Providing Domestically Caught U.S. West Coast Swordfish:

How to Achieve Environmental Sustainability and Economic Profitability

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Cover image: NOAA

Introduction

The California Current Large Marine Ecosystem off the U.S. West Coast is one of the richest temperate marine ecosystems in the world. Fueled by life-giving swarms of krill and forage fish like sardine and anchovy, these productive waters support a wide diversity of marine life including large and diverse populations of whales, dolphins, sea turtles and sea birds, as well as top ocean predators like white sharks, bluefin tuna and swordfish that come here to feed. The California Current ecosystem also supports many recreational and commercial fisheries. One of those fisheries, the U.S. West Coast drift gillnet swordfish fishery, is at a major crossroad.

Drift gillnets targeting swordfish are deployed at night amid this epicenter of ocean wildlife off California. This fishery is one of the dirtiest fisheries on the West Coast in terms of its overall bycatch rate and impact to protected marine life. The drift gillnet fishery must be heavily managed because its unselective fishing techniques result in the injury and death of rare and endangered species like sperm whales and leatherback sea turtles. Despite gear modifications and area closures to protect endangered sea turtles, major ecological concerns remain with the unacceptably high levels of bycatch associated with this fishing method. In addition, many fishermen have left the fishery and landings in California have decreased by 80 percent from 2000 to 2013.[1] Fortunately, however, there are other options that are cleaner and profitable ways to catch swordfish.

The federal Pacific Fishery Management Council is currently considering alternative swordfish fishing gears, including harpoon, shallow and deep-set longline, and deep-set buoy gear. If the gears demonstrate maximizing catch efficiency and minimizing bycatch, some of these methods have the potential to replace drift gillnets and revitalize West Coast commercial swordfish fishing. For the current drift gillnet swordfish fishery, the Pacific Fishery Management Council recently took action to implement hard caps designed to limit the take of nine species of whales, dolphins, and sea turtles. The Council also approved new monitoring requirements to be phased in by 2018, and a suite of performance metrics to reduce bycatch of other marine mammals and finfish slated to go into effect for the 2016-17 fishing season.

As fishery managers on the West Coast search for ways to boost waning regional swordfish catches, understanding the benefits and drawbacks of different gear types is essential. To that end, Oceana conducted a comparative analysis of the gear types utilized in North American swordfish fisheries, with recommendations for how alternative gear types can best replace drift gillnets. This analysis concludes with a transition plan for the drift gillnet fleet to deep-set buoy gear and harpoon gear that could lead to a clean and productive West Coast swordfish fishery.

Bycatch

Under federal U.S. law, the term “bycatch” refers to the discarded catch of marine life and unobserved mortality due to the direct interaction with fishing gear. Under the Magnuson Stevens Fishery Conservation and Management Act, Regional Fishery Management Councils and the National

Marine Fisheries Service have an ongoing responsibility to minimize and avoid bycatch.[2] As stated in the National Oceanic Atmospheric Administration (NOAA) National Bycatch Report:

> *Ensuring the sustainability of marine resources for future generations is the primary mission of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS). Reducing the unintentional capture, or bycatch, of fish, marine mammals, sea turtles, and seabirds is an essential part of this goal and is required under NMFS' guiding legislation*.[3]

Under the law, conservation and management measures are required to minimize and avoid bycatch. Bycatch should be avoided, but where it cannot be avoided, managers must work to minimize the mortality of bycatch. In some fisheries, like the West Coast swordfish fishery, different gear types can be used that are more selective, thus target species can be selectively caught, avoiding the take of non-target marine life in the first place.

The Drift Gillnet Fishery

Drift gillnets are a destructive fishing gear used off the California coast to catch swordfish and thresher sharks. The enormous nets, which can measure over a mile in length and two hundred feet deep, drift in the open ocean and indiscriminately entangle many forms of marine life. Due to this, drift gillnets have been internationally recognized as harmful. The practice is banned in the Mediterranean Sea and on the international High Seas. In the United States, domestic concerns over swordfish drift gillnet gear has led to prohibitions in Oregon, Washington and the U.S. Atlantic. [4,5,6] Despite widespread acknowledgement of the destructive nature of drift gillnets, the use of this fishing gear persists off California.

The California-based drift gillnet fishery is so wasteful that the fleet actually discards more animals than it retains. According to the NOAA Observer Program, from 2004 to 2014, the drift gillnet fishery discarded approximately 64 percent of all animals caught.[7] A few of the frequently discarded species include mola (ocean sunfish), blue sharks, pelagic stingrays, and shortfin mako sharks.

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[2] Magnuson Stevens Fishery Conservation and Management Act, 16 U.S.C. § 1853(a)(11).
[3] National Marine Fisheries Service. 2011. U.S. National Bycatch Report [W. A. Karp, L. L. Desfosse, S. G. Brooke, Editors]. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-117E, 508 p.
[4] PFMC. 2013, Status of the U.S. West Coast Highly Migratory Species Fisheries through 2013. Stock Assessment and Fishery Evaluation Report (SAFE).
[5] PFMC. 2011. Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species: As Amended Through Amendment 2.
[6] NMFS. 2013. Amendment 8 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Commercial Swordfish Management Measures. 2013.
[7] NOAA. 2015. West Coast Region Observer Program. http://www.westcoast.fisheries.noaa.gov/fisheries/wc_observer_programs/sw_observer_program_info/data_summ_report_sw_observer_fish.html

© NOAA, 1997. Short beaked common dolphin killed in a California swordfish drift gillnet. Its tail fin is cut off.

Estimated marine mammals and sea turtles caught in the DGN fishery from 1990-2013.

4,110	Dolphins
2,138	Seals and Sea Lions
500	Whales
306	Sea Turtles

Source: NOAA. 2015. West Coast Region Observer Program.

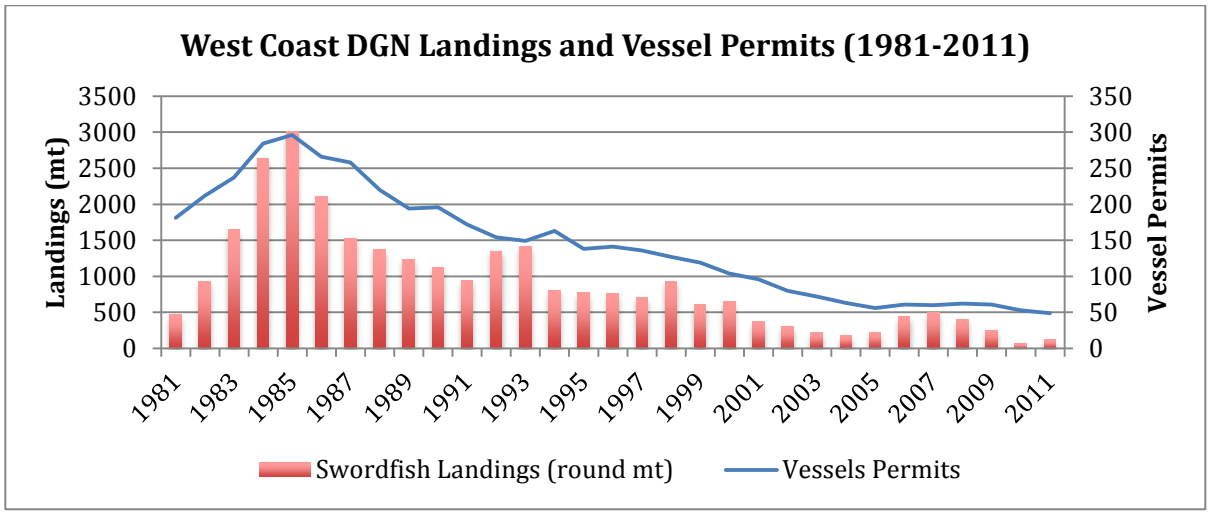
Since 1990, it is estimated that over 7,000 marine mammals and sea turtles have been caught in the California drift gillnet fishery.[8] In response to the take of marine mammals, bycatch reduction measures including buoy line extenders and acoustic pingers — devices that emit noise to keep marine mammals away from nets — were made mandatory in 1997. However, there have only been modest improvements in the fishery; from 1990 to 2000, a combined 13.7 marine mammals, sea turtles, and sea birds were caught per 100 drift gillnet sets. From 2004 to 2014, this number fell only marginally to 10.8 per 100 sets, a reduction of just 21 percent.[9] The National Marine Fisheries Service (NMFS) has assigned the fishery "Category I" status, signifying that marine mammals are frequently subject to serious injury or mortality.[10] Only six of more than 230 fisheries in the United States have earned this dubious distinction.[11] Today, an average of 90 marine mammal interactions are caused by the California drift gillnet fleet each year (2004-2014). A few of the protected species caught by the drift gillnet fleet include humpback, gray, and minke whales, bottlenose dolphins, Pacific white-sided dolphins, leatherback sea turtles, California sea lions, and Northern elephant seals.

Drift gillnets also threaten the existence of an entire population of endangered sperm whales living in the California Current ecosystem. In 2010, two sperm whales were observed caught by the California drift gillnet fleet. One of the whales was confirmed dead and the other whale sustained serious injuries that were likely to be fatal.[12] These mortalities exceeded the potential biological removal — the maximum number of deaths that the population can sustain and still recover — for the endangered whales under the Marine Mammal Protection Act.[13] The two sperm whale mortalities

[8] *Id.*
[9] *Id.*
[10] NMFS. 2014. List of Fisheries, 2014. Web. Last Accessed: October 19, 2015. http://www.nmfs.noaa.gov/pr/interactions/lof/final2014.htm
[11] Oceana, 2015. "Exposing California's Dirty Secret: The Truth about Drift Gillnets off our Coast." http://oceana.org/reports/exposing-california's-dirty-little-secret
[12] Carretta, James V., and L. Enriquez. 2012. Marine Mammal and seabird bycatch in California gillnet fisheries in 2010. NOAA Fisheries. Administrative Report LJ-12-01. https://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Programs/Coastal_Marine_Mammal/2010_Bycatch_Estimates_Carretta_Enriquez%20LJ-12-01.pdf
[13] NMFS. 2014. Recommendations from the Pacific Offshore Cetacean Take Reduction Team to Minimize Sperm Whale Interactions in the West Coast Swordfish Drift Gillnet Fishery. 2014. Agenda Item K.5.b. http://www.pcouncil.org/wp-content/uploads/K5b_NMFS_RPT_POCTRT_MAR2014BB.pdf

occurred in a set where an onboard observer noted that the acoustic pingers were functioning, both before and after the whales were killed.[14] NMFS estimated 16 sperm whales were injured or killed by the drift gillnet fleet in 2010 alone. Despite the efforts of fishery managers, bycatch reduction measures have failed to end the indiscriminate killing of marine life.

In addition to high levels of bycatch, participation and landings in the drift gillnet fishery are also declining. In California, annual landings by the drift gillnet fleet have declined since peaking at 2,198 metric tons (mt) in the mid-1980s.[15] In 2013, the California drift gillnet fleet landed approximately 61 mt.[16] Participation has also dropped precipitously; from 2000 to 2013 the number of drift gillnet permits that have been actively fishing declined by 84 percent, from 119 to just 19.[17]



West Coast DGN landings and vessel permits. Source: PFMC HMS SAFE 2012.

Exploring North American Swordfish Fisheries and Alternative Gears Used to Catch Swordfish

Alarmingly high levels of bycatch, frequent interactions with endangered and protected species, decreasing swordfish landings, and declining participation by fishermen, all signal that a transition from drift gillnets to clean gear types is needed. Fortunately, a number of other gear types are utilized in North American swordfish fisheries. Some of these gear types could help reestablish a productive West Coast swordfish fishery, while others might only exacerbate current problems. Exploring the methods used by other North American swordfish fisheries could demonstrate which alternative gears could help revitalize the West Coast swordfish fishery.

Harpoon Gear

[14] Carretta, James V., and L. Enriquez. 2012. Marine Mammal and seabird bycatch in California gillnet fisheries in 2010. NOAA Fisheries. Administrative Report LJ-12-01.
[15] PFMC. 2012, Status of the U.S. West Coast Highly Migratory Species Fisheries through 2011. Stock Assessment and Fishery Evaluation Report (SAFE).
[16] California Department of Fish and Wildlife (CDFW). 2014. Annual Marine Fisheries Report 2014.
[17] PFMC. 2014 HMSMT Report: Drift Gillnet Management. 2014. Agenda Item K.5.b. http://www.pcouncil.org/wp-content/uploads/K5b_HMSMT_DGN_MAR2014BB.pdf

In **California**, archeological records show that harpoon fishing for swordfish has been practiced for nearly 3,000 years.[18] While technologies have certainly changed, the fundamentals remain the same. To catch swordfish, fishermen spot the swordfish finning, jumping, or basking near the surface, and strike the fish with a harpoon that is attached to a buoy.

California's modern day swordfish harpoon fishery first developed in the early 1900s. Logbook records from 1974 to 1993 indicate that 74 percent of pursued swordfish were harpooned and 91 percent of the harpooned swordfish were landed.[19] Harpoon gear was once a major contributor to the West Coast swordfish fishery and in 1978 over 300 vessels made nearly 1,700 mt in landings.[20] However, after drift gillnets were authorized by the California legislature as a legal gear type, many harpoon vessels converted to drift gillnets and harpoon participation and landings waned. In 2014, only six mt of swordfish were landed on the West Coast using harpoon gear.[21] The harpoon fishery is considered highly selective and there is near zero bycatch associated with the fishery.[22] However, it is estimated that nine percent of the swordfish that are struck by harpoons are not landed, possibly sustaining fatal injuries.[23] The California harpoon fishery has no documented incidents of marine mammal bycatch.[24]

There is also a **Canadian** harpoon fishery operating in the Atlantic that is allotted just 10 percent of the Canadian national swordfish quota. Holders of type "A" harpoon licenses, which receive the vast majority of the quota, were able to produce their full quota in seven of the eight years from 2002 to 2009.[25] From 2000 to 2013, an average of over 172 mt was landed by harpoon gear in Canada.[26] Like the California harpoon fishery, the Canadian harpoon fishery is clean; there is no bycatch associated with the fishery and there are no expected interactions with endangered or protected species.[27] The Canadian harpoon fishery's steady production for over a decade shows that modern harpoon fisheries can be financially and ecologically viable.

[18] Kronman, M. 1988. Harpooning: slow but steady improvements in the technology of a timeless skill. Natl. Fisherman, August, p. 5357, as in, Coan Jr, A.L., Vojkovich, M., Prescott, D. 1998. The California Harpoon Fishery for Swordfish, *Xiphias gladius*.
[19] Coan Jr, A.L., Vojkovich, M., Prescott, D. 1998. The California Harpoon Fishery for Swordfish, *Xiphias gladius*.
[20] *Id.*
[21] PFMC 2015. HMS SAFE Table 16. http://www.pcouncil.org/wp-content/uploads/HMS-SAFE-Table-16.htm
[22] California Ocean Science Trust. 2013. Rapid Assessments for Selected California Fisheries. http://opc.ca.gov/webmaster/ftp/project_pages/Rapid%20Assessments/CA%20Rapid%20Assessments.pdf
[23] Coan Jr, A.L., Vojkovich, M., Prescott, D. 1998. The California Harpoon Fishery for Swordfish, *Xiphias gladius*.
[24] NMFS. 2014. List of Fisheries, 2014. Web. Last Accessed: October 19, 2015.
[25] Intertek Moody Marine (IMM). 2010. North Atlantic Swordfish Canadian Harpoon Fishery Public Certification Report.
[26] ICCAT. 2015. ICCAT Database. Web. Last Accessed: October 20, 2015.
[27] Intertek Moody Marine (IMM). 2010. North Atlantic Swordfish Canadian Harpoon Fishery Public Certification Report.

Shallow-set Longline

© NOAA, 2013. An endangered Pacific leatherback sea turtle ensnared by a Hawaii-based shallow-set longline.

A shallow-set longline consists of a mainline that can measure up to 60 miles long, attached to hundreds or thousands of baited hooks. Shallow set gear is set from dusk until dawn when targeting swordfish. The **Hawaii-based** shallow-set longline fleet is required to use circle hooks and mackerel-type bait, which have been effective at reducing sea turtle interactions. However, this fishery remains problematic; since reopening in 2004, the fishery has been forced to close twice due to interactions with endangered loggerhead and leatherback sea turtles. From 2007 to 2013, the fleet also caught 520 sea birds, 59 marine mammals, and 113 sea turtles.[28] From 2007 to 2013, on board observers noted that 44 percent of the animals caught by this fishery were discarded, often dead or dying.[29]

The **U.S. Atlantic** shallow-set longline (SSLL) fishery targets primarily swordfish and tunas. Swordfish caught in the Atlantic Ocean are subject to minimum size requirements and undersized fish must be released.[30] These size regulations are intended to protect juvenile fish, allowing them to grow and reproduce. However, as a result of being caught underwater for hours, hooked juvenile swordfish have little chance at survival. In the Atlantic shallow-set longline fishery, between 2005 and 2011, 71 percent of the swordfish discards were released dead.[31] Like the California drift gillnet swordfish fishery, the Atlantic SSLL fishery has been classified by NMFS as "Category I" under the Marine Mammal Protection Act due to the frequent serious injury or mortality of marine mammals.[32] In 2012, NMFS estimated that the fishery caught 413 marine mammals, 1,006 leatherback sea turtles, and 681 loggerhead sea turtles.[33] From 2005 to 2011, the Atlantic SSLL fishery's catch (not including the Gulf of Mexico and Caribbean) had a 49 percent discard rate and only 17 percent of the total catch was comprised of retained swordfish.[34]

Canada's swordfish fisheries are exclusive to the Atlantic coast and 100 percent of Canadian swordfish catch is exported to the United States.[35] This fishery catches an estimated 1,200

[28] NOAA. 2014. Pacific Islands Regional Office Observer Program. Hawaii Longline Shallow-set Quarterly and Annual Status Reports. http://www.fpir.noaa.gov/OBS/obs_hi_ll_ds_rprts.html
[29] NMFS. 2015. Hawaii Shallow-set Longline Data (2007-2013). Unpublished data.
[30] NOAA. 2014. NOAA Highly Migratory Species Commercial Compliance Guide. http://www.nmfs.noaa.gov/sfa/hms/compliance/guides/documents/hms_commercial_compliance_guide_april_2014__print_.pdf
[31] MRAG. 2013. MSC Public Certification Report for US North Atlantic Swordfish Pelagic Longline and Handgear Buoy Line Fishery.
[32] NMFS. 2014. List of Fisheries, 2014. Web. Last Accessed: October 19, 2015.
[33] NMFS. 2014. Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic Highly Migratory Species.
[34] MRAG. 2013. MSC Public Certification Report for US North Atlantic Swordfish Pelagic Longline and Handgear Buoy Line Fishery.
[35] Department of Fisheries and Oceans, Canada. 2014. "Swordfish: Species at a glance" Last Accessed October 19, 2015. http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/swordfish-espadon-eng.htm

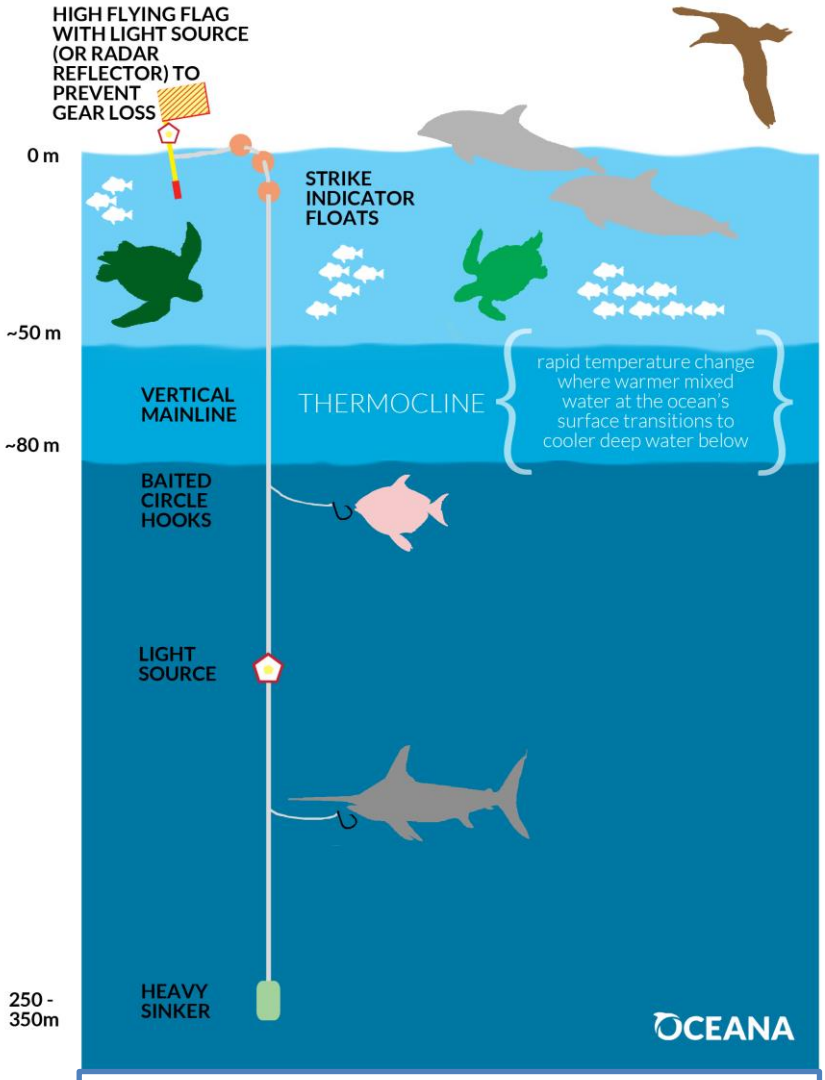
loggerhead sea turtles and 100,000 sharks per year.[36] The fishery also catches over eight sensitive species (marine mammals, sea turtles, and sea birds) for every 100 retained swordfish it lands; this is a higher rate than any of the other fisheries assessed in this report. Observer data shows that 51 percent of the catch was discarded between 2002 and 2009.[37] Despite a staggering amount of bycatch in the Canadian SSLL fishery, the fleet is allotted 90 percent of the national swordfish quota.

Deep-Set Buoy Gear

In 2006, a deep-set buoy gear fishery was established on the **U.S. Atlantic Coast**. There, fishing takes place at night, with one to two hooks attached to each buoy. Buoys are deployed and retrieved by hand and a vessel will normally deploy 11 to 14 buoys per trip. Between 2007 and 2012, the number of vessels participating in the fishery increased from 42 to 55.[38] Landings from logbook records show that the catch composition during that time period was over 90 percent swordfish.[39] Atlantic buoy gear is also subject to minimum size requirements for swordfish, but because buoy gear is constantly monitored, hooked bycatch is quickly landed and released; subsequently the fishery has very low rates of bycatch mortality. According to logbook records, between 2007 and 2012, 92 percent of the swordfish discarded were released alive.[40] This means that high numbers of released juvenile swordfish may grow large enough to reproduce. The buoy gear fishery has low bycatch interaction rates and NMFS has determined that the likelihood of buoy gear injuring marine mammals and protected species is remote.[41]

[36] Christian, Claire, et al. 2013. "A review of formal objections to Marine Stewardship Council fisheries certifications." *Biological Conservation* 161: 10-17.
[37] Intertek Moody Marine (IMM). 2011. North Atlantic Swordfish Canadian Pelagic Longline Fishery. Volume 1: Final Report and Determination.
[38] NMFS. 2014. Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic Highly Migratory Species.
[39] *Id.*
[40] *Id.*
[41] NMFS. 2013. Amendment 8 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Commercial Swordfish Management Measures. 2013.

Deep-Set Buoy Gear



Deep-set buoy gear targets swordfish and secondary species like opah, thresher sharks, and mako sharks below the thermocline during the daytime, depths that greatly reduce interactions with marine mammals and sea turtles.

Recently, researchers have begun testing new swordfish fishing gears in **California**. One of these experimental gear types, deep-set buoy gear, is modeled on the commercially successful swordfish fishery in the Atlantic Ocean. Each buoy is connected to a single vertical line with only two to three branch lines and baited hooks. The gear is deployed at depths between 250m and 350m during the daytime, beyond where species like sea turtles frequently swim. Initial results from the deep-set buoy gear trials in California are promising.

From 2011 to 2014, more than 90 percent of fish caught in deep-set buoy gear off California were marketable species, there were few discards, no sea turtle takes, and only one marine mammal interaction. The catch was primarily swordfish (approximately 60 percent), followed by opah

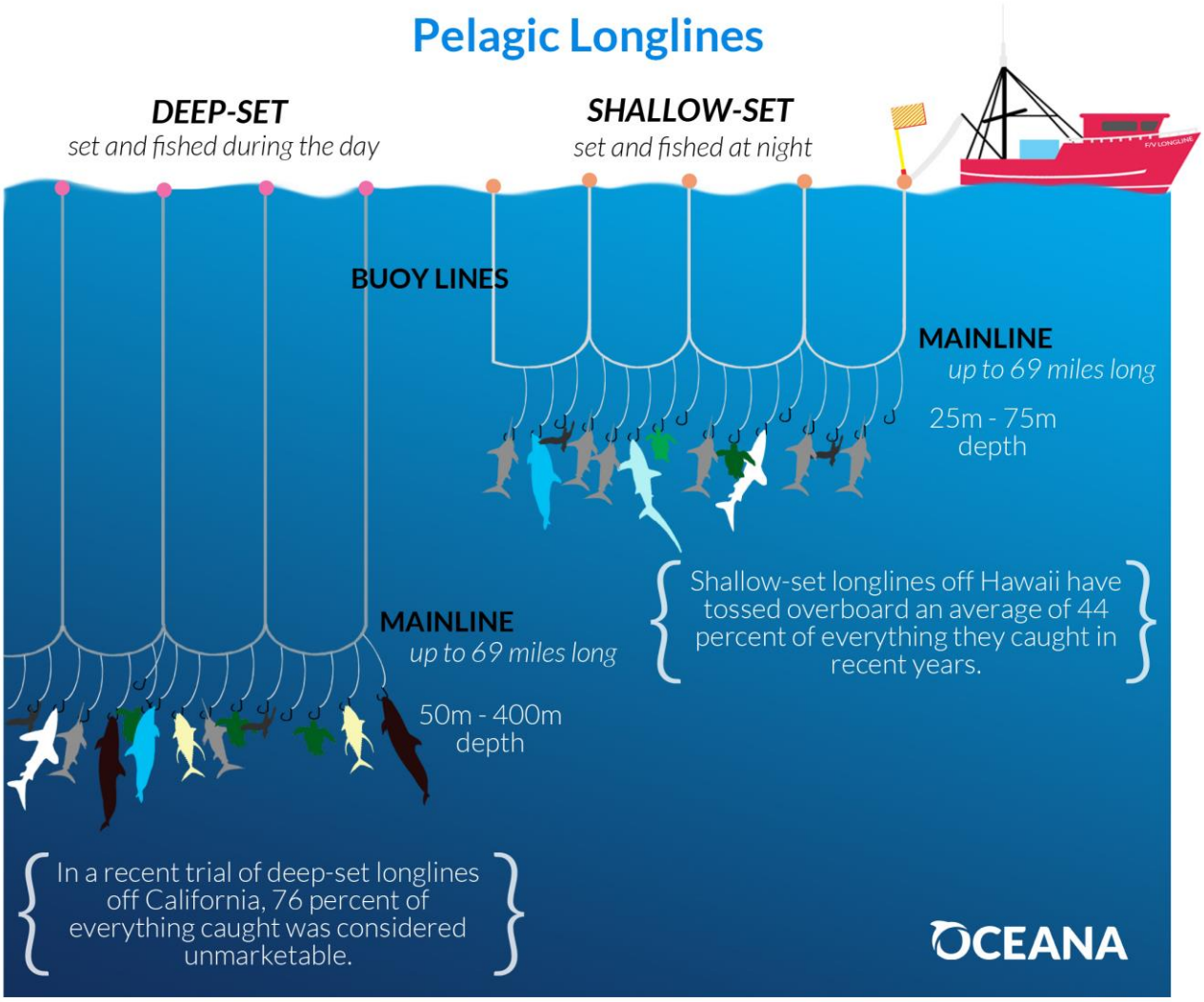
(approximately 20 percent), and the remainder was various shark species (mako, common thresher and bigeye thresher).[42]

Unlike many other gear types, deep-set buoy gear is actively tended by fishermen, and when a bite is detected the gear is immediately hauled in; this means that if bycatch is captured, it can be released quickly with a high probability of post-release survival. In fact, during the deep-set buoy gear trials, all of the non-marketable species captured were released alive.[43] Swordfish caught by deep-set buoy gear will be a higher value product pound for pound than drift gillnet or pelagic longline caught swordfish (imported and domestic), due to greater freshness, quality, and market demand for sustainable seafood. Initial market research in California indicates that deep-set buoy gear swordfish is likely to garner a market price similar to harpoon-caught swordfish, which is currently approximately $8.75 per pound. In 2011, ex-vessel prices for harpoon-caught swordfish were greater than twice that of drift gillnet swordfish[44]. A higher market price for selective gear increases its profitability and economic viability. Switching to deep-set buoy gear may involve initial transition costs, with more time required to set and retrieve the gear relative to deploying a drift gillnet. Deep-set buoys, however, may provide fishermen with additional opportunities to fish in locations that are off limits to drift gillnets per existing regulations and where pelagic longlines are banned due to bycatch interactions[45]. High levels of targeted catch and low levels of discard mortality make deep-set buoy gear an encouraging choice to be further explored on the West Coast. The PFMC and NMFS approved Exempted Fishing Permits for seven vessels to commercially fish deep-set buoy gear off California beginning in 2015.

Deep-set longline

An alternative experiment using deep-set longline gear was recently conducted off **California**. The initial results are discouraging. Just 24 percent of the catch was marketable species and less than 2 percent of the total catch was swordfish.[46] Deep-set longline gear is similar to shallow-set longline gear, however deep-set longlines are deployed at greater depths. The low percentage of target catch along with high bycatch rates make deep-set longline gear a poor choice for the West Coast swordfish fishery.

[42] Exempt Fishery Proposal Application for Deep-Set Buoy Gear. Pfl eger Institute of Environmental Research. February 2015. http://www.pcouncil.org/wp-content/uploads/H3a_Att2_PIER_MAR2015BB.pdf
[43] *Id.*
[44] Sepulveda, C. et al. 2015. PIER Exempt Fishery Proposal Application for Deep-Set Buoy Gear. Agenda Item H.3.a. http://www.pcouncil.org/wp-content/uploads/H3a_Att2_PIER_MAR2015BB.pdf
[45] Sepulveda et. al. Testing Modifi ed Deep-Set Buoy Gear to Minimize Bycatch and Increase Swordfish Selectivity. 2014.
[46] Dewar, H., Kohin, S. 2014. Deep-Set Longline Study. Agenda Item K.5.b. NMFS SWFSC Report. http://www.pcouncil.org/wp-content/uploads/K5b_NMFS_SWFSC_ALTERNATIVE_GEAR_MAR2014BB.pdf



Both shallow-and deep-set longlines off Hawaii discard important and iconic marine life accidentally caught during fishing, including sea turtles, sharks, whales, albatrosses, and dolphins.

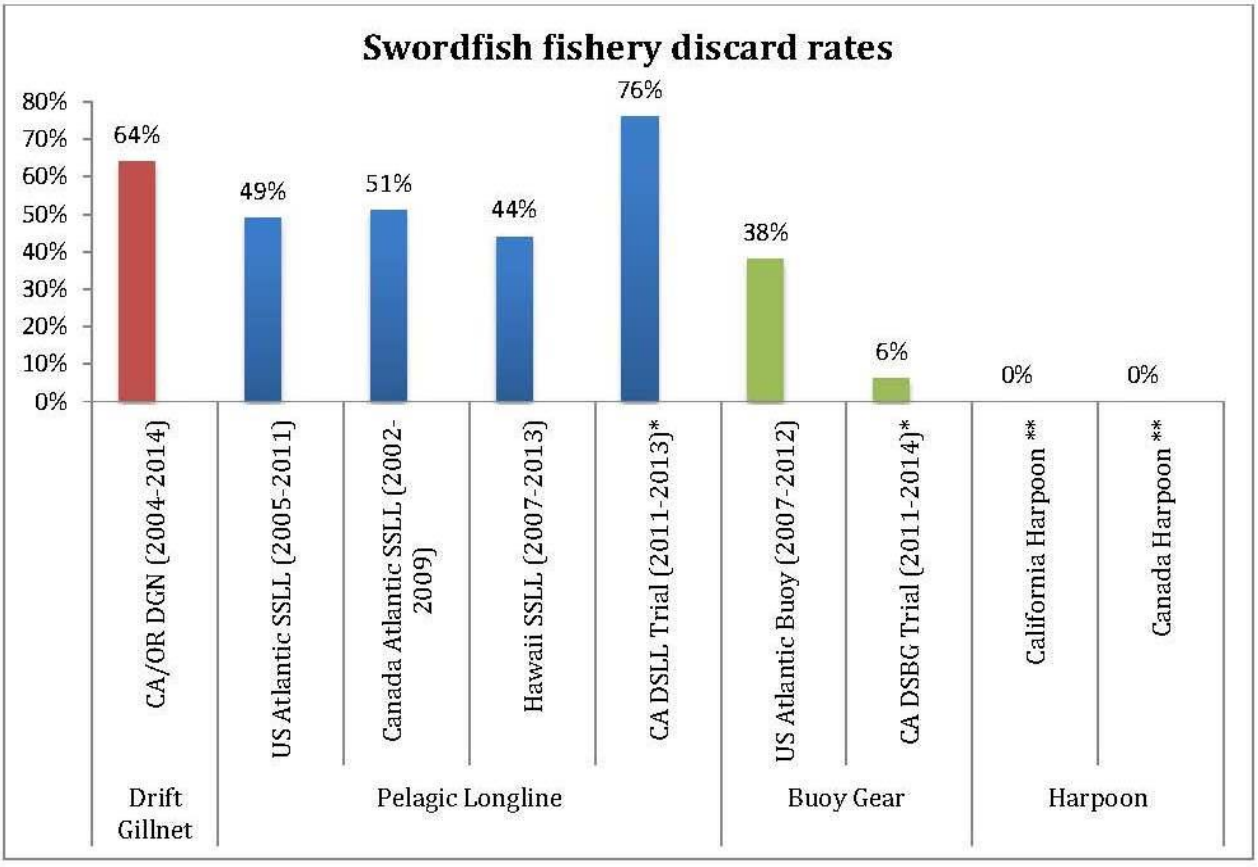
Comparison of Swordfish Fisheries

A comparison across swordfish fisheries can show us which gear types may be best suited to transition the West Coast swordfish fishery to clean and sustainable methods. For this analysis we compared discard rates, discard mortality, percentage of total catch that is swordfish, and sensitive species caught per retained swordfish across North American swordfish fisheries. These metrics were selected because they help address current concerns in the fishery regarding total catch and selectivity. When compared, these data help elucidate the best choice for a clean and productive swordfish fishery on the West Coast.[47]

[47] Note: The sources for all data used in these comparisons can be found in the references section. Data that was collected by onboard observers has been used (to the extent available) for the purposes of this analysis.

Discard Rate

The discard rate measures the percentage of the total catch that is discarded. Discards can be alive or dead and include undersized target catch, non-target species, or even protected species. The drift gillnet fishery has the highest discard rate of any of the commercial fisheries assessed. During a ten-year period from 2004 to 2014, the drift gillnet fishery discarded 64 percent of its catch. Data revealed that commercial longline fisheries also have high discard rates, ranging from 44 percent to 51 percent. For the experimental fisheries (deep-set longlines and deep-set buoy gear) non-marketable species have been used as a proxy for discards because non-marketable species have no economic value and are likely to be discarded. The California deep-set longline fishery's catch was comprised of an astounding 76 percent non-marketable species. The California deep-set buoy gear trials revealed that only six percent of the catch was non-marketable species and the harpoon fisheries are estimated to have a discard rate of zero.

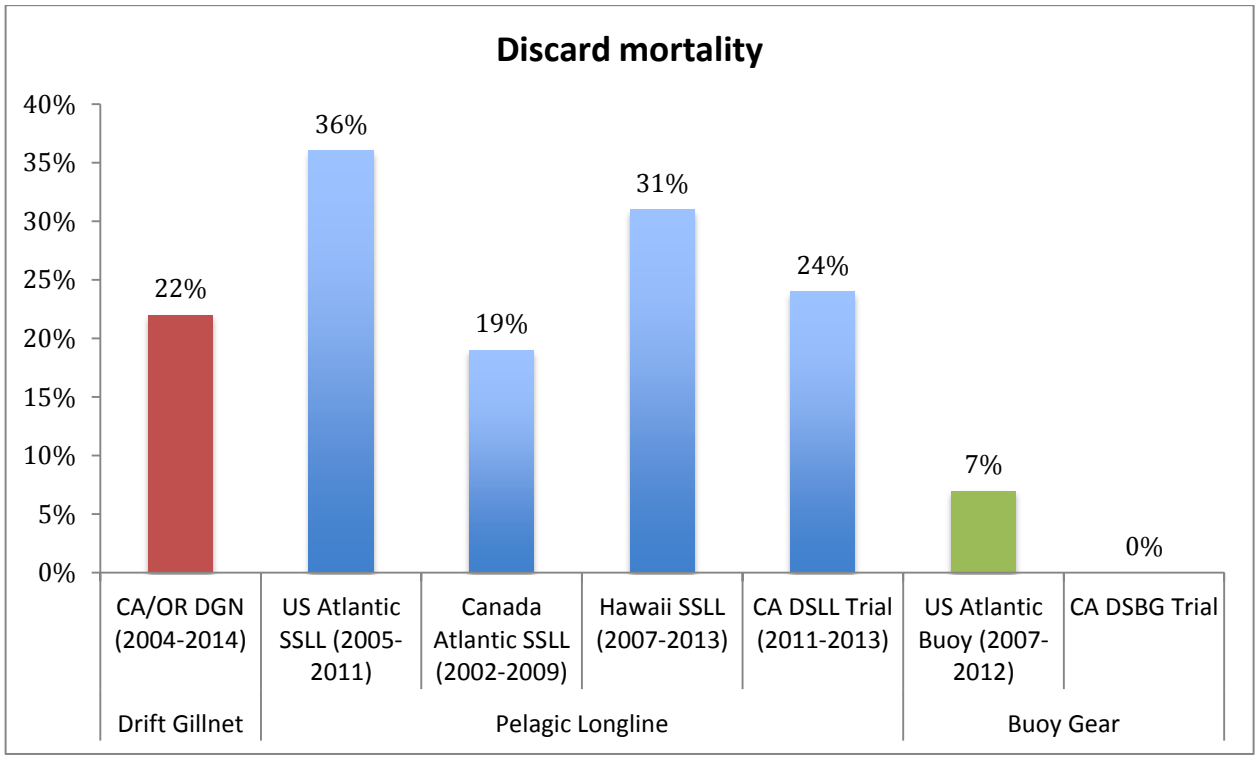


* Non-marketable species were assumed to be discards.
** Estimates based on Coan et al, 1998.

Discard Mortality

Not all discards are released dead. Discard mortality measures the percentage of discards that are discarded dead, injured, or in an unknown state. Data shows that of the swordfish fisheries analyzed, those utilizing shallow-set longline gear, deep-set longline gear, and drift gillnets performed the worst. These gears are normally passively fished for many hours at a time; as a result, animals that

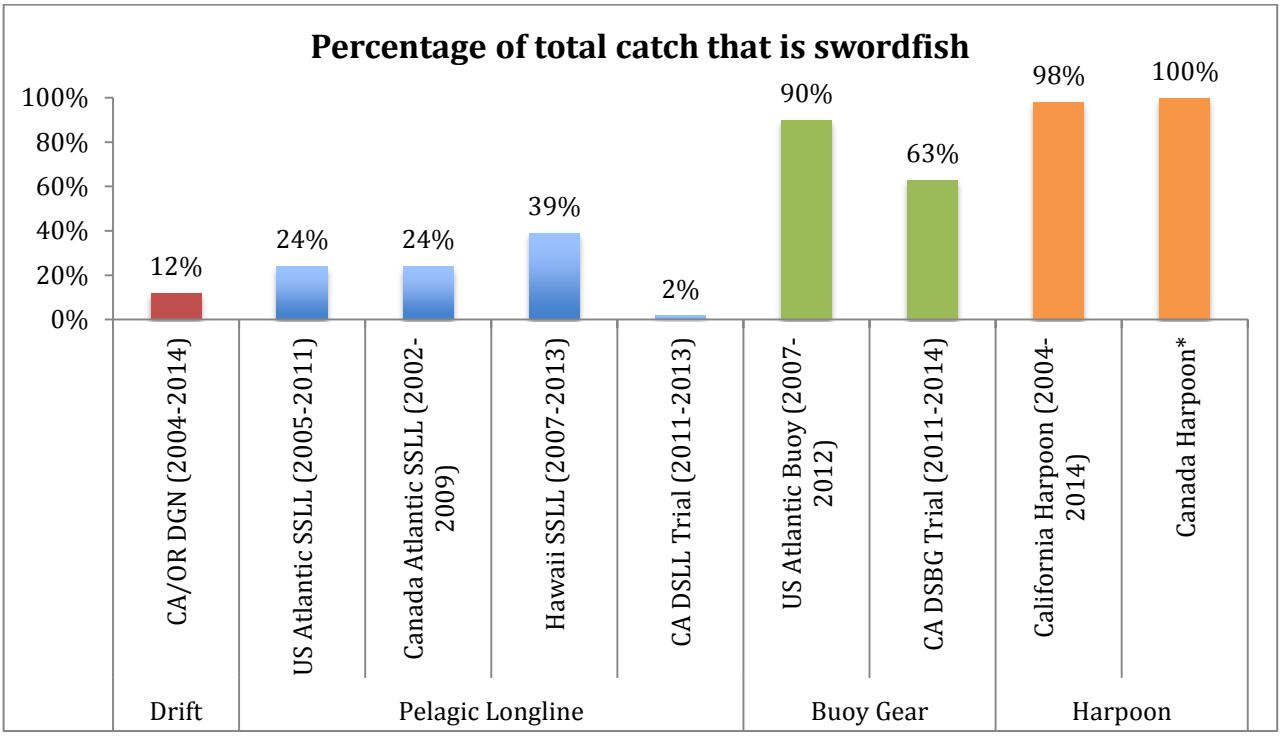
are caught in the nets or longlines are often trapped beneath the surface for hours. In contrast, buoy gear is actively monitored, meaning that bycatch can be quickly released, greatly improving the chance of survival. Another important note about discard mortality is that it is not inclusive of post-release mortalities. The process of being caught in nets or on hooks can be traumatic. Some animals that are released may live for several hours or days before succumbing to injuries. Due to insufficient species-specific scientific studies, these post-release mortalities are difficult to calculate and are not counted in discard mortality estimates, thus the figures for discard mortality likely underrepresents total mortality.



Note: Discards with a status of "unknown" or "injured" are counted as mortalities.

Percentage of the Total Catch that is Swordfish

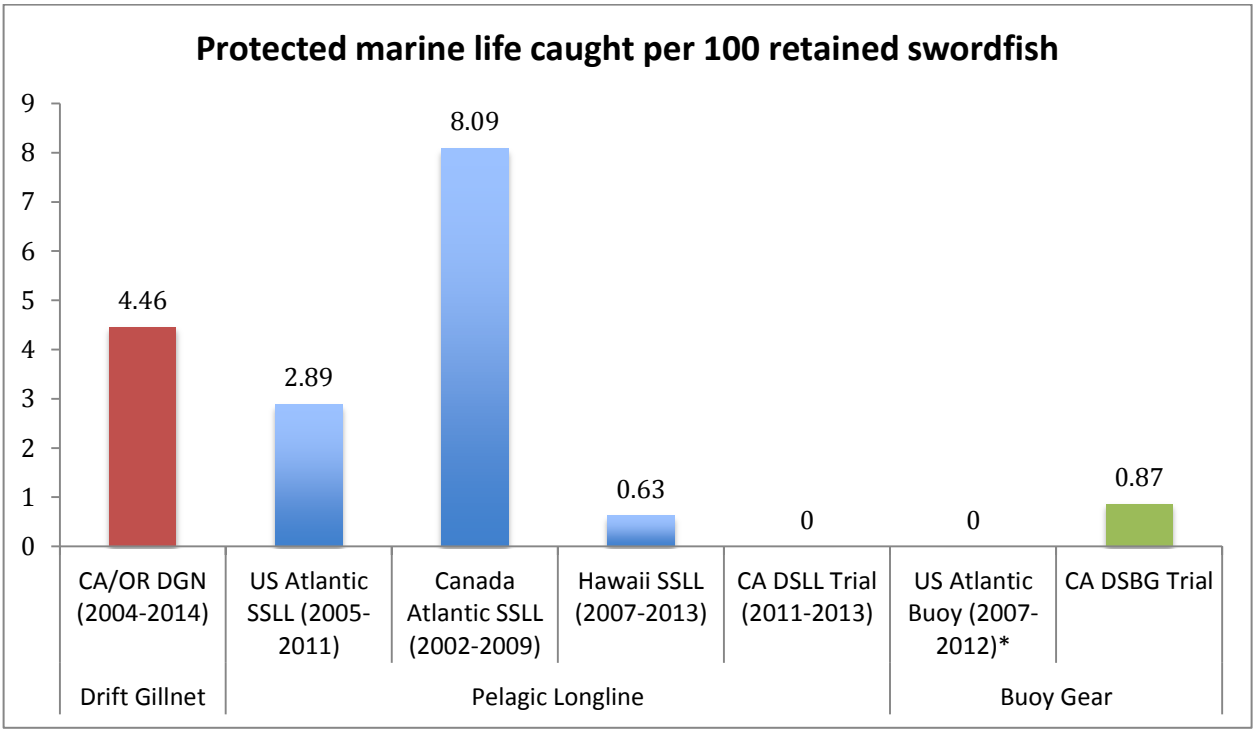
Maximizing the catch of the target species is critical to the productivity and profitability of a fishery. The ability to catch the target species — in this case swordfish — is also a strong indicator of a gear's efficiency. In the drift gillnet fishery only 12 percent of the animals caught were swordfish — the lowest number of any commercial fishery analyzed. Commercial longline gears performed better, with swordfish comprising between 24 percent and 39 percent of the total catch. The California DSBG trials resulted in a catch composition of 63 percent swordfish, and the commercially successful Atlantic buoy gear fishery is comprised of an astounding 90 percent swordfish. Notably, 98 to 100 percent of the harpoon catch is swordfish.



California harpoon data from 2015 HMS SAFE Table 16 http://www.pcouncil.org/wp-content/uploads/HMS-SAFE-Table-16.htm
* Based on estimates from Coan et al, 1998.

Comparing the Bycatch of Protected Marine Life to Retained Swordfish

Comparing the bycatch of protected marine life (marine mammals, sea turtles, and seabirds) with the amount of retained swordfish is a measure of the overall impact of a swordfish fishery on sensitive and important species adjusted for the amount of swordfish landed. The graph below answers the question: for every 100 swordfish kept, how many interactions did the fishery have with protected species? The highest proportion of protected species per 100 retained swordfish was recorded by the Canadian SSLL fishery, which caught over eight marine mammals, seabird or sea turtles per 100 retained swordfish.



* Based on data from Fisheries Logbook System in NMFS, 2014 and observer data from Kerstetter, 2009.

Transitioning the West Coast Swordfish Fishery to Deep-set Buoy Gear and Supplementing with Increased Harpoon Gear

The bycatch comparisons in this report show that drift gillnet gear is one of the most destructive methods for catching swordfish among North America's swordfish fisheries. Concerns over high discard rates, frequent interactions with protected species, and waning landings and participation demonstrate a need to transition from drift gillnets to selective fishing methods.

Shallow-set longlines, a gear type that is banned off the West Coast, is not a solution as it would only create a new suite of bycatch problems including additional takes of several endangered species. Data from SSLL fisheries in Hawaii, the U.S. Atlantic, and Canada, clearly show that pelagic longlines would do little to solve the bycatch issues that are pervasive in the California swordfish drift gillnet fishery. Like the swordfish drift gillnet fishery, the SSLL fishery in the Atlantic has been assigned "Category I" status and there is no reason to authorize another high bycatch gear type.

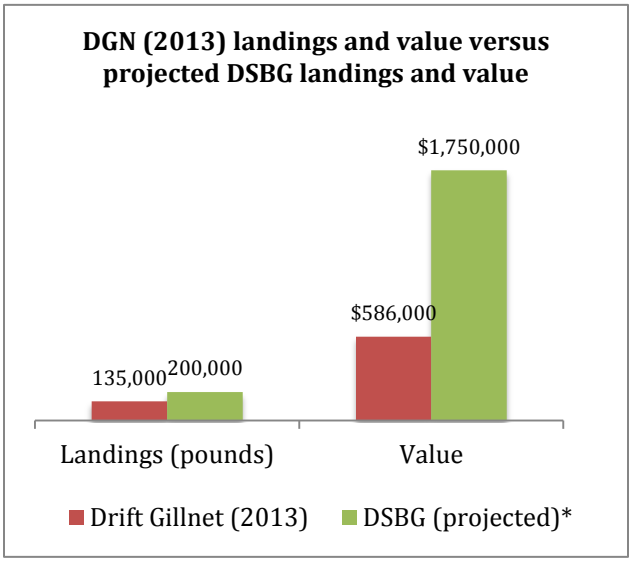
Deep-set longlines are also an unacceptable alternative. The DSLL trials in California have shown that less than 2 percent of the total catch is actually comprised of swordfish. Furthermore, the only other "Category I" fishery in the Pacific besides the West Coast drift gillnet fishery, is the DSLL tuna fishery based out of Hawaii. A commercial DSLL fishery on the West Coast would only exacerbate current bycatch issues. Although drift gillnets and longlines are poor choices for targeting swordfish, the West Coast swordfish fishery still has two excellent options: deep-set buoy gear and harpoon gear.

Deep-set Buoy Gear

Why deep-set buoy gear should replace drift gillnets: Buoy gear is efficient and catches a high percentage of swordfish. In the deep-set buoy gear trials conducted off California, 62.5 percent of the catch was swordfish, compared to only 12 percent in the California drift gillnet fishery. In the Atlantic buoy gear fishery, 90 percent of the total catch is swordfish. Buoy gear is also highly selective. Both in the California trials and the Atlantic fishery, no marine mammals, birds, or sea turtles were killed or seriously injured. One of the major advantages of buoy gear is that it is actively monitored. Once a bite is detected, the gear is hauled in, meaning that bycatch is expected to be primarily released alive. In the Atlantic buoy gear fishery between 2007 and 2012, 92 percent of the swordfish discards were discarded alive. Based on 100 percent live discards in trials thus far, a commercial California deep-set buoy gear fishery should expect the same positive results.

Why deep-set buoy gear can replace drift gillnets: The Atlantic buoy gear fishery and the recent deep-set buoy gear trials in California have shown that buoy gear is productive and clean. Since its inception, participation and landings in the Atlantic buoy gear fishery have remained steady or increased, while maintaining low levels of bycatch, proving that buoy gear is commercially sustainable.

The prospects for economic success in a commercial deep-set buoy gear fishery in California are promising. It is expected that swordfish landed with deep-set buoy gear will attain high ex-vessel prices, similar to that of harpoon gear, due to freshness and quality of the landed catch. In 2014 deep-set buoy gear trials, dressed (headed and gutted) swordfish fetched an ex-vessel price of $8.75 per pound compared to $4.34 per pound for drift gillnet caught swordfish.[48] This premium price-point suggests that even if deep-set buoy gear landings are lower than drift gillnet landings, fishermen can earn profits due to markedly higher price points.



Source: CDFW, 2014. Annual Marine Fisheries Report 2014; Exempt Fishery Proposal Application for Deep-set Buoy Gear.
* Projection is based on a 20-vessel fleet fishing 50 days per season.

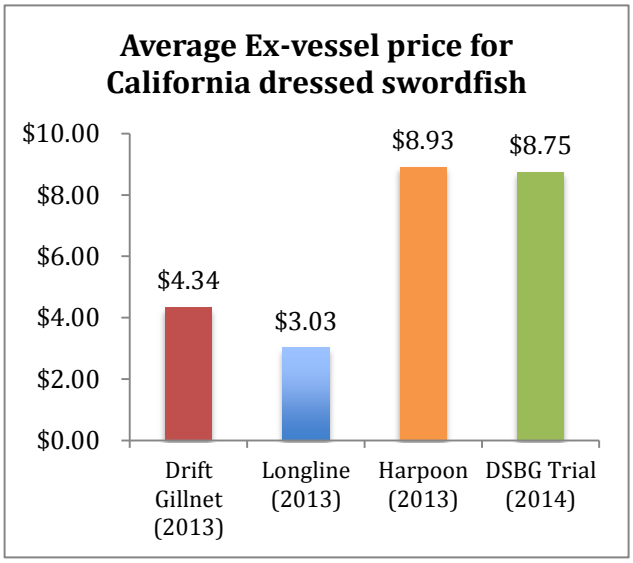
Based on data from the 2014 deep-set buoy gear trial, expenses for a two-person deep-set buoy gear operation should average $500 per day. A crew landing one average sized swordfish (200 lbs dressed weight) per day and selling at the average ex-vessel price ($8.75/ lb) for deep-set buoy gear, could expect to earn $1,250 per day in profit, or $62,500 over a 50-set season.[49] A fleet of 20 deep-set buoy gear equipped boats making 50 sets each per season could land 200,000 lbs of swordfish valued at $1.75 million ($1.25 million net profit). In comparison, the 2013 drift gillnet fleet landed just 135,000 lbs of swordfish valued at $586,000.[50] These promising ecological and economic indicators suggest that deep-set buoy gear has the potential to reinvigorate the West Coast commercial swordfish fishery. Continuing research on deep-set buoy gear is necessary, however the

[48] Sepulveda, C. 2015. Exempt Fishery Proposal Application for Deep-set Buoy Gear.
[49] *Id.*
[50] California Department of Fish and Wildlife (CDFW). 2014. Annual Marine Fisheries Report 2014

initial trials, along with proven commercial success in the Atlantic, shows that buoy gear is a viable commercial alternative to drift gillnet gear.

Harpoon Gear

Why harpoon gear can further increase sustainable West Coast swordfish landings: Harpoon fishing is an extremely selective method that produces little to no bycatch. Skilled harpoon fishermen can target and land swordfish with precision, making it one of the cleanest gear types available. In addition, consumer demand for harpoon caught swordfish is high and customers are willing to pay for sustainably caught, high quality swordfish. In 2013, California harpooned dressed swordfish held an average ex-vessel price of $8.75 per pound — over double the price of swordfish caught in drift gillnets and nearly triple that of longline-caught swordfish.[51] There are also opportunities for significant cost savings over other gear types such as drift gillnets and shallow-set longlines, which often require onboard observers to monitor fishing due to high levels of bycatch. Harpoon vessels do not require observers, saving the fleet considerable expense including the management costs associated with the observer program.



Source: CDFW, 2014. Annual Marine Fisheries Report 2014; Sepulveda, 2015. Exempt Fishery Proposal Application for Deep-set Buoy Gear.

Why harpoon gear can complement the deep-set buoy gear fishery: Harpoon landings reached a historic high in 1978, when 1,699 mt were landed in California.[52] However, since the introduction of drift gillnets, the harpoon fishery has seen declining participation and production. The harpoon fishery landed 24 mt in 2011 and just 4.2 mt in 2013.[53,54]

In recent years, however, it is not just harpoon caught swordfish that has been low. In 2013, California's swordfish drift gillnet fishery landed only 61 mt.[55] Because swordfish fishing with harpoon gear does not incur bycatch, harpoon gear isn't subject to time and area closures or other management safeguards like those needed to limit bycatch in the drift gillnet fishery. In other words, acting responsibly by fishing with clean gear types comes with the benefit of fewer management measures and more flexibility. Further, phasing out drift gillnet gear all together would help shift fishing effort to other legal gear types like harpoon, and encourage a rise in harpoon landings.

The main concern with the harpoon swordfish fishery is that it is only possible during certain ocean conditions where swordfish are basking at the surface, which makes it a less dependable fishing

[51] *Id.*
[52] Ito, R., Coan, I. 2007. U.S. Swordfish Fisheries in the North Pacific Ocean. ISC Billfish Working Group Workshop.
[53] *Id.*
[54] PFMC. 2012, Status of the U.S. West Coast Highly Migratory Species Fisheries through 2011. Stock Assessment and Fishery Evaluation Report (SAFE).
[55] California Department of Fish and Wildlife (CDFW). 2014. Annual Marine Fisheries Report 2014.

technique if fished on its own. However, during certain periods, it can be extremely productive and could therefore be a supplement to increase swordfish landings if opportunistically fished in tandem with deep-set buoy gear.

It is unknown if harpoon landings may once again peak to historic levels seen in the 1970s, but if California can encourage the resurgence of the once robust harpoon fishery, harpoon gear could provide a valuable complement to deep set buoy gear landings.

The Next Step: A Drift Gillnet Transition Plan

Oceana recommends a *transition plan for the West Coast swordfish fishery that phases out and prohibits drift gillnets within a time-certain period, while authorizing and incentivizing deep-set buoy gear and additional harpoon effort***.** We envision a transition plan that would build on interim measures to limit and control bycatch in the drift gillnet fishery, such as hard caps and area closures, and continued exempted fishing permits for deep set buoy gear experimentation. Then beginning in 2017, swordfish permits would be modified to allow for drift gillnets, harpoons, and deep set buoy gear under a multi-use permit. Financial incentive packages and options should be developed for active drift gillnet fishermen, giving them the choice to (1) trade-in their drift gillnets for deep-set buoy gear (2) exit the fishery, or (3) practice using deep-set buoy gear along with drift gillnet gear under the multi-use permit option. While harpooning is already allowed, additional incentives to promote additional use of this gear could be offered. After a three year period of DSBG use by fishermen, by 2020 — adequate time to learn to use deep-set buoy gear profitably and consistently — drift gillnet gear would be banned.

Transition Plan — Main elements

1) *Phase out and prohibit drift gillnets over a time-certain period.*

   Establishing a timeline for the phase out will allow the remaining swordfish drift gillnet fleet to plan their transition to clean gear types immediately.

2) *Require 100 percent observer coverage and establish hard caps on bycatch in the drift gillnet fishery during the transition period.*

   Drift gillnet fishing during this transition period continues to risk high bycatch levels and risks injuring and killing endangered and threatened species. Therefore instituting hard caps will ensure that immediate action is taken if interaction limits are reached. Existing conservation measures including the Pacific leatherback and loggerhead conservation areas must be maintained during this transition period.

3) *Do not support attempts to replace drift gillnets with gear types that are similarly destructive.*

   Proposals to re-establish damaging fishing gears such as a California-based shallow-set or deep-set longline fishery should be rejected.

4) *Expand and promote the use of deep-set buoy gear and harpoon gear.*

   Results from California testing and the experience in the Atlantic demonstrate that buoy gear has the potential to develop into a clean and viable fishery off the West Coast that can increase total landings above current levels. The continued research and development of buoy gear will allow for the swift authorization as an allowable gear type in the West Coast Highly Migratory Species Fishery Management Plan and inform any necessary management measures. A successful transition to deep-set buoy gear and harpoon gear will require cooperation among fishermen, fisheries managers, seafood markets and other stakeholders. Exchanging information on swordfish behavior, optimal harpoon gear, and effective harpoon techniques will give this fishery the best chance of success. Establishing a transition fund to support further testing and gear conversion will accelerate this process and provide economic incentives for fishermen to adopt new techniques.

5) *Implement the import provisions of the Marine Mammal Protection Act and ban swordfish imports from countries that do not meet U.S. bycatch standards*.

   Section 101(a)(2) of the MMPA states:

   "the Secretary of the Treasury shall ban the importation of commercial fish or products from fish which have been caught with commercial fishing technology which results in the incidental kill or incidental serious injury of ocean mammals in excess of United States standards."

   The U.S. currently imports two times more swordfish than it catches domestically, including a majority of Mexican and Canadian swordfish catch. By requiring swordfish exporters to demonstrate that they are using clean methods to catch swordfish, we can influence responsible fishing abroad and hold foreign imports to the same standards as domestically caught swordfish.

Conclusion

Drift gillnets and pelagic longlines targeting swordfish both have high levels of bycatch. Conversely, harpoon and buoy gear can selectively target swordfish with minimal to no bycatch. A plan should be developed to transition the current drift gillnet fishery off California from unselective drift gillnets to deep-set buoy gear and harpoon gear. Such a plan should provide fishermen a series of options, flexibility, and compensation so that they can continue to profitably catch swordfish as they learn to effectively use new, clean fishing methods. Financial compensation cushions the learning curve of a gear switch. By assisting fishermen with this transition and focusing efforts toward known sustainable fishing methods, we can achieve a clean, sustainable West Coast swordfish fishery.

References

CA/OR DGN: NOAA. 2015. West Coast Region Observer Program: Summaries & Reports.
US Atlantic SSLL: MRAG. 2013. MSC Public Certification Report for US North Atlantic Swordfish Pelagic Longline and Handgear Buoy Line Fishery.
Canada Atlantic SSLL: Intertek Moody Marine (IMM). 2011. North Atlantic Swordfish Canadian Pelagic Longline Fishery. Volume 1: Final Report and Determination.
HI SSLL: NMFS. 2015. Hawaii Shallow-set Longline Data (2007-2013). Unpublished.
CA DSLL Trial: Dewar, H., Kohin, S. 2014. Deep-Set Longline Study. http://www.pcouncil.org/wp-content/uploads/K5b_SUP_SWFSC_PPT1_MAR2014BB.pdf
US Atlantic Buoy: NMFS. 2014. Stock Assessment and Fishery Evaluation Report (SAFE) for Atlantic Highly Migratory Species; Kerstetter. 2009. Characterization of the Catch by Swordfish Buoy Gear in Southeast Florida.
CA DSBG Trial: Sepulveda, C. 2015. Exempt Fishery Proposal Application for Deep-set Buoy Gear. http://www.pcouncil.org/wp-content/uploads/H3a_Att2_PIER_MAR2015BB.pdf
California Harpoon: Coan Jr, A.L., Vojkovich, M., Prescott, D. 1998. The California Harpoon Fishery for Swordfish, *Xiphias gladius* and PFMC 2015. Highly Migratory Species Stock Assessment and Fishery Evaluation Reports Current HMS SAFE Report. http://www.pcouncil.org/highly-migratory-species/stock-assessment-and-fishery-evaluation-safe-documents/current-hms-safe-document/ (accessed October 2015),
Canada Harpoon: Coan Jr, A.L., Vojkovich, M., Prescott, D. 1998. The California Harpoon Fishery for Swordfish, *Xiphias gladius*.