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2009 REPORT ON THE BYCATCH REDUCTION ENGINEERING PROGRAM RELEVANT TO SECTION 316(d) OF THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT REAUTHORIZATION ACT OF 2006

Introduction

Section 316(a) of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSA) states, "Not later than 1 year after the date of enactment of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, the Secretary, in cooperation with the Councils and other affected interests, and based upon the best scientific information available, shall establish a bycatch reduction program, including grants, to develop technological devices and other conservation engineering changes designed to minimize bycatch, seabird interactions, bycatch mortality, and post-release mortality in federally managed fisheries." The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) established its Bycatch Reduction Engineering Program (BREP) through a NMFS Policy Directive signed January 11, 2008, by the NOAA Acting Assistant Administrator for Fisheries. This Policy Directive (see Appendix 1) contains terms of reference for the BREP, as well as the following BREP mission:

> "The mission of the BREP is to develop technological solutions and investigate changes in fishing practices designed to minimize bycatch of fish (including sponges and deep sea and shallow, tropical corals) and protected species (including marine mammals, seabirds, and sea turtles) as well as minimize bycatch injury and mortality (including post-release injury and mortality)."

Section 316(d) of the MSA requires the Secretary of Commerce to transmit an annual report to the Senate Committee on Commerce, Science, and Transportation and the House of Representatives Committee on Resources that:

1. Describes funding provided to implement this section;
2. Describes developments in gear technology achieved under this section; and
3. Describes improvements and reduction in bycatch and seabird interactions associated with implementing this section, as well as proposals to address remaining bycatch or seabird interaction problems.

This report responds to the requirements of Section 316(d) of the MRA. (Section 316 of the MSA appears in its entirety in Appendix 2.)

Funding Provided to Implement the BREP in 2008

Funding to implement the BREP totaled $847,394 in 2008. This funding came from a NOAA budget line item entitled Reducing Bycatch. Overall funding in the Reducing Bycatch line totaled $2,738,000 in 2008. The majority of Reducing Bycatch funding is used to expand the collection of fisheries data, using at-sea fisheries observers, in several key fisheries to monitor levels of bycatch of sea turtles, marine mammals, seabirds, and non-target finfish. The remainder of this funding is intended to carry out projects to conduct public–private bycatch gear research and testing and to enhance and coordinate technical expertise to respond to fisheries bycatch issues. This research funding served to implement the BREP in 2008 and is the subject of this report.

Table 1 lists the projects funded to implement the BREP in 2008. Individual projects, developments in gear technology related to these projects, and improvements and reduction in bycatch and seabird interactions associated with these projects are described on pages 5–40. It is important to note that several of these projects leveraged funds from sources outside NMFS and involved partners from other federal agencies, state governments, nongovernmental organizations, universities, and the fishing industry.

Table 1. Projects funded to implement the BREP in 2008

Project Title	*Funding Provided*	*Recipient*
Evaluation of Bycatch Reduction Devices in Shrimp Trawls	$158,000	NMFS Southeast Fisheries Science Center
Transfer of Turtle Excluder Device and Bycatch Reduction Device Technology in the Southeast Region	$91,500	NMFS Southeast Fisheries Science Center
Evaluation of Weaker Circle Hooks to Release Bluefin Tuna in the Yellowfin Tuna Longline Fishery	$46,000	NMFS Southeast Fisheries Science Center
Evaluation of Dolphin Interactions with Lazy Lines on Shrimp Trawls	$23,000	NMFS Southeast Fisheries Science Center
NMFS National Seabird Program	$108,824	NMFS Alaska Region; NMFS Office of Protected Resources
Alaska Fisheries Science Center Coordinated Seabird Studies	$38,000	NMFS Alaska Fisheries Science Center
Seabirds in the Western North Atlantic and Interactions with Fisheries	$14,000	NMFS Southeast Fisheries Science Center
Estimation of Seabird Bycatch in Northeast Commercial Fisheries	$30,000	NMFS Northeast Fisheries Science Center
Seabird Bycatch Avoidance for West Coast Groundfish Fisheries	$14,000	NMFS Northwest Regional Office and Washington Sea Grant
Monitoring Seabird Distribution and Abundance in the California Current	$14,000	NMFS Southwest Fisheries Science Center
Coastal Observation and Seabird Survey Team (COASST)	$10,000	University of Washington

Gear Modifications to Reduce Harbor Porpoise Interactions in Commercial Atlantic Gillnet Fisheries	$103,000	NMFS Northeast Fisheries Science Center
Fishing Technology and Conservation Engineering to Reduce Trawl Bycatch in Alaskan Fisheries	$100,000	NMFS Alaska Fisheries Science Center
Collaborative Research on Reducing Post-Release Mortality for Common Thresher Sharks Captured in the Southern California Recreational Fishery	$46,000	NMFS Southwest Fisheries Science Center
Reducing Shark Bycatch with Electropositive Metals in Hawaiian Fisheries	$29,070	NMFS Pacific Islands Fisheries Science Center
Gear Technician and Bycatch Reduction Gear Research at the Northwest Fisheries Science Center	$22,000	NMFS Northwest Fisheries Science Center
Total	$847,394	

Project Summaries

Project Title
Evaluation of Bycatch Reduction Devices in Shrimp Trawls

BREP Funding Provided
$158,000

Location of Research
Southeast Fisheries Science Center

Resource Challenge
Federal regulations require the use of an approved bycatch reduction device (BRD) in all shrimp trawls fished in Gulf of Mexico federal waters and the Southeastern Atlantic Ocean. The 2005 stock assessment for Gulf of Mexico red snapper (*Lutjanus campechanus*) indicated a need for a 74 percent reduction in shrimp trawl bycatch mortality compared to levels experienced during the 2001-2003 benchmark period. Research findings have indicated that the most commonly used BRD, the fisheye, does not achieve the required 44 percent red snapper mortality reduction criteria due to variability in performance between vessels with different trawl designs and rigging configurations. There is a critical need to develop improved bycatch reduction technology to ensure red snapper management objectives are met. In order to address this ongoing problem, the Harvesting Systems and Engineering Branch of NMFS' Southeast Fisheries Science Center conducts research to develop and evaluate shrimp trawl bycatch reduction technology.

In August 2006, the Gulf of Mexico Fishery Management Council approved a regulatory amendment to change the shrimp trawl BRD certification criterion for the western Gulf of Mexico. The new criterion matches the existing criterion for the eastern Gulf and the U.S. South Atlantic: a 30 percent reduction in finfish bycatch. The new criterion and testing protocols were implemented in February 2008. This action resulted in the certification and provisional certification of three additional BRD designs for use in the Gulf of Mexico: the Extended Funnel, Modified Jones Davis, and Composite Panel.

Project Summary
The project consists of the following performance measures:

<u>BRD Research and Development</u>
- Fish behavioral modification studies
- Development of improved BRD designs through collaborative efforts with industry
- Assistance in conducting new BRD certification testing

<u>Performance Monitoring and Reporting</u>
- Analyses and reporting of BRD certification data
- Monitoring and evaluation of BRD operational performance
- Technical recommendations and assistance in drafting language for rulemaking

Industry Outreach

- Technical training for net shops and fishers in BRD construction and installation
- Development of instructional media to assist fishers

Enforcement Training

- Technical training and assistance for NMFS, U.S. Coast Guard, and State law enforcement agencies

Developments in Gear Technology Achieved

The Composite-Panel BRD (Figure 1) was designed by the NMFS' Harvesting Systems and Engineering Branch as a variation on the alternative funnel construction method of the Jones-Davis BRD. The Composite-Panel BRD is installed in the Turtle Excluder Device (TED) extension immediately behind the TED. The funnel consists of two panels installed in the lower part of the extension. The panels taper inward creating a slow flow area that allows escapement of fish through two triangular escape openings cut into the extension on each side of the trawl. The funnel is assembled by using depth-stretched and heat-set polyethylene webbing with square mesh panels on the inside. The square-mesh panels function to reduce stretching of the outer panels. This new innovation in technology appears to exhibit the favorable attributes of funnel BRDs while greatly reducing the complexity and operational problems with previous designs.

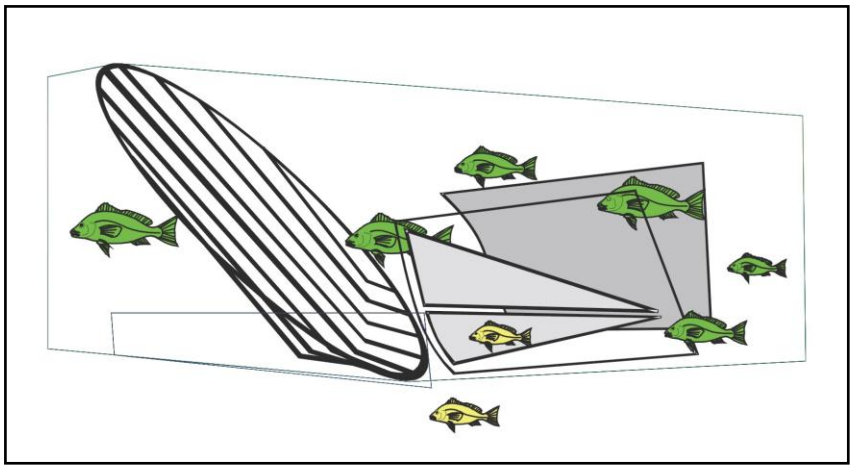


Figure 1. Composite panel BRD

Experiments were conducted to evaluate the relative efficiency of conventional and modified codends in excluding juvenile snapper. Preliminary results indicate that possibly 65 percent of juvenile snapper entering conventional shrimp trawl codends are able to escape through the meshes. Based on these results, a standard codend was tested against a slightly larger mesh size (51 mm) codend of the same design. As compared to the 44 mm codend, the larger mesh codend significantly reduced juvenile snapper capture by 24 percent without experiencing a significant reduction in shrimp. These evaluations and evaluations of square-mesh panels (Figure 2) in combination with an approved BRD design show significant promise in improving red snapper bycatch reduction.

Improvements and Reduction in Bycatch Associated with This Project
The provisionally certified Composite-Panel BRD has shown an overall finfish bycatch reduction rate of 25.3 percent in the Gulf of Mexico shrimp fishery. NMFS anticipates that additional fishery-dependent testing will achieve the minimum 30 percent requirement. The simplicity of the design makes it a practicable alternative to the more complex and expensive funnel BRD designs currently approved. Fishery-dependent evaluations of square-mesh panels are ongoing and are showing good potential for overall finfish reduction in combination with other approved BRDs. In addition, based on the high escape rate found with red snapper escaping from standard 44 mm codends, additional research is planned to quantify the survival or post-escape mortality of snapper that have escaped through the meshes of shrimp trawl codends.

Figure 2. Square mesh panel with experimental fisheye BRD

The project has conducted extensive BRD technology transfer to industry through written reports, presentations at fisher workshops, and hands-on dockside demonstrations. Manuals have been written and distributed to instruct fishers and net builders in the proper construction, installation, and use of the new BRDs. In 2008, net builders were contracted to construct more than 900 new BRD designs for distribution to the fishery. With the assistance of Texas Sea Grant agents, the introductory BRDs have been distributed in Florida, Alabama, Louisiana, and Texas. Gear specialists are working with the net builders during this phase of transition to insure quality control. Working with marine law enforcement, project personnel have conducted at-sea courtesy BRD inspections to promote communication and understanding with fishers on BRD technology.

Project Title
Transfer of Turtle Excluder Device and Bycatch Reduction Device Technology in the Southeast Region

BREP Funding Provided
$91,500

Location of Research
Southeast Fisheries Science Center

Resource Challenge
Federal regulations mandate the use of turtle excluder devices (TEDs) in nearly all shrimp trawls fished in State and Federal waters of the Southeast Atlantic Ocean and Gulf of Mexico (Figure 3). TEDs have been shown to exclude 97 percent of the sea turtles that are incidentally captured in shrimp trawls, providing a significant contribution to the conservation and recovery of sea turtles in the region. The Southeast shrimp industry continues to develop TED design innovations to improve shrimp retention and fish bycatch reduction. This project supports the development of industry innovation in TED design by providing technical support for evaluations and a mechanism with which to test design changes to ensure they meet federal requirements for turtle exclusion. Additionally, the project conducts fisher outreach and marine law enforcement training throughout the Southeast region to insure that TEDs are being used properly in the fishery.

Figure 3. Loggerhead turtle exiting a shrimp trawl net through a TED

Project Summary
The project consists of the following performance measures:

<u>TED Research and Development</u>

- Interface with industry to determine needed research and testing to solve operational problems with TEDs

- Conduct diver evaluations and certification tests of candidate TED designs and modifications

Performance Monitoring and Reporting

- Report results of certification tests and submit to the NMFS Southeast Regional Office for rulemaking
- Provide technical recommendations and assistance in drafting language for rulemaking
- Conduct assessments of "TED events," i.e., a request for TED exemptions due to storm debris, operational problems with TEDs, and sea turtle strandings in localized areas

Industry Outreach

- Technical training for net shops and fishers in TED construction and installation
- Development of instructional media to assist fishers

Enforcement Training

- Technical training and assistance for NMFS, U.S. Coast Guard, and State law enforcement agencies

Industry-developed TED design innovations were evaluated in cooperation with industry associations. Fisher-designers and key industry leaders are invited to participate in the project. SCUBA diver evaluations and underwater video obtained by project personnel provided important in-situ information to the TED designers. These evaluations provided a rapid method of identifying design flaws that may not be detected otherwise. Certification of the candidate TED was conducted through a standardized test using divers and a sample of 25 juvenile turtles. Final certification is based on the performance of the candidate TED when compared to the performance of a control TED.

Results from tests of industry-initiated TED innovations were reported, and technical drawings and specifications were produced for inclusion in rulemaking. Field assessments of TED use were provided to the NMFS Southeast Regional Office in response to State TED exemption requests due to hurricane debris, as well as localized sea turtle stranding events.

Industry outreach was conducted through visits to local net shops to ensure quality TED installation is maintained, as well as through dockside visits to fishers. Courtesy TED inspections were conducted by project personnel and are an effective means of ensuring proper TED installation and use. Training in proper methods for inspecting a TED was conducted for federal and state marine law enforcement agencies. Project personnel conducted at-sea training modules for law enforcement personnel assisting in TED compliance checks aboard vessels.

Developments in Gear Technology Achieved

The project has successfully worked with industry in the development of several new TED designs and modifications to improve shrimp retention. Each of the designs were evaluated and tested for turtle exclusion and have been submitted for inclusion in the federal TED regulations. Notably, the flat-bar TED, an aluminum TED design with narrow deflector bars, demonstrated an improvement in shrimp retention over

conventional TED designs. Additionally, the "Boone Big-Boy TED" successfully passed the certification test in 2008 as did a new triangular TED opening design that will provide improved durability to the TED system.

Improvements and Reduction in Bycatch Associated with This Project
Maintaining a working and cooperative relationship with the Southeast shrimping industry in solving operational problems with TEDs is necessary to ensure TEDs will be used properly and continue to be highly effective in saving sea turtles. This project served this purpose by providing assistance to industry in the development of new TEDs that will maintain sea turtle exclusion while improving operation for shrimp retention, debris exclusion, and durability of the device. As the operational characteristics of TEDs continue to improve, so too does fisher confidence in using the device as an integral component of their fishing gear.

Project Title
Evaluation of Weaker Circle Hooks to Release Bluefin Tuna in the Yellowfin Tuna Longline Fishery

BREP Funding Provided
$46,000

Location of Research
Southeast Fisheries Science Center

Resource Challenge
Pelagic longline fisheries for tuna and swordfish catch several non-target species such as blue and white marlin, sharks, and bluefin tuna, which are managed under international rebuilding plans and are experiencing overfishing. The bycatch of these species by pelagic longline fisheries is of concern to management agencies, and the United States has implemented several time/area closures in an effort to reduce bycatch mortality of these species in U.S. fisheries. The Gulf Mexico is a spawning area for the western Atlantic bluefin tuna stock and has become an area of concern due to the bycatch mortality of spawning bluefin tuna. NMFS is evaluating additional time/area closures in the Gulf of Mexico to mitigate the bycatch mortality of spawning bluefin tuna. Modifying fishing gear and/or fishing practices to reduce the mortality of bluefin tuna, while maintaining catches of yellowfin tuna in the Gulf of Mexico directed yellowfin tuna fishery, is being considered as an alternative to additional time/area closures.

Project Summary
During year one of the research (2007), fishery-independent experiments were conducted to collect data on the relative force exerted by bluefin and yellowfin tuna when captured on pelagic longline gear. Treatments of three different breaking strengths of monofilament leader (140, 200, and 250 lbs) were tested to determine which would effectively release bluefin tuna yet retain yellowfin tuna. Based on the data collected, 140-lb. and 200-lb. monofilament leader were determined to be capable of releasing bluefin tuna of the sizes of fish captured. In year two of the project (2008) we investigated the potential of experimental hooks as an additional method of preventing bluefin tuna capture. Spawning bluefin tuna are much larger than yellowfin tuna, and information from fishermen, gear manufacturers, and gear technicians indicate that large bluefin tuna are capable of straightening some types of hooks used in the yellowfin tuna fishery. The objective of the proposed work was to evaluate the efficacy of a weaker 16/0 circle hook (experimental) in reducing the bycatch of bluefin tuna by comparing it to a standard 16/0 circle hook (control) used in the pelagic longline fishery (Figure 4). The experimental hook will retain the dimensions of a 16/0 hook but will have less tensile strength, causing it to bend or straighten at loads that would not bend a conventional 16/0 hook. Fishery-dependent data were collected from two contracted pelagic longline yellowfin tuna vessels in the Gulf of Mexico. Vessels fished with industry standard gear utilizing the experimental hook on every other leader.

Figure 4. Control and experimental circle hooks

Developments in Gear Technology Achieved

Fishery-dependent testing of the weaker hooks yielded promising results. Seventy-two sets were made with a total of 36,766 hooks set in the experiment. A total of five bluefin tuna were caught during the experiment. Four were caught on the control hook, and one was caught on the experimental gear. A total of 652 yellowfin tuna were caught, with the experimental hook having a 6 percent higher catch rate than the control hook. The differences in the control and experimental hooks for bluefin and yellowfin catch rates were not significantly different. However, the failure to detect a significant difference in bluefin catch was likely due to the small sample size. Based on these results, NMFS proposes to continue this research in 2009 in order to obtain an adequate sample size to evaluate the potential use of new hook designs as an effective mitigation measure for reducing the mortality of bluefin tuna associated with pelagic longlines.

Improvements and Reduction in Bycatch Associated with This Project

While inconclusive as to the true efficacy of the experimental hook in releasing bluefin tuna, the results of year-two research are encouraging. A preliminary analysis of the data indicates that the experimental hook may actually have a positive effect on the catch of target species (yellowfin). With additional sampling effort, we hope to confirm that the weaker hooks are capable of releasing bluefin tuna and result in a positive effect on target catch. Such results would be an asset in the transfer of the new hook technology to the tuna longline fishery in the United States and worldwide.

Project Title
Evaluation of Dolphin Interactions with Lazy Lines on Shrimp Trawls

BREP Funding Provided
$23,000

Location of Research
Southeast Fisheries Science Center

Resource Challenge
Interactions of dolphins, primarily bottlenose dolphins (*Tursiops truncatus*), with shrimp trawls is a common occurrence in the Southeast U.S. shrimp fishery. Dolphins are known to feed on the fish bycatch of operating shrimp trawls. From 2000 to 2007, NMFS observers reported eight dolphin entanglements with the shrimp trawl "lazyline" or codend retrieval line. Seven of the eight entanglements were fatal. With each entanglement, the lazyline became looped around the tail flukes of the animal while the trawl was on the bottom, effectively preventing the dolphin from surfacing for air.

Project Summary
The objective of the project was to (1) assess dolphin behavior around actively fishing shrimp trawls using underwater video cameras and a dual-frequency identification sonar (DIDSON) system, and (2) investigate the practicability of using stiffer lazylines on a shrimp trawl as a means of preventing dolphin entanglement. The research vessel *Georgia Bulldog* was the project platform and was double-rigged (two nets). Operations were conducted in the vicinity of the Brunswick, Georgia ship channel. One net was outfitted with two video cameras, and the DIDSON system, all positioned to image the aft section of the trawl with varying views of the trawl lazyline. The DIDSON and video cameras were both hard wired, allowing real-time observations of the lazyline. Lazylines made from polypropylene, polyethylene, polydacron, multi-poly, and nylon with differing degrees of stiffness or "lay" were evaluated in-situ to examine their fishing configurations. Each lazyline was ¾ inch (19 mm) in diameter and 8 meters in length. A total of 18 tows were conducted over 4 days of trawling.

Dolphins were encountered during every tow during the project, interacting with each lazyline type. Using the DIDSON and the video cameras, dolphins were observed "rubbing" their backs and bellies against the lazyline (Figure 5). We also observed what appeared to be dolphins sliding down the lazyline as they "exited" the net area, pulling the lazyline with enough force to distort it from a normal fishing configuration. Between tows and while the trawl was being hauled and set, dolphins were always present, with at least a dozen dolphins observed on the surface at any given time.

As supplement to this investigation, NMFS Harvesting Systems and Engineering Branch SCUBA divers conducted underwater evaluations of stiffer lazylines while they were in a fishing configuration by physically manipulating the lines in attempt to form small loops and coils (as a dolphin might in an entanglement situation). From these evaluations,

divers concluded that the stiffer line materials, such as the polydacron crab lay line, were much more difficult to create a loop or coil in while the trawl was being towed.

Developments in Gear Technology Achieved
No differences in dolphin interactions were observed between line types that were slightly positively buoyant such as the polypropylene and the Bi-polymer rope (specific gravities 0.91 and 0.94 respectively) and line types that were negatively buoyant such as the nylon or SSR-100 Polydacron (specific gravity 1.14 and 1.18 respectively). It appears that dolphins will interact with lazylines, regardless of their composition and stiffness. Their interaction with the lazyline seems to be purposeful, possibly as an object of play and almost certainly as a "scratching post." Although no direct observations of dolphins interacting with lazylines in a potentially harmful manner were obtained, diver manipulation of the stiffer lazylines confirmed it would be much more difficult for dolphins to become entangled using these lines. This project also confirmed the operational feasibility of using stiff lazylines. Stiffer lines were only slightly more difficult to handle by deck personnel when deploying or retrieving the trawl.

Improvements and Reduction in Bycatch Associated with This Project
The project provided polydacron lines to several government chartered trawlers as a means of "ground truthing" their efficacy in preventing dolphin entanglements and ease of operation. To date, there have been no reports of dolphin entanglements from the trawlers. Positive feedback has been received on the operational qualities of the line. Should dolphin entanglements become more prevalent within the Southeast shrimp fishery, the requirement of stiffer lazylines could offer a solution at a relatively low cost to fishers.

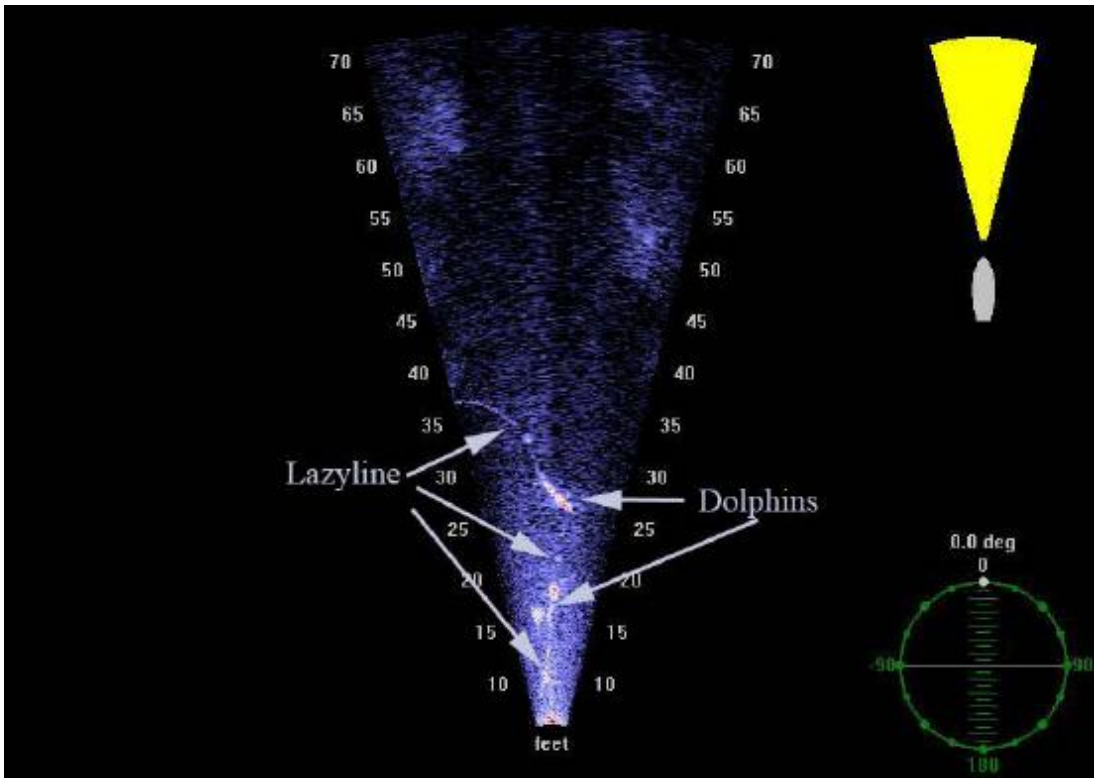


Figure 5. DIDSON image of dolphins and lazyline

Project Title
NMFS National Seabird Program

BREP Funding Provided
$108,824

Location of Research
Alaska Regional Office, Headquarters Office of Protected Resources

Resource Challenge
A growing concern exists regarding the long-term effects of seabird bycatch in longline fisheries conducted in many areas of the world's oceans. NMFS' role in the reduction of seabird bycatch in fisheries is guided by the following authorities:

- New seabird requirements in the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006;
- The Endangered Species Act;
- The U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (NPOA-Seabirds);
- The NMFS National Bycatch Strategy and National Bycatch Report; and
- Executive Order 13186 entitled "Responsibilities of Federal Agencies to Protect Migratory Birds."

Although seabird projects are underway in most NMFS Regional Offices and Science Centers, no additional employees have been dedicated to this work.

Project Summary
In addition to numerous projects (described below), the NMFS National Seabird Program (NSP) funds one-half of a full-time-equivalent position for a national seabird coordinator, as well as travel funds for the coordinator and some invitational travel to seabird and fishery conferences and regional fishery management organization meetings where seabird bycatch is on the agenda. The NSP continues to support both the domestic and international implementation of the U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (NPOA) and is working directly with the BREP to collaboratively implement new seabird language in Section 316 of MSA.

All NMFS Regional Offices or Science Centers have worked with the NSP to address NPOA implementation and seabird bycatch reduction through regulatory requirements, enhanced observer data collections and specific training for seabird identification, seabird bycatch estimation and analysis, and collaborative research, seabird surveys, education and outreach materials for fishermen and the public, and international efforts at regional fishery management organizations, bilateral meetings (involving Brazil, Canada, Chile, the European Commission, Japan, Korea, Mexico, Taiwan), fisheries observer conferences, and albatross and seabird conferences. The NSP is part of an inter-agency team to support a U.S. position for possible accession to an international treaty, the Agreement on the Conservation of Albatrosses and Petrels (ACAP). The NSP led a U.S. team at ACAP's Advisory Committee meeting and its working groups in 2008. The NSP

also chaired a Food and Agricultural Organization of the United Nations Expert Consultation to develop Best Practice Technical Guidelines on NPOAs in August 2008.

Developments in Gear Technology Achieved
The NSP monitored previously funded projects being conducted in Russia and Peru to reduce seabird bycatch, including a project that uses streamer lines to keep seabirds from getting hooked on longline hooks from Russian vessels (Figure 6).

Improvements and Reduction in Bycatch Associated with This Project
Improvements and reduction in bycatch associated with the NSP are described on pages 16-23.

Figure 6. A longline fishermen in Russia uses a streamer line to keep seabirds from getting hooked on the longline hooks. The streamer lines were first provided by a U.S. Fish & Wildlife Service project, and this effort continues through a World Wildlife Fund (WWF) project funded by the NSP. The streamer lines help protect the endangered short-tailed albatross, a rare species that is protected by the U.S. Endangered Species Act (Photo credit: WWF).

Project Title
Alaska Fisheries Science Center Coordinated Seabird Studies

BREP Funding Provided
$38,000

Location of Research
Alaska Fisheries Science Center

Resource Challenge
A growing concern exists regarding the long-term effects of seabird bycatch in longline fisheries conducted in many areas of the world's oceans. Alaskan fisheries face many challenges in reducing seabird bycatch, and numerous activities are needed to meet the requests and responsibilities placed on the NMFS Alaska Fisheries Science Center (AFSC) from biological opinions, conservation plans, and requests from constituents.

Project Summary
This project consisted of four components: (1) a student internship, (2) vessel-specific bycatch analysis, (3) documentation of seabird interactions with Alaskan groundfish fisheries, and (4) a seabird necropsy program.

The student intern assisted in bringing several important projects up to date. The first task was to complete activities in support of the seabird necropsy program. The intern sorted and developed an inventory of all frozen seabird specimens being held in the observer program freezer. Birds from several years were being held, and the AFSC would be unable to continue collecting birds without clearing the backlog. After the inventory was completed, the intern prepared all fulmars (a gull-like relative of the albatrosses and shearwaters) in the freezer for shipping to Oikonos in support of their National Fish and Wildlife Foundation project (see page 17). The second task was to code, quality control, and complete some preliminary summaries of a 2004-2006 observer special project on seabird mortalities on trawl vessels. That work was completed, and some summary graphs and tables were readied for a report that is now being prepared. The third task was to bring all point-count seabird surveys up to date by coding and conducting some initial quality control. That task has been completed.

The vessel-specific bycatch analysis project examined the seabird bycatch rates of individual longline vessels to determine whether bycatch is spread out evenly among all vessels or if a few vessels have higher rates and therefore contribute more to the overall estimate. If the latter is the case, NMFS may be able to reduce the seabird bycatch in the longline fishery even further by working with those vessels and companies that show higher bycatch rates. NMFS expects to produce a peer-reviewed journal article or NOAA Technical Memorandum based on the results of this project.

The project on reporting seabird interactions with Alaskan groundfish fisheries is being conducted by Dr. Ann Edwards of the University of Washington. Dr. Edwards presented her work at the 4th International Conference on the Conservation of Albatrosses and

Petrels in Capetown, South Africa. She also developed excellent collaborative ties with other scientists from around the world, several of whom showed much interest in her work on (1) stable-isotope sampling from feather clips of albatross and (2) how foraging strategies (natural versus offal) may affect breeding success (Figure 7). This project is also supporting the production of a NOAA Technical Memorandum on seabird bycatch in Alaska from 1993 to 2006.

Figure 7. Dr. Ann Edwards collecting feather samples for stable-isotope analysis from Laysan albatross at Midway Atoll (Photo credit: Ann Edwards).

Finally, the AFSC supported an application by the nonprofit group Oikonos to the National Fish and Wildlife Foundation (NFWF) for funding to conduct necropsies of Northern fulmars recovered from beach-cast surveys and observer samples. Northern Fulmar carcasses have been examined for plastic ingestion in the North Sea of the Atlantic for the past 20 years. The Oikonos NFWF project is expanding that examination of plastic ingestion to Pacific seabirds. Most seabirds collected by observers from the AFSC observer program are Northern fulmars, which constitute about 50 percent of the bycatch. Observers also collect albatrosses, shearwaters, larids, and other specimens that would not be covered by the NFWF project. Therefore, the AFSC supported adding the necropsy of these other species to the project. To date, the AFSC has sent approximately 11 full freezer boxes of fulmar specimens to Oikonos for necropsies. As a result of this project, the Hawaii observer program has been able to ship albatrosses to Oikonos for necropsy. The Hawaii observer program had a backlog of carcasses in its freezer and had suspended the collection of further carcasses and was in a position of having to discard the specimens. The Hawaii observer program is once again collecting specimens. The AFSC also is working with the Northwest Fisheries Science Center so that specimens recovered in west coast fisheries can be sent to the Oikonos for processing. Oikonos plans to present necropsy results at the 2009 Pacific Seabird Conference.

Developments in Gear Technology Achieved
This project did not directly achieve any developments in gear technology.

Improvements and Reduction in Bycatch Associated with This Project
The vessel-specific bycatch analysis project may allow NMFS to reduce seabird bycatch in the longline fishery further by working with vessels and companies that show high bycatch rates.

Project Title
Seabirds in the Western North Atlantic and Interactions with Fisheries

BREP Funding Provided
$14,000

Location of Research
Southeast Fisheries Science Center

Resource Challenge
The two principal challenges in this project were to (1) improve the identification of the bird bycatch in the Western North Atlantic U.S. pelagic longline fishery reported by observers and (2) improve the estimation of bycatch of the total fleet based on bird bycatch reports from the observer program.

Project Summary
The focus of this project was to improve information on the seabirds caught as bycatch in the Western North Atlantic U.S. pelagic longline fishery. Observers deployed by the Southeast Fisheries Science Center cover the entire geographic distribution of U.S. longline fleets in the Western North Atlantic Ocean, from the Outer Banks off Newfoundland to the Equator, including the Gulf of Mexico and the Caribbean Sea. Until 2004, when the NSP started funding this project, more than half the seabirds reported in the Pelagic Observer Program were reported only as "seabird" with no taxonomic detail. Beginning in 2004, all birds observed caught were identified at least to genus, and most were identified to species. In addition to observer training on seabird identification, the project provided identification verification by an expert, summarization and description of the bird bycatch of the current year, estimation of the seabird bycatch of the entire fleet based on observer reports, development of documented species profiles with population estimates, and preparation of the National Report on the Seabird Bycatch of the Western North Atlantic U.S. Pelagic Longline Fishery.

Developments in Gear Technology Achieved
This project did not directly achieve any developments in gear technology.

Improvements and Reduction in Bycatch Associated with This Project
This project supported two seabird identification training sessions in 2008, which trained approximately 35 observers in the U.S. pelagic longline fishery observer program for the Western North Atlantic, including the Gulf of Mexico and the eastern Caribbean. This training should help NMFS identify which species of seabirds are being caught in longline fisheries and target bycatch reduction programs for those species.

Project Title
Estimation of Seabird Bycatch in Northeast Commercial Fisheries

BREP Funding Provided
$30,000

Location of Research
Northeast Fisheries Science Center

Resource Challenge
Fisheries observer coverage has not been sufficient to estimate seabird bycatch in most fisheries and gear types. In addition, seabird takes have been rare for many species observed taken. Since 2001, there have been approximately 18 different species of seabirds taken in Northeast commercial fisheries. Gannets, gulls, greater shearwaters, and loons have been most commonly taken. Ten to eleven different gear types have been involved. Takes have been observed in all months throughout Northeast waters. In the Northeast, NMFS believes it is possible to estimate bycatch for (1) gross taxa like "loons" and "shearwaters" in gillnets; (2) northern gannets in pair trawls (the only documented bycaught species in this fishery); and (3) "gulls" in bottom longline gear. Given that observer coverage targeting non-seabird species has been fairly high during the last two-to-three years, it should be possible to get some kind of bycatch estimates at least for these years for these taxa-gear combinations.

Project Summary
The objective of this project is to, over a three-year period, develop methodologies for expansion of observer takes to total takes by fishery and species, if possible. This project uses a generalized additive model/generalized linear model (GAM/GLM) approach for bycatch estimation. Northeast Fisheries Science Center contract personnel have been working on estimation of seabird bycatch in Northeast fixed and mobile gear fisheries. During this period, the GAM/GLM models were developed and implemented based on Northeast observer reports, vessel trip reports for the relevant fisheries, and oceanographic data (e.g., sea surface temperature). A manuscript discussing these results is being drafted.

Developments in Gear Technology Achieved
This project did not directly achieve any developments in gear technology.

Improvements and Reduction in Bycatch Associated with This Project
Bycatch estimation methodologies developed through this project should lead to seabird bycatch estimates that should in turn help NMFS identify which Northeast fisheries are catching seabirds and target bycatch reduction programs for those fisheries.

Project Title
Seabird Bycatch Avoidance for West Coast Groundfish Fisheries

BREP Funding Provided
$14,000

Location of Research
Northwest Regional Office and Washington Sea Grant

Resource Challenge
Bycatch of Endangered Species Act (ESA)-listed seabird species in the west coast groundfish fishery is a concern to NMFS. Excessive takes of ESA-listed seabirds have the potential to close down fisheries and have serious ecological and economic consequences.

Project Summary
The NMFS Northwestern Regional Office is collaborating with Washington Sea Grant to undertake work on seabird and fishery conservation and ESA compliance related to the west coast groundfish fishery and ESA-listed seabird species. Specifically, this project is characterizing the west coast longline fleet (number of vessels, vessel size); its gear type; its infrastructure (masts, poles rigging); and its geographic and temporal distribution and overlay with available at-sea data (telemetry and bird counts).

This project also is characterizing the west coast trawl fleet (number of vessels, vessel size); its gear type; its infrastructure (masts, poles rigging); and its geographic and temporal distribution and overlay with available at-sea data (telemetry and bird counts). This scope of this characterization is dependent on available data.

Finally, this project is conducting port-to-port outreach meetings to make fishers aware of the need for seabird bycatch mitigation in longline fisheries and to share solutions developed for Alaska fisheries and other demersal fisheries around the world. This project will determine need for additional outreach to the longline fleet.

Developments in Gear Technology Achieved
This project did not directly achieve any developments in gear technology.

Improvements and Reduction in Bycatch Associated with This Project
Based on this project's characterization efforts and earlier work on seabird bycatch mitigation technologies in Alaska and elsewhere, this project will recommend seabird bycatch avoidance measures for the West Coast longline fleet and determine need for further development of mitigation for this fleet. Based on the overlay of data from the West Coast trawl fleet, this project should also identify fleets with highest likelihood of interactions with albatrosses.

Project Title
Monitoring Seabird Distribution and Abundance in the California Current

BREP Funding Provided
$14,000

Location of Research
Southwest Fisheries Science Center

Resource Challenge
Monitoring is the most basic of tools for fisheries management objectives to be obtained. Without knowledge of the identity and abundance of seabirds in a particular region, and trends in distribution and abundance over space and time, the impact of management actions cannot be comprehensively assessed. This project addressed four key mandates and statutes that NMFS implements (U.S. NPOA-Seabirds, NMFS National Bycatch Strategy, Executive Order 13186, and ESA) by documenting which species of seabirds occur in the California Current, where they occur, and how these distribution and density patterns compare to those documented during past surveys.

Project Summary
This project's objectives include collecting data on seabird distribution and abundance in the California Current, documenting and archiving data, and making data and resulting products available to U.S. Fish and Wildlife Service personnel and other governmental and academic institutions for collaborative use in investigations regarding the California Current ecosystem. These objectives are being achieved through the Oregon, California, Washington Line-transect and Ecosystem Survey (ORCAWALE) 2008 cruise, which is a continuation of regularly occurring cruises conducted by the Southwest Fisheries Science Center to assess the abundance and distribution of marine mammals and to characterize the pelagic ecosystem from the U.S.-Mexico border to the U.S.-Canada border and seaward to 300 nautical miles. Past surveys were conducted in 1991, 1996, 2001, and 2005, and are scheduled to occur every three years into the future. The primary objective of ORCAWALE is to conduct a marine mammal assessment for purposes of monitoring trends and abundance. In order to facilitate interpretation of trends, an associated objective is to characterize the pelagic ecosystem within the study area, through the collection of underway and station-based physical and biological oceanographic sampling, studies of mid-trophic level organisms (using net sampling and acoustic backscatter methods), and research on non-protected apex predators (seabirds). The cruise ended on December 1, 2008. Planned tracklines for the cruise and tracklines completed as of October 2008 are shown in Figure 9.

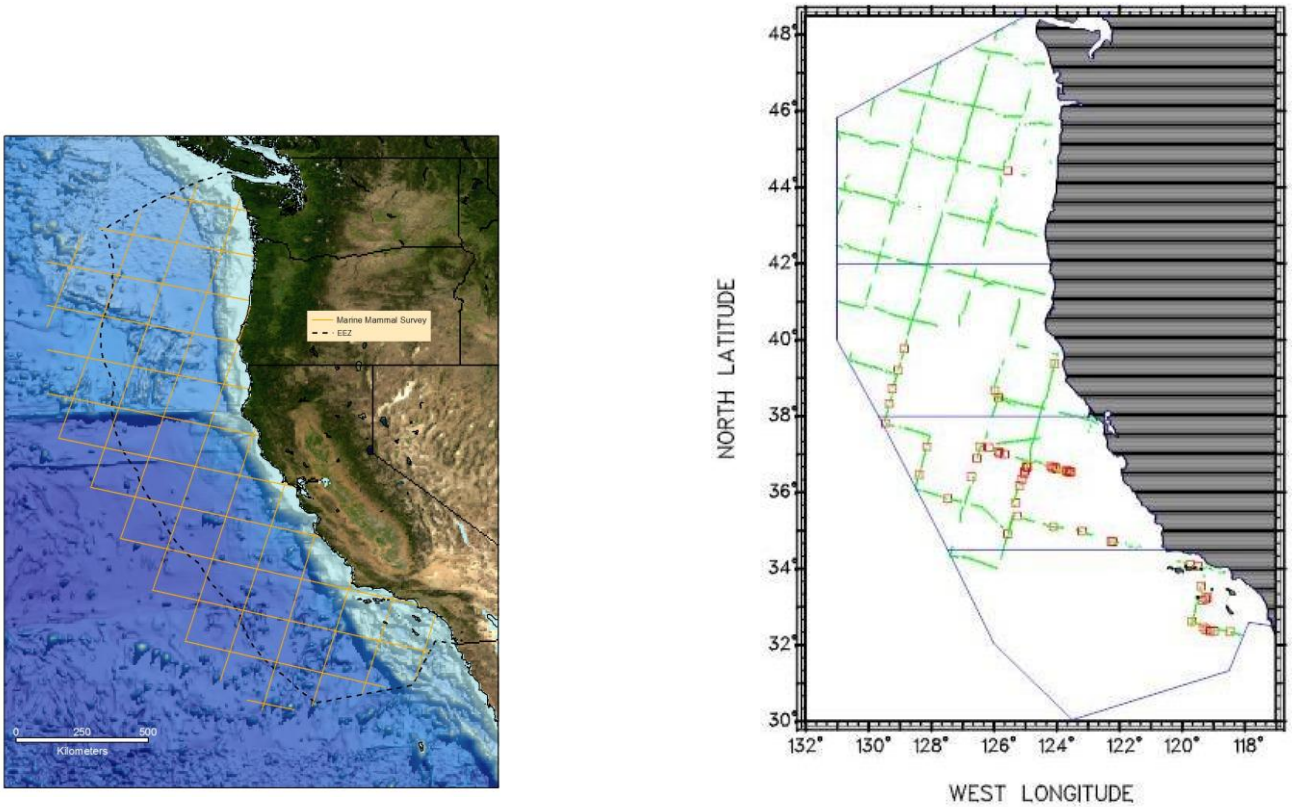


Figure 8. Planned ORCAWALE cruise tracklines (left) and tracklines completed as of October 2008 (right)

Visual surveys of seabirds were conducted from the flying bridge during daylight hours by two seabird observers. A log of sighting conditions, effort, sightings, and other required information was entered into a computer using the program SEEBIRD, interfaced with the ship's Global Positioning System (for course, speed, and position information) and Scientific Computing System (for weather and heading information). Seabird observers used handheld and 25x150 binoculars. Nightly data edits were accomplished using the data check program BIRDEDIT.

Developments in Gear Technology Achieved
This project did not directly achieve any developments in gear technology.

Improvements and Reduction in Bycatch Associated with This Project
Accomplishments to date include collection of seabird survey data along the tracklines displayed above. Approximately six months after completion of the cruise, data will be cleaned and processed, and a data report will be produced in the form of a NOAA Technical Memorandum. Additionally, these seabird data will be used in a number of collaborative projects designed to investigate seabird distribution and abundance in this region, including a project funded by the California-based non-profit organization Resources Legacy Fund Foundation to develop predictive models of seabird distribution in this region.

Project Title
Coastal Observation and Seabird Survey Team (COASST)

BREP Funding Provided
$10,000

Location of Research
University of Washington

Resource Challenge
Thousands of seabirds are taken incidentally in fisheries each year. COASST beached bird surveys offer one method for documenting bycatch incidents in the Pacific Northwest and Alaska without costs associated with at-sea work. Data collected provide estimates of mortality from bycatch and other sources, sensitivity to bycatch by entanglement type, and information on the distribution of bycatch-sensitive species.

Project Summary
COASST is a citizen-science project that utilizes a network of over 500 trained volunteers to collect data on beached birds at more than 280 sites throughout the Pacific Northwest and Alaska, creating a wealth of high-quality, verifiable data at a geographic scale that would not be possible using paid agency personnel. COASST is the largest program of its kind in the world and the only program to photograph and individually mark carcasses, allowing quantification of persistence and scavenging rates, as well as confirmation of species identification and incidents of fisheries bycatch from recreational and commercial gear. These project funds supported the expansion of data collection efforts in Alaska, and supplies and materials for documentation of entangled seabirds across over 360 kilometers of coastline and aboard fishing vessels along the West Coast.

Developments in Gear Technology Achieved
This project did not directly achieve any developments in gear technology.

Improvements and Reduction in Bycatch Associated with This Project
This project helped maintain data collection on more than 283 COASST beaches in the Pacific Northwest and Alaska. This project also supported 12 training and refresher sessions for new and current volunteers. In addition, this project contributed to the documentation of 25 cases of seabird entanglement since June 2007, one quarter of which involved birds from the order *Procellariiformes* (petrels, fulmars, and albatrosses). Data collected through this project will help NMFS to develop additional techniques to reduce seabird bycatch.

Project Title

Gear Modifications to Reduce Harbor Porpoise Interactions in Commercial Atlantic Gillnet Fisheries

BREP Funding Provided
$103,000

Location of Research
Northeast Fisheries Science Center

Resource Challenge
Initially this project was designed to test the effectiveness of gillnets infused with 10 percent barium sulfate. Attaining gillnets with 10 percent barium sulfate (BaSO4) has been a challenge but has also provided some important information on previous work on this issue. Prior to purchasing BaSO4 webbing, the Northeast Fisheries Science Center (NEFSC) sent samples provided by the manufacturer for analysis. The results of the analysis found that these samples and subsequent samples were deficient in BaSO4. Additionally, the NEFSC is collaborating on an international project looking at this same issue, and the investigators for the international project had samples from previous studies analyzed and found that their samples were also deficient. Because of these findings, it is speculated that there may be varying amounts of BaSO4 in gillnets used in previous studies, which may be the cause of the inconsistencies in the results between these studies.

Project Summary
The revised goal of this project is to determine and document conservation benefits for reducing harbor porpoise bycatch resulting from differing hanging ratios (0.5 versus 0.33) in the sink gillnet fishery in the area south of the Cape Cod South Management Area. Contracts have been awarded for the materials, vessels, and the sampling for this project. We are prepared to commence work on the study in February to May of 2009, a time that has a documented high bycatch rate of harbor porpoise.

Developments in Gear Technology Achieved
The methodology was modified to account for the lack of a supplier of BaSO4 webbing (see Resource Challenge section above). A request for proposals was submitted in April 2008 and was awarded in September 2008 for a contract to provide data collectors for the study. Additionally, two contracts were awarded for providing the webbing and hanging the gillnets. NMFS anticipates delivery of the gillnets before 2009.

Improvements and Reduction in Bycatch Associated with This Project
The initial study revealed a problem in attaining gillnets with the correct BaSO4 concentration. It is likely that this would be problematic for the industry as well. Additionally, ensuring that the correct concentration is used in commercial gear would be difficult for enforcement. As such, the study evolved to investigate differences in bycatch rates between two hanging ratios commonly used in the industry. Results from

this work could have a practicable applicability to reducing bycatch of cetaceans in the gillnet fishery.

Project Title
Fishing Technology and Conservation Engineering to Reduce Trawl Bycatch in Alaskan Fisheries

BREP Funding Provided
$100,000

Location of Research
Alaska Fisheries Science Center

Resource Challenge 1
Working with the Bering Sea bottom trawl fleet to develop and improve devices for trawl selectivity.
In 2008, this fleet came under new regulations (Amendment 80 to the Bering Sea/Aleutian Island Fisheries Management Plan) that allocated both target catch and bycatch to vessels within cooperatives. This greatly increased incentives of individual operators to find ways to manage the composition of target catch and bycatch. Because target quotas for the flatfish increased, primary emphasis was on reducing the bycatch of prohibited species, particularly halibut. Some participants in this fishery have been among the most active in developing bycatch reduction methods, particularly the use of grate excluders to reduce bycatch of large halibut. The management change increased demand for additional cooperative research services from the Alaska Fisheries Science Center's Conservation Engineering Project (Conservation Engineering Project), as former participants looked to improve methods and those new to the use of selectivity devices worked to come up to date.

Project Summary
The Conservation Engineering Project provided observation equipment (video, sonar, and other sensors) and personnel for onboard participation (travel, overtime, and contract personnel), and also made existing designs for bycatch reduction devices (BRDs) and fish behavior information more accessible. This project also advised fishers on effective ways of field-testing their own devices and methods. This project's primary fieldwork, aboard the F/V *Cape Horn* in June 2008, tested flexible grid excluders just ahead of the codends in the Bering Sea flathead sole fishery. The most effective of these excluded approximately 65 percent of the halibut with a loss of 20 percent of the target flatfish.

Developments in Gear Technology Achieved
This ongoing activity continues to develop and improve BRDs, which improves the selectivity of trawls in Alaska's groundfish fisheries and facilitates BRD application in the fishery. Our long-term goal is to create a diverse and flexible toolbox of devices and a fleet familiar with their applicability to a range of bycatch situations. The greatest advance in 2008 was a greatly increased routine use of these BRDs, motivated by management changes and fleet cooperation.

Improvements and Reduction in Bycatch Associated with This Project
Figure 9 shows the trends in halibut bycatch in the major Alaska bottom trawl fisheries since 2005.

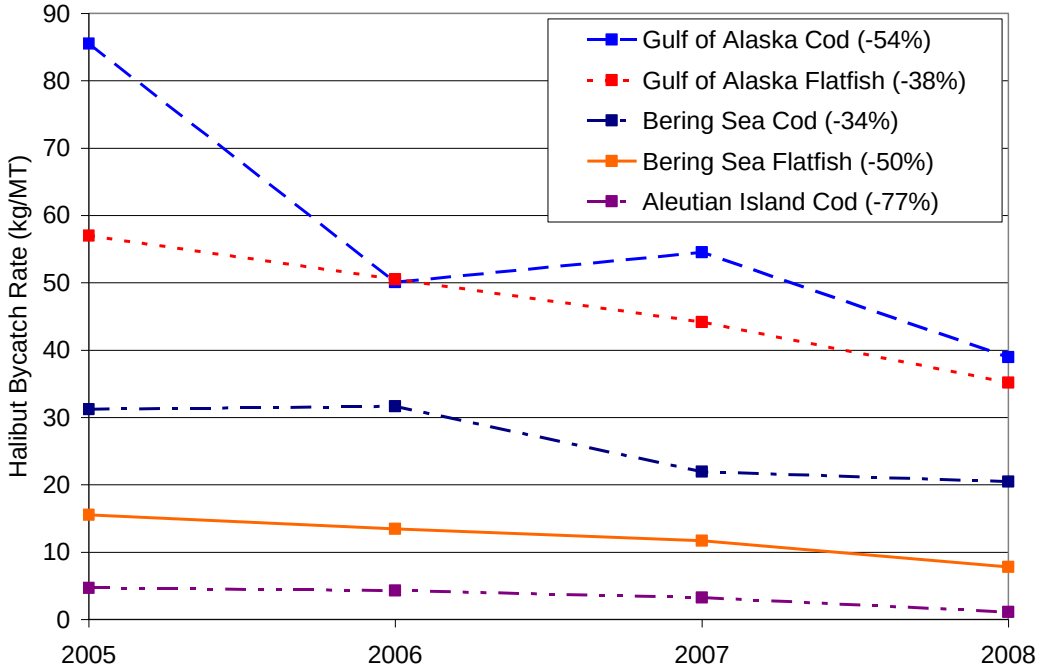


Figure 9. Reductions in halibut bycatch rates for major Alaska bottom trawl fisheries from 2005 to 2008

All of these fisheries have achieved substantial reductions in halibut bycatch rates (34 – 77 percent). As these fisheries have bycatch caps, and there have been improvements in incentives to reduce bycatch, use of BRDs is one of several mutually supporting causes of these reductions. More years of data are needed to confirm the trends, including performance during the remaining part of 2008.

Resource Challenge 2
<u>Further modifications and improvements to a prototype trawl system to reduce salmon bycatch.</u>
Salmon bycatch has been a critical issue for the Alaska pollock fishery. A family of salmon excluders has been developed in cooperation with the United Catcher Boats and the North Pacific Fisheries Research Foundation, with support from several fishing companies and other organizations. Improvements to these devices and documentation of their effectiveness are needed to facilitate their use to reduce salmon bycatch in pollock fisheries.

Project Summary
Fieldwork in March, August, and September of 2008 supported further testing aboard both catcher/processors and trawlers delivering to shoreside plants by developing and providing video and sonar equipment to monitor gear and fish behavior. Very few salmon were encountered by the pollock fleet and the vessels conducting tests in August and

September. Although rare encounters were beneficial for the fishery, they prevented useful assessments of salmon escapes and only allowed investigators to evaluate and fine-tune excluder configuration.

Developments in Gear Technology Achieved
The current excluders allow salmon to escape through portals uncovered by a weighted panel that drops during periodic slow-downs. Through improved monitoring of this process, NMFS has documented effective weighting and slow-down procedures. NMFS also has tested two prototype devices that transmit panel position to the vessel in real time.

Improvements and Reduction in Bycatch Associated with This Project
Although salmon bycatch rates were very low in 2008, this is more likely due to reduced overlap of pollock and salmon distributions than the limited excluder use that occurred.

Resource Challenge 3
<u>Evaluation of trawl groundgears that produce less damage (unobserved bycatch) to living structure in soft bottom areas.</u>
These modifications to trawl sweeps were developed during cooperative research with Bering Sea catcher-processor bottom trawl fleet. The North Pacific Fisheries Management Council endorsed their use in June 2007, but delayed implementation action for one year to allow the fleet to identify the most practicable ways to apply the modifications. Major issues included determining the minimum spacing necessary to maintain the clearance of trawl sweeps above the seafloor and effective attachment methods that will survive the rigors of day-to-day fishing.

Project Summary
This effort required Conservation Engineering Project support in providing devices that measured sweep clearance above the seafloor and providing personnel to conduct measurements during fishing operations. NMFS also assisted in the development and testing of attachment methods.

Developments in Gear Technology Achieved
NMFS demonstrated that seafloor clearances similar to those from our performance experiments could be achieved with double (30 foot to 60 foot) the spacing between elevating devices or triple the spacing if larger devices are used. This reduces handling and attachment problems, as well as further reducing direct seafloor contact.

Improvements and Reduction in Bycatch Associated with This Project
Beyond some vessels testing these devices to be ready for regular use, substantial improvements will be achieved only after regulations are implemented, which will not be possible until early 2010.

Resource Challenge 4

Harvest of rockfish with pelagic trawls.

In 2007, a pilot project demonstrated that rockfish could be effectively harvested with pelagic trawls, greatly reducing bycatch and seafloor effects of that fishery. A method for monitoring the degree of bottom contact of these trawls and demonstration of minimal contact were identified as needed to advance this concept.

Project Summary

The Conservation Engineering Project adapted devices to indicate direct seafloor contact. Project funding was used to procure devices and to support personnel to apply them aboard a Gulf of Alaska rockfish trawler in July 2008. The devices were attached at the center and wingtip of the trawl as well as below a depressor weight ahead of the trawl. Results were correlated with observations from a headrope-mounted sonar showing the trawl's cross-section (and the seafloor) at the center of the footrope.

Developments in Gear Technology Achieved

NMFS demonstrated both the ability to monitor seafloor contact for pelagic rockfish trawls and that rockfish were effectively harvested during the study trip by a trawl with only minimal and incidental seafloor contact.

Improvements and Reduction in Bycatch Associated with This Project

This information provided by this study supported the Rockfish Pilot Project, which has promoted use of pelagic trawls to harvest Gulf of Alaska rockfish. In 2008, approximately 18 percent of the rockfish fishery used pelagic trawls. The halibut bycatch using pelagic trawls was 1.1 kg/mt of groundfish, compared to 7.5 kg/mt for bottom trawls. This is in addition to the associated reduction in habitat effects.

Project Title
Collaborative Research on Reducing Post-Release Mortality for Common Thresher Sharks Captured in the Southern California Recreational Fishery

BREP Funding Provided
$46,000

Location of Research
Southwest Fisheries Science Center

Resource Challenge
The common thresher shark (*Alopias vulpinus)* is one of 13 economically important highly migratory species (HMS) actively managed under the Fishery Management Plan for U.S. West Coast HMS Fisheries. Thresher shark harvest is monitored under a harvest guideline management strategy due to their vulnerability and low resiliency to overexploitation. In Southern California there is a rapidly expanding "foul-hooking" fishery that targets the common thresher shark by the tail. The subsequent hauling of the shark in backwards during the fight reduces the capacity of this shark to breathe, and thus may lead to high post-release mortality rates in this fishery. This is problematic as one of the continued conservation tools used by managers and marine conservation groups is to promote the practice of catch-and-release. The widespread use of tail-hooking techniques by recreational fishers and the unknown fate of released thresher sharks complicate the design of an effective management strategy for this valuable resource. Further complicating issues is the presence of large gravid females during the peak fishing months of this fishery and the increased fight times associated with landing these large sharks. Thus this project's goal is to assess post-release mortality in this species and investigate alternative fishing techniques that increase survivorship in released sharks.

Project Summary
The proposed work is directed at determining the first post-release mortality estimate for common thresher sharks captured by recreational fishermen off Southern California and to develop and promote alternative fishing methods that increase post-release survivorship. The mortality assessment is conducted using pop-off satellite archival tags (PSATs) deployed on sharks landed using the same techniques that are employed in the southern California thresher fishery (Figure 10). Concurrent investigations of the physiological indicators of capture stress for tail-hooked sharks (i.e., blood and tissue biochemistry, stress proteins) are also being conducted to compare with samples obtained from mouth-hooked individuals.

A total of 28 thresher sharks were caught and released during the 2007-2008 season. Twelve pop-off satellite archival transmitters were deployed by the research team on adult and sub-adult thresher sharks caught using the tail-hooking techniques. Preliminary findings from this study suggest a post-release mortality estimate of 17 percent for the sharks sampled thus far (155-230 cm FL). The large majority (93 percent) of thresher sharks captured during this project were hooked in the caudal fin using the fishery standard techniques (trolling heavy baited lures with "J"-hooks). Juvenile and sub-adult thresher sharks (102 to 152 cm FL) that were not tagged incurred fight times ranging from 9 to 30 minutes on 24 kg conventional tackle and remained vigorous when brought alongside the tagging vessel prior to release.

Figure 10. A large thresher shark fitted with a PSAT and ready for release (Photo: S. Aalbers, PIER)

All adult tail-hooked thresher sharks (> 155 cm FL) captured during the study period were tagged and released (Figure 11). Once at the boat the sharks appeared exhausted and lethargic; however, all individuals with fight times less than 85 minutes were able to recover and survive the acute effects of capture as determined by the PSAT records. The two largest individuals with fight times in excess of 105 minutes did not survive. These preliminary data suggest that large tail-hooked thresher sharks exposed to prolonged fight times have increased mortality rates when compared to smaller individuals. Further studies on larger individuals are necessary to statistically validate this work.

In June 2008 the Pacific Fishery Management Council's Highly Migratory Species Management Team echoed concern about the expanding recreational fishery for thresher sharks in the Southern California Bight and recommended that the Council consider new management measures for the fishery, further highlighting the importance of reliable post-release mortality estimates. Initial findings from the first phase of this BREP-funded project have contributed valuable and timely information to managers of the recreational thresher shark fishery.

Developments in Gear Technology Achieved

The use of circle hooks may significantly reduce the number of foul-hooked sharks captured in the recreational fishery. However, additional field trials are necessary to determine effectiveness of this gear modification.

Improvements and Reduction in Bycatch Associated with This Project

This project quantified the mortality rates of sharks captured and released in the recreational fishery in southern California. This mortality is, in part, due to the current methods employed by the recreational fleet that significantly reduce the ability of the

thresher sharks to breathe. This mortality is not observed, and it is not quantified in current fishery management plans. Additional aspects of this BREP work are focused on the development of innovative solutions that can be used to reduce post-release mortality in this fishery.

Figure 11. A large, post-release female thresher shark recovering near the surface after a 75-minute tail-hooked struggle using rod and reel gear (Photo: S. Aalbers, PIER)

This project incorporates a strong public outreach component that urges active participants in the fishery to assist in the development of alternative fishing methods that reduce foul-hooking and increase mouth-hooking. Over 300 recreational fishermen attended four seminars offered in 2008 as part of this project, with over a dozen anglers expressing willingness to participate in gear trials slated for 2009.

Project Title
Reducing Shark Bycatch with Electropositive Metals in Hawaiian Fisheries

BREP Funding Provided
$29,070

Location of Research
Pacific Islands Fisheries Science Center

Resource Challenge
The incidental capture of sharks is estimated at over 300,000 metric tons annually and often comprises a large proportion of the total catch. For example, sharks comprise >25 percent of the total catch in Australian and Fijian tuna longline fisheries and comprise ~15 percent of the total catch in the Hawaii-based longline fisheries, with substantial catches (>50 percent of total catch) in the swordfish longline sector prior to 2002. Because sharks are among the top predators in marine ecosystems, the continued depletion of their populations could result in detrimental cascading effects for high seas biodiversity. NMFS has recognized shark bycatch as a management priority, and the 2001 Final U.S. National Plan of Action for the Conservation and Management of Sharks states, "Management entities should invest in elasmobranch research, fishery monitoring, reduction of bycatch and bycatch mortality, minimization of waste, and enforcement."

Project Summary
1. Shark Deterrent and Incidental Capture Workshop.
NMFS organized a meeting entitled "Shark Deterrent and Incidental Capture Workshop" that brought together NMFS scientists, university-based shark researchers, bycatch specialists, and industry partners to assess and develop future shark bycatch research directions. The meeting was co-sponsored by the Consortium for Wildlife Bycatch Reduction, the New England Aquarium, the University of Hawaii, and NOAA's Pacific Islands Fisheries Science Center and held at the New England Aquarium in Boston. Fourteen papers on shark fisheries, shark sensory biology, current elasmobranches bycatch experiments, and other related topics were presented. These presentations have been collected into a NOAA Technical memorandum and submitted for publication.

2. Programmatic Environmental Assessment (EA) for shark research conducted by the Pacific Islands Fisheries Science Center (PIFSC).

NMFS completed and submitted the programmatic EA entitled "Elasmobranch Bycatch Reduction in Domestic and International Fisheries," which examined the potential environmental impacts of elasmobranch-related (sharks, rays, skates) research activities conducted by the Fisheries Biology and Stock Assessment Division (FBSAD) at the PIFSC. This EA fulfilled the requirements of the National Environmental Policy Act (NEPA) and NOAA Administrative Order NAO 216-6 and was mandated by the PIFSC in order for this project to be conducted.

3. Feeding trials with free-swimming sharks in North Shore, Oahu.
NMFS concluded experiments to test the ability of electropositive (E+) metals to deter sharks from feeding on bait. Utilizing a shark-viewing cage, NMFS conducted paired choice experiments to examine the feeding behaviors of galapagos sharks (*Carcharhinus galapagensis*) and sandbar sharks (*Carcharhinus plumbeus)*. Experiments were conducted in shark viewing cages off the coast of the North Shore of Oahu, Hawaii. These cages allowed the experimenter to observe and film shark behaviors as they approached and attacked bait on the ends of wooden poles. Experiments consisted of paired trials in which two fish were placed outside of the shark cage. At the end of each pole was either a piece of Pr-Nd (praseodymium-neodymium) electropositive alloy cut into a 5cm-by-2.5cm-by-0.64cm piece or a lead fishing weight of approximately the same size, serving as a visual control.

Investigators completed 16 trips to the North Shore during which they conducted paired trials (displaying two treatments simultaneously). Out of the 16 trips, investigators carried out 77 trials, with 58 trials ending when the bait associated with a control metal was eaten first and only 19 trials ending when the bait associated with E+ metal was eaten first (Figure 12). When broken down by bait eaten per trip and analyzed using the Wilcoxon paired sample test, investigators found a significant difference between the two treatments ($p < 0.001$) in which there were 3.6 first bites on the control bait and 1.2 bites on the experimental bait (adjacent to the Nd-Pr alloy).

In addition to monitoring which bait was eaten first, investigators also examined the behavior of the sharks as they approached each pole. When sharks approached the pole with the Nd-Pr alloy, they often exhibited aversion responses in which the animals would make sharp turns away, attempt to stop, and cease biting attempts on the bait. Investigators analyzed the number of aversion responses as the shark approached the two bait treatments. Figure 13 shows the total number of aversion responses exhibited at each bait treatment and also shows the mean number of aversion responses for each treatment during a trip. Analysis with the Wilcoxon paired sample test indicated a significant difference in number of aversions between the two treatments ($P < 0.01$).

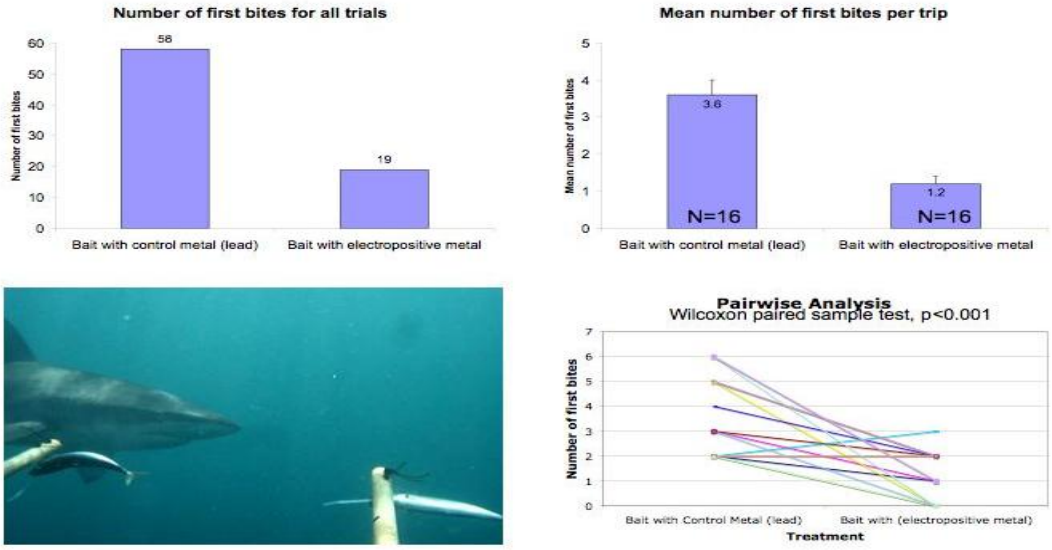


Figure 12. The number of first bites for all trials and for each trip. Analysis with the Wilcoxon paired sample test indicates a significant difference (p<0.001) between the two treatments indicating that the presence of the metal reduced the number of times bait associated with the Pr-Nd metal was eaten.

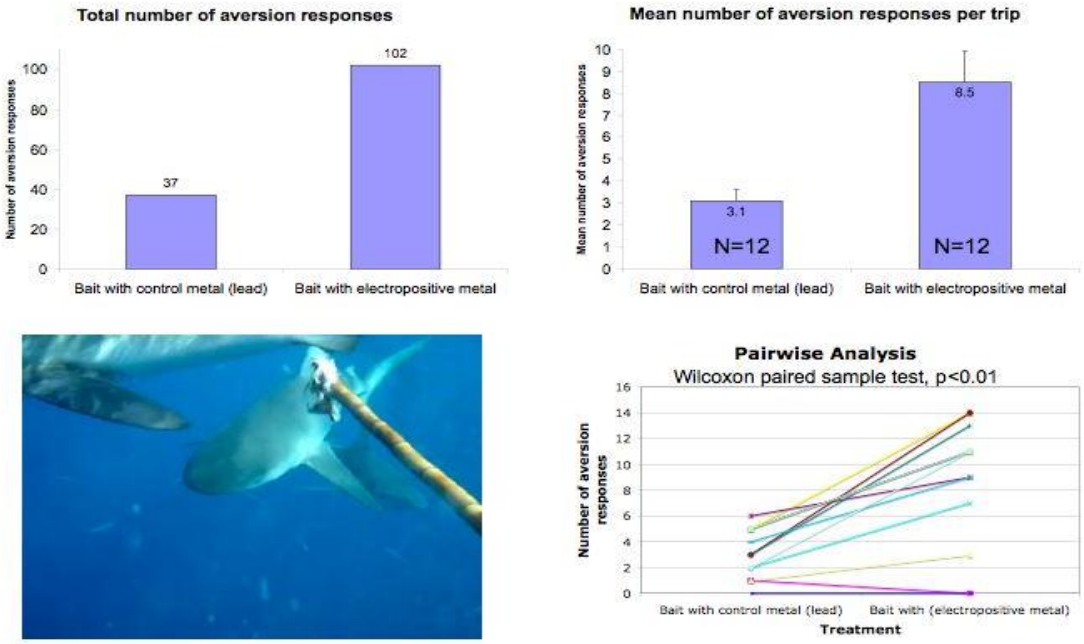


Figure 13. Aversion responses during all shark interactions and the mean number of aversion response for each trip. The Wilcoxon paired sample test indicates a significant difference (p<0.01) between the two treatments indicating that the presence of the metal increased the number of aversion responses exhibited as the animals approached the bait.

4. Inshore longline and behavioral experiments.
To conduct behavioral and inshore longline experiments we developed a collaboration with Dr. Kim Holland of the University of Hawaii's Hawaii Institute of Marine Biology located on Coconut Island in Kaneohe Bay. Working with Melanie Hutchinson, a graduate student of Dr. Holland's lab, NMFS initiated two experiments, one focusing on the effects of Nd-Pr (Neodymiun/Praseodymium) alloy on the catch rates of sharks on bottom set longline gear and the other examining the effects of Nd-Pr alloy and other lanthanide alloys on the feeding and swimming behavior of scalloped hammerhead (*Sphyrna lewini)* and sandbar *(Carcharhinus plumbeus)* sharks. Preliminary results from longline field trials in Kaneohe Bay, Hawaii suggest that catch rates of juvenile scalloped hammerhead sharks are reduced by 86 percent on branchlines with the Nd-Pr alloy attached to branchlines as compared to lead weight-controls (2.7 CPUE versus 18.7 CPUE, respectively, N=16). Sharks for behavioral experiments were collected, experimental observation arenas were prepared for behavioral experiments, and initial behavioral experiments examining effects on swimming behavior have been initiated.

5. Characterization of the physical properties of Nd-Pr metals.
NMFS is collaborating with Dr. Stephen Kajiura from Florida Atlantic University to investigate the physical properties of the Nd-Pr alloy as well as other lanthanide metal alloys. The exact electrochemical properties that trigger the aversion responses in sharks are not well-understood. It is thought that the electric field generated during the oxidation reaction is sufficiently strong that it disrupts the electrosense of the shark. As a first step, investigators measured the electric field produced as the Nd-Pr alloy reacts in water. Investigators also have made initial voltage measurements in seawater of the Nd-Pr alloy, Nd metal, and stainless steel hooks (16/0 circle hooks). Subsequently, we also made measurements of Nd-Pr alloys and Nd alloys under different temperature regimes. Other physical measurements are ongoing.

Developments in Gear Technology Achieved
In conducting these experiments, NMFS developed a system of assays that can used to test a variety of potential shark bycatch deterrents and determine their usefulness in commercial fisheries. The Nd-Pr alloy is one such deterrent that may be useful in reducing shark interactions with pelagic longline gear. Obvious next steps to develop this bycatch reduction technology are to examine the effects of this metal on shark and target fish catch rates in a pelagic longline fishery.

Improvements and Reduction in Bycatch Associated with This Project
NMFS is in the process of developing a shark bycatch reduction strategy that may significantly reduce shark interactions with pelagic longline gear. Behavioral and fishing experiments indicate that several different species of sharks respond to Nd-Pr alloys with aversive behaviors. Preliminary bottom set longline experiments suggest that the presence of the metals may decrease shark interactions with fishing gear.

Project Title
Gear Technician and Bycatch Reduction Gear Research at the Northwest Fisheries Science Center

BREP Funding Provided
$22,000

Location of Research
Northwest Fisheries Science Center

Resource Challenge
The Pacific Coast groundfish fishery is subject to bycatch reduction requirements under the Magnuson-Stevens Conservation and Management Act (Magnuson-Stevens Act) and Endangered Species Act (ESA). Species that have been identified as overfished (depleted) under the Magnuson-Stevens Act must be rebuilt. Because Pacific Coast groundfish species are so intermixed, the harvest of healthy stocks has been constrained so that the overall catch of groundfish stocks is reduced, with the intent that the total catch of depleted stocks that co-occur with healthy stocks is reduced. These catch reductions have placed an economic hardship on fishers and fishing communities. NMFS has also identified concerns over potential bycatch of ESA-listed endangered or threatened salmon in the whiting fishery and bottom trawl fisheries.

Project Summary
The Northwest Fisheries Science Center (NWFSC) sought funding to support staffing for a fishing gear technician in the NWFSC's Habitat and Conservation Engineering (H&CE) group within the NWFSC's Fishery Resource Analysis and Monitoring Division. Working with our fisheries research partner, the Pacific States Marine Fisheries Commission (PSMFC), the Center has completed a job search for a technician who will be stationed at the NWFSC's field station in Newport, Oregon, and focus on gear research, assist the group coordinator in the continued development of the NWFSC's bycatch reduction research, and collaborate with other NMFS and regional gear researchers. The 2008 funding allowed the H&CE group to continue the gear technician billet at the PSMFC into 2009. Continued funding will ensure support for a series of pilot projects to test several new promising trawl modifications to reduce fish bycatch and habitat impacts from mobile fishing.

Developments in Gear Technology Achieved
During the time while the NWFSC was conducting its job search for a gear technician, NMFS continued work on an ongoing bycatch reduction research project and initiated a new pilot project. The ongoing project is collaboration with the gear research group at the Oregon Department of Fish and Wildlife (ODFW) and is focused on observations of fish behavior in the vicinity of the bycatch reducing selective flatfish trawl footrope using a dual-frequency identification sonar (DIDSON) ultrasonic camera. Reducing bycatch in commercial fishing gear requires an understanding of the behavior of fish interacting with the gear. The use of lights may confound observations of fish behavior in the proximity of fishing gear, submersibles, or remotely operated vehicles. The DIDSON uses only

ultrasound to form images of fish, as well as the gear, surrounding structures, and the seafloor. We used DIDSON to examine diel behavior differences in roundfish along a 12-meter section of the footrope on the starboard wing of the flatfish trawl. The DIDSON was mounted looking forward along the starboard wing of the net out to a range of 12 meters (Figure 14). We tracked the movements of individual roundfish, continuously measuring the distance from the footrope. Analysis of fish tracks revealed that during the day, roundfish remained farther from the footrope, maintained a relatively constant distance, and showed less variation in direction. At night, fish approached the footrope at a sharper angle and displayed a more abrupt change in speed and direction (Figure 15). These behavioral differences suggest that herding efficiency and gear selectivity is different between day and night fishing.

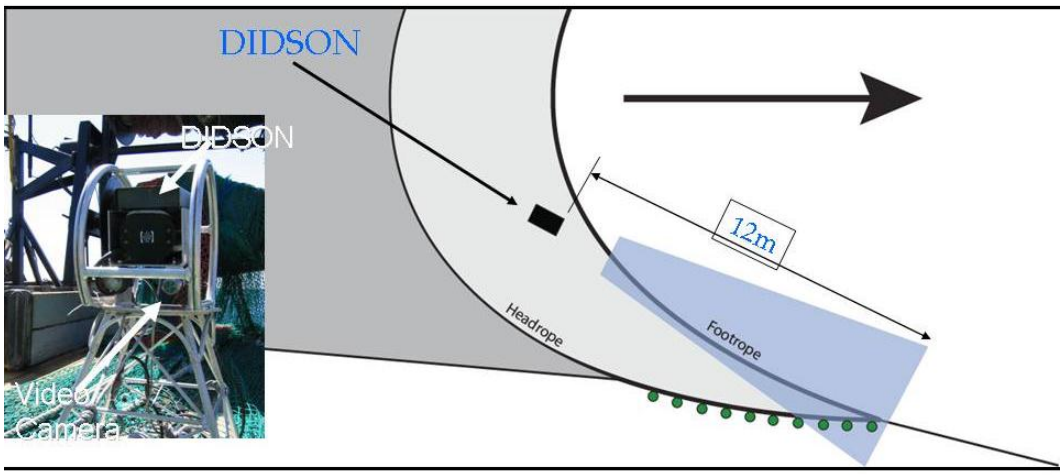


Figure 14. Position of the DIDSON ultrasonic camera in the selective flatfish trawl, providing a view along a large portion of the starboard footrope, from the tip of the wing to a point approximately nine meters back along the footrope.

The NWFSC initiated a pilot project in spring 2008 to integrate seabed classification with commercial fishing activities to investigate whether this type of information would be useful in reducing bycatch in west coast groundfish fisheries. This project is being conducted in the vicinity of Morro Bay, California, as collaboration between the NWFSC's Habitat and Conservation Engineering group and West Coast Groundfish Observer Program, The Nature Conservancy, and Oregon State University's Active Tectonics and Seafloor Mapping Lab. The goal of the project is to capture bottom type using a Quester Tangent QTC VIEW simultaneously with bottom trawling. Questions to be considered include: can high-quality data be collected during normal fishing operations to inform NMFS about bottom type with minimal impact on fishing operations, and, will patterns in bycatch relate to specific seafloor classifications?

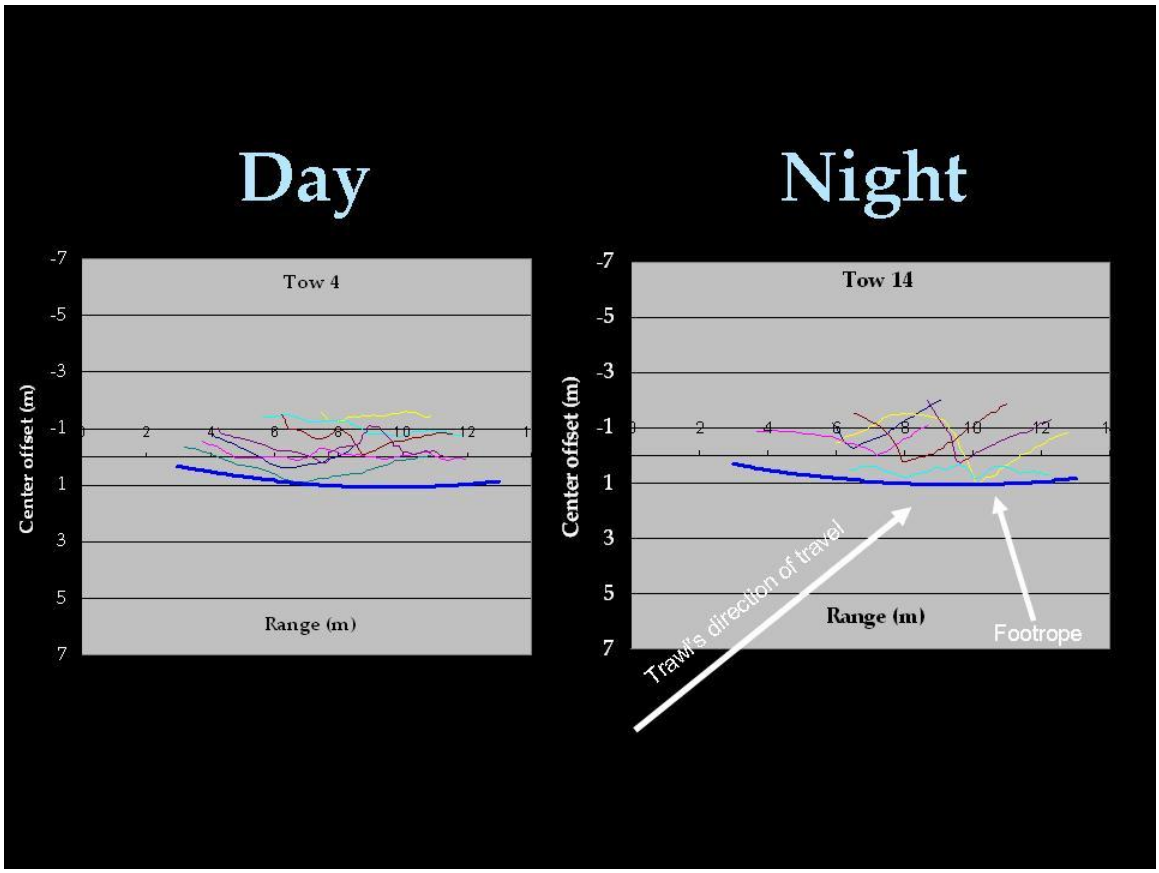


Figure 15. Representative tracks of individual groundfish; night time tracks showed a sharp angular change in direction as the fish approached the footrope.

Improvements and Reduction in Bycatch Associated with This Project

With the addition of a temporary gear technician, the NWFSC will be able to initiate a series of pilot projects to test several new promising trawl modifications to reduce fish bycatch and habitat impacts from mobile fishing. A continuation of ongoing collaborative studies with ODFW on the behavior of fish interacting with gear, using video and ultrasonic cameras, is providing for the discovery of behavioral differences (e.g., in herding efficiency and escapement) that can be mined for gear designs that will reduce bycatch. Data from this project are currently being used by ODFW to consider potential modifications to the selective flatfish trawl (and other trawl types) to improve its capability to reduce bycatch.

The NWFSC initiated a successful pilot project to evaluate the efficacy of integrating seabed classification with commercial fishing activities to investigate whether this type of information would be useful in reducing bycatch. Data collected during summer 2008 are being analyzed as of this writing.

Proposals to Address Bycatch or Seabird Interaction Problems

NMFS has undertaken a bycatch reduction strategic planning effort to identify bycatch or seabird interaction problems that should be addressed by NMFS through 2015. These identified bycatch or seabird interaction problems are described by NMFS Regions and Programs below.

Northeast Region
The NMFS Northeast Region and Northeast Fisheries Science Center have identified the following proposals:

- Turtle bycatch reduction in scallop trawls and dredges (2009)
- Harbor porpoise take reduction in bottom set gillnets (2009-2010)
- Seabird bycatch reduction through completing gillnet seabird bycatch estimation analysis (2009-2010)
- Turtle bycatch reduction in non-scallop trawl fisheries (2010-2015)
- Continuation of the estimation of bycatch of turtles and marine mammals in northwest Atlantic trawl, gillnet, pot, dredge and longline fisheries (2010-2015)
- Seabird bycatch reduction through completing seabird bycatch estimation analysis for gear type(s) other than gillnets (2011-2013)
- Finfish bycatch reduction in squid, herring, and Northeast multispecies trawl fisheries (2011-2015)
- Atlantic large whale take reduction in fisheries that entangle whales, through the development of gear modifications and other technologies to reduce takes (2011-2015)

Southeast Region
The NMFS Southeast Region and Southeast Fisheries Science Center have identified the following proposals:

- Bluefin tuna bycatch reduction in Gulf of Mexico yellowfin tuna fishery (2009-2012)
- Seabird bycatch reduction through enhanced observer coverage to assess potential protected species interactions with fisheries in the Atlantic (2009-2015)
- Turtle bycatch reduction in non-shrimp trawl fisheries (Atlantic flynet fishery, Atlantic whelk trawl fishery, Gulf butterfish fishery (2009-2015)
- Turtle excluder device and bycatch reduction device refinement in shrimp trawl fishery (2009-2015)
- Turtle bycatch reduction in various Atlantic and Gulf of Mexico gillnet fisheries (2009-2015)
- Turtle entanglement/bycatch reduction through development of weak links for the vertical lines used for buoys in a variety of pot fisheries (2009-2015)
- Shrimp bycatch reduction through testing of Australian “hopper” gear for improved survivability of shrimp bycatch (2011-2015)

Atlantic Highly Migratory Species(HMS)
The Atlantic HMS Management Division in the NMFS Office of Sustainable Fisheries has identified the following proposals:

- Billfish, bluefin tuna, and sea turtle bycatch reduction in Gulf of Mexico longline fisheries through investigation and characterization of green-stick gear (2009-2012)
- Buoy gear bycatch reduction in the swordfish handgear fishery through investigation and characterization of bycatch in that fishery (2010)
- Sea turtle bycatch reduction in Atlantic shallow-set longline using techniques developed in experiments in the Pacific Ocean (2010-2013)
- HMS rod and reel bycatch reduction through investigation and characterization of bycatch in that fishery (2012-2015)

Southwest Region
The NMFS Southwest Region and Southwest Fisheries Science Center have identified the following proposals:

- Shark bycatch and bycatch mortality reduction in drift gillnet and pelagic longline fisheries (2009-2011)
- Turtle bycatch reduction through development of predictive models of turtle distribution (2010-2011)
- Seabird bycatch reduction through enhanced collection of seabird distribution and abundance data on cetacean and ecosystem assessment cruises, action at international regional fishery management organizations, and information and outreach to fishery participants (2010-2011)
- Shark bycatch mortality reduction in recreational catch-and-release fishery (2010-2012)
- Ocean sunfish (*Mola mola*) bycatch reduction in drift gillnet fishery (2011-2013)

Northwest Region
The NMFS Northwest Region and Northwest Fisheries Science Center have identified the following proposals:

- West coast roundfish bycatch reduction by improving performance of already proven bycatch reduction gear types, e.g., selective flatfish trawl to reduce rockfish bycatch in flatfish fishery (2009-2010)
- Endangered Species Act-listed salmon bycatch reduction, as well as rockfish bycatch reduction, through refinement and implementation of flexible sorting grids in the west coast Pacific hake fishery (2009-2015)
- Habitat impact reduction through testing the linkage between observer derived estimates of bycatch with co-registered information on type of habitat swept (e.g., information derived from fishing vessel onboard acoustic seabed classification systems) (2009-2015)

- Seabird bycatch reduction through continuation of Seabird Bycatch Research Project to reduce potential fisheries interactions with short-tailed albatross and other seabird species (2010-2012)
- Seabird bycatch reduction in Alaska and Northwest longline fisheries by providing free streamer lines and cost-sharing on integrated weight lines (2010-2015)

Alaska Region
The NMFS Alaska Region and Alaska Fisheries Science Center have identified the following proposals:

- Salmon bycatch reduction in Alaska pollock fisheries through development of trawl modifications (2009-2012)
- Pacific halibut bycatch reduction in Gulf of Alaska and Eastern Bering Sea groundfish (cod, flatfish, pollock) trawl and longline fisheries through development of fisheries-specific bycatch reduction devices (2009-2015)
- Crab bycatch reduction in groundfish fisheries through development of gear modifications (although trawl bycatch is a higher volume issue, bycatch of blue king crab in cod pots (baited traps) has a higher priority due to concern over potential overfishing of that species) (2009-2015)
- Seafloor habitat and Essential Fish Habitat impact reduction by modifying trawls and trawling methods (2009-2015)
- Seabird bycatch reduction in Alaska trawl fisheries by further developing effective seabird mitigation gear, enhancing bycatch monitoring, exploring the role of vessel attraction and providing free seabird bycatch reduction gear (2009-2015).
- Seabird bycatch reduction in Alaska and Northwest longline fisheries by providing free streamer lines and cost-sharing on integrated weight lines (2010-2015)
- Reduction of unobserved crab mortality due to trawl encounters through development and implementation of modified trawl groundgear (2010-2015)
- Development of a more efficient method for identifying incidentally caught Pacific halibut that are live-release candidates (i.e., high survival rate), and development of methods consistent with observer program protocols for sorting, accounting, and discarding halibut rapidly (2010 - 2015)

Pacific Islands Region
The NMFS Pacific Islands Region and Pacific Islands Fisheries Science Center have identified the following proposals:

- Shark bycatch reduction in the Hawaii-based pelagic longline fishery through continued testing of chemical (electropositive metals) deterrents (2009-2011)
- False killer whale take reduction in the Hawaii-based pelagic longline fishery through evaluation of circle hook effects (2009-2010)
- Turtle bycatch reduction through development of measures to reduce interactions in gillnet fisheries (2009-2015)

- Seabird bycatch reduction and longline fishermen protection by developing and refining safe-lead weights and side-setting (2010)
- Marlin bycatch reduction in longline fisheries targeting tuna by continuing to develop operational alterations (depth, time, season, area) in the fleet (2010-2011)
- Turtle bycatch reduction through continued operation and analysis of "TurtleWatch," which provides fishing area advisory charts indicating turtle avoidance areas to Hawaii longliners (2010-2015)
- International sea turtle, shark, and gamefish bycatch reduction through testing and promoting longline bycatch mitigation methodologies including: (1) continued testing of circle hooks to reduce sea turtle bycatch and maintain target catch; (2) continued testing of stiffer lines to reduce turtle entanglements in longlines; (3) testing chemical methods of reducing shark bycatch (now under domestic development); and (4) testing of operational alterations to reduce marlin catches (2010-2015)
- Seabird bycatch reduction in longline fisheries by providing free safe-lead gear and cost-sharing for side-setting vessel conversions (2010-2015)

National Seabird Program
The NMFS National Seabird Program has identified the following proposals:

- National Seabird Program Strategic Planning Workshop (2009)
- Seabird bycatch reduction through outreach related to a Seabird Carcass Collection Program that would coordinate information on seabird bycatch composition in fisheries (2009-2015)
- Seabird bycatch reduction through outreach to fishery participants regarding seabird species distribution on fishery survey cruises (2009-2015)
- Seabird bycatch reduction through continuing ongoing international projects for sharing of mitigation gear technology (e.g., with Russia and Peru) and seabird interaction actions at regional fishery management organizations (2009-2015)

Conclusion

The BREP has made significant progress in 2008 to develop technological devices and other conservation engineering designed to minimize bycatch, seabird interactions, bycatch mortality, and post-release mortality in federally managed fisheries. Improvements to bycatch reduction devices and turtle excluder devices in Atlantic and Gulf of Mexico trawl fisheries, gillnets in Northeast fisheries, trawls in Alaskan and Northwest fisheries, pelagic longlines in Hawaii-based fisheries; improvements in our understanding of post-release mortality in Southwest shark fisheries; and documentation and monitoring of seabird bycatch around the country will help NMFS meet its obligations under the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, Marine Mammal Protection Act, and the U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries.

Bycatch reduction is a top priority for NMFS because bycatch contributes to overfishing, threatens critically endangered species, and can shut down fisheries, significantly impacting U.S. economic growth. There is a high demand for new gear engineering products and services from Regional Fishery Management Councils, which are required to develop management plans that minimize bycatch and habitat impacts. Commercial and recreational fishers also have a demand for improved products to minimize bycatch and habitat impacts. With new gears to minimize bycatch, fishers can increase fishing seasons and efficiency through less sorting time and loss of bait. New gears may also increase catch rates for target species.

The costs of not addressing bycatch problems can be high. For example, the Hawaii-based longline swordfish fishery has had serious sea turtle bycatch problems. This fishery was shut down completely in 2001 due to turtle bycatch. Landings of swordfish dropped from 6.2 million lbs in 2000 to 519,000 lbs in 2001, and Hawaii longline fishery revenues decreased by over $20 million from 2000 to 2001. New bycatch reduction innovations implemented for this fishery in 2004—including circle hooks, set limits, and hard caps on turtle interactions—allowed the fishery to reopen. After these innovations were implemented for the Hawaii-based fleet, landings increased from 549,000 lbs in 2004 to 3.53 million lbs in 2005, and revenues increased by $15.9 million. In 2006, the hard cap on loggerhead turtle interactions was hit in March, closing the fishery for the rest of the year. In 2007, the caps were not reached, and the fishery was able to continue operating throughout the year. The Western Pacific Fishery Management Council is considering removing the set limit based on the fishery's success in reducing sea turtle bycatch. Millions of dollars of economic benefit will be realized if this key U.S. fishery can continue to operate without reaching the sea turtle interaction caps.

The BREP could create similar significant economic benefits by reducing losses in other key U.S. fisheries. As the BREP implements its required grant program, effective collaborations between NMFS scientists and fishers to create bycatch solutions will continue to expand and help ensure sustainable fisheries and protection of at-risk species.

Appendix 1. NMFS Bycatch Reduction Engineering Program Policy Directive

Department of Commerce • National Oceanic & Atmospheric Administration • National Marine Fisheries Service

NATIONAL MARINE FISHERIES SERVICE POLICY DIRECTIVE POLICY DIRECTIVE 01-107 EFFECTIVE DATE
Fisheries Management
BYCATCH REDUCTION ENGINEERING PROGRAM
NOTICE: This publication is available at: http://www.nmfs.noaa.gov/directives/.
OPR: F/SF3 (Benaka) **Certified by:** F/SF (Risenhoover) **Type of Issuance:** Initial
SUMMARY OF REVISIONS:

Section 316 of the Magnuson-Stevens Fishery Conservation and Management Act, as amended through January 12, 2007 (MSA), requires the Secretary of Commerce (Secretary), in cooperation with the Councils and other affected interests, and based upon the best scientific information available, to establish a Bycatch Reduction Engineering Program (BREP), including grants, by mid-January 2008 to develop technological devices and other conservation engineering changes designed to minimize bycatch, seabird interactions, bycatch mortality, and post-release mortality in federally managed fisheries. According to the MRA, the BREP will:

1. be regionally based;
2. be coordinated with projects conducted under the cooperative research and management program established under MSA;
3. provide information and outreach to fishery participants that will encourage adoption and use of technologies developed under the BREP; and
4. provide for routine consultation with the Councils in order to maximize opportunities to incorporate results of the BREP in fishery management plans (FMPs) developed by the Councils.

Section 316 also:

- authorizes FMPs prepared by a Council or the Secretary to establish a system of incentives to reduce total bycatch and seabird interactions;
- authorizes the Secretary, in coordination with the Secretary of the Interior, to undertake projects in cooperation with industry to improve information and technology to reduce seabird interactions; and
- requires the Secretary to submit an annual report to Congress that describes funding provided to implement Section 316, developments in gear technology

achieved under Section 316, and improvements and reduction in bycatch and seabird interactions associated with implementing Section 316.

This policy directive implements the BREP to carry out the objectives of Section 316 of the MSA, and national bycatch reduction coordination activities that have been carried out by the Office of Sustainable Fisheries over the past several years, including long-term planning and outreach and funding of bycatch research critical to management objectives. This policy directive establishes the following authorities and responsibilities for the BREP:

Provide National Coordination

- Provide guidance to ensure that the results of bycatch reduction engineering and post-release injury and mortality projects supported by NOAA are responsive to management needs and can be used to support management decisions.
- Solicit and review annual updates of action items and progress for Regional Bycatch Implementation Plans. The Regional Bycatch Implementation Plan updates have included, and will continue to include, action items related to not only bycatch reduction engineering and other research but also to monitoring, management (including international efforts), and education and outreach.
- Track results of projects funded by the BREP.
- Advocate, coordinate, and support, to the extent practicable, incentives to reduce bycatch of fish and protected species as well as bycatch mortality, including providing guidance on best practices for incentive programs as necessary.
- Ensure that appropriate bycatch reduction policies are incorporated into the NOAA Policy Directives System.
- Serve as a liaison to the National Observer Program for purposes of its National Bycatch Report.
- Collaborate with the Office of Habitat Conservation to implement the Deep Sea Coral Research and Technology Program required by Section 408 of the MSA.
- Provide a forum, as appropriate, to help develop solutions to regional and national bycatch issues.
- Serve as a point of contact among NOAA managers, the NMFS National Seabird Program, and regionally based bycatch reduction engineering programs.
- Ensure that BREP annual performance milestones are tracked and met consistently.

Allocate Funding

- Develop funding allocations for annual BREP spending plan, based on review of proposals submitted and the approved BREP spending plan process.
- Facilitate the timely distribution of national funds to enhance implementation of bycatch reduction engineering efforts.
- Coordinate long-term budgeting processes to ensure full funding for the BREP.
- Help ensure that programs affected by technologies developed through the BREP have sufficient resources to facilitate or accommodate their application.

Coordinate Planning and Policy Development

- As appropriate, conduct long-term strategic planning to identify regional and national bycatch reduction engineering priorities, develop incentive programs to reduce post-release mortality and injury, and provide assistance to the Regions in identifying fisheries for which gear technology may provide solutions and fisheries for which gear technology solutions may not be feasible.
- Ensure that fisheries of bycatch concern identified through the National Observer Program's National Bycatch Report receive bycatch reduction engineering resources as appropriate.
- Coordinate with Regional Administrators and Science Center Directors to brief Regional Fishery Management Councils on BREP work at least once a year and receive feedback from Councils on bycatch reduction concerns and priorities.
- Represent bycatch reduction efforts in NOAA and NMFS strategic planning activities.

Enhance Communication

- Compile, coordinate review of, and manage clearance of the annual BREP Report to Congress.
- Regularly brief NOAA leadership groups and stakeholder groups such as the Council Coordinating Committee, the Marine Fisheries Advisory Committee, and the Marine Fish Conservation Network on the successes of and challenges for the BREP and solicit feedback on bycatch reduction concerns.
- Respond to requests as appropriate from NOAA, the Department of Commerce, Congress, and other members of the public regarding bycatch reduction engineering, incentives to reduce post-release injury and mortality, and other bycatch reduction issues.
- Compile and distribute information on BREP activities to constituent groups, fishery managers and scientists, and other organizations with an interest in bycatch reduction through presentations at professional meetings and publication of articles in journals and NMFS publications such as the annual business report.

Conduct Outreach Activities

- Develop and enhance collaborative partnerships with other NOAA programs including the National Observer Program, National Cooperative Research Program, the National Sea Grant College Program (especially its fisheries extension agents), Regional Bycatch Committees and Action Teams[1], and the Offices of Protected Resources (including the National Seabird Program), International Affairs, Habitat Conservation, and Science and Technology, to leverage bycatch reduction engineering resources.
- Manage and regularly update the NMFS Bycatch Feature website.
- Collaborate with the National Observer Program, the National Sea Grant College Program, and other NOAA bycatch stakeholders to ensure a consistent and effective message is provided to the public regarding NOAA's bycatch reduction

1. When NMFS published its National Bycatch Strategy in the *Federal Register* on March 11, 2003, some Regions, including the Northeast Region, responded by creating Regional Bycatch Committees and Action Teams. Some of these teams and committees may still exist, even though they have been relatively inactive in recent years.

engineering efforts and to encourage adoption and use of technologies developed through the BREP.
- Support and track, to the extent necessary, international technology transfer and capacity building efforts based on successful technologies developed through the BREP for federally managed fisheries.

The mission of the BREP is to develop technological solutions and investigate changes in fishing practices designed to minimize bycatch of fish (including sponges and deep sea and shallow, tropical corals) and protected species (including marine mammals, seabirds, and sea turtles) as well as minimize bycatch injury and mortality (including post-release injury and mortality).

Organization and Reporting:

The BREP will be administered by a National Coordinator in the NMFS Office of Sustainable Fisheries, in conjunction with a Science Lead and Management Lead. The Office of Sustainable Fisheries, in consultation with the Offices of Protected Resources, Science and Technology, and International Affairs, will provide policy oversight and overall coordination of activities through the National Coordinator. Coordination activities include providing staff support to the BREP, documenting BREP activities, managing the annual spending plan process, serving as primary point of contact for the annual BREP Report to Congress, and any other activity deemed necessary by the BREP or NMFS leadership.

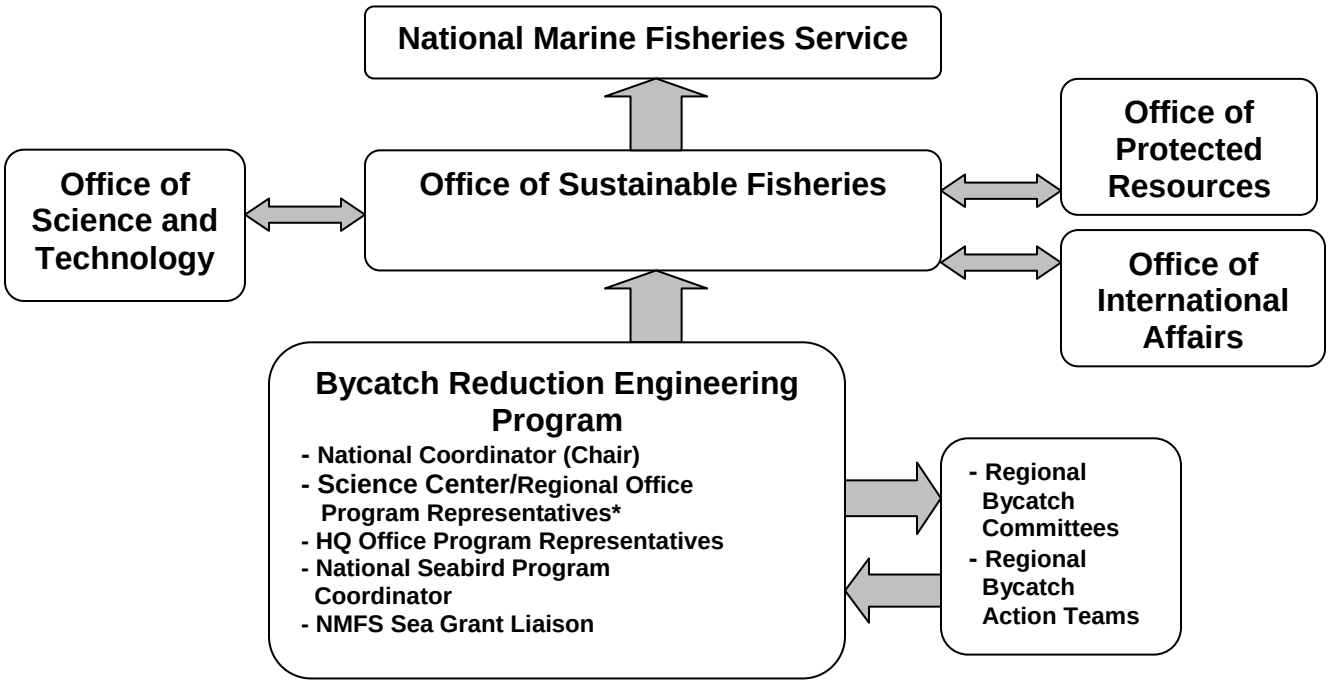
The Science Lead and Management Lead will be identified by the BREP National Coordinator from among the six Regional representatives described below. The Leads will rotate on a regular basis. The Science Lead and Management Lead will work with the National Coordinator to help coordinate BREP activities and develop final BREP recommendations on spending plans, policy issues, and other topics. These Leads also will help ensure that the BREP focuses on Regional issues as it carries out its work. If all primary Regional representatives come from Science Centers, then the Management Lead may be selected from among alternate Regional representatives (see below).

The BREP will include, along with the National Coordinator, the following program representatives:

- One representative with hands-on bycatch reduction engineering and post-release injury and mortality experience from each Regional Fisheries Science Center/Regional Office (i.e., six total Regional representatives);
- The NMFS Sea Grant Liaison (or other Sea Grant designee);
- The NMFS National Seabird Program Coordinator;
- One representative each from the headquarters Offices of Protected Resources, Science and Technology, Habitat Conservation, and International Affairs; and
- One representative from the Highly Migratory Species Management Division in the Office of Sustainable Fisheries.

Regional representatives will be responsible for representing their entire Region, rather than a Regional Office or Science Center perspective. The Regional Administrator and Science Center Director should not only nominate a primary Regional representative, but also an alternate representative. If the primary representative comes from a Science Center, then the alternate representative should come from a Regional Office. In addition, if the primary representative is someone who focuses mostly or exclusively on protected species or fisheries bycatch, then the alternate representative should be, to the extent practicable, someone who focuses on the other area (either protected species or fisheries). The Regional representatives should serve as liaisons between the BREP and already existing Regional Bycatch Committees and Action Teams, to the extent such Committees and Teams are active.

BREP organization and Line Office/Group oversight



*Two of these Program Representatives will be designated the BREP Science and Management Leads.

The Office of Sustainable Fisheries, in consultation with the Offices of Protected Resources, Science and Technology, and International Affairs, will designate a Science Lead and a Management Lead from among the Science Center/Regional Office Program Representatives.

The BREP should attempt to develop consensus recommendations whenever possible. The standard for reaching consensus is that all BREP members can accept the proposed recommendation. If the BREP cannot reach consensus, it may be necessary to vote in order to determine where differences of opinion exist. In the event voting is necessary, each member of the BREP shall have only one vote. The vote will be considered by the National Coordinator, Science Lead, and Management Lead, who will attempt to reach a consensus. If consensus cannot be reached, all perspectives will be forwarded to the Directors of the Offices of Sustainable Fisheries, Protected Resources, and Science and Technology for their advice.

The BREP shall periodically meet or have conference calls. When a member of the BREP cannot attend a meeting or conference call, it is his or her responsibility to either appoint an alternative to attend, or to communicate his or her views to other members of the BREP prior to the meeting. Minutes of all meetings and conference calls will be developed by the National Coordinator in coordination with Science and Management Leads.

No quorum is needed for the BREP to conduct business; however, every effort will be made to schedule meetings so that most members can attend. The BREP will meet via conference call whenever possible. Beginning in FY09, regular face-to-face meetings will be scheduled, possibly in conjunction with a National Observer Program Advisory Team (NOPAT) meeting or the National Cooperative Research Program's annual meeting. Agendas for all meetings will be developed by the National Coordinator in coordination with the BREP Science and Management Leads. Agendas will be distributed to BREP members for review and input prior to all meetings. Materials will be distributed prior to all meetings via the BREP intranet site whenever possible. Meetings of the BREP may include presentations of projects funded by the BREP, with feedback on the projects provided and discussions of how the results of these projects can meet management needs.

Funding Processes:

Currently the non-observer portion of the Reducing Bycatch line in the NOAA budget (i.e., ~$800K) will fund basic BREP operations in FY08. In the absence of additional BREP funding, the BREP will strive to leverage other sources of bycatch reduction engineering funding in NOAA to help achieve the mission of the BREP.

BREP funds are allocated on an annual basis based on technical review and recommendations from the BREP. The annual fund allocation process will include the following characteristics:

- The request for proposals will be sent by the BREP National Coordinator to the Regional Administrators, Science Center Directors, and HQ Office Directors in mid-September. Members of the BREP will be cc'ed on the request.
- The request for proposals will include several criteria, which may change from year to year, upon which the proposals will be evaluated, for example, the relation of the proposed project to current action items in a Regional Bycatch Implementation Plan, or whether the proposed project builds on results from a successful pilot project previously funded by the BREP or Reducing Bycatch budget line.
- Prioritized Regional proposals will be sent by Regional Administrators and Science Center Directors jointly, as well by as the Director, Office of Sustainable Fisheries (for Atlantic highly migratory species), to the BREP National Coordinator by the end of October.
- The BREP National Coordinator will preview proposals by mid-November to ensure no major required components are missing.
- The BREP will review proposals and finalize a draft spending plan by mid-January.
- The final spending plan will be approved by the Director, Office of Sustainable Fisheries.

The preceding schedule will be compressed if a NOAA budget was available soon after the beginning of the fiscal year. The request for proposals will require that:

- Proposals be no longer than five pages in length;
- Proposals address scalability and specify whether the proposal is for a multi-year project;
- Investigators for proposals that receive funding submit progress reports six months after receiving funding as well as final reports within a specified period of time after projects are completed; and
- Proposals primarily related to electronic monitoring or observer data analysis be submitted to NOPAT.

When the BREP becomes fully funded, a portion of BREP funding will be allocated as grants through existing national and regional NOAA grant programs, which could include Sea Grant, the Marine Fisheries Initiative, and the Cooperative Research Partners Program. The BREP will require prospective grantees to submit proposals, and the BREP will evaluate proposals based on conformance with the BREP mission and other criteria. The BREP will publicize grant opportunities through the Federal Register, the NMFS Bycatch Feature website, and other means. When fully funded, the BREP will distribute a significant portion of available BREP funding, including grant funding, among the Regions, which will develop Regional spending plans. However, spending plans will be subject to comment and/or approval by the BREP.

The duration of the BREP will be indefinite because the MSA does not indicate a limit to the BREP's duration.

This policy directive's objective will be attained when the above-listed responsibilities are carried out effectively on a routine basis. Additional performance measures will include number of bycatch reduction projects developed and number of new bycatch reduction technologies adopted by industry.

Procedural directives will be issued to implement this policy as needed.

John Oliver_____January 11, 2008_____
Assistant Administrator for Fisheries Date

Appendix 2. Section 316 of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006

H. R. 5946—31

SEC. 116. BYCATCH REDUCTION ENGINEERING PROGRAM.

(a) IN GENERAL.—Title III (16 U.S.C. 1851 et seq.), as amended by section 113 of this Act, is further amended by adding at the end the following:

‘‘SEC. 316. BYCATCH REDUCTION ENGINEERING PROGRAM.

‘‘(a) BYCATCH REDUCTION ENGINEERING PROGRAM.—Not later than 1 year after the date of enactment of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, the Secretary, in cooperation with the Councils and other affected interests, and based upon the best scientific information available, shall establish a bycatch reduction program, including grants, to develop technological devices and other conservation engineering changes designed to minimize bycatch, seabird interactions, bycatch mortality, and post-release mortality in federally managed fisheries. The program shall—

‘‘(1) be regionally based;

‘‘(2) be coordinated with projects conducted under the cooperative research and management program established under this Act;

‘‘(3) provide information and outreach to fishery participants that will encourage adoption and use of technologies developed under the program; and

‘‘(4) provide for routine consultation with the Councils in order to maximize opportunities to incorporate results of the program in Council actions and provide incentives for adoption of methods developed under the program in fishery management plans developed by the Councils.

‘‘(b) INCENTIVES.—Any fishery management plan prepared by a Council or by the Secretary may establish a system of incentives to reduce total bycatch and seabird interactions, amounts, bycatch rates, and post-release mortality in fisheries under the Council’s or Secretary’s jurisdiction, including—

‘‘(1) measures to incorporate bycatch into quotas, including the establishment of collective or individual bycatch quotas;

‘‘(2) measures to promote the use of gear with verifiable and monitored low bycatch and seabird interactions, rates; and

‘‘(3) measures that, based on the best scientific information available, will reduce bycatch and seabird interactions, bycatch mortality, post-release mortality, or regulatory discards in the fishery.

‘‘(c) COORDINATION ON SEABIRD INTERACTIONS.—The Secretary,

in coordination with the Secretary of Interior, is authorized to undertake projects in cooperation with industry to improve information and technology to reduce seabird bycatch, including—

‘‘(1) outreach to industry on new technologies and methods;

‘‘(2) projects to mitigate for seabird mortality; and

‘‘(3) actions at appropriate international fishery organizations to reduce seabird interactions in fisheries.

‘‘(d) REPORT.—The Secretary shall transmit an annual report to the Senate Committee on Commerce, Science, and Transportation and the House of Representatives Committee on Resources that—

‘‘(1) describes funding provided to implement this section;

‘‘(2) describes developments in gear technology achieved under this section; and

‘‘(3) describes improvements and reduction in bycatch and seabird interactions associated with implementing this section, as well as proposals to address remaining bycatch or seabird interaction problems.’’