Testing Modified Deep-Set Buoy Gear to Minimize Bycatch and Increase Swordfish Selectivity

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Abstract

This project investigates the use of alternative deep-set buoy gear (DSBG) configurations for the targeting of swordfish (*Xiphias gladius*) at depth during the day off the coast of southern California. Gear configurations presented in this work build upon previous DSBG studies that incorporate regional depth distribution data from both swordfish and non-target species into the gear design. Multiple test configurations were developed and trialed from July through January of the southern California 2013-2014 swordfish season. Hook depths were continuously monitored using depth and temperature data loggers deployed on each set of test gear. All deployments used 8m gangions of 1.8mm monofilament and 18/0 circle hooks baited with either mackerel (*scomber* spp.) or squid (*illex* spp.). Mainline characteristics included 250-350m of 2.8mm monofilament and a 4kg drop sinker. A total of 12 experimental deployment days (1,850 hook-hours) were performed to evaluate hook depth distribution, deployment feasibility and the effects of additional hooks set^{-1} of gear. An additional 12 deployment days (2,590 hook-hours) were performed using the two test configurations that resulted in consistent depth distribution between 250-350m and maintained strike detectability for rapid release of non-target species. Final test trials resulted in the capture of swordfish (11), blue sharks (*Prionace glauca*) (6), mako shark (*Isurus oxyrhinchus*) (1) and salmon shark (*Lamna ditropis*) (1). The refined DSBG configurations tested in this study continue to suggest high selectivity for swordfish. The test configurations developed in this study will be used by cooperative fishers during the 2014-2015 fishing season. This work constitutes one component of the necessary steps for fishery implementation off the coast of southern California.

Introduction

The swordfish (*Xiphias gladius*) is a highly migratory species that supports lucrative commercial fisheries around the globe (Ward et al., 2000). Off the west coast of the United States the swordfish is one of eleven federally managed species under the Fishery Management Plan for West Coast Fisheries for Highly Migratory Species (PFMC, 2011). Despite healthy stocks and robust domestic markets (Hinton and Maunder 2012; Brodziak 2010; PFMC, 2013) U.S. west coast fisheries for swordfish have declined by over 90% over the past 30 years (PFMC, 2013). This decline has been primarily attributed to stringent regulations on California's primary swordfish fishery, the CA drift gillnet fishery (DGN) for swordfish and thresher sharks (Hanaan et al., 1993). Off California, DGN interactions with bycatch species of concern (e.g., marine mammals, sea turtles) have spurred numerous restrictions that have directly affected local DGN fishers through time and areas closures as well as mandated gear and operational modifications (Hanan et al., 1993; Carretta et al., 2003, PFMC, 2013). The DGN fleet has dwindled to a historic low and is now seasonally restricted to operate within the Southern California Bight (SBC), a

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relatively small portion of the CA coastline spanning Point Conception to the Mexican border (PFMC, 2013).

Recent efforts have focused on the development and design of alternative swordfish gears that reduce the potential for interactions with bycatch species of concern (i.e., turtles and marine mammals). Because swordfish have been shown to persist primarily below the thermocline during the day (Carey and Robison, 1981; Sepulveda et al., 2010; Dewar et al., 2011), efforts to increase gear selectivity have primarily focused vertical segregation (Benson et al., 2009). Among the gears tested off California is deep-set buoy gear (DSBG), a simple hook and line gear-type that is designed to selectively target swordfish at depth (250-350m) during the day (Sepulveda et al., in press). Initial DSBG trials have confirmed that: (1) swordfish can be selectively targeted at depth, (2) non-target catch (e.g., sharks) rates appear to be relatively low, and (3) the gear has had no interactions with any species of concern.

The present study was performed to test modified DSBG configurations that increase deployment and retrieval efficiency, enhance bait presentation and increase nocturnal detectability. The findings from this work will be used in cooperative fisher trials in 2014-2015 and provide the foundation for fishery implementation off the coast of California.

Objectives

1. Trial modified configurations of deep-set buoy gear for swordfish off the Southern California Bight.

2. Identify two configurations that can be used in subsequent cooperative trials

3. Characterize catch rates of target and non-target species.

4. Provide regional management with the necessary information for the future implementation of DSBG off the U.S. west coast.

Methods

Location and permitting

All experiments were performed within the Southern California Bight (SCB) between the months of July and January of 2013-2014. Experimental fishing trials were conducted under the guidance of NOAA technical monitors and based on the terms and conditions contained in the environmental assessment approved through NOAA's Southwest Regional Office (NOAA SWRO). Field deployments were also performed *under valid Scientific Collection Permits (SCP #s 2471 & 5463) issued through the California Department of Fish and Wildlife (CDFW).*

Gear evaluation

Test gear was evaluated based on several factors, including: (1) duration gear sets took to reach the target depths (250-350m), (2) the ability to maintain the target depth range for the duration of the 4hr deployment period, (3) ability to detect strikes and actively monitor gear operations and (4) the feasibility and ease of deployment and retrieval. DSBG target depths (250-350m) were based on previous movement data for swordfish and non-target species of the SCB (Sepulveda et al., in press; Sepulveda et al., 2010; Dewar et al., 2011). Electronic data storage tags (Cefas Technology Limited [CTL], Suffolk, UK [DSTs] were used to monitor depth and temperature on all sets of gear deployed.

Gear designs, rigging and set characteristics

Consultation with commercial fishers from existing fisheries in Florida and Hawaii were used to modify and develop DSBG configurations to increase fisher acceptance and gear efficiency. All modifications trialed maintained the ability to actively monitor gear status, detect strikes and release non-target species (i.e., sharks) shortly after interaction. Initial tests included the use of configurations that increased total hook count from two hooks per vertical piece to six and iterations in between. These configurations also included altering drop-sinker position, mass (2-5kg) and the use of both monofilament and braided mainline (500kg) material. Additional modifications included altering mainline orientation from vertical to horizontal using three vertical buoy lines (see results Figure 1). The resultant configuration was also attempted with monofilament and braided mainline material and varied drop sinker mass (2-8kg).

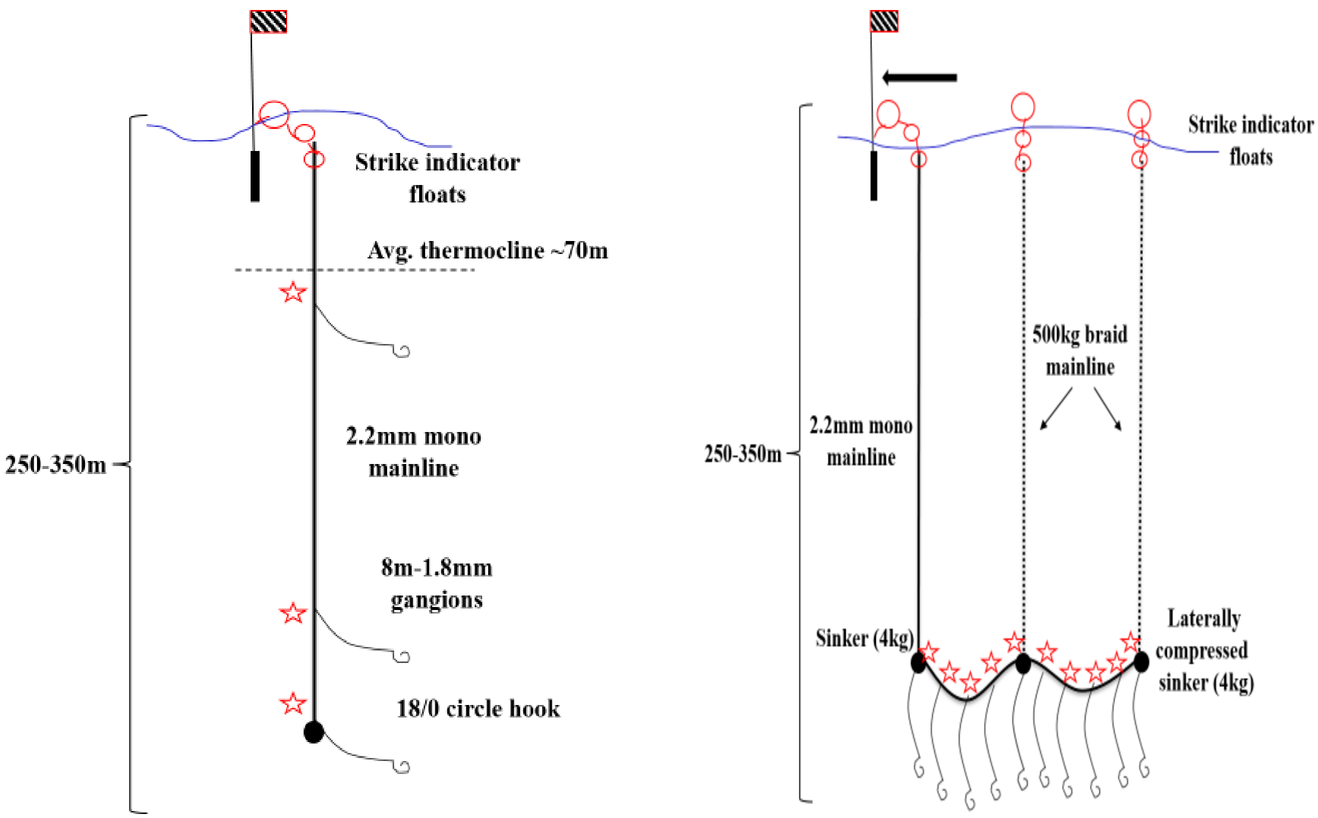

Figure 1. *Diagram of the two final DSBG configurations chosen for experimental trial in this study. a) vertical configuration, b) horizontal configuration (arrow represents orientation and direction of travel, stars represent illumination).*

Deployments

Test deployments were used to evaluate gear performance prior to periods of increased swordfish abundance in the SCB (July-August). For all trials, gear was continually monitored using stabilized binoculars from the research vessel platform and total horizontal separation between buoys did not exceed 3nm. Set duration was maintained at 4hr and all gear was immediately serviced and re-deployed upon detection of a strike. Gear loss was prevented using strobe-flashers (Pacific Ocean Producers, HI) and hi-flyer flags (2.5m). All deployments followed the requirements and DSBG set protocols authorized by NOAA SWR.

Results

Field testing was conducted from July to January of the 2013-2014 swordfish season. Initial test sets were performed during periods of low swordfish harvest to investigate depth characteristics and feasibility of the different configurations. The two gear configurations that resulted in consistent depth maintenance, minimal tangling and high deployment feasibility included a vertical and horizontal gear type (Figure 1 a&b). Figure 1.a is similar to standard DSBG (Sepulveda et al., in press), however it contains one additional hook for increased targeting of the water column and a strobe flasher for nocturnal detection. Figure 1b orients the hooks off a horizontal mainline suspended by three vertical buoy lines. The head of the gear (oriented in the direction of travel) uses a locator flag and a 250m monofilament leg. The two additional vertical legs (250m) are constructed out of braided 500kg material to reduce drag and orient the gear in the current. The drop sinkers used for both braid buoy lines are laterally compressed to reduce drag and orient the gear such that it drifts in the direction of the leading edge (signified by the arrow in Figure 1b).

The preliminary test sets collectively accounted for 1,850 hook hours with a total catch of three opah (*Lampris guttatus*), 3 bigeye thresher sharks (*Alopias superciliosus*) and one swordfish. The two test configurations (shown in figures 1a&b) were used in subsequent trials during periods in which swordfish were present in commercial catch logs. Fishing trials were performed over 12 fishing days (2,590 hook hours) resulting in the capture of 11 swordfish, 6 blue sharks (*Prionace glauca*), 1 salmon shark (*Lamna ditropis*) and 1 mako shark (*Isurus Oxyrinchus*).

Discussion

This study builds upon previous work to develop, test and trial alternative fishing gear that targets swordfish at depth (below the thermocline) during the day off the U.S. west coast. Despite the presence of a healthy swordfish stock, fishery development off the U.S. west coast has met with several hurdles, primarily in response to potential fishery interactions with species of special concern (i.e., sea turtles and marine mammals). Given the need to develop selective fishery practices for domestic seafood harvesters, this work coupled low-impact methods with depth distribution data from both target and non-target species of the SCB.

This work has identified two test configurations that improve upon previous DSBG configurations trialed within the SCB (Sepulveda et al., in press). Collectively, the gear modifications increase deployment and retrieval efficiency, increase total hook count and increase nocturnal detectability. The two options provide fishers with the ability to alter the gear under different environmental conditions (i.e., wind, sea state) and continue to maintain the positive attributes of DSBG (i.e., ability to detect strikes). Collectively, the two resultant gear configurations work will be trialed by cooperative fishers to assess fisher acceptance and gear effectiveness in 2014-2015.

Deep-set operations

Deep-set fisheries for pelagic species have been used to increase target selectivity for nearly 40 years (Suzuki et al., 1977; Sakagawa et al., 1987). Although most deep-set operations are used to target tuna species (i.e., bigeye tuna, *Thunnus obesus*; Scombridae), deep-set fisheries for swordfish have also been shown to increase selectivity (Beverly and Robinson, 2004; Beverly et al., 2009). Although swordfish are targeted by deep-set operations around the world (Japan, Florida, Gulf of Mexico and the Mediterranean; Sepulveda et al., in press, Beverly and Robinson, 2004; Onada et al., 2006; NMFS, 2012), this study represents the first attempt to develop this type of fishery off the U.S. west coast. Although deep-set methods may entail added costs, with more time required to set and retrieve the gear compared to surface operations (Beverly and Robinson, 2004), it may be that these methods provide fishers with additional opportunities in locations where bycatch interactions prevent the development of more traditional fishery options (i.e., shallow-set long line).

Catch rates

The goal of the present study was to test and develop modified DSBG configurations for use by cooperative fishers in 2014-2015. Therefore estimates of catch per unit effort (CPUE) are not indicative of fishery potential, nor do they represent commercial catch rates given that various configurations were trailed during the study period. However, the present study did capture 11 swordfish during 2,590 hook hours suggesting that swordfish can be caught using the proposed methods. Further, the ratio of target to non-target catch suggests the trial gear to be relatively selective for swordfish

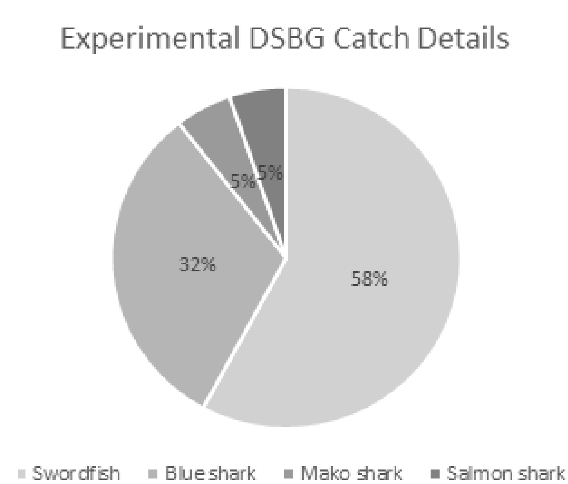

Figure 2. *A pie chart illustrating the catch associated with 12 days of deployment effort ((2,590 hook hours).*

(Fig. 2). Because species composition within the SCB changes throughout the year, it is probable that additional non-target species, such as opah and bigeye thresher sharks may also comprise a significant component of the catch. This is evident given that the initial experimental deployments of this work captured species that were not caught during the Fall trials. All of the non-target species encountered in this study are common in the CA DGN fishery, with opah and mako sharks providing valuable revenue as secondary and tertiary targets of the fishery (Hanan et al., 1993).

Future Research

This study provides the initial steps towards identifying new domestic swordfish fishery options for the U.S. west coast. Future research efforts will focus on cooperative fisher trials and include a robust assessment of catch details, which will include the effects on non-target species. In particular, efforts to quantify post-release survivorship for non-target species will be critical in assessing the impacts DSBG will have on non-target species of the SCB (i.e., blue shark, bigeye thresher shark).

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