# Testing Tackle Modifications and Fish Descender Tools for Reducing Dolphin Depredation and Scavenging of Sport Fish

## Final Technical Report

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## Abstract

Interactions between bottlenose dolphins (*Tursiops truncatus*) with recreational fishing at offshore reefs and in estuaries can be harmful to the animals, and cause angler complaints that dolphins use fishing vessels as a source of food by depredating catch from their hooks and scavenging on the fish they are required to discard. Our project explored methods to reduce dolphin interactions on offshore reefs and inshore areas where dolphins interfere with sport fishing. We evaluated if fish descenders could be used to discard fish back to depth without dolphins scavenging them, and tested prototype Dolphin Mitigation Devices (DMDs) designed to discourage dolphins from taking fish off hook and line. During 19 fishing trips to offshore reef sites near Destin, Florida, 66 fish releases using pressure-activated descenders were video recorded to observe if fish were able to evade being scavenged. Dolphins were observed around the vessels on 5 occasions, with no interactions noted with descender-released fish. Testing of fish descenders during inshore catch-and-release fishing in Sarasota Bay were inconclusive, although dolphins typically were not attracted to descender devices during our trials. Prototype DMDs attached to hook and line tackle used by reef anglers showed no difference between fish landing success of treated hooks compared to untreated hooks, and no depredations of DMD rigs were observed. Creel surveys conducted with 220 anglers at three Gulf fishing piers showed general adherence to recommended tips for “dolphin friendly fishing,” although angler dislike of dolphins directly correlated with fishing experience. Pier anglers expressed interest in our DMD concepts, leading to a modified design specifically for use at coastal piers. Continued outreach and promotion of simple mitigation methods can encourage recreational anglers to adopt fishing strategies that reduce the frequency of dolphin interactions. This project included 48 coastal and inshore photo-identification surveys to monitor human-dolphin interactions, and recorded survival progress of two young dolphins that were entangled in fishing gear.

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## Introduction and Rationale

Bottlenose dolphins are a nuisance to anglers at offshore reefs, coastal fishing piers, and inland estuaries along the Gulf of Mexico. They approach charter and private fishing vessels to take advantage of fish being caught on hook and line rigs, either through direct depredation of the gear, or by scavenging of discarded fish (GOMFMC 2007). Depredation is of concern due to the potential harm to dolphins from line entanglement, being caught in hooks, and ingestion of tackle. Scavenging also is a serious problem since this atypical source of food serves as an attractant that exposes the animals to indirect harm from retribution and incidental entanglement (Cunningham-Smith, *et al*. 2006, Powell and Wells 2011). Indeed, the incidence of dolphin mortality due to fishery interactions along the Gulf Coast has escalated in recent decades (Wells *et al*. 1998; 2008, Thoms 2006, NOAA/NMFS 2016).

During 2014, several incidences of entangled dolphins found near coastal fishing piers in northwest Florida suggesting that anglers might not use best practices recommended in "Dolphin Friendly Fishing Tips" (www.nmfs.noaa.gov/pr/pdfs/education/dolphin_friendly_tips.pdf) that are usually displayed on piers and in widely available messaging. Following multiple disentanglement rescue interventions by the Southeast Stranding Network in 2014, we envisioned a need to assess angler attitudes toward dolphins at fishing piers to confirm if public outreach was effective. Likewise, there was a desire to explore if tools and techniques could be developed to reduce dolphin interactions at the coastal piers and inshore fishing locations.

Various deterrent devices have been suggested to reduce dolphin depredation of caught fish on hook and line rigs (e.g., GOMFMC 2012). Zollett and Read (2006) described a flapping wire attached to a trolling rig as an effective deterrent for dolphin depredation of king mackerel, and Rabearisoa *et al*. (2012, 2015) showed the effectiveness of wire spiders and fabric socks, collectively termed "Depredation Mitigation Devices" (DMDs), to shroud hooked fish from depredation by delphinids. More recently, tackle modifications using chain shrouds and "cages" on long-line rigs were demonstrated to be effective deterrents against depredating toothed whales (Hamer, *et al*. 2015). While functioning in commercial fisheries in those studies, no work had been done to test the effectiveness of such devices in recreational Gulf reef and inshore fishing.

In our prior study (Shippee *et al*. 2011), we found that scavenging of discarded fish at offshore reefs by dolphins was a likely precursor to depredation of hooked fish. Recreational (sport) fish caught on deep-sea reefs are often required to be released under current management guidelines due to season closure or size limits. As fish are reeled from depth, rapid decompression may cause barotrauma, a condition where their swim bladder hyper-inflates and renders them overly buoyant and unable to swim normally. High mortality of embolized reef fish occurs due to this physiological insult (Burns and Restrepo 2002, Rummer and Bennett 2005). Further, their compromised condition makes them easily available to predators when released alive at the surface. Dolphins can scavenge a sizeable portion of the catch discarded from the side of a fishing vessel, increasing the mortality of fish that otherwise had survival potential.

Quick recompression by return to depth is deemed an effective technique to improve survival of prized sport fish such as red snapper, grouper and amberjack (Drumhiller 2012, Loftus and Radonski 2012, Stunz and Curtis 2012). In addition, rapid descent could potentially reduce or eliminate the likelihood of the fish being scavenged by dolphins by getting them from the surface where they are most vulnerable back to the bottom where they can find shelter. Several tools are commercially available for returning fish to depth with weighted lines, which might deter scavengers simply because the speed of the rapidly descending fish can make it difficult for predators to intercept it, and the devices could be dressed with other attached deterrents to confuse dolphins enough to avoid them.

Practical application of descender tools to improve survival of released fish, with the added potential of reducing scavenging by predators (dolphins, sharks, barracudas, and birds) could quickly gain the acceptability of anglers seeking solutions to dolphin interactions. However, descender tools face challenges with compatibility in charter fishing fleets along the Gulf Coast and require demonstration of their benefits, as well as their ease of use.

We undertook this study to evaluate descenders and mitigation devices as dolphin deterrents. Testing would depend on the ability to reliably catch sport fish in the presence of depredating and scavenging dolphins while being able to observe device effectiveness at depth. We chose two approaches for testing: conduct trials aboard fishing vessels at reef sites where dolphin interactions were frequently reported in northwest Florida, with captains and crew that were eager to participate; and by conducting inshore tests at Sarasota Bay where dolphins frequently engage in fisheries interactions and are accessible to researchers. Secondary goals were to evaluate the potential acceptability of using fish descenders and DMDs by sport fishing patrons; and to consider alternative suggestions proposed by sport anglers, captains, and crewmates that participated in this research. In addition, we continued monitoring dolphins in the study locations to further characterize the nature of fisheries interactions, and to conduct outreach to increase awareness of these issues.

## Methods

The following definitions are used in this study:

***DMD*** (Depredation Mitigation Device) refers to wires, plastic streamers, shrouds, and other materials that are attached to the terminal tackle of fishing rigs (generally between the leader and the fishing hooks). The flapping and twisting motions of these elements are considered to be distracting to dolphins and should discourage them from approaching hooked fish that are being reeled to the surface.

***Descender Rigs*** are devices for rapidly lowering fish from the surface using a descent line attached to a weighted clamp or pin that securely holds the fish until it reaches a desired depth.

***Charter fishing*** refers to for-hire boats conducting routine reef fishing trips open to the general public, up to and including multi-passenger headboats (aka Party boats).

***Dedicated*** fishing trips are those where the investigators direct the vessel and are able to control location and time spent at a site. Because charter fishing trips generally avoid encounters with dolphins, dedicated trips were needed to conduct controlled experiments for this research.

<u>Testing of fishing devices</u>:

Fishing trips were made to Gulf reefs and in Sarasota Bay for this study. Trips were conducted with crews consisting of an observer and data recorder, and two to four members that manned fishing poles and deployed descender gear to release fish. On dedicated trips, the vessel was usually anchored to remain stationary so that cameras and gear could be safely deployed without fear of wrapping on a spinning boat prop. On charter trips, we usually had a 2-3 member team and asked deckhands to assist us with information about dolphin activity and fish catch. Our anglers employed devices (DMDs and descenders) to catch and release fish, and underwater video was taken to assess the fate of fish being released from descenders.

Several underwater action-cameras were used to observe fish releases. A Virb HD camera (Garmin International, Inc, Olathe, KS) housed in a waterproof case measuring 12.0 x 7.5 cm served as a primary camera that could be easily deployed on descent lines or on a handheld pole (Figure 1); and a tethered drop camera (Splashcam Deep Blue, Ocean Systems, Inc, Everett, WA) was occasionally used to observe the underwater behavior of released fish, either hanging from the side of a boat or suspended above the release device at depth. A custom built live-view drop camera was eventually acquired (www.flywirecameras.com/shop/) to better fulfill this purpose. The primary camera was mounted close to the descender tool to record a clear view of the fish during descent/release, and a secondary camera was lowered below the boat to capture a wider view of the water column to observe if any predators (dolphins, sharks, large fish) were present around the descender line.

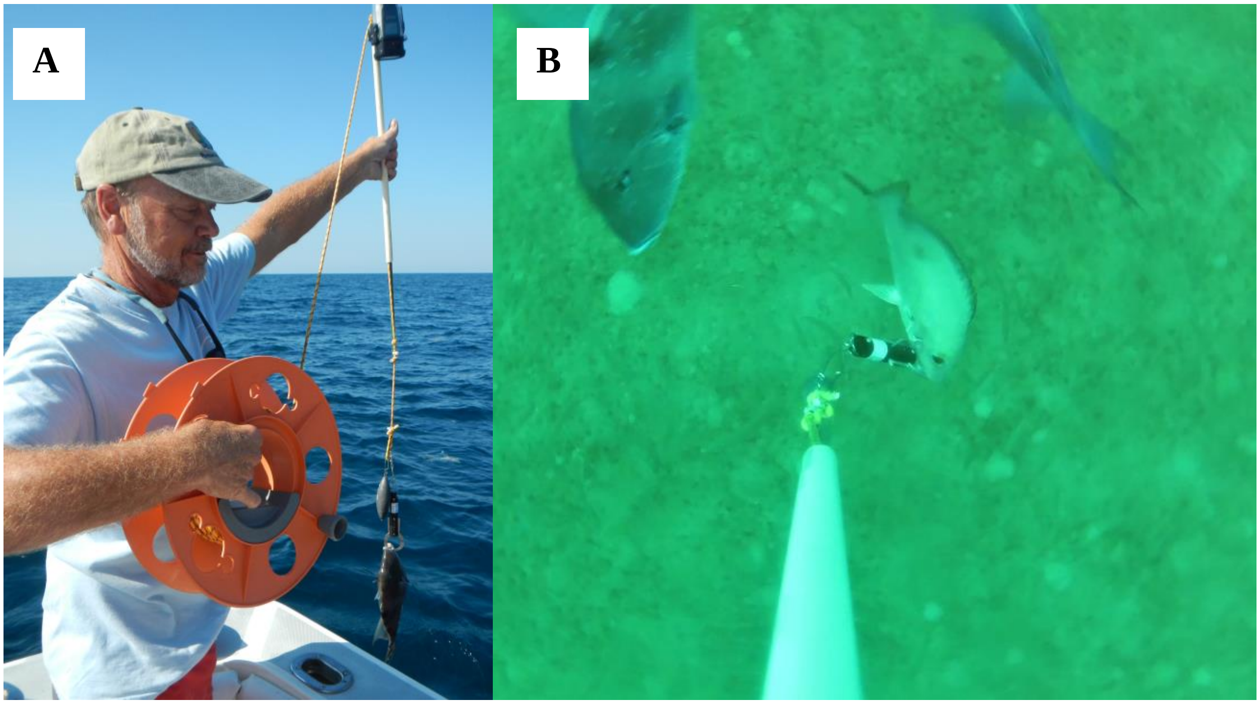


Figure 1. Primary camera descent rig with Virb camera.
A) handheld deployment; B) view of fish on bottom just prior to device release.

The fish decender chosen for testing on Gulf reefs was the Seaqualizer® (Seaqualizer LLC, Key Biscayne, FL), which grips the fish by the lip using a clamp that will not release until reaching a preset depth (Figure 2-A). This device was deemed the easiest tool to use, and best suited to the offshore reef fishery where dolphin scavenging problems occur. Seaqualizers are available in different “jaw” sizes, and have three depth settings that are easily changed by the angler. There is a shallow water model (“Striper”) with release depths of 30-70-100 ft (9-21-31 m), while the standard model releases at 50-100-150 ft depths. Most of the commonly visited offshore fishing reefs along the northern Gulf coast are 65 to 150 ft deep, so either model could be used.

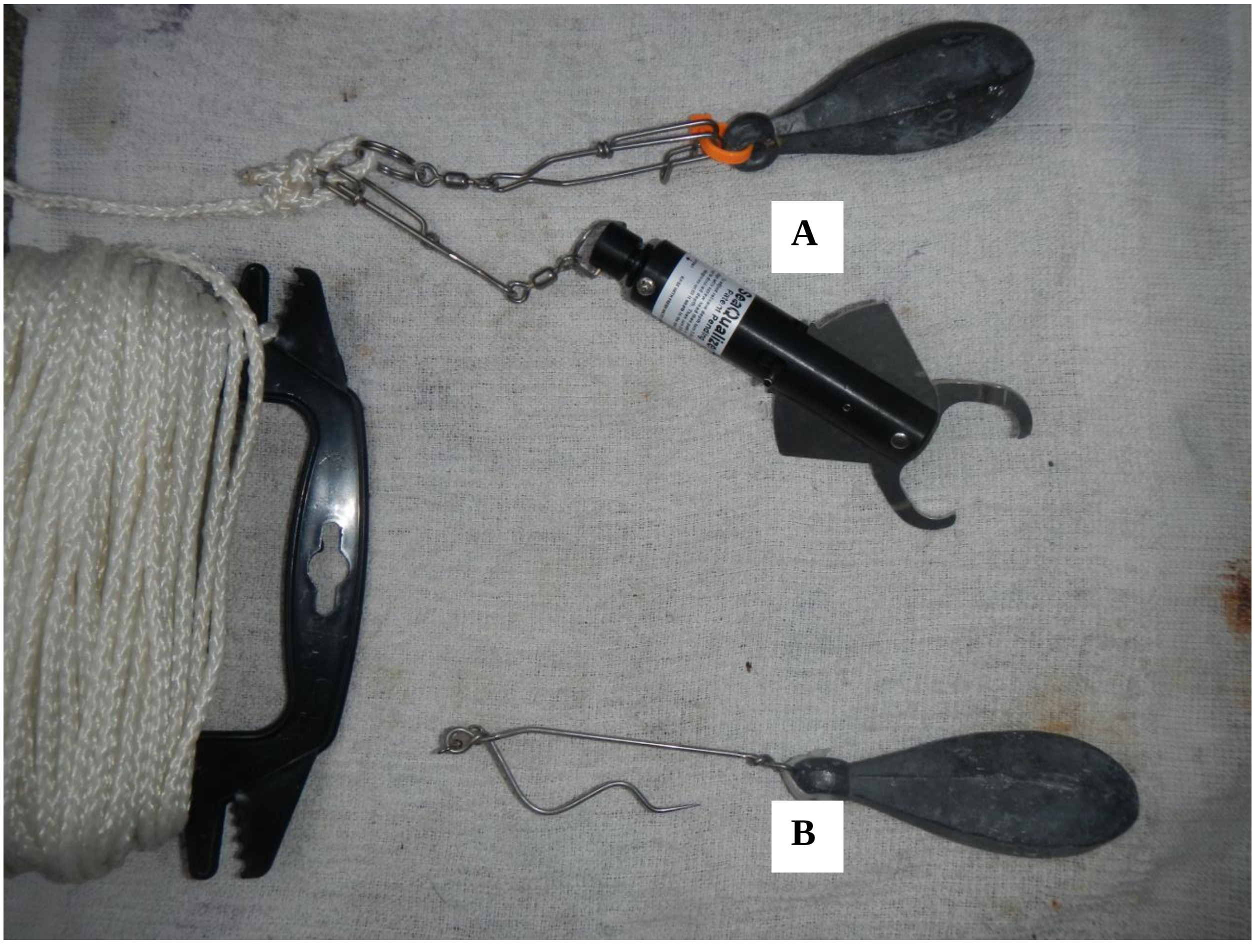


Figure 2. Fish descenders.
A) Seaqualizer pressure release device; B) Shelton Fish Descender

On reef fishing trials, each fish landing time was noted and the caught fish was identified to species, measured to total length (also fork length on some), photographed, and then placed on the release device with video camera in record mode. When the fish was being lowered over the side, the observer(s) would record the time out of water, and then keep watch for dolphins. If dolphins were seen near the boat, the observer noted any change in their surface behavior that might indicate interest in our fishing, or toward a released fish. Potential responses of dolphins included: whether they changed direction relative to the boat when fish were landed, whether the dolphins approached or chased the fish on the descender or after release, whether the fish was captured by a dolphin, and whether the dolphins' behavior changed. Observers noted if dolphins scavenged fish released at the surface, and if fishing lines were depredated. Depredation events were assumed by: 1) presence of dolphins; 2) sudden and intense downward pull on the angler's pole after a fish was being reeled up; 3) reports from experienced crew members (i.e. deckhands on charter boats); and/or 4) observation of any dolphins surfacing near the boat with fish in mouth following a hit on a pole. Whenever possible, photographs were taken of dolphins for individual identification purposes.

DMD concepts were tested during reef fishing trips in conjunction with the descender trials. Various DMD prototypes were constructed in advance, and then attached on ordinary fishing rigs for use in the field. Ideally, the devices could be suspended below a tethered video camera rig (*e.g.,* SplashCam, or FlyWire camera) to allow recording how they performed. The DMDs were designed with the goal of being simple to construct and employ such that most anglers could build their own versions from commonly acquired materials. Two performance measures were assessed: 1) ability to successfully catch the target fish, and 2) effectiveness of discouraging dolphins from approaching the rig and removing hooked fish. The second measure depended on dolphins being present while fishing with the DMD. We planned a number of dedicated fishing trips in expectation to encounter dolphins often enough to achieve a robust sample size for evaluating the DMD as a deterrent device, and the design(s) that showed promise were also used aboard charter fishing vessels for cooperating sport anglers and charter boat crews to evaluate under routine fishing conditions. Data were collected on fishing success experienced by other anglers using unmodified tackle for comparison to observations on the use of the DMDs.

Inshore fishing trials in Sarasota Bay were conducted using 3-5 crew members, with similar duties as described above. Three commercially available descender devices were acquired for testing: the RokLees (www.ecoleeser.com/product.html), a modified Fish Grip clamp device (www.thefishgrip.net), and a simple barbless hook design that resembles a large bobby pin, called the Shelton Fish Descender® (SFD, Shelton Products, Newark, CA)(Figure 2-B). The SFD was assumed to be the most practical device for our application: it attaches on a weighted line with the pin inserted through the lip of a live fish, which is lowered quickly over the side of the boat or pier and descended down in the water column, and then is released by a quick pull upwards on the descent line. The SFD is suitable for use in shallow inshore waters, although medium sized fish can wiggle easily off the pin before reaching depth.

Regardless of which descender was used, the procedure was to place a fish on the release device when in the presence of patrolling dolphins and lower it to the bottom with a video camera attached above the device to record whether the fish was observed swimming away or being taken by dolphins. Observers watched for changes in dolphin surface behavior relative to fishing events in the same fashion as aboard reef fishing trips, e.g., distance from boat, change in direction, approach toward released fish, and observations of fish being scavenged. For these trials, live fish were acquired either by purchase from a bait shop or other supplier, or by fishing earlier in the day, and were held in an aerated well onboard the research boat. Fish were released on the descender when dolphins were in ~10 m proximity to the boat for testing purposes (Figure 3). Focal animal observations of dolphins were conducted prior to and after fish release trials to analyze behavior of individual dolphins engaged in patrolling near fishing boats.


Figure 3. Example of dolphin approaching and patrolling within 10 m of a fishing boat.

Data analysis:

We planned to conduct sufficient experimental trials using DMDs and descender tools to determine their effectiveness as dolphin deterrents. Ideally, a minimum of 30 trials that released fish in the presence of dolphins was desired to produce robust sample sizes for statistical analysis. Obtaining adequate samples sizes under circumstances involving wild dolphins interacting with sport fishing was expected to be challenging, although we felt there would be sufficient encounters with dolphins to accomplish this based on past experience. Parameters for measuring success of descender tools included: 1) whether dolphins approached or chased fish that were discarded at the surface, 2) whether dolphins pursued the fish on the descender tool upon release, 3) whether the released fish was captured by a dolphin, and 4) how long the dolphins remained in the area (within 50 m of the boat) following fish release.

Digital videos from each day's fishing event were transferred to computer disk for analysis in the lab and scored. In all fish descent trials, fish were considered successfully returned to depth if three outcomes are met: 1) the descender tool functioned as planned, 2) the fish swam away from the device without floating or becoming inverted, and 3) the fish descended without predator interference as observed via video. Scored results of video recordings were tabulated using MS Excel for analysis.

Coastal fishing pier surveys:

We devised a creel survey method to address if anglers' behaviors were contributing to increases in dolphin interactions at the coastal fishing piers (Figure 4). Three piers in the northwest Florida study area were surveyed, located at Okaloosa Island (Fort Walton Beach), Navarre, and Pensacola Beach. Dolphin interactions were commonly reported at each, but especially Okaloosa Island. The Navarre Pier was reopened in summer of 2010 after a 5-year reconstruction, while the other piers were in continuous operation for decades. These concrete piers extend outward from the beach into the Gulf 385 m (Okaloosa Island) to 473 m (Navarre).

Survey questions focused on common techniques that are addressed in the "dolphin friendly fishing tips." We added questions to gauge angler attitudes about wildlife entanglement, line recycling, and dolphin interactions. Anglers were also asked if they would provide comments and suggestions after the surveys were completed. Surveys were conducted by members of our team that were familiar with dolphin interaction issues and with experience in approaching the public. Questions were presented and scored on paper sheets, which were compiled each day and transferred to a database. A daily summary sheet was also completed detailing number of anglers on the pier, environmental conditions, if dolphins were present, and if interactions were observed. Preliminary analyses of angler responses were tabulated with MS Excel for graphic presentation.

Photographic identification surveys:

We conducted boat-based surveys in the inshore and near-shore zones surrounding the passes at Destin and Pensacola, FL, and within Perdido Bay, AL. Methods followed standard techniques in accordance with NOAA Scientific Research Permit No. 522-1785 (issued to R. Wells), using digital photographs of dolphin fins and scars/marks to match with catalog images taken in prior surveys since 2006 in this area. On few occasions, dolphins were approached and photographed using an underwater Virb camera mounted on a handheld extension pole deployed from the bow of the research boat while underway at slow speed. Digital images were added to the long-term Gulf of Mexico catalog for future processing and database indexing.

Figure 4. Coastal fishing pier at Navarre with “tip” signs posted along the railing.

## Results

<u>Fish Descender testing trials:</u>

In total, we made 19 separate fishing trips during October 2014 - March 2017 to offshore reefs located near Destin and Pensacola, FL (Table 1). Six were aboard party boats with >25 anglers, 7 were on charter boats with 6-8 anglers, and 6 were aboard private boats with ≤5 anglers. In total, fishing occurred at 81 discrete reef spots that were independent opportunities for dolphins to approach the vessel. Approximately half of the trips (N=11) were made to deep-sea reefs located beyond state waters in depths of 22-37 m, and the remainder were to nearshore reefs located closer to port in depths of 10-25 m (Figure 5).

Table 1. Fishing trips to offshore reefs in northwest Florida during 2014-17.

| Date | Vessel | Location | Type | Distance offshore (km) | Trip Time (Hr:min) | Dolphin Sightings | Fishing Spots | Max Depth (ft) | # Fish Release | DMDs Used |
|---|---|---|---|---|---|---|---|---|---|---|
| 10/8/2014 | Champ2 | Destin | Charter | 9.0 | 4:38 | 0 | 2 | 75 | 6 | N |
| 10/27/2014 | Destiny | Destin | Party | 35.5 | 6:19 | 0 | 7 | 145 | 1 | N |
| 12/5/2014 | Champ1 | Destin | Charter | 20.0 | 5:49 | 0 | 3 | 75 | 3 | N |
| 12/17/2014 | Destin Princess | Destin | Party | 37.0 | 6:18 | 0 | 8 | 105 | 7 | N |
| 8/2/2015 | Champ2 | Destin | Charter | 24.0 | 5:43 | 1 | 3 | 120 | 3 | N |
| 2/18/2016 | Swoop | Destin | Party | 40.0 | 6:00 | 0 | 6 | 140 | 1 | Y |
| 3/22/2016 | Destiny | Destin | Party | 47.0 | 8:00 | 0 | 4 | 115 | 3 | Y |
| 5/31/2016 | Miss Aegina | Destin | Charter | 34.0 | 10:15 | 0 | 5 | 115 | 3 | Y |
| 7/13/2016 | Entertainer | Pensacola | Charter | 35.0 | 8:00 | 0 | 5 | 100 | 5 | Y |
| 9/9/2016 | GW Powell | Destin | Private | 3.5 | 6:45 | 0 | 3 | 70 | 4 | N |
| 9/14/2016 | Angler | Destin | Private | 9.0 | 4:00 | 1 | 2 | 70 | 3 | N |
| 9/16/2016 | Six Shooter | Pensacola | Charter | 9.0 | 3:00 | 0 | 2 | 70 | 3 | Y |
| 9/17/2016 | Angler | Destin | Private | 3.5 | 4:00 | 0 | 1 | 70 | 0 | Y |
| 9/22/2016 | Six Shooter | Pensacola | Charter | 43.5 | 7:30 | 0 | 5 | 200 | 6 | Y |
| 9/29/2016 | Angler | Destin | Private | 4.0 | 5:50 | 0 | 1 | 70 | 5 | N |
| 10/2/2016 | Angler | Destin | Private | 15.0 | 7:17 | 1 | 2 | 85 | 6 | Y |
| 10/24/2016 | Angler | Destin | Private | 9.0 | 5:35 | 0 | 1 | 70 | 1 | Y |
| 2/12/2017 | Swoop | Destin | Party | 43.0 | 6:00 | 1 | 7 | 190 | 5 | Y |
| 3/14/2017 | Destiny | Destin | Party | 40.0 | 8:22 | 1 | 14 | 118 | 1 | Y |

Spotted dolphins (*Stenella frontalis*) were sighted frequently, but never approached our stationary vessel at a fishing reef. Bottlenose dolphins were encountered on 5 separate fishing trips at five different reef spots, representing 6% of all fishing locations. On each encounter occasion, the animals (single N=2, multiple N=3) came within 35 m of the vessel and lingered for 5 to 35 minutes. A total of 8 fish releases using a descender were made in the presence of dolphins; constituting red snapper (N=5), triggerfish (N=1), and hardtail (N=2). There were no observations of the dolphins attempting to chase or interact with any released fish, either from surface views or on underwater videos, despite the proximity of the dolphins to the vessel. On all trials with dolphins, the fish swam out of underwater view after release at a depth of >15 m.

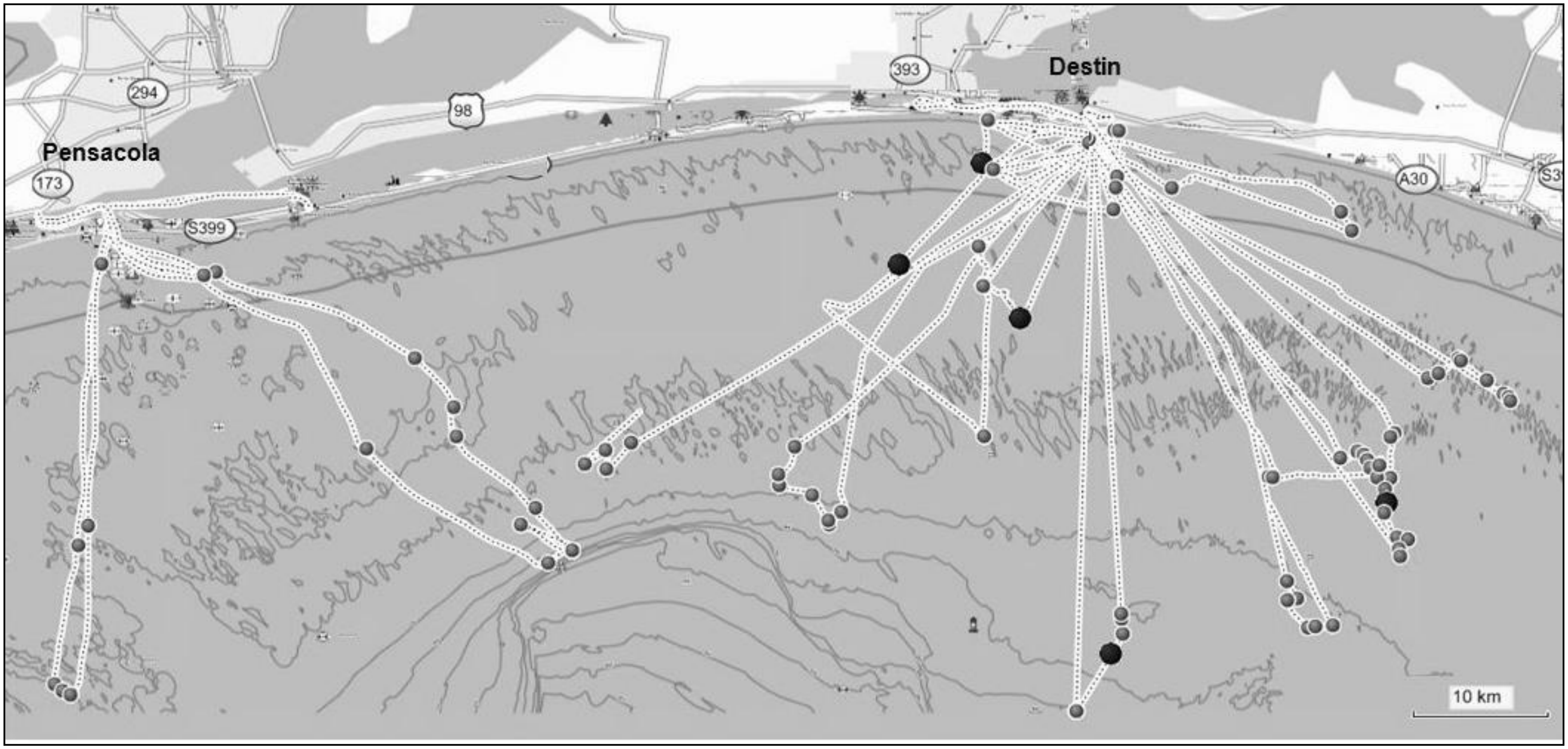


Figure 5. Location of fishing trips from Destin and Pensacola, FL during 2014-17.
Gray circles indicate reef spots where fishing occurred; large black circles are spots where dolphins approached the vessel while fishing.

All fish descents at offshore reefs were made with Seaqualizer devices set to open at 15 or 22 m depending on water depth. The descenders were typically attached to 0.75 -1.0 kg weights with 0.5 cm braided line spooled on a simple cable reel for hand deployment. Seaqualizers proved easy to use and usually worked as intended, although a few fish (N=3) wiggled loose before descending to depth. Two camera arrangements were used to record the descents: a Virb HD camera placed approx 50-70 cm on the descent line above the Seaqualizer looking downward (Figure 6); and a tethered drop camera mounted 50-80 cm above the release device allowing real-time surface observation aboard the vessel. After the initial fishing trips, the Virb setup became the primary choice and was consistently used throughout the remaining trips. Other underwater cameras were either handheld on a pole or suspended beneath the side of the fishing boat to observe fish releases at the surface. Suspending a camera near the bottom looking up towards the boat was found to be impractical due to clouds of fish in the water column making it difficult to detect which fish was the subject of the release trial.

Figure 6. Descender rig with underwater camera.
Virb camera in housing with pressure gauge, attached above Seaqualizer device holding fish. Line is spooled on a hand reel for easy deployment and recovery.

Underwater video observations of 66 individual fish releases were recorded, in addition to observing other caught fish being discarded at the surface by anglers and deckhands on the vessels. The majority (N=40) were red snapper (*Lutjanus campechanus*), which were required to be discarded due to season closure or size limits. Other species released in lesser numbers were: gray triggerfish (*Balistes capriscus*; N=9), hardtail jack (*Caranx crysos;* N=7), sea bass (*Centropristis philadelphica*; N=4), amberjack (*Seriola dumerili;* N=2), tomtate (*Haemulon aurolineatum*; N=2), gag grouper (*Mycteroperca microlepis*; N=1), and whitespotted soapfish (*Rypticus maculatus*; N=1). Fish total lengths ranged from a 60 cm amberjack, 30-48 cm red snappers, triggerfish, and grouper, to <20 cm hardtail jacks, tomtate, and soapfish.

Underwater videos of fish releases demonstrated that most regained swimming vigor after attaining a depth of >10 m (35 ft), as indicated by a depth gauge visible on the descent line. Red snapper showed the greatest improvement in vigor even when severely embolized (Figure 7), while gray triggerfish showed mixed results with some individuals floating back to the surface after release. Post-release video observations indicated apparent fish survival on 50 trials (headed back to depth or swimming out of view), and probable non-survival on approx. 6 trials (fish floated toward surface or appeared lifeless after release). Fish that were held out of water for handling and measurement for longer than 5 min tended to show poor vigor after descent, and could have been easily taken by predators.

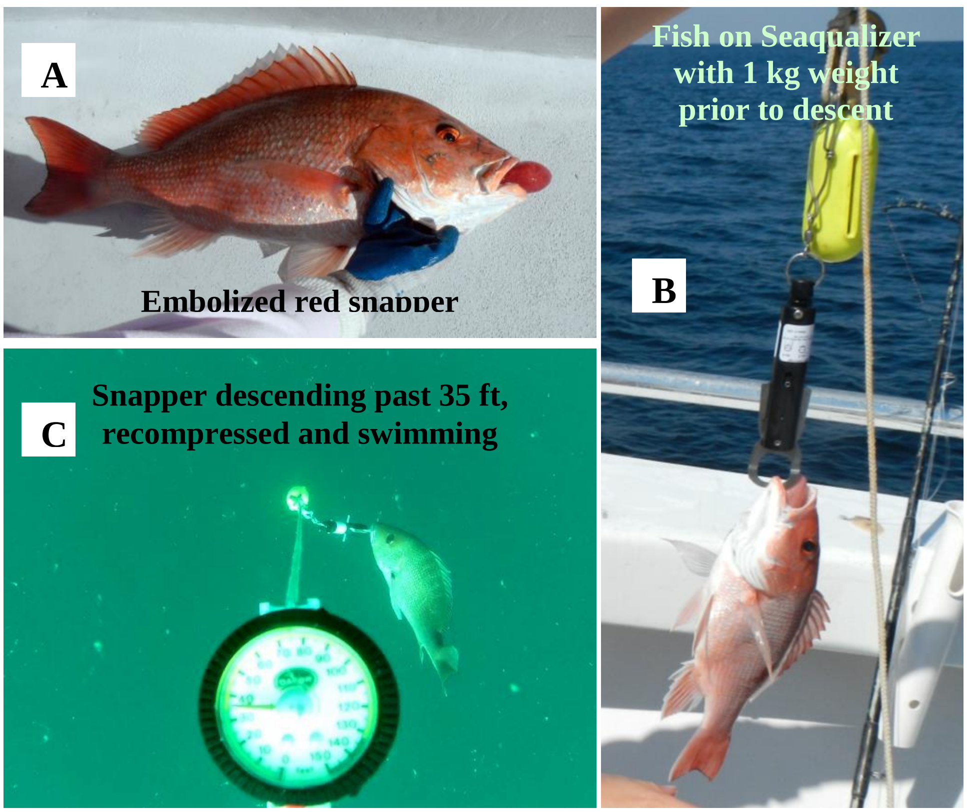


Figure 7. Releasing an embolized fish.
A) red snapper suffering barotrauma with distended stomach after being reeled from depth; B) fish attached to descent device on weighted line; C) underwater video clip of fish descent with depth gauge in view.

Inshore field trials were done in Sarasota Bay to test commercial fish descenders to mitigate dolphin scavenging. Preliminary work was conducted in April 2016 to investigate underwater camera visibility in the murky inshore environment and determine the best camera angles for observing descender trials in shallow water. Of three commercially available fish descent devices (Roklees, SFD, and modified 'Fish Grip'), only the SFD showed applicability to the fish sizes and depths available. Water visibility was found to be adequate to observe fish releases near the bottom with a camera mounted ~1.0 m above the device on the tether line.

A configuration with the SFD attached directly to a 1.0 kg weight on a 15 m line wrapped on a hand spool was selected as the best design. A Virb HD camera fastened to the line was aimed downward toward the SFD. Additional underwater cameras suspended beside the boat proved inadequate to capture images of the fish lowered past 2.5 m depth. Video records from a head-mounted action camera on an onboard observer were used to document dolphin surface behavior.

A series of descender trials was conducted near dolphins in Sarasota Bay during 23-27 May 2016. Each day, live fish were collected with hook and line in various locations around the bay and in the Gulf, and were held in an aerated tank aboard the boat until suitable dolphins were located for release trials. The majority of fish were hardtail jacks (*Caranx crysos*) and pinfish (*Lagodon rhomboides*) measuring 15-20 cm, and several spotted seatrout (*Cynoscion nebulosus*) measuring ~25 cm on the final day.

The time period of these trials coincided with spring season tarpon fishing activity near the coast, with reduced inshore angler activity of the type likely to attract depredating or scavenging dolphins, therefore it was difficult to find appropriate animals (i.e., known depredators) in ideal situations to conduct trials.

We conducted 345 minutes of observations on six groups of dolphins containing at least one known depredating individual, following the animals until they appeared to be patrolling around fishing activity or until we were able to descend fish in their presence. Because of the reduced fishing activity that would attract dolphins, we attempted several SFD trials when dolphins were nearby the research vessel, regardless of whether they were actively patrolling or scavenging from other anglers. In total, 18 fish descents were made in the presence of dolphins, but only 4 trials occurred while animals were actively patrolling nearby. Dolphins were milling (N=8) or traveling (N=6) during the remaining trials. Dolphin group size ranged from 2 to 8 animals, and individuals were within 2 to 40 meters of our boat during descender trials (# trials within 10 m = 5). The SFD worked successfully on 9 of the 18 trials, but was not as reliable as we had hoped. On the remaining trials, fish either fell off at the surface (N=6) or did not come off the device on the first descent attempt (N=3). One of these unsuccessful descents took place while actively patrolling dolphins were within 5 m of our boat and one of the animals immediately scavenged the fish (a spotted seatrout) after it fell off the device at the surface. This was the only occasion where a dolphin approached or chased a fish during trials. Other responses were minimal. Direction changes were observed on 6 trials, with individuals heading towards us during 4 trials and away from us during 2 trials. For the majority of trials (N=12), there appeared to be no response from the animals whatsoever, even if a fish did fall off at the surface or require multiple descent attempts before release.

<u>Depredation Mitigation Device (DMD) prototype design and testing:</u>

Initial DMD testing involved a "tickler wire" concept that had been developed in our previous study (Figure 8). The prototype design contains a folding wire leader attached just prior to the terminal tackle components on two-hook bottom fishing rigs, which typically consist of a 1.0 m length of ~60 lb test monofilament line with three loops at intervals of 40 cm, with the first two loops wrapped through the eyes of appropriate sized circle hooks, and the final loop holding a ~0.5 kg lead weight. The tickler rig is constructed of four hinged 30 cm strands of #19 gauge (400 lb test) wire leader that lie bundled together. The hinge knuckles are tucked in a short piece of ~5 mm diameter plastic tubing attached at the upper end of the rig, and dislodge when pulled firmly to release the strands of wire. The folded tickler sits ~40 cm above the first hook. Ideally, the fighting action of a hooked fish is sufficient to pull the wires so they unfold and flail about the fish. Once the fish is landed, the wires are refolded and tucked back into the tubing for the next deployment. With the tickler attached, the terminal tackle rig with two hooks is approximately 1.6 m in length and slightly cumbersome to swing over the side of a boat.

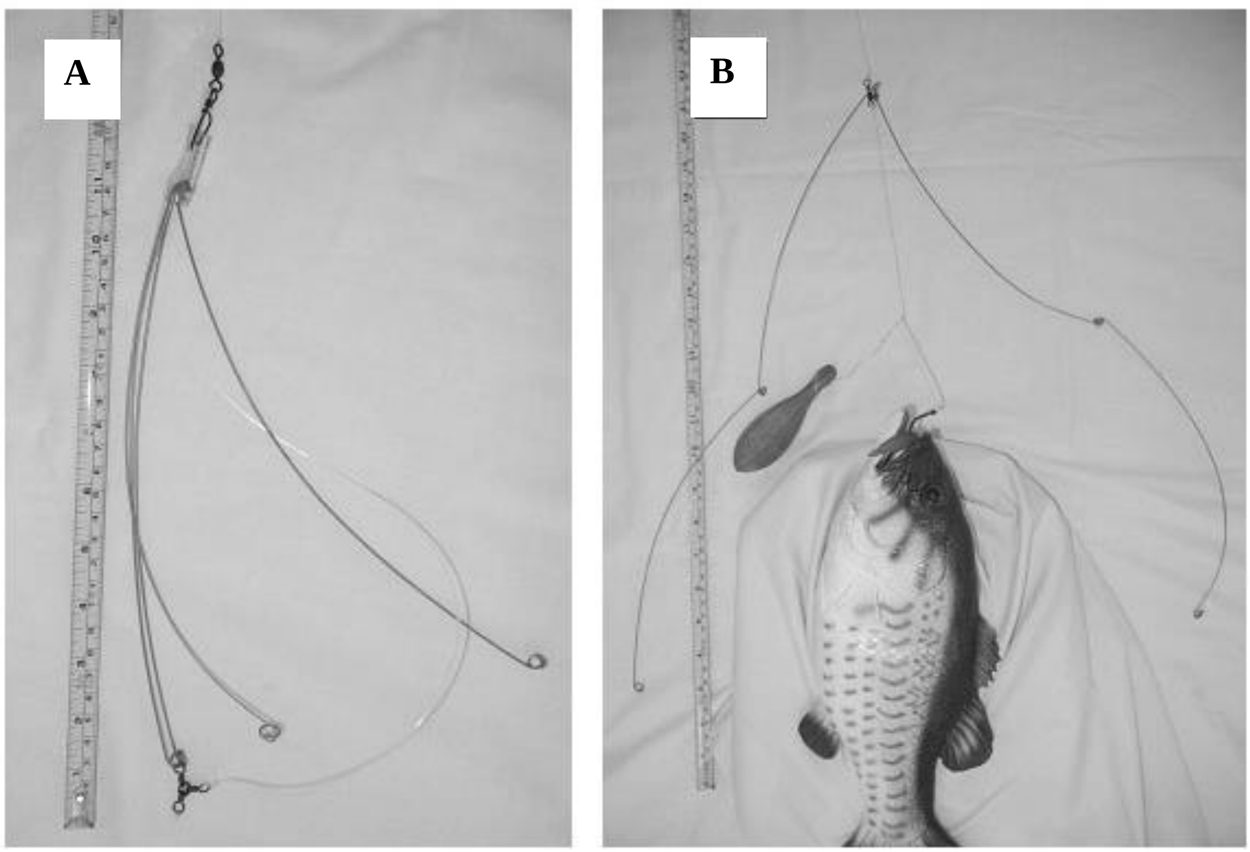


Figure 8. Folding tickle wire design.
A) Wires folded and tucked into plastic tubing; B) Wires deployed and unfolded around hooked fish.

The tickler prototype was used successfully to catch reef fish, but demonstrated limitations. The fold of stiff wires was always exposed to rub against fishing lines regardless of whether deployed from the tubing or not, leading to frequent tangles. With a fish on the hook, there was a high likelihood of the wires twisting into the monofilament, or catching adjacent fishing rigs if other anglers were close-by. Tangles occurred on approximately half the trials (~N=10), sufficient to deem this prototype concept not useable by sport anglers. These flaws inspired the next generation DMD of a more compact and simplified design with less potential for tangles.

Hammer *et al*. (2015) described a device comprised of a canister suspended proximal to fishing hooks on long-line rigs that deployed small chains once a fish was caught. The chains encircle the fish, discouraging toothed whales from depredating. We modified this concept using a 9.0 cm long x 3.7 cm wide plastic snap-lid gum bottle for our chain canister, which can hold two parallel strands of #16 jack-chain of 40 cm length. The monofilament line passes internally connected to a swivel eye at the upper end, and is clamped with a bead located at 10.5 cm loosely stuffed inside the container with the chain. The bitter end of the line extending through the lid connects to the fishing hook. When a large enough fish is caught, the pull on the line will cause the lid to pop open thus releasing the chains to stream toward the fish. In the absence of a fish, the smooth-sided container remains closed so that there is nothing protruding to cause tangles. The term "popper" rig is used to refer to this design prototype (Figure 9).

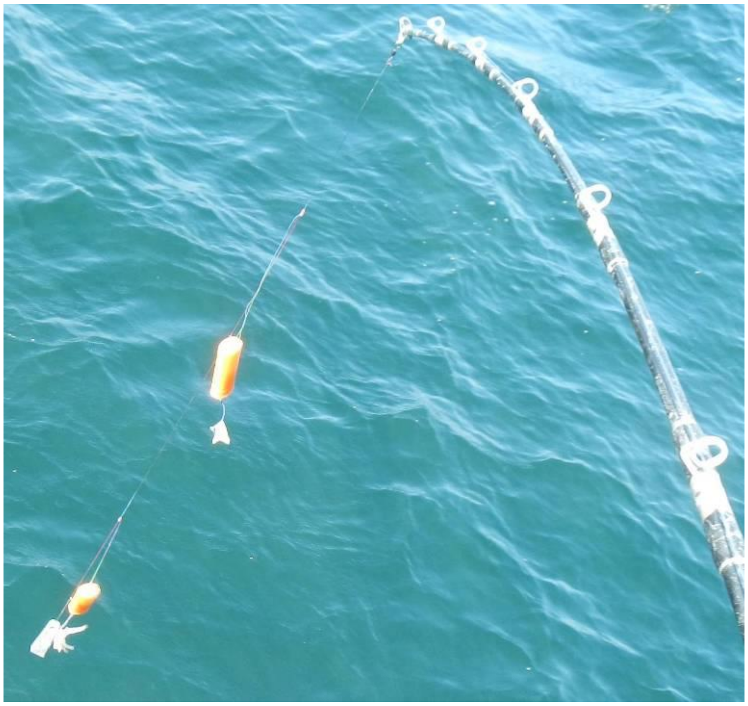

Figure 9. Two hook bottom rig with popper DMDs.
Canisters are attached above baited hooks, ready to deploy.

Our testing on several charter fishing trips proved the popper design could be easily used with little fear of tangles, until the chains deployed. At that point, the chain loops present potential tangle problems with lighter test fishing lines that could snag between links, and the links could catch up in fishing hooks. Despite those limitations, we determined that the chains deployed successfully any time a sizeable fish was caught on the hook, and would most certainly deploy in the event of a predator attempting to depredate a fish off a hook (Figure 10).


Figure 10. Fish caught with popper DMD device.
A) Underwater clip of large vermillion snapper on DMD rig with ball chains deployed;
B) smaller snapper caught on DMD rig that did not deploy chains due to fish size.

Fish catch rates were compared between poles with popper rigs to untreated hooks on a charter fishing trip with five anglers aboard (Table 2). The average ratio of DMD hooks was 38% of 8 total hooks, with overall landings of DMD fish to all fish of 31%. This showed there was little to no difference in catch rate of the DMD-treated vs standard hooks.

Table 2. Comparison of DMD treated to untreated hooks.

| Type of fish caught | DMD treated | No. DMD hooks in use | Standard hook | No. stnd. hooks in use | Total |
|---|---|---|---|---|---|
| Triggerfish | 17 | 3 | 22 | 5 | 39 |
| Red Snapper | 1 | 3 | 3 | 5 | 4 |
| Vermillion Snapper | 5 | 2 | 15 | 6 | 20 |
| Red Porgy | 4 | 3 | 12 | 5 | 16 |
| Other | 1 | 2 | 10 | 6 | 11 |
| **TOTAL** | **28** | **--** | **62** | **--** | **90** |

Popper DMDs were easy to use and reload between catches. Following critiques from deckhands aboard a charter trip, we decided to replace the jack-link chain with #10 aluminum ball chain to eliminate the open loops where hooks could tangle (Figure 11). Trials on subsequent fishing trips found the design was equally easy to use, with few to no tangles observed.

Figure 11. Comparison of DMD chain types.
Left = jack-link chain style DMD; Right = ball chain style DMD.

Anglers that target mackerel on the coastal fishing piers were presented with the popper DMD concept for feedback. A suggestion was made to develop a design that kept the canister at a distance from the terminal tackle and hook, which is usually a lure or whole bait free floating at the surface on a leader of 0.75 to 1.0 m length. In response, a modified design was developed to provide a pier version of the popper DMD (Figure 12). A sturdy cylindrical container was chosen, of the type typically used for storing glucose measurement strips, of ~5 cm long x ~3 cm diameter with a tight fitting snap lid that requires a stronger pull to open than the gum bottles used on the bottom rig DMD. Pull tests indicate the average force to open a gum bottle container is 5 lbs, while the pier DMD container requires a ~10 lb pull force. A 60 cm length of #10 ball chain easily fits inside the container. The design places the container at the upper end of the leader, so that when a fish bites on the hook and tugs sufficiently hard, the canister opens and releases the wire/chain to travel down the leader and flap around as the fish struggles against the line. This concept was tested on a two deployments during a reef fishing trip, but has not yet been demonstrated at a coastal pier at the time of this writing.

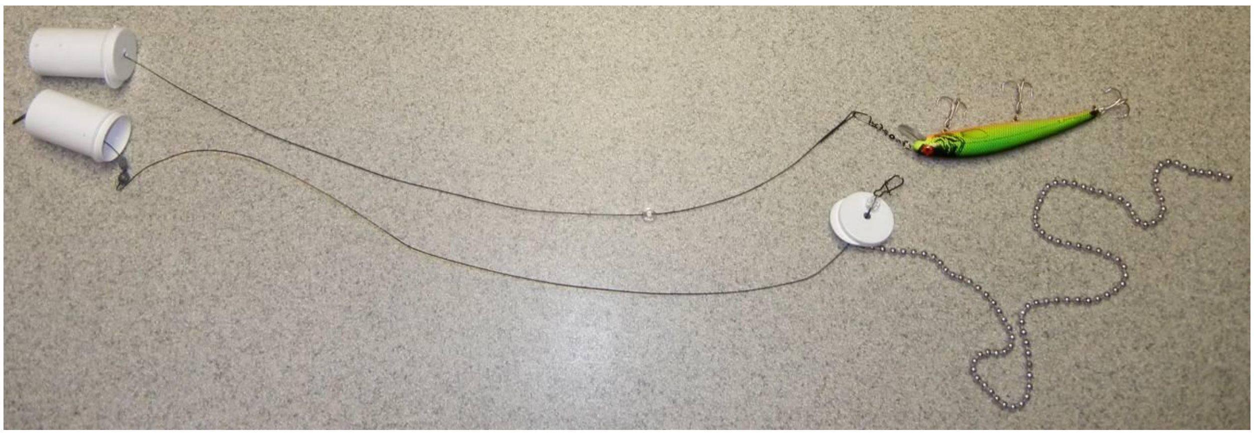

Figure 12. DMD design for use in mackerel fishing on coastal fishing piers.
Top: undeployed canister on leader; bottom: deployed ball chain slides down to lure and dangles around fish.

Despite the number of fishing trips made to a variety of reef sites, we were unable to conduct sufficient trials in the presence of dolphins on offshore reefs to conclude whether the popper DMDs were effective deterrents against depredation. At the time of this writing, several dozen poppers were assembled for distribution to participating anglers for use during the coming fishing season in 2017.

<u>Coastal fishing pier surveys:</u>

We conducted angler interviews during Mar-Oct 2016 at the three shoreline fishing piers in our study site. A 20-question form was used to collect angler’s responses about interactions with dolphins around the piers, including asking about their experience level, if they have encountered dolphins, and if they followed “Dolphin Friendly Fishing Tips” (Figure 13).

In total, 222 surveys were collected, along with comments and suggestions made by participants. The majority of anglers were adult males, with approximately 27% stating they were novice or new to the pier, and 73% stating a higher level of experience and frequency of fishing at the piers.

Chicago Zoological Society

**Gulf Fishing Pier Survey on Dolphin Interactions**

**Time:** ____:____ **am pm**
**Date:** ______________
**Survey #:** ______________

**Pier location:** ☐ Okaloosa ☐ Navarre ☐ Pensacola

1. **Age and Gender** ☐ Youth ☐ Adult ☐ Senior | ☐ Male ☐ Female
2. **Residency?** ☐ Visiting ☐ Local **Zip code:** ______________________
3. **Your fishing experience?** ☐ Beginner ☐ Occasional ☐ Seasoned ☐ Expert guide
4. **How often do you fish at <u>this pier</u>?** ☐ First time ☐ Rarely ☐ Monthly ☐ Weekly
5. **How long were you fishing today?** ☐ < 1 hr ☐ 1-3 hrs ☐ 3+ hrs
6. **What motivates you to fish here?** ☐ Sport ☐ For Food ☐ For bait ☐ Trophy/Prize
7. **How often do you check your line and tackle for weak spots?** ☐ Never ☐ Rarely ☐ Often
8. **Are you concerned about discarded fishing line in the water or on the ground?** ☐ No ☐ Yes
9. **Have you ever seen any marine animals entangled in fishing line?** ☐ No ☐ Yes
   ☐ Dolphin ☐ Sea Turtle ☐ Manatee ☐ Bird other______________________
10. **Would you use fishing line recycling bins available at this pier?** ☐ No ☐ Yes ☐ Maybe
11. **How far will you walk to use a recycling bin?** ☐ One bench ☐ 2-3 benches ☐ all the way
12. **Have you ever had a dolphin approach your bait/lure at this pier?** ☐ No ☐ Not sure ☐ Yes
13. **Did it happen today?** ☐ No ☐ Yes → How long ago today? ________ hrs
14. **Have you ever seen a dolphin take bait or fish at this pier?** ☐ No ☐ Not sure ☐ Yes
    a. **Did a dolphin take <u>your</u> bait or catch today?** ☐ No ☐ Not sure ☐ Yes
       ☐ Dolphin broke line ☐ Dolphin took bait/catch but did not break line
       ☐ Line was cut ☐ Other (please explain)______________________
15. **Did you change the way you were fishing because of dolphins?** ☐ No ☐ Yes
    Explain ______________________________________________
16. **Have you ever seen a dolphin take fish released at this pier?** ☐ No ☐ Not sure ☐ Yes
    a. **Did the dolphin stay nearby after release of the fish?** ☐ No ☐ Not sure ☐ Yes
17. **Do dolphins show preference for specific bait *<u>or</u>* fish on this pier?** ☐ No ☐ Not sure ☐ Yes
    Bait:______________________ Catch:______________________
18. **What will you do with leftover bait at the end of your fishing day?**
    ☐ Discard in water ☐ Keep for later (take home) ☐ Give to others
19. **How do you feel about dolphins being around this pier when you fish?**
    ☐ Deep dislike ☐ Minor nuisance ☐ Don't care ☐ Like them
20. ***Hand them a Dolphin Card:*** **Have you seen this card before?** ☐ No ☐ Yes
21. **How useful is this information?** ☐ Not useful ☐ Interesting ☐ Enlightening ☐ Very useful

Figure 13. Questionnaire designed for creel surveys on Gulf fishing piers.

Survey responses revealed that many pier anglers (especially seasoned locals) have a strong dislike/hatred for dolphins and consider them to be a constant nuisance (Figure 14). Verbal comments offered by some anglers showed they have changed their way of fishing due to the dolphins depredating their bait and catch, such as only using lures. Some only fished during tarpon and cobia seasons due to high depredation rates by dolphins on other fish species. Many complained about difficulty fishing for mackerel because of dolphin depredation. Some anglers claimed to have seen dolphins entangled in bait-fishing (sabiki) rigs. A few reported that pier anglers sometimes throw cobia jigs at the dolphins in retribution. Others have developed their own devices in attempts to mitigate depredation, with varied success.

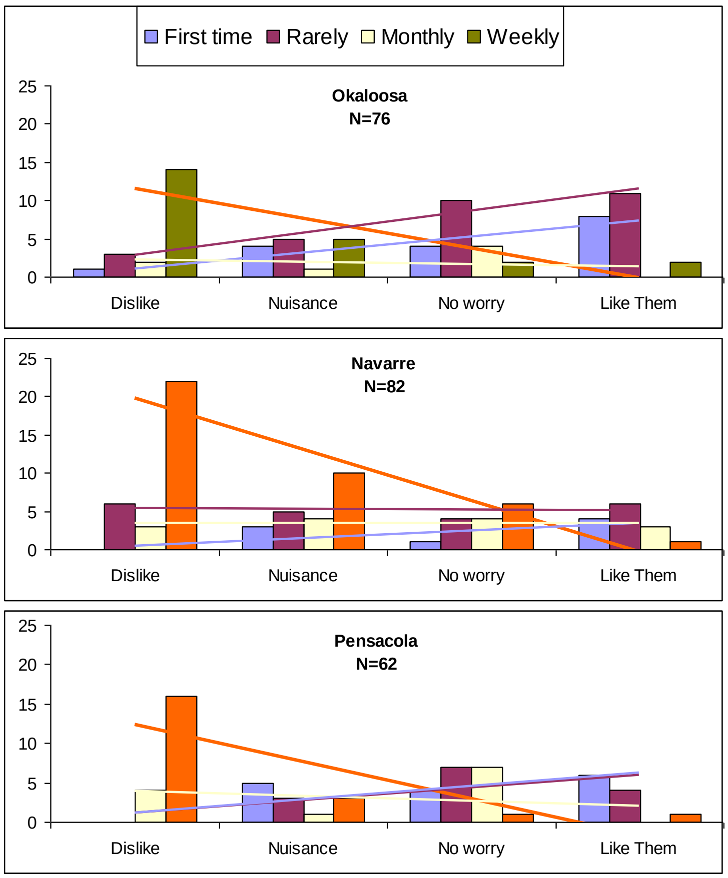


Figure 14. Attitude of fishing pier anglers toward dolphins.
X axis = # responses to Frequency at pier; Y axis = Attitude toward dolphins.

Anglers gave mixed replies on questions relating to their experience with dolphins, and with observations of entanglement, scavenging of discards, or depredation of caught fish, but the majority expressed clear concern about the potential for entanglement of marine animals (Figure 15). Responses varied in concert with experience level, but the majority of anglers stated that they regularly check their lines for weakness; that they do recycle their used fishing lines; and that they will use the fishing line recycling bins on the piers. Some pier recycling bins were in disrepair and there were several comments asking they be restored. Despite a high response rate to questions about anglers' observing depredation of catch, observations of dolphins at the pier and responses about depredation events on the specific day of the survey were very low.

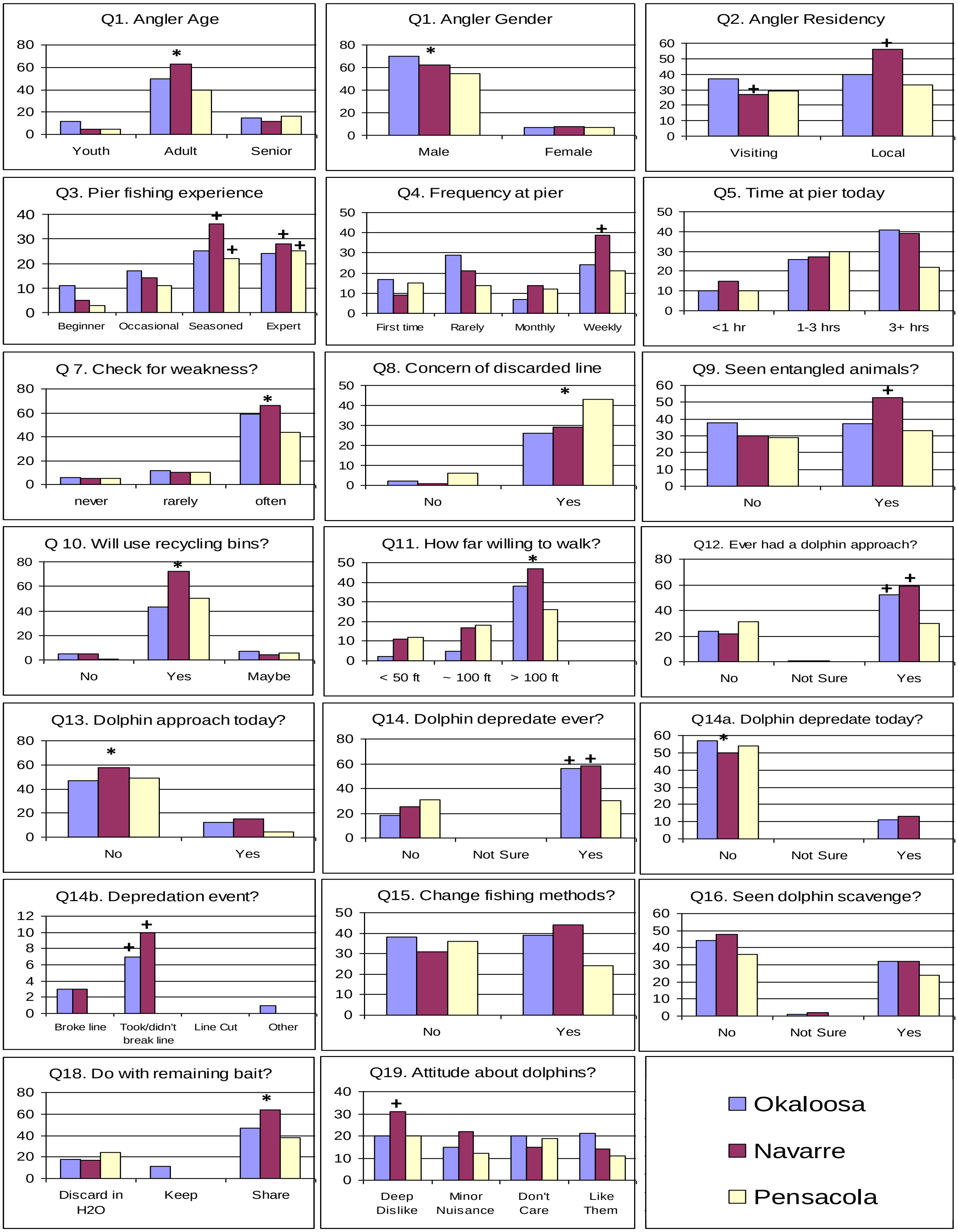


Figure 15. Overall angler responses to survey questions.
* = significant at all piers; + = significant at selected pier

An example of a DMD concept was presented by an angler that incorporated steel rings fastened to nylon line with a snap clip and weight, that could be quickly hooked onto a fishing line once a fish was caught – the device would ride down the line toward the hook and then dance around the fish as it was being reeled back to the pier (Figure 16). The man reported he had some success in landing king mackerel when dolphins were near the pier, while other anglers' lines were being depredated.

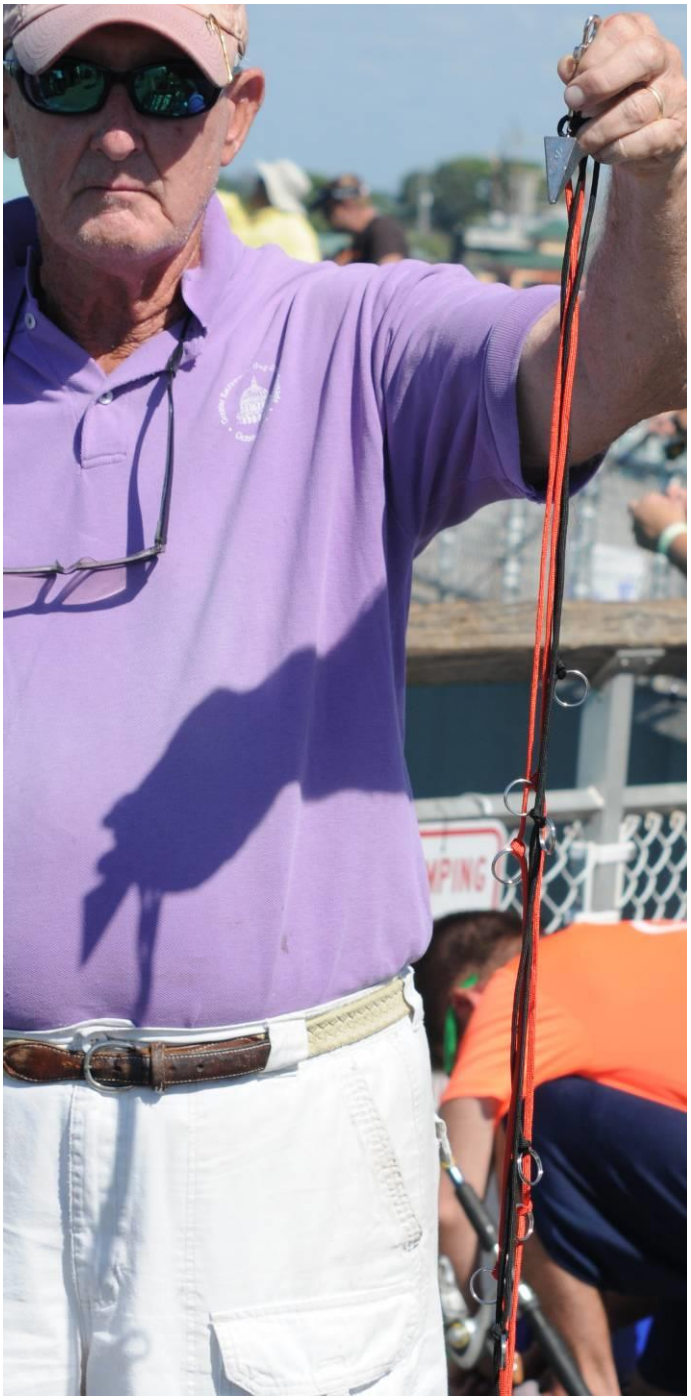

Figure 16. Angler-innovated DMD that clips onto line to travel down to caught mackerel.

<u>Photographic identification surveys and monitoring of human interactions with dolphins:</u>

In total, 48 trips along inshore regions and the nearshore Gulf beaches covering 2,216 km distance were made between 2014-17 to catalog individual dolphins and monitor for human interactions (Figure 17).

37 surveys were made around Destin Pass and west Choctawhatchee Bay. In addition, we assisted on 9 surveys in Pensacola Bay and the nearshore Gulf to support an ongoing study of dolphin abundance, distribution, and stock structure (pers. comm., C. Toms 2016). By request of the stranding network, we also conducted two surveys of neighboring Perdido Bay to monitor individual dolphins that had been subject to human interactions. There were 159 dolphin sighting locations with 52 hrs of focal observations (Table 3). More than 14,000 photographs were added to the existing photo catalogs for this area. Frequent observation of human-dolphin interactions were recorded, primarily involving close approaches by small personal watercraft to groups of dolphins at Destin Pass. Processing and analysis of images is ongoing at the time of this writing.


Figure 17. Dolphin sighting locations during 2014-17.
Sightings of groups of dolphins are represented by green dots.

Table 3. Small boat surveys in inshore and Gulf waters during 2014-17.

| DATE | AREA | #SIGHTS | #DOLS | #CALVES | #YOYS | Total time (hr:min) | Total Distance (km) | Focal Time (min) | Focal distance (km) | #Photos | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/07/14 | Destin | 5 | 26 | 7 | | 5:32 | 40.1 | 140 | 10.8 | 700 | West Choctaw Bay |
| 05/23/14 | Perdido | 5 | 17 | 5 | 2 | 6:35 | 58.8 | 76 | 4.9 | 270 | Search for injured calf |
| 6/19/14 | Destin | 0 | 0 | | | 3:00 | 40.0 | | | 0 | Destin Pass |
| 6/20/14 | Destin | 2 | 20 | 5 | 1 | 2:00 | 25.0 | 37 | 2.0 | 709 | Search for tangled calf Mango |
| 7/11/14 | Destin | 5 | 21 | 5 | 1 | 5:54 | 57.3 | 141 | 9.6 | 1182 | Found Mango |
| 7/13/14 | Destin | 1 | 3 | 1 | | 3:30 | 45.0 | 7 | 1.0 | 12 | VIRB underwater test |
| 7/22/14 | Destin | 2 | 15 | 2 | | 2:10 | 17.3 | 23 | 1.0 | 59 | Mango search; not found |
| 7/23/14 | Destin | 1 | 20 | 3 | | 1:55 | 12.8 | 55 | 1.0 | 420 | Monitor Jet ski harassment |
| 7/24/14 | Destin | 1 | 2 | 1 | | 4:53 | 34.2 | 121 | 5.3 | 91 | UW photos & Videos of Mango |
| 7/28/14 | Destin | 2 | 7 | 1 | | 4:30 | 35.0 | 15 | 1.1 | 44 | Mango search; not found |
| 7/29/14 | Destin | 11 | 25 | 5 | | 7:34 | 62.4 | 173 | 12.6 | 414 | Mango intervention; not found |
| 7/30/14 | Destin | 2 | 3 | 1 | | 7:21 | 22.6 | 360 | 13.9 | 85 | Mango rescue |
| 8/5/14 | Destin | 2 | 12 | 2 | | 2:00 | 15.0 | 35 | 1.1 | 155 | No Mango sighting; Jet skis |
| 8/6/14 | Destin | 6 | 30 | 7 | | 4:19 | 48.8 | 60 | 6.7 | 452 | Monitor Jet ski harassment |
| 8/8/14 | Destin | 5 | 26 | 6 | | 3:25 | 48.8 | 72 | 7.0 | 262 | Monitor Jet ski harassment |
| 9/9/14 | Destin | 6 | 21 | 7 | | 5:34 | 67.6 | 110 | 7.5 | 482 | Pier - Mango search; not found |
| 9/24/14 | Destin | 3 | 18 | 3 | | 2:10 | 17.1 | 15 | 0.8 | 476 | In pass and beach; no Mango |
| 10/16/14 | Destin | 4 | 15 | 2 | | 1:44 | 14.7 | 28 | 1.6 | 181 | Saw Mango distance |
| 10/30/14 | Destin | 2 | 9 | 2 | 1 | 3:39 | 21.6 | 64 | 4.9 | 395 | Search in Pass and Gulf |
| 11/20/14 | Destin | 6 | 24 | 3 | | 3:09 | 35.2 | 89 | 5.5 | 683 | Mango resite; UW video |
| 12/5/14 | Destin | 1 | 9 | 2 | | 0:39 | 3.0 | 35 | 1.5 | 224 | Mango resite; in large group |
| 12/17/14 | Destin | 1 | 4 | | | 0:10 | 1.5 | 0 | 1.5 | 87 | Inside Pass to GOM |
| 4/26/15 | Destin | 0 | 0 | | | 2:00 | 21.0 | | | 0 | Search Pass, camera test in bay |
| 5/6/15 | Destin | 2 | 6 | 1 | 1 | 2:10 | 17.0 | 15 | 1.1 | 122 | 1st obs of mouth entangled calf |
| 5/31/15 | Pensacola | 4 | 12 | 3 | | 3:38 | 43.6 | 120 | 5.0 | 540 | White headed dolphins |
| 6/16/15 | Pensacola | 4 | 10 | 2 | | 2:42 | 11.1 | 30 | 5.0 | 511 | NOAA Biopsy whiteheads |
| 7/6/15 | Pensacola | 4 | 10 | | | 9:27 | 72.3 | 45 | 7.0 | 85 | Assist biopsy project |
| 7/7/15 | Pensacola | 4 | 10 | | | 9:26 | 134.0 | 65 | 15.0 | 85 | Assist biopsy project |
| 7/9/15 | Pensacola | 4 | 10 | | | 7:38 | 85.7 | 164 | 10.5 | 85 | Assist biopsy project |
| 7/10/15 | Pensacola | 4 | 10 | | | 9:43 | 74.9 | 45 | 7.0 | 85 | Assist biopsy project |
| 8/30/15 | Destin | 4 | 20 | 5 | | 4:00 | 51.9 | 52 | 4.5 | 437 | Mouth entangled calf |
| 9/20/15 | Choctaw | 1 | 4 | | | 0:30 | 1.0 | 30 | 0.3 | 71 | Monitor boat interactions |
| 10/16/15 | Destin | 7 | 37 | 6 | 1 | 3:10 | 46.9 | 84 | 5.7 | 690 | Mouth calf; Mango resight |
| 10/20/15 | Destin | 0 | 0 | | | 2:56 | 47.0 | 0 | 0.0 | 0 | No sightings |
| 4/19/16 | Perdido | 6 | 16 | 3 | | 7:53 | 110.0 | 69 | 3.1 | 480 | Injured dolphin search |
| 5/15/16 | Destin | 2 | 3 | 1 | | 5:49 | 33.7 | 31 | 2.5 | 77 | SRS Dx off LJP; descender tests |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8/15/16 | Pensacola | 4 | 20 | | 8:00 | 100.0 | | | 338 | Escambia Bay biopsy |
| 8/16/16 | Pensacola | 4 | 20 | | 8:00 | 100.0 | | | 10 | Upper Pensacola Bay biopsy |
| 8/20/16 | Pensacola | 6 | 12 | 2 | 7:30 | 110.0 | 55 | 5.0 | 10 | East Bay biopsy |
| 9/14/16 | Destin | 2 | 13 | 1 | 5:38 | 59.9 | 128 | 7.0 | 513 | Mouth tangled calf UW video |
| 9/29/16 | Destin | 4 | 18 | 3 | 5:50 | 65.0 | 45 | 3.5 | 465 | Photos mouth calf |
| 10/20/16 | Destin | 3 | 19 | 3 | 3:32 | 43.5 | 56 | 3.8 | 308 | UW video of dolphins |
| 10/23/16 | Destin | 1 | 7 | 2 | 4:09 | 30.0 | 7 | 0.5 | 62 | Inside Pass, saw tangled calf |
| 10/24/16 | Destin | 4 | 29 | 9 | 5:36 | 48.8 | 70 | 4.4 | 238 | In pass/bay; Mango; mouth calf |
| 11/15/16 | Destin | 3 | 12 | 5 | 4:02 | 50.6 | 122 | 8.5 | 356 | Many dolphins, manatee in Pass |
| 12/14/16 | Destin | 1 | 8 | 1 | 1:48 | 28.7 | 14 | 0.7 | 116 | Many dolphins in Pass |
| 2/2/17 | Destin | 7 | 60 | | 7:25 | 79.9 | 187 | 13.1 | 992 | Dolphins in GOM |
| 3/4/17 | Destin | 1 | 4 | 1 | 1:49 | 26.0 | 5 | 0.5 | 12 | Small group at pass mouth |
| **Total** | | **159** | **697** | **118** | **216:04** | **2,216** | **51.58** | **215** | **14,071** | |

<u>Long-term monitoring of entangled dolphins in Destin:</u>

We received reports from boat captains in June 2014 of an entangled juvenile dolphin at Destin Pass. Surveys were then made to locate and photograph the animal to provide information to the stranding network (Figure 18). On three separate observation days, the mother/calf pair was seen swimming slowly in shallow areas within the western bay away from other groups of dolphins. The animal was a two year old calf of a well-known female dolphin in the Destin community that was easily identified. We used a handheld pole-mounted HD camera deployed from the bow of our survey boat to capture clear underwater video that showed the nature of the entanglement and injury to the dolphin. A length of fishing line had wrapped around the peduncle and flukes, with apparent amputation of a significant part of the left fluke and ligatures developing around the right fluke. A ~3 m streamer of line covered in algal growth was trailing behind the dolphin and likely producing drag, such that the animal was no longer swimming with up and down fluke strokes, and was exhibiting scoliosis with an upward distortion of the caudal peduncle. The videos indicated that a capture intervention could likely save the calf. Members of the Southeast Stranding Network assembled a rescue team and spent three days in July 2014 locating and then finally capturing the mother and calf; measurements with photographs and tissue samples were collected, and the entanglement was removed, with immediate release of the animals back to the bay. We continued to monitor for the mother and calf in the following months, and had multiple resightings in 2014-15, finding them associated with larger groups. Underwater videos from Nov 2014 of the calf showed resolution of the scoliosis and indicated that normal swimming strokes were restored. The most recent sighting of the calf and mother was in Oct 2016 and both appeared to be in normal condition.

Another report of an entangled juvenile dolphin with a photograph taken from a Destin tour boat was received in May 2015, with fishing line wrapped through the mouth and beneath the throat. Significant overgrowth indicated the injury had been in place for some time. The animal was distinctly identified as a two-year old calf of a known female in the Destin catalog. We resighted and photographed the calf on several occasions but were unable to acquire underwater images of the jaw until Sep 2016, which showed the fishing line was still loosely attached (Figure 19). The calf appeared to be in good body condition and exhibited normal swimming and social behavior, so intervention was not recommended. The most recent observation of the calf was in Oct 2016, with an underwater video clip appearing to show that the line was no longer present.

Figure 18. Entangled calf in Destin, July 2014.
Top photo shows line streaming from tail fluke and extent of scoliosis; bottom photo shows calf beneath the mother with healed fluke wound and normal swim strokes in Nov 2014.

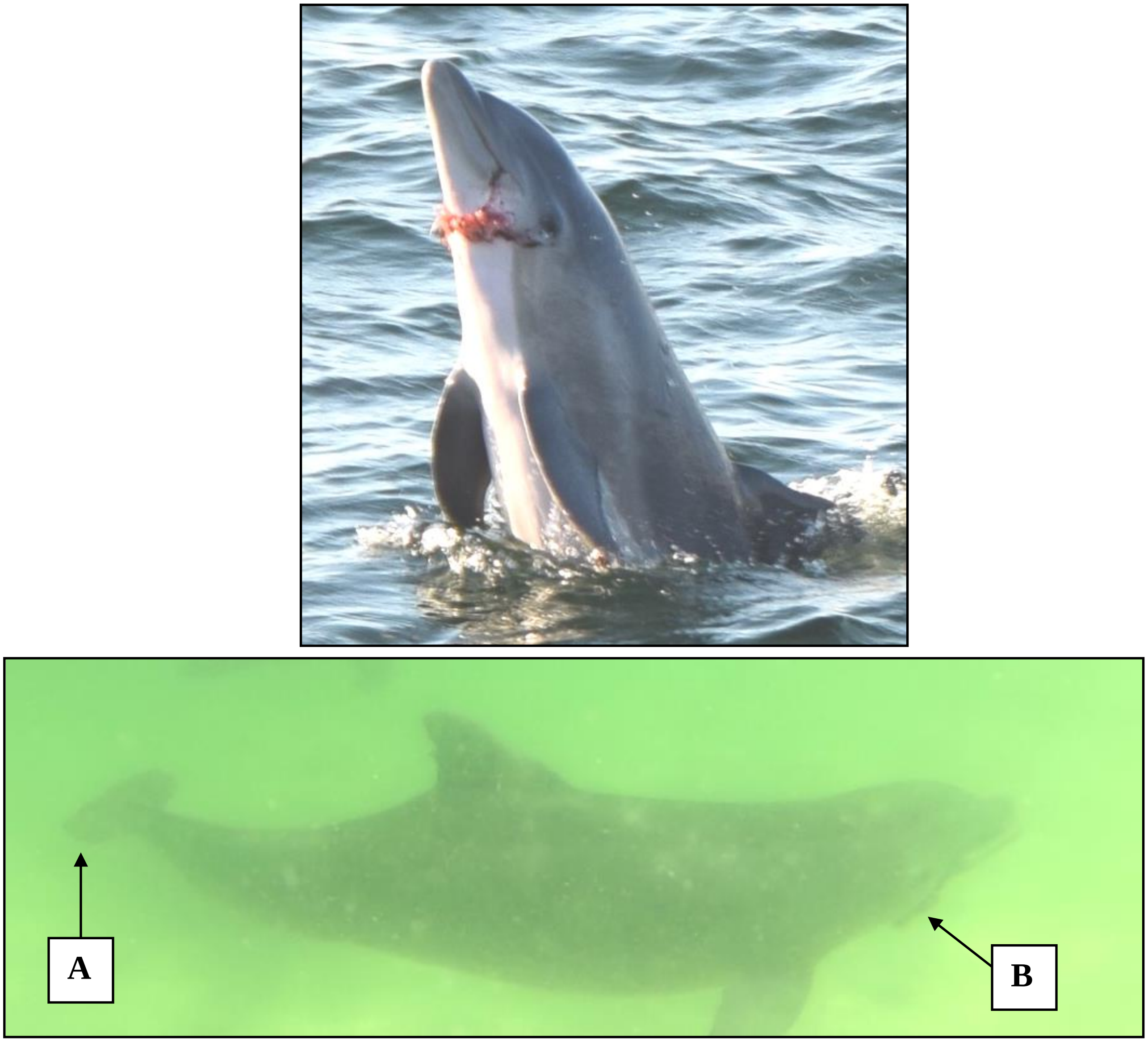


Figure 19. Dolphin with entanglement in Destin first reported in May 2015
Upper photo shows line draped from mouth around throat; lower = Sep 2016 underwater clip showing A) healed partial fluke amputation and B) line dangling from mouth

## Discussion

There is an increasing need for advising sport anglers about best practices for reducing or avoiding interactions with dolphins. This study was intended to address several approaches that might help resolve these issues. First and foremost, we explored if an easy to use fish descender device was a handy tool for reef anglers to carry in their tackle kits. Despite the lack of robust data to demonstrate the effectiveness in countering dolphins' scavenging of released fish, we learned that the Seaqualizer device was very reliable and can be used easily in reef fishing scenarios. Secondly, we investigated the practical use of several prototype mitigation devices that might be useful to discourage dolphins from depredating caught fish off hooks. Lastly, our creel surveys at coastal fishing piers showed that most anglers do in fact adhere to recommended best practices for dolphin friendly fishing, but that more outreach and line recycling opportunities would be helpful.

During our 2008-10 study, we encountered dolphins on 61% of fishing trips to Gulf reefs, and observed fishing interactions on 38% of those. Charter captains interviewed since then reported that dolphin interaction problems were continuing, which led us to expect a similar encounter rate in the current study. Therefore, it was surprising to have had only 5 encounters with dolphins on the 19 separate fishing trips in this study, with very few observations of scavenging and depredation compared to the prior study. Several deckhands on charters we took mentioned that dolphins seemed to be less problematic in the past few years. The possibility exists that abundance of dolphins around the offshore Gulf reefs may have declined since the 2010-14 Unusual Mortality Event associated with the BP oil spill, but a systematic survey effort would be required to ascertain this, which was beyond the scope of the current study.

The results of our experiments in Sarasota Bay suggested that an improved type of descender device for use in shallow water was needed. It was encouraging to find that dolphins were rarely attracted to our descender attempts. However, we encountered frequent problems in attaching the small size (10-20 cm) game fish caught in the bay to the SFD, and had even less success with the other descenders we tested. A device that securely holds the fish until it reaches bottom would be more practical, and since most anglers recover their catch using a scoop net we envision a modification that closes the net into a bag with a weighted handle as a potential descender concept. A prototype design has not yet been evaluated at the time of this writing.

Developing and testing DMD concepts was insightful. Initially, the simplest design of using a stiff wire to flail around a hooked fish seemed logical, but did not prove to be practical when used aboard fishing boats and near other anglers on the same deck, where constant untangling of lines cost fishing time and interfered with landing success. The more elegant concept of keeping the DMD contained in a canister proved easy to employ without impacting the fishing action, but each device required more construction time and care in assembly to insure proper function. If a canister DMD can be demonstrated to be effective at preventing dolphin depredation of caught fish, it likely would be an item pursued for development by commercial manufacturers for sale in tackle stores. To that end, further development and testing is warranted.

Our methodology to employ remote underwater cameras to observe fishing gear and released fish showed utility in the relatively clear waters on offshore Gulf reefs. The technique proved less useful in the inshore environment of Sarasota Bay, with limited ability to detect whether released fish were able to avoid predation. Another means to measure descender effectiveness is through fish tag recovery (e.g., gcrl.usm.edu/fisheries_center/tagged.fish.catch.php). FWC researchers conducting reef fish tagging studies aboard several of the charter vessels we fished from cooperated with our study by providing those fish for our use, which yielded video records of the fish survival at depth following release. Subsequent reporting of recovery of those tags will give better survival data. Assuming suitable tags can be applied to smaller fish caught in inshore waters, this method done in conjunction with future experiments to study effectiveness of dolphin mitigation techniques would contribute supplementary data for analysis of results.

We included questions on our creel survey that could be universal to the differing fishing modes employed on coastal piers. Anglers on the piers generally target fish in two categories: surf and bottom dwelling species (e.g., pompano, sheepshead, red drum, blue fish, ladyfish); and pelagic migratory species such as mackerel, and cobia. Bottom dwelling species are targeted with weighted lines and baited hooks, while pelagic species are attracted to live bait on surface cast rigs and to floating lures. Pelagic mackerel use visual cues to assess and select bait they will bite, thus requiring anglers to have a level of expertise to be successful in landing these fish. Dolphins that linger around the piers tend to depredate mackerel and ladyfish, both of which are elusive prey in natural circumstances, but become easy targets when struggling on a hook and line..

We believe most regular pier angles would eagerly welcome using nearly any type of approved mitigation device to reduce dolphin depredations. Two examples of innovative concepts created by pier anglers were found: one device used a ribbon with safety pins secured in the material that could be streamed down the fishing line; and the other used multiple metal rings tied onto nylon 550-cord that could be clipped onto a line to travel down to a caught fish. Both anglers reported getting their ideas from reports of scientific literature indicating the effectiveness of flailing wire leaders and shrouds as dolphin deterrents (e.g., Zollet and Read 2006, Rabearisoa *et al*. 2012). This was encouraging as it demonstrates that research results in this field do reach recreational users of fishing gear. Further advances in gear improvements and techniques with appropriately targeted outreach can have broad impact to encourage individual incentives as anglers use this information to shape best practices and innovations.

The consequences of interactions with fishing gear are often seen in recovered carcasses of stranded marine mammals along the Gulf coast, and an increasing history of interventions to rescue dolphins from line entanglements prompts the need for follow-up monitoring to determine the success of these efforts. In the case of the rescue conducted in July 2014 at Destin, the calf was found to have recovered after several months, with resolution of a developing spinal defect following removal of the entanglement. Not all entanglements require the risk and expense of conducting a human intervention, and in our second case of finding an entangled animal in Destin we showed that resighting and using non-invasive underwater observation provided important information to stranding network coordinators to help guide determinations about the health outcomes of their management decisions.

There are divergent human attitudes about wildlife interactions during recreational activities when comparing nature-based touring to recreational resource harvesting (*i.e*., fishing and hunting). Ecotour businesses depend on the survival of the wildlife they approach, which builds incentive to strongly support wildlife conservation efforts. On the other hand, sportsmen engaged in recreational fishing and hunting can be at odds with that same wildlife when it is perceived as a competitor for their target prey. The common ground for advancing conservation of marine mammals in conjunction with promotion of sport activities involving resource harvesting depends on effective outreach and education (Figure 20), as well as partnering with stakeholders to develop practical solutions using modified gear and methodologies. The outreach for "Dolphin Friendly Fishing Tips" and "Don't Feed Wild Dolphins" appear to have had an impact in this regard, but more effort is needed to provide anglers with opportunities to appropriately discard spent fishing line and gear, and to become educated on means to correctly assist and report animals that are entangled. Ultimately, the angler on the boat or pier is at the frontline of conservation, and should be encouraged to participate with programs to help protect their marine resources.


Figure 20. Angler outreach efforts in northwest Florida at Sea Grant sponsored events.

## Implications and Next Steps

1. Continue to demonstrate the use of simple tackle enhancements and commercially available descender tools as means to safely prevent or reduce fishery interactions from dolphin depredation on rod and reel fishing gear and scavenging on discarded fish.
    - Enlist cooperative efforts to test the practicality of using these techniques under recreational charter and private fishing circumstances.
    - Communicate findings to marine mammal and fishery management agencies (e.g., NOAA Fisheries, Florida Fish & Wildlife Conservation Commission, and Alabama Dept. of Conservation and Natural Resources.
    - Demonstrate mitigation techniques that increase survival of released fish in the presence of predators, thereby benefiting stock recovery of reef fish species (*e.g.*, red snapper and grouper).
    - Increase public awareness through outreach aimed to reduce conflicts between dolphins and anglers by discouraging unintentional provisioning of marine mammals with discarded fish.
    - Encourage sport anglers to embrace DMDs and fish descender practices as an enjoyable component of the charter fishing experience and promote common use of these devices in Gulf reef fishing.

2. Increase opportunities at public (and private) piers, marinas, and parks where anglers gather that provide line recycling options, outreach, and incentives to participate in resource conservation programs.
    - Participate in the Monofilament Recycling and Recovery Program (MRRP) to improve existing fishing line recycling bins on coastal piers and other locations.
    - Communicate MRRP benefits with sport anglers at outreach events.
    - Enlist more sport retailers and tourism attractions to host MRRP receptacles.

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