the length of time captured fish could lure loons into gear, and slower net haul backs allowed loons to get out of the way of gear while it was being pulled in to retrieve fish catch. While the study did not report the percentage bycatch reduction afforded by these practices, fishers that deployed nets for under 24 hours accounted for nearly half of fishing effort, but only 20% of loon bycatch, and fishers that hauled in gear at a slower rate accounted for almost 90% of fishing effort, but only 50% of loon bycatch. Neither of these practices appeared to affect yield.

• *Alternative Setting:*
There is evidence that marine bird bycatch can be reduced by relocating vessels from sites where discards or offal have been dumped before re-setting nets between hauls. This trial shows promise based on preliminary observations of bycatch patterns by fishers within the New England groundfish fishery, and has been suggested by NMFS.

Nets set lower in the water column (~ 2m deeper) caught 73% fewer marine birds in pelagic floating gillnet fisheries within the north Pacific. It is unclear how applicable this fishing practice would be to nearshore gillnet fisheries which attract a different assemblage of marine birds, and deploy gillnets in far shallower waters. However, this practice warrants further investigation.

b) Gear setting timing management trial - High numbers of Red-throated Loons occur in U.S. Atlantic waters only during winter months. Within these months, abundance varies by time of day. Studies of different fisheries (coastal gillnets, pelagic longlines, etc.) have found that determination of timing of peak abundances, identification of local "hot spots", and quantification of daily activity patterns of a marine bird species can be used to strategically plan fishing activities to avoid bycatch, while having a minimal effect on yield. Research in Puget Sound, WA found that reducing nearshore salmon gillnet fishing effort during one to two hours at dawn (a period of increased marine bird foraging activity), reduced the bycatch rate of Rhinoceros Auklets (*Cerorhinca monocerata*) by 60% and the bycatch rate of Common Murres (*Uria aalge*) by 30%, while reducing fishing yield by under 5%. The same study estimated that focusing most fishing effort on periods of high salmon abundance within a fishing season resulted in a 43% reduction in bycatch of marine birds, without a measureable effect on annual fishing yield. We propose to test whether slightly modifying timing of fishing efforts (within season and/or time of day) will reduce Red-throated Loon bycatch rates within mid Atlantic gillnet fisheries, without significantly affecting fishing yield. NMFS observer records, at-sea survey information, and movement data will be used to determine abundance and distribution patterns, informing how the timing of fishing

efforts will be modified. Fishery haul records will also be examined to minimize the effects of the timing modification trial on fishing yield.

c) Olfactory deterrent trial - Prior research demonstrated that shark liver and pollock oils deployed by fishing vessels reduced the frequency with which marine birds dove upon fishing gear by up to 11 times, and lowered the concentrations of marine birds attending vessels by up to 10 times. While oil deterrents have not been tested on loon species, or within gillnet fisheries, the technique has been particularly effective for deterring other marine bird species in trawl and longline fisheries. It is hypothesized that fish oil discourages marine birds via olfactory mechanisms, and thus could be broadly applicable to many marine birds and gear types. Thus, we propose to test the efficacy of different fish oils to deter Red-throated Loons from interacting with gillnets in mid Atlantic fisheries, thereby reducing bycatch.

1.2.3.2. Gear Modification Trials: Several studies have described physical characteristics of gillnet gear that can minimize marine bird bycatch. With slight modifications, gillnets can be configured to reduce marine bird bycatch without reducing catch of target fish species. We propose to test the following gear modifications for effectiveness in reducing loon bycatch with a minimal effect on fishing practices/yield:

a) Wider net spacing - Commercial gillnet fishers in U.S. Atlantic waters often set long "strings" of up to 15 connected nets, regularly totaling over 90 m in length. An analysis of NMFS observer data indicated that Common Loon bycatch in New England fisheries (including bottom gillnets) was nearly five times lower for fishing operations that used a larger spacing ($\geq$ 2ft.) between nets in a string, presumably because spacing allowed loons diving near/on the gillnets an easier escape route. While this benefit was not detected for Red-throated Loons in mid Atlantic gillnet fisheries, gillnet operations using wider spacing were scarce in the area. Thus, restricted sample sizes may have prevented a thorough assessment.

b) Increased net visibility - Research has indicated that diving habits of many marine birds make them more likely to become entangled in upper rather than lower sections of deployed gillnets. Based on this finding, a gear modification trial was conducted in a coastal Puget Sound gillnet fishery that aimed to reduce marine bird bycatch by increasing the visibility of the uppermost net levels to diving birds. Highly visible mesh added to the upper 10% of gillnets reduced Common Murre bycatch by 40%, without affecting fishing (salmon) yield. However, this gear modification did not reduce bycatch of Rhinoceros Auklets. Highly visible mesh added to the upper 25% of gillnets reduced bycatch of Common Murres by 45% and bycatch of Rhinoceros Auklets by 42%, though it had the drawback of reducing fishing yield by 50%. In another study, barium sulphate nets, which are more visible to marine birds during diving than standard monofilament mesh, reduced marine bird bycatch in Atlantic Canadian sink gillnet fisheries by five times, without a significant effect on fishing (cod, pollack, dogfish) yield. While the effect of increased net visibility on loon bycatch has not been examined, this technique shows promise, and should be tested for effectiveness and effect on yield in mid Atlantic gillnet fisheries.

c) Acoustic deterrents - Although not widely tested with marine birds (originally developed for marine mammals), there is evidence that sound-transmitting devices attached to commercial gillnets can reduce bycatch by scarring diving birds away from deployed nets. During a trial within the Puget Sound coastal gillnet fishery, sound-transmitters, called "pingers", reduced bycatch of Common Murres by 50%, while having no significant effect on fishing (salmon) yield.

However, pingers did not reduce bycatch of Rhinoceros Auklets in the fishery. Thus, the effectiveness of pingers as a bycatch deterrent may be species specific, and would require field testing with Red-throated Loons (and potential modification) before a formal trial was initiated.

d) Lower profile nets - Research has indicated that diving habits of many marine birds make them more likely to become entangled in gillnet mesh closer to the water's surface. In some fisheries, fewer target fish are caught in surface waters than in demersal zones, suggesting that upper level gillnet mesh is unnecessary for catching fish. Based on these findings, a trial of lower profile gillnets (height reduced by 50%) was conducted in commercial gillnet operations in nearshore waters of Pamlico Sound. Bycatch of Common Loons and Double-crested Cormorants were reduced by 33% and 30% respectively. Contrary to the prediction that reducing the height of gillnets would have minimal effect on catch rates of target fish (southern flounder), yield was reduced by 46%. Despite this result, there may be other mid Atlantic gillnet fisheries where low profile nets would have less impact on yield while reducing bird bycatch. More field trials are required to identify whether such fisheries exist.

1.2.3.3. Combined Strategy Trials: Fishing practice management and gear modification trials are not mutually exclusive, and may be most effectively implemented in combination. Bycatch reduction trials in a Puget Sound coastal gillnet fishery concluded that a combination of pingers, and modification of seasonal and within-day gear setting timing resulted in the greatest decrease of marine bird bycatch (77%), with a minimal effect on (< 5%) fishing (salmon) yield. We propose to test different combinations of fishing practice management and gear modification to determine how best to reduce Red-throated Loon bycatch with a minimal effect on commercial fisheries.

1.2.3.4. Fisher Participation in Trials: Successful implementation of fishing practice management and gear modification trials will require the partnership and cooperation of fishers to help design and implement trials aboard their vessels. We are collaborating with staff of NMFS and multiple regions of USFWS to locate potential participants within mid Atlantic gillnet fisheries. At present we have identified a small number of industry trade groups and management cooperatives that tout sustainable environmental practices as part of their mission statements. We are also pursuing fishery contacts through the Mid Atlantic Fisheries Management Council and the Atlantic States Marine Fisheries Commission. We intend to offer financial incentives to fishers for participating in our work, and will stress the benefit of finding workable marine bird bycatch reduction strategies for the fishing industry - bycatch fouls gear, increases fish processing time, and lowers yield.

2. Tier 2 Actions - Additional Priorities

Tier 2 actions are critical to successful implementation of a broad marine bird bycatch reduction strategy in U.S. Atlantic waters. They include 1) developing plans to address additional marine bird-fishery interactions in U.S. Atlantic waters that may require attention, 2) planning and conducting research to inform future bycatch reduction efforts, and 3) initiating effective outreach to raise awareness of marine bird bycatch in U.S. Atlantic fisheries among the fishing community, regulatory agencies, and the general public.

2.1. Other Priority Targets.

2.1.1. ATLANTIC PELAGIC LONGLINE FISHERIES:

Estimates from NMFS Observer Program data suggest that fewer than 300 marine birds are caught in U.S. Atlantic pelagic longline fisheries per year. However, fisheries observers monitor less than 9% of longline sets, and there is evidence from longline observer programs in other parts of the world that haul observations underestimate mortality caused by longline fisheries. U.S. Atlantic pelagic longline fisheries overlap portions of the ranges of endangered and rare marine birds (e.g. Bermuda Petrel, *Pterodroma cahow*; Black-capped Petrel, *Pterodroma hasitata*; and Audubon's Shearwater, *Puffinus lherminieri*). While populations of these birds would be most adversely affected by even low incidences of bycatch, current levels of fishery observer coverage may be insufficient to detect such bycatch due to the species' low abundances. The U.S. Atlantic pelagic longline observer program, until recently, did not identify marine bird bycatch to species. Thus, it is unclear whether rare species have been taken in the past. Relatively inexpensive bycatch deterrents, such as streamer lines, which are widely employed in longline fisheries in other areas, may be a viable safeguard against marine bird bycatch in U.S. Atlantic pelagic longline fisheries. Increased and standardized observer coverage is also needed.

2.1.2. MID-ATLANTIC NEARSHORE & INSHORE FISHERIES:

Studies conducted by the USFWS in the 1990s reported that marine bird bycatch in nearshore and inshore (bays & inlets) fisheries (particularly gillnet fisheries) was vastly underestimated and largely unmonitored. Based on data collected during a one season monitoring period, it was estimated that several thousand diving birds were killed each year in these fisheries, particularly diving ducks and loons. Many small gillnet operations occur within state waters (defined as shore to 3 nautical miles offshore) which are regulated by complex and frequently changing laws. Such laws differ among states and are often more lenient than federal regulations. Most nearshore and inshore fisheries are not included in NMFS observer programs. Poaching, which is difficult to prevent under existing enforcement strategies, may also be responsible for much bycatch in state waters. Coordination is needed among state fish and wildlife agencies to implement a standardized bycatch program for nearshore and inshore fisheries throughout mid Atlantic states. This program would identify commercial fishing operations that result in the highest mortality, and dedicate law enforcement to prevent poaching. Commercial mid Atlantic nearshore and inshore fisheries will be targeted for fishing practice management and gear modification trials, and potentially buyouts of fishing leases for operations with the most marine bird bycatch (this would be feasible for smaller-scale fisheries).

2.1.3. NORTHERN GANNET MULTI-FISHERY ASSESSMENT:

According to NMFS observer data, Northern Gannets are consistently recorded as bycatch in several fisheries in the mid Atlantic and New England, and within many different types of gear. While annual bycatch is estimated at < 500 individuals per year, observer coverage is less than 5% in many fisheries and there has not been an analysis of the cumulative effect of the different fisheries on the species. Such an analysis is needed, as well as better observer coverage focused on many of the fisheries which interact with gannets (e.g., trawl fisheries).

2.2. Research Priorities.

2.2.1. IDENTIFY BYCATCH HOTSPOTS:

Spatio-temporal patterns of marine bird distribution in the U.S. Atlantic will be overlaid with fishing effort data to develop predictive models for when and where marine bird-fishery interactions are likely to occur. These models can inform targeted trials and eventual management to reduce marine bird bycatch throughout the U.S. Atlantic. Marine bird distribution can be determined using a combination of: 1) NMFS Observer data, 2) at sea surveys (aboard ships of opportunity, etc.), 3) aerial surveys, and 4) individual tracking (satellite tags, geolocators, etc.). This information is also critical to reducing marine bird conflicts with offshore wind energy. Thus, an increasing number of efforts to collect such data are being initiated. In recent years the Atlantic Coastal Cooperative Statistics Program has maintained a comprehensive record of fishing effort in U.S. Atlantic waters.

2.2.2. INCREASE & STANDARDIZE MARINE BIRD BYCATCH OBSERVER PROGRAM:

The NMFS Fisheries Observer Program is currently the best source of marine bird bycatch data for U.S. Atlantic fisheries. However, observer coverage is low or completely lacking for many fisheries (e.g., nearshore/inshore, longlines, trawlers, southern U.S. Atlantic) and prioritizes coverage based largely on marine mammal, rather than marine bird concerns. Increased observer effort is needed within fisheries that have a high potential for marine bird bycatch. Observer programs should prioritize marine birds similarly to marine mammals, and implement a standardized, defensible methodology for more accurately determining marine bird bycatch levels. This information will be used to inform targeted trials and help prioritize eventual management to reduce marine bird bycatch.

2.2.3. ANALYZE NMFS OBSERVER PROGRAM DATA:

NMFS Fisheries Observer Program data will be analyzed to better understand factors that can inform targeted trials and prioritize eventual management to reduce bycatch throughout the U.S. Atlantic including: 1) demographic patterns (age/sex class) of bycatch mortality and associated impacts on marine bird populations, 2) the influence of biotic variables (food availability, sea surface temperatures, climate events, etc.) on marine bird associations with fishing vessels, and 3) temporal (among and within season, time of day) differences in marine bird bycatch mortality.

2.2.4. EXPAND BEACHED BIRD SURVEYS:

The Seabird Ecological Assessment Network (SEANET), based at Tufts University veterinary school, conducts beached bird surveys along multiple sections of the U.S. Atlantic coast, using a network of volunteer “citizen scientists”. SEANET surveys produce background marine bird stranding rates and identify mass mortality events. Necropsies are performed on marine bird carcasses by professional veterinary school staff who can often determine whether deaths were fishing related. This data can be added to NMFS Observer Program data for bycatch analyses (see section 2.2.3. above) which will inform targeted trials and help prioritize eventual management. SEANET coverage will be expanded to areas where it does not exist, and surveys will be increased in frequency. Widespread use of citizen scientists will also serve to increase public awareness of marine bird bycatch in U.S. Atlantic fisheries.

2.3. Outreach Program.

Conservation actions require the involvement and support of stakeholders, regulators, and the public for effective implementation. We propose a broad outreach program in U.S. Atlantic states to educate the commercial fishing community, management agencies, and the general public about marine bird

identification, the important role of marine birds in aquatic ecosystems (including as an economic resource in nature tourism), and life history traits that make them vulnerable to human threats, including bycatch. Outreach materials will be developed and distributed, including brochures, water resistant marine bird identification pamphlets, and informational DVDs. Presentations targeting specific audiences and topics will be given. Specific outreach actions include:

• Holding targeted outreach workshops for fishers, fishery cooperatives, and industry trade groups to discuss the importance of marine bird-fishery interactions and solicit ideas and participation from the fishing community on focal actions (see sections 1.1.2., 1.2.2.).

• Representing marine bird issues within the Federal Fisheries Management Councils and the Atlantic States Marine Fisheries Commission in conjunction with partners at NMFS and multiple branches/regions of USFWS

• Coordinating with existing fishery bycatch reduction education efforts for marine mammals and sea turtles (e.g., New England Aquarium Bycatch Consortium, Fishery Management Council protected species subcommittees).

• Identifying state agency partners and working with state regulatory agencies to raise awareness of marine bird bycatch in commercial fisheries within state waters (including recommending initiation of interstate fisheries observer programs).

• Identifying venues for outreach aimed at commercial fishers such as Coast Guard vessel safety boardings, fishing license offices, and dockside.

• Identifying venues for outreach aimed at the public such as schools, supermarkets, whale watches, recreational fishing charters, and environmental events.

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Table 1. Annual average marine bird bycatch estimates (with variance measures) for U.S. Atlantic fisheries by gear type and region, with approximate observer coverage as percentage of hauls observed. Estimates are from analyses of NMFS Observer Program data except Forsell (1999), which is included for comparison.

Species or Assemblage[a]	Gear	Region	Years	Annual Bycatch Est.	Observer Coverage (%)	Source[b]
Red-throated loon (*Gavia stellata*)	Gillnet (float & bottom)	Mid Atlantic	1996 - 2007	**897** (95% CI: 620-1297)	1.5 - 4.4	Warden 2010
Common Loon (*Gavia immer*)	Gillnet (float & bottom)	Mid Atlantic	1996 - 2007	**477** (95% CI: 370-615)	1.5 - 4.4	Warden 2010
Common Loon (*Gavia immer*)	Gillnet (float & bottom)	New England	1996 - 2007	**74** (95% CI: 29-189)	2.8 - 8.7	Warden 2010
Shearwaters, mostly Greater (*Puffinus gravis*)	Bottom Gillnet	New England	1994-1999	**1510** (not provided)	2.0 - 7.0	Soczeck 2006
Shearwaters, mostly Greater (*Puffinus gravis*)	Bottom Trawl	New England & mid Atlantic	1994-2010	**112** (stdev = 147)	3.0	Spiegel 2010
Shearwaters, mostly Greater (*Puffinus gravis*)	Bottom Longline	US Atlantic	1994-2010	**37** (stdev = 87)	< 5.0 - 10.0	Spiegel 2010
Shearwaters, mostly Greater (*Puffinus gravis*)	Pelagic Longline	US Atlantic & eastern Gulf	1992-2006	**35** (not provided)	not provided	Hata 2007
Northern Gannet (*Morus bassanus*)	Midwater Trawl	New England & mid Atlantic	1994-2010	**166** (stdev = 267)	5.5	Spiegel 2010
Northern Gannet (*Morus bassanus*)	Bottom Gillnet	New England & mid Atlantic	1994-2010	**115** (stdev = 98)	2.0 - 10.0	Spiegel 2010
Northern Gannet (*Morus bassanus*)	Bottom Trawl	New England & mid Atlantic	1994-2010	**82** (stdev = 127)	3.0	Spiegel 2010
Northern Gannet (*Morus bassanus*)	Beach Seine	New England & mid Atlantic	1994-2010	**78** (stdev = 177)	3.0	Spiegel 2010
Northern Gannet (*Morus bassanus*)	Bottom Gillnet	New England	1994-1999	**40** (not provided)	4.0 - 7.0	Soczeck 2006
Northern Gannet (*Morus bassanus*)	Pelagic Longline	US Atlantic & eastern Gulf	1992-2006	**11** (not provided)	not provided	Hata 2007
Cormorants (*Phalacrocorax spp.*)	Bottom Gillnet	New England & mid Atlantic	1994-2010	**558** (stdev = 1111)	2.0 - 10.0	Spiegel 2010
Marine Waterfowl	Bottom Gillnet	New England & mid Atlantic	1994-2010	**97** (stdev = 336)	2.0 - 10.0	Spiegel 2010
Gulls (mostly *Larus spp.*)	Bottom Gillnet	New England	1994-1999	**100** (not provided)	2.0 - 7.0	Soczeck 2006
Diving birds (mostly loons)	Coastal Gillnet	Mid Atlantic	1998 (Feb -Apr)	**2,387** over 3-months annual not provided	not provided (83 "obs. days")	Forsell 1999

[a] Other marine bird bycatch estimates for NW Atlantic fisheries: **Alcids** (Atlantic Puffin, Dovekie, Razorbill, Murre spp.) = several hundred, Canada gillnet; **Northern Fulmar** (*Fulmaris glacialis*) < 150, Canada gillnet; **Storm Petrels** = 2, U.S. Atlantic & eastern Gulf pelagic longline; **Brown Pelican** (*Pelicanus occidentalis*) = 5, U.S. gillnet & longline.

[b] Spiegel (2010) = simple unpublished approximations obtained by multiplying observed bycatch numbers by the percentage of hauls not observed and averaging among years.

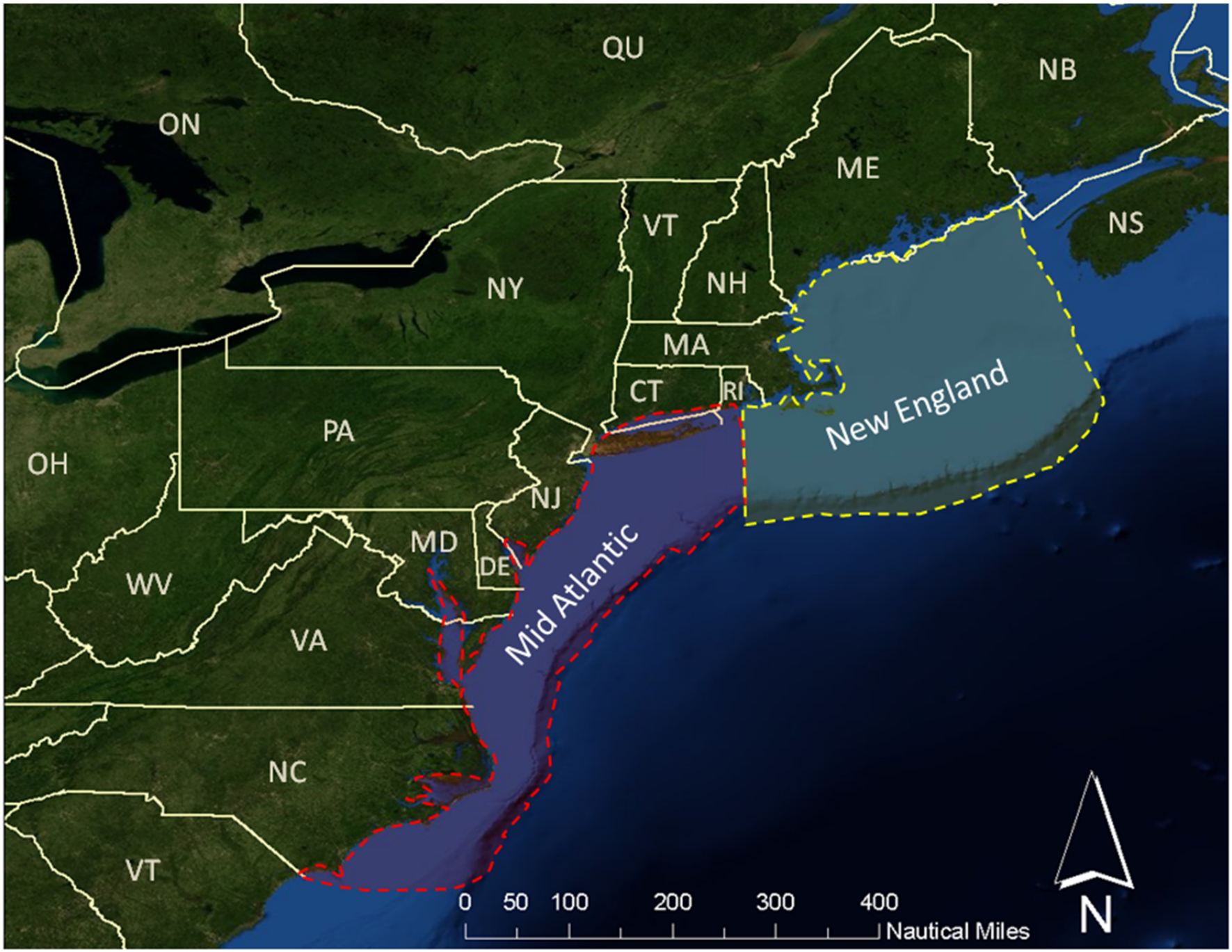

Figure 1. New England (red line) and mid Atlantic (yellow line) study area boundaries for proposed marine bird bycatch fishing practice management and gear modification trials.