UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232

August 3, 2021

Dear Recipient:

In accordance with provisions of the National Environmental Policy Act (NEPA), we announce that the *Draft Environmental Impact Statement (DEIS) for Amendment 6 to the Fishery Management Plan for West Coast Highly Migratory Species Fisheries: Authorization of Deep-set Buoy Gear* is available for review.

The proposed action is to authorize deep-set buoy gear as a legal commercial fishing gear in the Fishery Management Plan for West Coast Highly Migratory Species Fisheries (HMS FMP), and pursuant regulations. Management measures, to be established in the HMS FMP, federal regulations, or both; include but are not limited to permit program functions, gear and operational specifications, monitoring, and reporting.

The document is accessible electronically through the following website at:
https://www.fisheries.noaa.gov/bulletin/draft-eis-available-public-review-proposed-amendment-6-fishery-management-plan-west

Written comments may be submitted to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service via electronic mail during the public comment period (the closing date for the public comment period is noted at the above website). When submitting comments, please include the identifier "Deep-set Buoy Gear DEIS" on the subject line.

Comment Coordinator:

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Thank you in advance for your input and assistance in finalizing the Environmental Impact Statement.

Sincerely,

Barry Thom
Regional Administrator

Amendment 6 to the Fishery Management Plan for West Coast Highly Migratory Species Fisheries: Authorization of Deep-set Buoy Gear

Draft Environmental Impact Statement

Amendment 6 to the Fishery Management Plan for West Coast Highly Migratory Species Fisheries: Authorization of Deep-set Buoy Gear

Draft Environmental Impact Statement

Lead Agency:

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service

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Abstract:

The Proposed Action is to identify deep-set buoy gear (DSBG) as a legal commercial fishing gear under the Fishery Management Plan for West Coast Highly Migratory Species Fisheries and pursuant regulations. This would allow fishermen to obtain federal permits to fish for swordfish using DSBG in Federal waters offshore of California and Oregon. To the extent that DSBG is economically viable, the Proposed Action would assist in supporting a fleet of vessels with West Coast home ports that could increase the availability of locally-caught swordfish in the market. This Proposed Action is intended to support a healthy domestic fishery with economic benefits for fishing communities, processors, restaurants, and consumers. In addition to a no-action alternative, two action alternatives are considered, both of which are expected to have minimal impacts on non-target fish species and protected species in the Proposed Action Area.

This Environmental Impact Statement (EIS) is being prepared using the 1978 version of the Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA). Although CEQ promulgated new NEPA regulations in 2020, NEPA reviews initiated prior to the effective date of the 2020 regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA regulations was September 14, 2020. This review began on March 4, 2019, and the agency has decided to proceed under the 1978 regulations.

Comments must be received within 45 days of the Notice of Availability for this document.

Executive Summary

This draft environmental impact statement (DEIS), pursuant to the National Environmental Policy Act (NEPA), considers potential impacts of a Proposed Action to authorize deep-set buoy gear (DSBG) under the Fishery Management Plan for West Coast Fisheries for Highly Migratory Species (HMS FMP). Under this Proposed Action, DSBG would be identified as a legal commercial fishing gear in the HMS FMP and pursuant regulations. Management measures including but not limited to permit program functions, gear and operational specifications, monitoring, and reporting would be established in the HMS FMP or federal regulations or both.

Section 1 of this document provides an introduction to, and background information on, the Proposed Action, including descriptions of the purpose and need and the Proposed Action Area. Section 1 also summarizes public comments received on the Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS), which NMFS published on March 4, 2019 (84 FR 7323).

Section 2 summarizes the three alternatives analyzed under the Proposed Action. Alternative 1 is the no-action alternative. Alternative 2 is to authorize DSBG under an open access regime and includes specifications regarding gear description, gear tending, gear deployment and retrieval, use of multiple gear configurations on a single trip, permitting, fishing area and timing, species retention, and monitoring. Alternative 3 is to authorize DSBG under a limited entry (LE) permit program, including the same specifications as Alternative 2 along with five sub-options for the timing and number of LE permits to be issued. Section 2 closes with a discussion of other alternatives considered during the process of developing the Proposed Action but not analyzed in detail.

Section 3 describes the affected environment. This includes target and non-target fish species, prohibited fish species, protected non-fish species (including marine mammals, reptiles, and seabirds), essential fish habitat and critical habitat, and the socioeconomic environment. Components of the affected environment are discussed in terms of their likelihood of being affected by the Proposed Action. Components that are not likely to be affected (e.g., certain fish species and protected species, essential fish habitat, and critical habitat) are not discussed further in the document.

Section 4 analyzes the impacts of the alternatives on components of the affected environment that are likely to be affected, or may be affected, by the Proposed Action. NMFS used records from exempted fishing permit (EFP) trials through 2020 in its assessment of impacts. This section include biological impact analyses for species for which NMFS has records of interactions with DSBG (prior to 2021) and

qualitative discussions of species that may be affected by the Proposed Action alternatives, but for which NMFS has no records of interactions with DSBG. Section 4 also includes a socioeconomic analysis of impacts to fisheries in or near the Proposed Action Area, to HMS fishermen and fishing communities involved with DSBG fishing, and to downstream users of DSBG-caught swordfish (e.g., processors, restaurants, and consumers).

As discussed in Section 4, our analysis indicates that authorizing DSBG would result in a net increase in the number of domestically caught swordfish off the U.S. West Coast. The average expected DSBG swordfish catch under an open access regime is 8,812 individual fish per year. The average expected catch under an LE regime, once the maximum number of LE permits is made available, is 5,286 fish per year. Impacts to non-target species do not appear likely to negatively affect stocks of these species. We also project that authorizing DSBG would result in a net increase in annual landings and revenues to regions where DSBG swordfish has been landed to date, but that increases in revenues will be attenuated by a negative price effect (i.e., increased landings of DSBG swordfish is associated with a decrease in DSBG swordfish price).

Section 5 discusses cumulative impacts to the affected environment resulting from synergistic effects of the Proposed Action with other past, present, and future foreseeable actions. This includes the effects of pending legislation affecting the U.S. West Coast swordfish fishery, in particular legislation that would ban drift gillnet fishing.

This document closes with a list of the persons and organizations who provided information for, or were responsible for the preparation of, the DEIS (in Section 6) and references cited (in Section 7), followed by two appendices.

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Acronyms

CFR	Code of Federal Regulations
CPUE	Catch per Unit Effort
CV	Coefficient of Variation
DGN	Drift Gillnet *(refers to Large Mesh Drift Gillnet)*
DPS	Distinct Population Segment
DSBG	Deep-Set Buoy Gear
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFP	Exempted Fishing Permit
EIS	Environmental Impact Statement
EPO	Eastern Pacific Ocean
ESA	Endangered Species Act
FPA	Final Preferred Alternative
FR	Federal Register
FWS	U.S. Fish and Wildlife Service
HMS	Highly Migratory Species
HMS FMP	Fishery Management Plan for West Coast Fisheries for Highly Migratory Species
HMSMT	Highly Migratory Species Management Team
IATTC	Inter-American Tropical Tuna Commission
ITS	Incidental Take Statement
LBG	Linked Buoy Gear *(also labeled DSLBG in some contexts)*
LCA	Loggerhead Conservation Area
LE	Limited Entry
LL	Longline
LX	Hook & Line Gear
MBTA	Migratory Bird Treaty Act
MFMT	Maximum Fishery Mortality Threshold
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSST	Minimum Stock Size Threshold
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NS	National Standard
PBR	Potential Biological Removal
PFMC	Pacific Fishery Management Council
PIER	Pfleger Institute of Environmental Research
PLCA	Pacific Leatherback Conservation Area
PPA	Preliminary Preferred Alternative
PPD	Posterior Predictive Distribution
ROA	Range of Alternatives
SAR	Stock Assessment Report
SBG	Standard Buoy Gear
SCB	Southern California Bight
SWFSC	Southwest Fisheries Science Center
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean

1. INTRODUCTION

1.1. Background

Since the early 20th century, fishermen have harvested swordfish off the U.S. West Coast using a variety of methods. Traditionally, gear types have included harpoon, hook and line, drift gillnet (DGN), and longline gear. Motivated by reduced production by fishing vessels on the U.S. West Coast and increased reliance on foreign supplies of swordfish to meet demand, NMFS and the Pacific Fishery Management Council (hereafter, the Council) have indicated an interest in the development of new gear types for targeting swordfish while minimizing interactions with protected species and bycatch of non-target finfish. Results of deep-set buoy gear (DSBG) trials indicate its potential as a productive, profitable swordfish gear type with low environmental impacts.

Since 1985, swordfish catch by West Coast vessels has declined 96 percent, from 3,073 metric tons (mt) at a value of $11.9 million in 1985 to 320 mt at a value of $2.8 million in 2020. This is in large part due to attrition in the DGN fleet (NMFS 2014). At the current annual attrition rate of 10 percent, West Coast swordfish catch is likely to continue to decline (SWFSC 2010; NMFS 2014).

Between 2015 and 2020, 84 percent of the total swordfish supply on the U.S. West Coast came from foreign imports, with 16 percent supplied from domestic sources. This gap between domestic demand and domestic supply can be attributed to a number of factors, including attrition in the DGN fleet, the lower price of imports compared to artisanal domestic gears such as harpoon, and increased regulations for domestic fleets fishing with higher-volume gear, such as longline and DGN. Harvest by the harpoon fleet is small, accounting for less than 3 percent of the total U.S. West Coast swordfish catch from 2015 through 2020. DSBG exempted fishing permit (EFP) trials accounted for 12 percent of the total, with the remainder caught by DGN and Hawaii-based longline fleets.

In recent years, interest in authorizing DSBG has grown as fishermen have gained more experience with the gear through both research and EFP trials primarily taking place in the Southern California Bight (SCB). DSBG employs a hook-and-buoy system to catch target species during the daytime in deep water, while they are feeding, with hooks commonly set at depths below 250 meters. This is in contrast to other gears such as DGN and shallow-set longline (SSLL), which target swordfish near the surface at night above the thermocline and are associated with higher rates of bycatch and protected species interactions. DSBG configurations include "standard" buoy gear (SBG) and "linked" buoy gear (also referred to as deep-set linked buoy gear) (LBG). Standard DSBG configurations consist of strike indicator buoys deployed at the surface, a vertical mainline, baited circle hooks at depth, and a weighted sinker to ensure

that hooks reach depth rapidly. Linked DSBG configurations include additional sub-surface branch lines connecting the various strike indicator buoys and more hooks at depth.

DSBG initially developed off the U.S. West Coast through a series of research fishing trials that began in 2011. This initial research indicated that both standard and linked DSBG were effective gear types for selectively targeting swordfish and potentially profitable to fishermen. DSBG also demonstrated high selectivity for swordfish with minimal bycatch and protected species interactions. These promising results led the Council to recommend that NMFS issue EFPs to fishermen to expand testing of DSBG throughout the U.S. West Coast Exclusive Economic Zone (EEZ). EFP fishing began in 2015, with the most recent round of permits authorized through December 31, 2021.

The Council initially adopted a range of alternatives (ROA) for recommending federally-authorized DSBG fishing off the U.S. West Coast in June of 2018, but later (in November 2018) refined its ROA and adopted a preliminary preferred alternative (PPA). In September 2019, the Council adopted its final preferred alternative (FPA) (see Section 2.3.2), after making a few minor clarifications and one amendment to remove the end date on swordfish fishing experience in the limited entry (LE) qualifying criteria of its PPA. At its March 2021 Meeting, the Council slightly modified the LE permit qualification tiers and clarified some of the terminology used in its preferred amendment. These clarifications do not affect the information in this document.

1.2. Description of the Proposed Action

The Proposed Action is to authorize a DSBG gear-type targeting swordfish under the Fishery Management Plan for West Coast Fisheries for Highly Migratory Species (HMS FMP) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA). DSBG would be identified as a legal commercial fishing gear in the HMS FMP and pursuant regulations. Management measures could be established in the HMS FMP or in federal regulations under the HMS FMP’s management framework.

1.3. Purpose and Need

The purpose of the Proposed Action is to authorize the use of DSBG as an additional fishing gear in the West Coast commercial swordfish fishery to minimize bycatch and bycatch mortality of finfish and protected species (including sea turtles, marine mammals, and seabirds) to the extent practicable while at the same time maximizing the potential for an economically viable West Coast-based swordfish fishery. To the extent that DSBG is economically viable, the Proposed Action would support a fleet of vessels with West Coast home ports that could increase the availability of locally-caught swordfish in the market.

The Proposed Action to authorize DSBG as a new gear type as a component of a West Coast swordfish fishery is needed to effectively address the 10 National Standards (NS) for Conservation and Management included in MSA, Section 301 (and implemented in 50 CFR part 600, subpart D), in particular NS 1 (optimum yield) and NS 9 (minimize bycatch). DSBG could provide another fishing gear that could help satisfy the need for commercially viable options to support sustained participation in the swordfish fishery by West Coast fishing communities. In doing so, authorization of the DSBG fishery would also address NS 8 (consider the importance of fishery resources to fishing communities).

1.4. Proposed Action Area

The Proposed Action Area includes all Federal waters off the coasts of California and Oregon. "Federal waters" refers to the EEZ, beginning 3 nautical miles (nm) offshore and extending 200 nm out to sea.

Figure 1-1. Map of Action Area, EEZ off of California and Oregon.

1.5. Scoping: Notice of Intent

On March 4, 2019, NMFS published a notice of intent (NOI) to prepare an EIS (84 FR 7323) for authorizing DSBG. The NOI invited interested parties to submit comments on alternatives to be considered in an EIS and to identify potential issues, concerns, and additional alternatives that might be considered. The public comment period closed on April 3, 2019.

1.5.1. Public Comments

NMFS received six written comments on the NOI. The commenters requested that NMFS:

- Include a gear definition in the ROA that requires inclusion of tubing on surface lines to reduce the risk of entanglement;
- Analyze the benefits of incentivizing DGN fishermen to trade in their DGN permit;
- Continue to consider dual authorization of both standard and linked configurations of DSBG;
- Evaluate DSBG data generated by researchers from the Pfleger Institute of Environmental Research (PIER) in addition to DSBG EFP data;
- Clarify in the EIS why active gear tending is a key regulatory requirement;
- Explore an alternative for a single DSBG gear endorsement on the General HMS permit, or clarify that DSBG fishermen would receive both an SBG and an LBG endorsement;
- Clarify and justify an acceptable range of observer coverage for a DSBG fishery;
- Evaluate an LE program coastwide, not just one limited to Southern California;
- Consider whether modifying the LE qualifying criteria to include DSBG crewmembers before non-active fishermen is more likely to achieve a goal of producing more swordfish landings;
- Consider using "highest landing of swordfish by weight" as the metric for determining who would qualify for an LE DSBG permit under the Council's tiered criteria that would "[give] highest priority within a tier to those individuals with the highest landings"; and
- Clarify that "gear *may not* be deployed prior to sunrise" in the DSBG deployment and retrieval requirements consistent with the Council's ROA. The NOI inaccurately stated that "gear *must* be deployed prior to local sunrise."

Comments on the NOI also included copies of public comments regarding DSBG authorization made at previous Council meetings and a PIER research manuscript. NMFS also received public comments during a public hearing on March 26, 2019. Public comments made during the hearing were similar in nature and scope to the comments detailed above. NMFS considered input into the NOI during its decision-making process and incorporated the above comments into the analysis in the DEIS to the extent practicable and with respect to the scope of the Council's FPA and preferred HMS FMP amendment language.

2. ALTERNATIVES

This section discusses the three Proposed Action Alternatives: a no-action alternative, under which no DSBG fishery would be authorized, and two action alternatives, under which a DSBG fishery would be authorized along with certain regulations on how the gear is permitted. The first action alternative (Alternative 2 in this document) would authorize an “open access” DSBG fishery in Federal waters outside of the SCB. Management measures related to fishing gear and its use would apply. The second action alternative (Alternative 3 in this document) would authorize a “limited entry” (LE) DSBG fishery in the SCB. Many of the same management measures related to fishing gear and its use that are applicable in the open access fishery would also apply in the LE fishery.

The alternatives described in this Section are based on the Council’s adopted ROA, including its final preferred alternative (FPA). The Council adopted its ROA and preliminary preferred alternative (PPA) at its November 2018 meeting. As its PPA, the Council adopted the action alternative that includes an LE permit program for vessels fishing in Federal waters east of 120° 28’ 18” W. longitude (i.e., Alternative 3 in this document). All other Federal waters off of California and Oregon would be “open access.” NMFS prepared a report containing the Council’s ROA and PPA for review and feedback during the March 2019 Council meeting (NMFS 2019). The Council finalized its PPA as its FPA in September 2019, and modified its FPA in March 2021. The FPA specifies a rate of growth in the number of LE permits to be considered and limits the number of LE permits individuals could hold to one. The Council’s FPA prioritizes active DSBG EFP and DGN fishery participants. The Council’s ROA includes several options for qualifying criteria to determine the order of applicants to whom a DSBG permit would be issued under an LE program, which are addressed in the discussion of Alternative 3. The other action alternative in the Council’s ROA, which forgoes the LE regime and instead authorizes an open access fishery in Federal waters off California and Oregon, is represented in Alternative 2. NMFS’s preferred alternative is Alternative 3, which aligns with the Council’s FPA. This alternative was developed with significant public input and informed by preliminary iterations of the analyses included in this document.

2.1. Alternative 1—No Action

Under this alternative, DSBG would not be authorized as a legal gear under the HMS FMP, and any continued use of the gear would be contingent on the ongoing issuance of DSBG EFPs. In June 2019, the Council recommended that NMFS extend currently-issued DSBG EFPs and issue 16 new two-year DSBG EFPs. In June 2020, the Council again recommended extension of current DSBG EFPs. In September 2020, the Council recommended NMFS issue 19 additional two-year DSBG EFPs. In June 2021, the Council recommended extension of current DSBG EFPs and recommended NMFS issue seven new

DSBG EFPs. The Council could continue to recommend that NMFS issue EFPs if DSBG is not authorized as a legal gear. Other gear types currently authorized to target swordfish under the HMS FMP (i.e., harpoon and DGN gear) would continue to be authorized.

2.2. Alternative 2—Authorize an Open Access Fishery

Under this alternative, DSBG would be authorized as a legal gear type under the HMS FMP with applicable management measures regarding use of the gear, as discussed in this subsection. This alternative addresses the purpose and need of the proposed action by authorizing the use of the gear as another legal gear type that can be used to target swordfish in Federal waters off California and Oregon. Additional management measures contained in 50 CFR part 300, subpart C (applicable to eastern Pacific tuna fisheries) and 50 CFR part 660, subpart K (applicable to all HMS fisheries off the West Coast States) may also apply.

Gear Description

DSBG refers to an overarching gear type with multiple configurations, including standard buoy gear and linked buoy gear, as defined below. Both of these gear types would be authorized.

Standard Buoy Gear (SBG) - An individual piece of SBG consists of a vertical monofilament mainline suspended from a buoy-array with a terminal weight. Up to three gangions with hooks may be attached to the mainline at a minimum depth of 90 meters. No more than 10 individual pieces of SBG may be deployed at any one time.

Linked Buoy Gear (LBG) - An individual piece (section) of LBG consists of a monofilament mainline which extends vertically from a buoy-array (either directly or from a minimum 50 foot poly-line extender) to a weight; then horizontally to a second weight; then vertically to a minimum 50 foot poly-line extender attached to a second buoy-array. Up to three gangions with hooks may be connected to each horizontal section of the mainline, all of which must be fished below 90 meters. The pieces may be linked together by the mainline, which is serviceable between each piece of LBG and must be suspended between links below a depth of 50 feet. No more than 10 sections of LBG may be deployed at any one time, with no more than 3 hooks per section.

Both DSBG configurations (SBG and LBG) must meet the following specifications:

1) Buoy-array: The surface buoy flotation and strike detection array consists of a minimum of three buoys (a minimum 45 lbs buoyancy non-compressible hard ball, a minimum 6 lbs

buoyancy buoy, and a strike detection buoy) with no more than 6 feet of line between adjacent buoys, all connected in-line by a minimum of ⅜ inch diameter line. Use of buoy tether attachments (e.g., non-streamlined gear with loops and/or dangling components) is prohibited. SBG and terminal LBG buoy-arrays must include a locator flag, a radar reflector, and vessel/fisher identification compliant with all current state requirements and regulations.

2) Weights must be a minimum of 3.6 kg.
3) Lines connecting surface buoys must be at least ⅜ inch diameter.
4) Minimum size 16/0 circle hooks with not more than 10 degrees offset.
5) No more than ten pieces of SBG or LBG, in total, may be deployed at one time, with no more than three hooks per piece.

Gear Tending

All pieces of gear must remain within a 5 nm diameter circle, and the vessel may be no more than 3 nm from the nearest piece of gear. These requirements allow the gear to be actively tended, so that any strike can be attended to quickly.

Gear Deployment/Retrieval Timing

Gear may not be deployed until local sunrise and must be onboard the vessel no later than 3 hours after local sunset.

Use of Multiple Gears on a Single Trip

Gear types other than DSBG may be used on the same trip when DSBG is used, as long as the requirement to actively tend DSBG is met. This requirement will limit the gears with which fishermen could concurrently fish with DSBG and maintain maneuverability to allow for active tending of DSBG and/or staying within the active tending boundary. Other gears could be set and retrieved on the way out to and returning from sea, and DSBG fished in between, potentially at a large distance from other gear.

All landings must be tagged or marked to identify the gear used. This would facilitate properly attributing catch to the gear type used on a trip. Additional requirements may be necessary so that catch can be accurately recorded by gear configuration on the fish ticket/landings receipt. Any such identification would distinguish between fish caught with SBG versus LBG, as is required on landing receipts.

Permitting

New gear endorsements would be added to the existing Federal General HMS permit for both SBG and LBG (see gear definitions in section 1.2.1).

Geographic Area

The fishery would be authorized in all Federal waters offshore of California and Oregon.

Fishery Timing

This fishery may operate throughout the year.

Species Retention

All species may be retained and landed unless prohibited by other law(s) or regulation(s).

Fishery Monitoring

Existing HMS FMP regulations governing observer coverage (50 CFR 660.719) establish a requirement that any HMS-permitted vessel must accommodate a NMFS certified observer when required by the agency. NMFS will annually determine the level of observer coverage for the DSBG fishery based on anticipated fishing effort and available funding.

HMS FMP regulations also require logbooks (50 CFR 660.708). NMFS, in consultation with the Council, will determine how to implement logbook and data submission requirements for the DSBG fleet.

2.3. Alternative 3—Authorize a Limited Entry Fishery (NMFS Preferred Alternative/Council FPA)

This alternative would include all the specifications described above for Alternative 2, except that fishing using DSBG in Federal waters of the SCB (i.e., Federal waters off California east of 120° 28’ 18” W. longitude) would require a LE authorization. For example, DSBG would be allowed under an open access regime outside of the SCB and under a LE regime inside the SCB.

This alternative addresses the purpose and need of the proposed action by authorizing DSBG as another legal gear type that can be used to target swordfish in Federal waters off California and Oregon, and with limitations on qualifications that must be met to obtain a LE permit to access fishing grounds in the SCB. Some stakeholders considered limiting entry to fishing in the SCB, under Alternative 3, as a necessary precautionary approach for the purpose of minimizing bycatch or avoiding a potential negative price-

effect of increased domestic supply of swordfish or both. These concepts are analyzed in more detail in Section 4.

The parameters described below would apply to all LE permits. In addition, five options were considered and analyzed regarding the timing and number of permits to be issued. Those options are discussed in Section 2.3.1. Two options for establishing criteria to obtain LE permits were also considered. Those qualification criteria are discussed in section 2.3.2.

Permit Possession

The HMS LE DSBG permit would be held by a person, as defined at 50 CFR 660.702, who must designate a single vessel on the permit. The designated vessel need not be owned by the permit holder. The permit holder may change the vessel designation on the permit by written request to NMFS no more than one time per calendar year unless an extraordinary event renders the assigned vessel incapable of operation. The vessel owner must also hold a General HMS permit. Multiple DSBG LE permits may designate the same vessel. However, only one permit may be fished from any one vessel at a time. Permit holders are not required to be onboard the vessel when DSBG is in use.

Permit Renewal

The HMS LE DSBG permit would be valid for one year and expire if not renewed. Expired permits would revert to NMFS and would be made available for reissuance.

Permit Transfer

HMS LE DSBG permits would not be transferable when the gear is initially authorized, except for a one-time transfer to a family member upon the death of an individual permit holder. The Council may take action at some point after the gear is authorized to allow the transfer of permits if the Council determines that transfer would benefit management of the fishery. The Council may consider allowing permit transfers, and imposing any related conditions, through the biennial management process.

2.3.1. Permit Issuance Options

The Council's ROA included five options for the timing and number of LE permits to be issued under this alternative. Each of those options is described below. The option the Council adopted in its FPA (which is also NMFS's preferred option) would allow NMFS to issue up to 50 permits in the first year and up to 25 permits annually in subsequent years until a maximum of 300 permits have been issued or until NMFS determines that the maximum allowable number of permits should be less than 300. This option is

described in detail below as option 3.5. See Appendix A, Table A-2, for a visual comparison of the timing of permit issuance under each of the five options described below.

2.3.1.1. Option 3.1

NMFS would issue up to 25 permits per year, not to exceed 300 total. If NMFS issues 25 permits per year, the maximum number of permits (300) would be reached in 12 years.

2.3.1.2. Option 3.2

NMFS would issue up to 50 permits per year, not to exceed 300 total. If NMFS issues 50 permits per year, the maximum number of permits (300) would be reached in 6 years.

2.3.1.3. Option 3.3

NMFS would issue up to 100 permits per year, not to exceed 300 total. If NMFS issues 100 permits per year, the maximum number of permits (300) would be reached in 3 years.

2.3.1.4. Option 3.4

NMFS would issue up to 300 permits maximum, beginning in the first year.

2.3.1.5. Option 3.5 (Council's FPA)

NMFS would issue up to 50 permits in the first year, with up to 25 permits issued annually in subsequent years until either a) a maximum of 300 permits are issued, b) NMFS determines that less than 300 are necessary to ensure compliance with the Endangered Species Act and Marine Mammal Protection Act, or c) the Council recommends to NMFS that less than 300 permits are necessary to meet stakeholder needs.

2.3.2. Limited Entry Permit Qualification Criteria

The Council's FPA includes an ordered ranking of who might qualify for LE permits as they become available. All of the options for qualifying criteria that the Council and NMFS considered prioritize swordfish fishing experience through DSBG EFPs, DGN, and other gears. Some options for qualifying criteria involve a "trade-in" program which incentivizes current DGN fishermen to give up DGN fishing to qualify for DSBG earlier than they otherwise would. The cumulative impacts of potential trade-ins and other pending changes to the DGN fishery are discussed in Section 5. We do not anticipate any difference among LE qualifying criteria options in terms of impacts to the affected environment. The criteria will not change the number of permits issued.

Table 2-1 below provides a brief comparison of the three alternatives in terms of the general regulatory action and expected impacts. Section 4 describes and compares these impacts in greater detail.

Table 2-1. Snapshot Comparison of Alternatives.

	Alternative 1: No Action	**Alternative 2: Open Access Fishery**	**Alternative 3: Limited Entry Fishery**
Total Permits Available	None; DSBG restricted to EFPs at the Council's discretion	500 (assumed based on HMSMT recommendation)	300
Timing of Issuance	N/A	Immediate	Ramp-up over a 12 year period
Swordfish Catch Estimates	Between 600 and 1,250 individual swordfish per year, contingent on future issuance of DSBG EFPs	Between 7,650 and 10,000 individual swordfish per year, depending on effort levels after authorization	Between 4,400 and 5,300 individual swordfish per year, depending on effort levels after authorization
Non-Target Finfish Bycatch	Minor, likely no greater than current impacts of EFP fishing	Higher bycatch than Alternative 1; will depend on profitability and utilization of the gear	Lower bycatch than Alternative 2; substantially lower bycatch during 12-year "ramp up" period
Protected Species Interactions	Likely very low, infrequent interactions with loggerhead sea turtle and northern elephant seal possible in EFP fishing	Likely low, with between 0 and 9 interactions with loggerhead sea turtles and between 0 and 17 interactions with northern elephant seals expected each season	Likely low, with between 0 and 6 interactions with loggerhead sea turtles and between 0 and 11 interactions with northern elephant seals expected each season
Socioeconomic Impacts	Low, restricted only to DSBG EFP holders and downstream users of swordfish	Moderate; aggregate fishery revenues may approach $7 million annually depending on effort levels	Moderate, but lower than Alternative 2; revenues may approach $4.5 million annually depending on effort levels

2.4. Alternatives Considered but Not Analyzed in Detail

NMFS, the Council's Highly Migratory Species Management Team (HMSMT), and stakeholders presented several alternatives during Council discussion on DSBG authorization, reports by advisory bodies, and NEPA scoping. These alternatives were considered but are not analyzed in this document. Many of these alternatives included variations on the timing and maximum number of LE permits to be

issued and on the qualifying criteria for LE permits. As the Proposed Action is an amendment to the HMS FMP, NMFS's mandate is to approve, partially approve, or disapprove the Council's proposed amendment. As such, NMFS supports the Council's FPA as our preferred alternative in this document. This FPA was developed over a multi-year process involving substantial input from fishermen, the Council's advisory bodies, environmental groups, and other stakeholders.

The following alternatives were considered, but ultimately excluded from the Council's ROA. They are not analyzed further in this document.

- Phased-in approach with the Council re-evaluating information obtained from fishing operations once every 2 years.
- A lottery for the issuance of a limited number of permits in the first 2-year period.
- Authorization of an open access fishery until a specific concern is raised, at which time the Council could develop a Proposed Action to address the concerns (which may include altering the management scheme to LE or using time/area closures or other measures instead).
- Extension of the Proposed Action Area to include waters offshore of Washington in addition to waters offshore of California and Oregon.

The Council considered five sub-options regarding LE qualifying criteria (one of which it adopted in its FPA, as referenced above in Section 2.3.2). However, the order of who would qualify is likely to have a very minor, if any, influence on the effects of the limited entry alternative on the environment. Additionally, there are no data available on whether the impacts of DSBG fishing on the affected environment may differ based on who holds LE permits, as all DSBG effort to date has occurred under EFPs. For these reasons, we do not consider differences in LE qualifying criteria further in this document.

3. AFFECTED ENVIRONMENT

3.1. Introduction

This section describes the environment that may be affected by the Proposed Action. This affected environment includes target and non-target fish species, prohibited fish species, protected non-fish species (including marine mammals, reptiles, and seabirds), essential fish habitat and critical habitat, and the socioeconomic environment (including fisheries in or near the Proposed Action Area, HMS fishermen and fishing communities, and downstream users of swordfish). Species likely to be affected by the Proposed Action include swordfish (the target species of the fishery), bigeye thresher shark (a commonly caught non-target species), and additional species incidentally caught in DSBG EFP trials.

3.2. Status of Target and Non-Target Fish Species

This section describes target and non-target fish species in the Proposed Action Area. In addition to the target species—swordfish—we discuss all non-target species observed or reported caught while fishing under DSBG EFPs, as well as any species in the Proposed Action Area that are overfished, subject to overfishing, or prohibited under the HMS FMP. A goal of the HMS FMP is to prevent overfishing and rebuild overfished stocks. Non-target fish species in or near the Proposed Action Area considered likely to be caught include 17 species that have been observed or reported caught in DSBG trials from January 2015 through December 2020. Non-target fish species considered not likely to be caught include three tuna species in the Proposed Action Area that have not been observed or reported as caught while fishing under DSBG EFPs.

NMFS has processed data from observer records and logbooks for DSBG EFP activity from January 2015 through December 2020. Table 3-1 displays reported total catch in DSBG EFP trials.

Table 3-1. Summary of Reported DSBG Trials Catch, in Number of Individuals

	2015	2016	2017	2018	2019	2020
Swordfish	136	474	645	606	1072	1257
Bigeye Thresher Shark	66	57	46	34	40	51
Blue Shark	3	4	2	1	6	17
Shortfin mako shark	0	0	0	1	3	1
Pelagic thresher shark	0	0	0	2	0	0
Common thresher shark	0	0	0	1	0	0
Salmon Shark	0	0	0	0	1	0
Sixgill Shark	0	0	0	0	1	0
Humboldt squid	0	0	1	0	0	0
Giant squid	0	0	1	0	0	0
Opah	2	1	0	0	0	0
Escolar	4	4	3	4	10	3
Common Mola	0	0	0	1	1	0
Pacific Hake	0	0	0	0	1	1
Oilfish	0	0	0	0	0	2
Yelloweye Rockfish	0	0	2	0	0	0
Vermillion Rockfish	0	0	0	0	2	1
Northern elephant seal	1	0	0	1	1	0
Loggerhead sea turtle	0	0	0	1	0	0
Total Days Fished	132	283	377	627	764	1076

3.2.1. Target Species

Swordfish (*Xiphias gladius*)

Stock assessments for swordfish in the North Pacific Ocean indicate two stocks in the Proposed Action Area and in the vicinity of the Proposed Action Area: a Western and Central North Pacific Ocean (WCNPO) stock and an Eastern Pacific Ocean (EPO) stock (ISC 2014a). The WCNPO stock is not overfished or subject to overfishing (ISC 2018a) and has been in a healthy condition for over a decade (Sippel 2015). The WCNPO stock off the U.S. West Coast is an underutilized domestic resource (Berube et al. 2015). Based on data through 2012, NMFS determined that the EPO stock is subject to overfishing, but not overfished (ISC 2014a, NMFS 2016).

The Proposed Action and existing U.S. West Coast fisheries operations fall within the WCNPO stock area. For the WCNPO in 2016 (the terminal year of the assessment), the relative spawning stock biomass (SSB/SSB_{MSY}; where SSB is the biomass, MSY is the maximum sustainable yield, and SSB_{MSY} is the spawning stock biomass that would produce MSY) was estimated at 1.87. Additionally, spawning stock

biomass was estimated to be greater than the minimum stock size threshold (MSST) specified in the HMS FMP by a factor of 2.4 (i.e., below MSST, the stock would be considered overfished). The relative fishing mortality rate (F_{2016}/F_{MSY}, where F_{2016} is the fishing mortality rate in 2016 and F_{MSY} is the fishing mortality rate would achieve MSY) was 0.47. The maximum fishing mortality threshold (MFMT) in the HMS FMP is specified as equal to F_{MSY}; above this level the stock would be considered subject to overfishing (PFMC 2018b).

3.2.2. Non-Target Species

3.2.2.1. Non-Target Species Considered Likely to be Affected

Bigeye thresher shark (*Alopias superciliosus*)

There is little information available on the population dynamics or stock status of bigeye thresher shark in the Proposed Action Area. Studies have found evidence to indicate that the species, in general, is vulnerable to exploitation at relatively low levels of fishing mortality, due to low levels of productivity and/or spawning biomass (Fu et al. 2016; Young et al. 2015). A 2016 report to the Western and Central Pacific Fisheries Commission's (WCPFC's) Scientific Committee presented a novel approach to evaluating stock status and fishing pressure for the Pacific-wide population of bigeye threshers, based on the risk of fishing pressure exceeding the population's ability to recover (Fu et al. 2016). Accounting for uncertainty in the available data and analytical methods, the study found that the average probability of total fishing impact exceeding a maximum impact sustainable threshold (MIST) ranged from 20 percent to 40 percent, depending on assumptions of post-release mortality. In 2016, NMFS published a comprehensive status review for bigeye thresher sharks and found that the species was not in danger of extinction, nor was it likely to become so within the foreseeable future. Accordingly, the bigeye thresher shark did not meet the definition of a threatened or endangered species, and thus, the bigeye thresher shark did not warrant listing as threatened or endangered (81 FR 18979, April 1, 2016).

Blue shark (*Prionace glauca*)

The most recent north Pacific blue shark stock assessment occurred in 2017 and included data through 2015 (ISC 2017). The assessment results indicate that, relative to status determination criteria specified in the HMS FMP (i.e., MSST and MFMT), the north Pacific blue shark stock is not overfished nor is it subject to overfishing. In 2015, spawning biomass exceeded MSST by a factor of 2.0 to 2.3 (and also exceeded MSY), and F_{2017} was estimated to be well below MFMT (ISC 2017; PFMC 2019).

Shortfin mako shark (*Isurus oxyrinchus*)

Shortfin mako constitutes an important incidental catch to the DGN fishery, whose market quality and ex-vessel value are important components of the landed incidental catch (Cailliet and Bedford 1983; Holts et al. 1998). Shortfin mako is also caught in California's recreational fishery. A majority are caught by anglers fishing with rod-and-reel gear from private vessels in the SCB from June through October, peaking in August. During the early 1980s, they increased in prominence as a popular game fish, and annual catch estimates peaked in 1987 at 22,000 fish. Since 2001, annual catch estimates have ranged from 2,000 to 6,000 fish, with a percentage of sharks successfully released by southern California fishermen favoring catch-and-release versus harvest.

Based on the most recent stock assessment for shortfin mako in the North Pacific Ocean (ISC 2018b), which included data through 2016, NMFS determined that the stock is not overfished nor subject to overfishing. Spawning stock biomass in 2016 was greater than the MSST specified in the HMS FMP by a factor of 1.6. The relative fishing mortality rate in 2016 (F_{2016}/MFMT) was 0.47 (PFMC 2019).

On January 25, 2021, NMFS received a petition from Defenders of Wildlife to list the shortfin mako shark under the ESA and to designate critical habitat. On April 15, 2021, NMFS announced a 90- day finding on a petition to list the shortfin mako shark, initiation of a status review of the species to determine whether listing under the ESA is warranted, and solicited public input (86 FR. 19863, April 15, 2021).

Pelagic thresher shark (*Alopias pelagicus*)

There is little information available on the population dynamics or stock status of pelagic thresher shark in the Proposed Action Area. Pelagic threshers are often misidentified as common threshers, resulting in uncertainty in the quality of existing data on this species (Young et al. 2015). A 2010 study in the northwestern Pacific found that pelagic threshers in that region had experienced a decrease in population due to fishing mortality, indicating overexploitation (Tsai et al. 2010). However, no comparable stock assessments or analyses of fishing pressure are available for the EPO.

Common thresher shark (*Alopias vulpinus*)

In August 2014, animal advocacy organization, Friends of Animals, requested common thresher sharks be listed as endangered or threatened under the Endangered Species Act (ESA), or, alternatively, delineated as six distinct population segments (DPSs) with each segment being listed as endangered or threatened. Friends of Animals cited fishing pressure, life history characteristics, and the lack of regulatory

mechanisms to protect the sharks as the reasons for the listing. In 2016, NMFS published a comprehensive status review for common thresher sharks and found that the species was not in danger of extinction, nor was it likely to become so within the foreseeable future. Accordingly, the common thresher shark did not meet the definition of a threatened or endangered species, and thus, the common thresher shark did not warrant listing as threatened or endangered (81 FR 18979, April 1, 2016).

A stock assessment for common thresher shark off the west coast of North America was completed in 2016 using data through 2014, then peer reviewed in 2017 and revised in 2018. The assessment reported that the stock experienced a relatively large and quick decline in the 1970s and early 1980s but that the population appears to have stabilized after DGN regulations were imposed in 1990 (Teo et. al 2018). Over the past 15 years, the stock recovered quickly, and it is currently close to the unexploited level. Results of the assessment indicate the common thresher shark stock is not overfished (SSB_{2014} exceeds MSST by a factor of 1.4) and is not subject to overfishing (F_{2014} was estimated to be 0.21 of the MFMT) (PFMC 2019).

Salmon shark (*Lamna ditropis*)

Salmon sharks are not a target species in any U.S. fishery, but are targeted by Japanese longline fisheries in the northern Pacific. The stock status of salmon sharks in the Pacific Ocean has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Sixgill shark (Hexanchus griseus)

The sixgill shark, also referred to as the bluntnose sixgill shark or cow shark, is not a target species in any U.S. commercial fishery but is occasionally targeted by sport fisheries. The stock status of bluntnose sixgill sharks in the Pacific Ocean has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Humboldt squid (*Dosidicus gigas*)

Humboldt squid provide an economically important fishery in the Gulf of California, Mexico, with an estimated population size of 20.2 million squid in that region (Morales-Bojórquez et al. 2012). Humboldt squid are subject to fishing pressure in this area, with periodic declines in spawning biomass preceded by commercial catches above the estimated maximum sustainable yield (Urías-Sotomayor et al. 2018). Studies have noted an expansion of the range of Humboldt squid in the EPO, including off the California coast, likely driven by climate factors and decreased presence of predator species (Stewart et al. 2014, Zeidberg & Robison 2007). They are not a target species of any U.S. West Coast fishery, although they

have been incidentally caught and marketed by certain fisheries, including the DGN fishery. No evidence suggests that the species is overfished or subject to overfishing within the Proposed Action Area.

Giant squid (*Architeuthis dux*)

Giant squid is not targeted by any U.S. fishery and is not managed under the HMS FMP. One study suggests that there may have been a recent population expansion globally, as specimens analyzed from many different regions display low levels of genetic diversity (Winkelmann et al. 2013). The same study suggests that giant squids may comprise a single global stock, although details about the stock's spatial distribution and life history movement patterns are not available given the current lack of data. The stock status of giant squid has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Opah (*Lampris guttatus*)

Between 2014 and 2020, over 2050 mt of opah were landed in California, with annual landings ranging from 138 mt to 402 mt. Opah are occasionally caught by HMS gear types such as DGN and longline, and they have been considered as a potential target species in certain configurations of DSBG tested in research trials. Sport fishermen targeting albacore from British Columbia to Baja, California occasionally catch opah. Within California, many sport-caught opah are taken from the northern Channel Islands to the Coronado Islands, just south of the U.S.-Mexico border. The stock status of opah has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Escolar (*Lepidocybium flavobrunneum*)

There is little information available on the population dynamics for this species. Escolar are not a target species of any U.S. West Coast fishery, though they are occasionally caught as bycatch in the longline fishery and in DSBG EFP trials. They are generally brought to market when they occur as bycatch. The stock status of escolar has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Common mola (*Mola mola*)

There is little information available on the population dynamics for this species. Common mola are not a target species of any U.S. West Coast fishery. They are frequently caught as bycatch in the West Coast DGN fishery, where the majority are released alive. The stock status of common mola has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Pacific hake (*Merluccius productus*)

Pacific hake are an important target species of U.S. groundfish fisheries and are occasionally caught incidentally in other fisheries. The stock was declared overfished in 2002 and was considered rebuilt as of 2004. A 2017 stock assessment found that the stock is currently at healthy levels and is not overfished nor subject to overfishing (Berger et al. 2017).

Oilfish (*Ruvettus presiosus*)

There is little information available on the population dynamics for this species. Oilfish are not a target species of any U.S. West Coast fishery. The stock status of oilfish has never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high.

Yelloweye rockfish (*Sebastes ruberrimus*)

Yelloweye rockfish have historically been caught by trawl and hook-and-line gear types in commercial and recreational fisheries off the U.S. West Coast. Catches of yelloweye rockfish peaked in the 1980s and 1990s and reached 552 mt in 1982. In 2002, yelloweye rockfish were declared overfished, and total catches have been maintained at much lower levels in the years since. Currently, yelloweye are caught only incidentally in fisheries targeting other species that are found in association with yelloweye (Gertseva and Cope 2017).

A 2017 assessment of yelloweye rockfish stocks in state and Federal waters off the U.S. West Coast found that the stock is currently at 28.4 percent of its unexploited level. The large majority of catches are made in sport fisheries operating out of California, Oregon and Washington, with smaller incidental catches occurring in commercial fisheries (Gertseva and Cope 2017).

Vermilion rockfish *(Sebastes miniatus)*

Vermilion rockfish have historically been caught by trawl and hook-and-line gear types in commercial and recreational fisheries off of the West Coast. Vermilion rockfish are considered part of the shelf rockfish complex, which is not considered an overfished stock (PFMC 2018a).

3.2.2.2. Non-Target Species Considered Not Likely to be Affected

Species listed in this Section include HMS that are known to be present in the Proposed Action Area, but have not been observed or reported as caught in the DSBG trials from January 2015 through December 2020. These species are not likely to be affected by the Proposed Action alternatives but are discussed here because they are management unit species of the HMS FMP that are present in the Proposed Action

Area and in relative abundance in the SCB, where DSBG effort has been more concentrated. These species are marketable and likely to be kept if caught..

Yellowfin tuna (*Thunnus albacares*)

Yellowfin tuna in the Pacific Ocean are managed as two stocks: the WCNPO stock and the EPO stock. The yellowfin tuna stock in the Proposed Action Area is the EPO stock. The best scientific information available (BSIA) for the purposes of determining stock status includes a stock assessment, which includes data through 2019, and a risk analysis completed by the Inter-American Tropical Tuna Commission (IATTC) scientific staff (Maunder et al. 2020, Minte-Vera et al. 2020). The assessment results show that relative to status determination criteria of the HMS FMP, the EPO stock is neither overfished (e.g., if the ratio of SSB to MSST is greater than 1, where SSB_{2020}/MSST =3.16) nor subject to overfishing (e.g., if the probability of current F to F_{MSY} is greater than 0.5, where probability $F_{2017-2019}$ >F_{MSY} is 0.09; Minte-Vera et al. 2020; Maunder et al. 2020).

The United States' total contribution to EPO yellowfin tuna harvest is small, accounting for less than 3 percent of the total catch of the EPO yellowfin tuna stock. Based on resolutions adopted by the IATTC, NMFS implements management measures at 50 CFR 300 subpart C for commercial fisheries that catch tropical tunas, including yellowfin tuna, in the eastern Pacific (e.g., 86 FR 5033, January 19, 2021).

Pacific bluefin tuna (*Thunnus orientalis*)

Pacific bluefin tuna is a single Pacific-wide stock with trans-Pacific migratory patterns. The majority of U.S. West Coast catch is caught opportunistically by commercial purse seiners fishing in the SCB and recreationally by commercial passenger fishing vessels, which have typically fished in Mexico's territorial waters, and private vessels. Using fishery data through 2018, the Pacific bluefin tuna stock was last assessed in 2020 (ISC 2020). The assessment results indicate that the stock is still overfished and subject to overfishing with respect to status determination criteria specified in the HMS FMP (i.e., SSB_{2018} was estimated as 0.29 of MSST and F_{2018} was estimated to exceed MFMT by 0.09). Projections of harvest scenarios performed in 2018 indicated that a continuation of current management measures under a low recruitment scenario would result in achieving the initial biomass rebuilding target by 2024 with 98 percent probability (ISC 2018). Projections as to the year and the percent probability of achieving the initial rebuilding target were more optimistic for of the harvest scenarios examined in the 2020 assessment. Further, under an average recruitment scenario with zero removals, projections indicate that the second rebuilding target could be met by 2022. This is in part due to the larger number of immature

bluefin at the terminal year of the assessment, which contributes to more rapid growth of the population in the projections (ISC 2020).

In accordance with IATTC Resolutions, and in an effort to rebuild the Pacific bluefin tuna stock, NMFS regularly implements commercial catch and trip limits for U.S. commercial catch of Pacific bluefin tuna in the EPO at 50 CFR 300 subpart C (e.g., 86 FR 16303, March 29, 2021). Once these the catch limits are reached, NMFS prohibits U.S. commercial vessels from targeting, retaining on-board, transshipping, or landing Pacific bluefin tuna through the remainder of the calendar year.

Bigeye tuna (*Thunnus obesus*)

Bigeye tuna in the Pacific Ocean are managed as two stocks: the WCPO stock and the EPO stock. The bigeye tuna stock in the Proposed Action Area is the EPO stock. The 2020 stock assessment completed by IATTC scientific staff using data through 2019 is the latest assessment determined to be BSIA for purposes of determining stock status (Xu et al. 2020). The assessment results show that fishing effort has been below the level corresponding to MSY. Relative to the status determination criteria of the HMS FMP, the EPO stock is neither overfished (i.e., B_{2019} was estimated to be 1.84 times MSST) nor subject to overfishing (i.e., F_{2019} was estimated at the MFMT, but not above that) (Xu et al. 2020). Based on resolutions adopted by the IATTC, NMFS implements management measures at 50 CFR 300 subpart C for commercial fisheries that catch tropical tunas, including bigeye tuna, in the eastern Pacific (e.g., 86 FR 5033, January 19, 2021).

3.2.3. Prohibited Fish Species

Table 3-1 below lists the prohibited non-HMS species designated under the HMS FMP. In general, prohibited species must be released immediately if caught, unless other provisions for their disposition are established, including for scientific study (76 FR 56327, September 13, 2011).

Table 3–1. Non-Target Fish Species Prohibited under the HMS FMP

Common Name	**Scientific Name**
Great white shark	*Carcharodon carcharias*
Basking shark	*Cetorhinus maximus*
Megamouth shark	*Megachasma pelagios*
Pacific halibut	*Hippoglossus stenolepis*
Salmonids	*Onchorhynchus* spp.

No interactions with prohibited species have been observed in DSBG EFP trials as of December 2020. These species are not likely to be affected by the Proposed Action alternatives, but are listed here because they are designated as prohibited species in the HMS FMP.

3.3. Status of Protected Species

3.3.1. Marine Mammals

All marine mammals in the waters of the United States are protected under the Marine Mammal Protection Act (MMPA). The MMPA and its implementing regulations set out strict requirements for monitoring marine mammal stocks and estimating human impacts on these stocks. NMFS produces an annual Stock Assessment Report (SAR) that provides updated status and population estimates for each marine mammal stock in a region, based on the most recent available information. In addition to estimating the stock's population, NMFS must identify sources of human-caused mortalities and calculate the maximum human-caused mortalities that can be sustained by the stock if the stock is to persist at its current population or increase. Under the MMPA, potential biological removal (PBR) level is the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (i.e., the number of animals that will result in the maximum productivity of the population or species). If the level of direct human-caused mortality exceeds a marine mammal stock's potential PBR level, that stock is considered a "strategic stock." A marine mammal stock is also considered a strategic stock if it is listed as an endangered or threatened species under the ESA, or if it is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future. If a marine mammal stock is determined to be below its optimum sustainable population, it is considered a "depleted stock."

Updated information for most of the marine mammals in the Proposed Action Area can be found in the most recent United States Pacific Marine Mammal SARs (Carretta et al. 2020). However, because not every species was updated or revised in that publication, information for some species in the Proposed Action Area are cited using previous SARs, so that the most recent data for each species is presented.

3.3.1.1. Marine Mammals Considered Likely to be Affected

Although DSBG has never been authorized under the HMS FMP for use in the U.S. West Coast EEZ, its use has been permitted in DSBG EFP trials. This section describes marine mammals considered likely to be affected by the Proposed Action based on interactions observed in DSBG EFP fishing. Data from DSBG EFP trials identified one species, northern elephant seals, as having observed interactions in

DSBG EFP fishing. Based on that data, northern elephant seals are considered to have some potential for interaction with DSBG and are therefore likely to be affected by the Proposed Action.

Northern elephant seal (*Mirounga angustirostris*)

The best estimate of population abundance for the California breeding stock is 179,000 from 2014 data, with a minimum population estimate of 81,368 animals. PBR for this stock is calculated to be 4,882 animals per year (Carretta et al. 2020). Threats to this stock include mortality and injury in fishing gear (greater than 4.0 mean annual takes per year, based on data from 2008 through 2012). Takes have been documented in the DGN fishery, the California halibut and white seabass set gillnet fishery, the California small-mesh drift gillnet fishery, and the California/Oregon/Washington groundfish trawl fishery. Other threats include shooting, entanglement in marine debris, power plant entrainment, tar, and boat collisions. The stock is not classified as a strategic stock under the MMPA (Carretta et al. 2020). Two interactions with northern elephant seals have been observed in DSBG EFP fishing, one in 2015 and one in 2018. Both animals were released alive and uninjured.

3.3.1.2. Marine Mammals That May be Affected

This section describes marine mammals that have had no interactions to date in DSBG EFP fishing, but that we consider may be affected by the Proposed Action based on technical discussions with NMFS Protected Resources Division (PRD) (Christina Fahy, NMFS PRD, pers. comm. April 2019). These species dive deep and/or feed on squid like those used as bait in DSBG fishing (i.e., Risso's dolphin, beaked whales, sperm whale), have been documented entangled by other fisheries that employ vertical lines (i.e., humpback whale, gray whale), or are ESA-listed pinnipeds that have been caught by longline fishing near the Proposed Action Area (i.e., Guadalupe fur seal). Although data do not indicate that these species will interact with DSBG as would be authorized under the Proposed Action alternatives, we will discuss potential impacts qualitatively later in this document (see Section 4).

Risso's dolphin (*Grampus griseus*)

Risso's dolphins in California/Oregon/Washington waters are considered one stock in the SARs. The best estimate of population abundance for this stock is 6,336 (CV = 0.32), with a minimum population estimate of 4,817 animals. PBR for this stock is estimated to be 46 animals per year. The mean annual serious injury and mortality in commercial fisheries for this stock is estimated to be 1.3 animals (CV = 0.93), based on data from 2010 through 2014. This stock is not classified as a strategic stock under the MMPA (Carretta et al. 2020).

Humpback whale (*Megaptera novaeangliae*)

NMFS assesses one stock of humpback whales (the California/Oregon/Washington stock) along the U.S. West Coast. The stock includes two separate feeding groups: a California and Oregon feeding group of whales that belong to the Central America and Mexico DPSs defined under the ESA, and a northern Washington and southern British Columbia feeding group that primarily includes whales from the Mexico DPS but also includes a small number of whales from the Hawaii and Central America DPSs (Calambokidis et al. 2008; Barlow et al. 2011; Wade et al. 2016; Carretta 2018). Abundance estimates from photographic mark-recapture surveys conducted in California and Oregon waters every year from 1991 through 2014 represent the most precise estimates (Calambokidis 2017). These estimates only include animals photographed in California and Oregon waters and not animals that are part of the separate feeding group found off Washington State and southern British Columbia (Calambokidis et al. 2009, 2017). California and Oregon estimates range from approximately 1,400 to 2,400 animals, depending on the choice of recapture model and sampling period. The most precise estimate of abundance for California and Oregon waters is the 2011 through 2014 Chao estimate of 2,374 whales (CV = 0.03) (Calambokidis 2017). Calambokidis et al. (2017) estimated the northern Washington and southern British Columbia feeding group population size to be 526 animals based on 2013 and 2014 mark-recapture data. Combining abundance estimates from both the California/Oregon and Washington/southern British Columbia feeding groups (2,374 + 526) yields an estimate of 2,900 animals for the California/Oregon/Washington stock. With a minimum population estimate of 2,784 humpback whales, the PBR for this California/Oregon/Washington stock is 33.4 humpback whales per year; however, because this stock spends approximately 50 percent of its time outside U.S. waters, the PBR allocation for U.S. waters is 16.7 humpback whales per year (Carretta et al. 2020). Because the Central America DPS is listed as endangered and the Mexico DPS is listed as threatened under the ESA, the stock is classified as strategic and depleted under the MMPA (Carretta et al. 2020).

NMFS recently completed a comprehensive status review of the humpback whale under the ESA, to determine whether an endangered listing for the entire species was still appropriate. On September 8, 2016, NMFS announced a final rule to revise the listing status of the species and divide the globally-listed endangered species into 14 DPSs, remove the current species-level listing, and in its place list four DPSs as endangered and one DPSs as threatened (81 FR 62259, September 8, 2016). The remaining nine DPSs are listed based on their current statuses. Mentioned above, three of the DPSs (the Mexico DPS, the Central America DPS and the Hawaii DPS) occur in the Proposed Action Area. The Mexico DPS is listed as threatened and the Central America DPS is listed as endangered; however, the Hawaii DPS is not listed under the ESA. Additionally, in April 2021, NMFS published a final rule to designate critical habitat for

the Central America, Mexico, and Western North Pacific DPSs of humpback whales (86 FR 21082, April 21, 2021). Note that current DPSs, as identified under the ESA, do not align with stock units assessed for the purposes of carrying out the MMPA, and although there may be changes to the specification of the MMPA stock unit along the U.S. West Coast in the future, the population estimates above are the current best available science.

Sperm whale (*Physeter macrocephalus*)

The SARs divide sperm whales into three discrete groups for management purposes, including waters off California/Oregon/Washington, Hawaii, and Alaska. Previous estimates of sperm whale abundance from 2005 (3,140, CV = 0.40) (Forney 2007) and 2008 (300, CV = 0.51) (Barlow 2010) show a ten-fold difference that cannot be attributed to human-caused or natural population declines and likely reflect inter-annual variability in movement of animals into and out of the study area. New estimates of sperm whale abundance in California, Oregon, and Washington waters out to 300 nm are available from a trend-model analysis of line-transect data collected from six surveys conducted from 1991 to 2008 (Moore and Barlow 2014) using methods similar to previous abundance trend analyses for fin whales (Moore and Barlow 2011) and beaked whales (Moore and Barlow 2013). Abundance trend models incorporate information from the entire 1991 through 2008 time series to obtain each annual abundance estimate, yielding estimates with less inter-annual variability. The best estimate of sperm whale abundance in the California Current is the trend-based estimate from the 2014 survey of 1,997 animals (CV = 0.57), which is corrected for diving animals not seen during surveys. The minimum population abundance estimate is 1,270 whales, and the PBR for this stock is estimated to be 2.5 animals. The mean annual serious injury and mortality in commercial fisheries is less than 0.64 sperm whales (CV = 1.4), based on data collected from 2008 to 2017. Fisheries documented to have taken sperm whales include the DGN fishery (average 1.4 per year over 5 years, based on the observed serious injury of 2 sperm whales in 2010) and illegal, unreported, and unregulated (IUU) fisheries, based on stranded whales. Sperm whales are listed as endangered under the ESA, and consequently the California to Washington stock is automatically classified as a depleted and strategic stock under the MMPA (Carretta et al. 2020).

Ginkgo-toothed and Mesoplodont beaked whales (*Mesoplodon spp.*)

The genus *Mesoplodon* includes at least 14 species. Six species of Mesoplodont beaked whales are found in the Proposed Action Area, including Hubbs' (*M. carlhubbsi*), pygmy beaked whale or lesser beaked whale (*M. peruvianus*), gingko-toothed (*M. gingkodens*), Blainville's (*M. densirostris*), Perrin's (*M. perrini*), and Stejneger's (*M. stejnegeri*) beaked whales. However, because of both the difficulty in identifying and the rarity of sightings of these six species, little species-specific information is currently available.

Based on an analysis of line-transect data from survey conducted between 1991 and 2014, abundance for all species of Mesoplodon beaked whales in waters off California, Oregon, and Washington waters combined is estimated to be 3,044 animals (CV=0.54) (Moore and Barlow 2017; Carretta et al. 2020). This estimate accounts for the proportion of unidentified beaked whale sightings likely to be Mesoplodon beaked whales and uses a correction factor for missed animals adjusted to account for the fact that the proportion of animals on the trackline that are missed by observers increases in rough seas. With a minimum population estimate of 1,967 animals, the estimated PBR for this group of species is 20 mesoplodont beaked whales per year, and the average serious injury and annual mortality of mesoplodont beaked whales in U.S. commercial fisheries is estimated to be 0.1 animals, based on data from 2011 through 2015 (Carretta et al. 2020). This group of species is not classified as a strategic stock under the MMPA (Carretta et al. 2020).

Gray whale (*Eschrichtius robustus*)

The population size of the Eastern North Pacific (ENP) gray whale stock has increased over several decades, despite an unusual mortality event in 1999 and 2000. Abundance estimates of gray whales reported by Calambokidis et al. (2014) show a high rate of increase in the late 1990s and early 2000s, but have been relatively stable since 2003. In 2010, the International Whaling Commission (IWC) Standing Working Group on Aboriginal Whaling Management Procedure noted that different names had been used to refer to gray whales feeding along the U.S. West Coast. The group agreed to designate animals that spend the summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the Pacific Coast Feeding Group (PCFG; IWC 2012). While the PCFG is recognized as a distinct feeding aggregation (Calambokidis et al. 2012; Mate et al. 2010; Frasier et al. 2011; Lang et al. 2011; IWC 2012), the status of the PCFG as a population stock remains unresolved (Weller et al. 2013). A NMFS task force charged with evaluating stock status of the PCFG noted that "both the photo-identification and genetics data indicate that the levels of internal versus external recruitment are comparable, but these are not quantified well enough to determine if the population dynamics of the PCFG are more a consequence of births and deaths within the group (internal dynamics) rather than related to immigration and/or emigration (external dynamics)." Further, given the lack of significant differences found in DNA (or nuclear deoxyribonucleic acid) markers between PCFG whales and other ENP gray whales, the task force found no evidence to suggest that PCFG whales breed exclusively or primarily with each other; rather, they interbreed with ENP whales, including potentially other PCFG whales. Additional research is needed to better identify recruitment levels in the PCFG and further assess the stock status of PCFG whales (Weller et al. 2013). In contrast, the task force noted that

Western North Pacific (WNP) gray whales should be recognized as a population stock under the MMPA, and NMFS prepared a separate report for WNP gray whales in 2014.

At this time, given the lack of evidence to support the PCFG as a separate stock, the most recent estimate of abundance for the ENP whales based on a 2010/2011 southbound survey is estimated to be 26,960 animals (CV = 0.05), with a minimum population estimate of 25,849 animals. The PBR for this stock is 801 animals per year. The mean annual serious injury and mortality in known commercial U.S. fisheries is greater than 8.7 gray whales, based on data from 2012 through 2016 (Carretta et al. 2020). The gray whale was removed from the endangered species list in 1994 as a result of its strong recovery, and it is not classified as a strategic stock under the MMPA (Angliss and Outlaw 2005).

Baird's beaked whale (*Berardius bairdii*)

The SARs designate Baird's beaked whales in the EEZ waters off the coasts of California, Oregon, and Washington as one stock. While there have been several estimates of abundance of this stock Sightings of Baird's beaked whales have been rare, even during ship and aerial transect surveys, resulting in varied estimates of abundance. However, the most appropriate estimate for this stock is 2,697 animals (CV=0.60), which was derived from a trend-based analysis of line transect data from surveys conducted between 1991 and 2014 (Moore and Barlow 2017; Caretta et al. 2020). PBR for this stock is 16 Baird's beaked whales per year, which is based in part on a minimum population size estimate of 1,633 animals (Caretta et al. 2018). One Baird's beaked whale was incidentally killed in the DGN in 1994; however, no beaked whales have been observed killed or entangled in this fishery since regulations were put in place in 1997 that require the use of acoustic pingers (NMFS 2015). Additional threats may be anthropogenic noise, especially military sonars, or other commercial and scientific activities involving the use of air guns. The total fishery mortality and serious injury for this stock can be considered insignificant and approaching zero, and it is not classified as a strategic stock under the MMPA. Baird's beaked whales are not listed as threatened or endangered under the ESA nor is it classified as a depleted stock under the MMPA (Carretta et al. 2020).

Cuvier's beaked whale (*Ziphius cavirostris*)

The SARs designate the Cuvier's beaked whales in the EEZ waters off the coasts of California, Oregon, and Washington as one stock. Sightings of Cuvier's beaked whales off the U.S. West Coast have been infrequent, although they are the most commonly encountered beaked whale in this region. Seasonal trends are not apparent from stranding records. Early abundance estimates were imprecise and biased low by an unknown amount because of the large proportion of time this species spends submerged, and because ship surveys before 1996 covered only California waters and thus did not include animals off

Oregon and Washington. A trend-based analysis of line-transect data from surveys conducted between 1991 and 2008 yielded new estimates of Cuvier's beaked whale abundance. The new estimate is substantially higher than the previous estimate, in part because it accounts for unidentified beaked whale sightings likely to be Cuvier's beaked whales, and because of a correction factor for individuals missed by observers in rough observing conditions. The best estimate of abundance is represented by a model-averaged estimate for 2014 of 3,274 animals (CV = 0.67), with a minimum population estimate of 2,059 animals. The estimated PBR for this stock is 21 animals per year, and a regression tree-based bycatch model produced an average annual take (serious injury and mortality) estimate of 0.02 animals (CV=2.8) in U.S. commercial fisheries is for the 2011 to 2015 time period, even though no Cuvier's beaked whales were observed entangled in U.S. commercial fisheries during that time (Carretta et al. 2020). As with other beaked whales, anthropogenic noise may also threaten the Cuvier's beaked whale, particularly mid-frequency active sonars, although the extent of this threat is unknown. The stock is not listed as "threatened" or "endangered" under the ESA, nor designated as "depleted" under the MMPA. Because the estimated annual average incidental mortality of this stock of Cuvier's beaked whale does not exceed its PBR level, it is not classified as a strategic stock under the MMPA (Carretta et al. 2020).

Guadalupe fur seal (*Arctocephalus townsendi*)

The most recent calculations of abundance are based on pup count data collected in 2013 and a scaling-up method to produce total population size estimates of 34,187 individuals to 43,954 individuals (García-Aguilar et al. 2018). These estimates do not include animals at San Benito Island (Caretta et al. 2020). With a minimum population estimate of 31,019 animals, the estimated PBR for Guadalupe fur seals is 1,062 animals per year. The estimated total mortality and serious injury for U.S. commercial fisheries is estimated as less than 2 animals per year. However, the fraction of this stock that occurs in U.S waters or spends time in U.S. waters is unknown, and thus, a proration factor for calculating PBR for U.S. waters is undetermined (Caretta et al. 2020).

The Guadalupe fur seal is listed as "threatened" under the ESA; therefore, it is considered a "strategic" and "depleted" under the MMPA (Carretta et al. 2020). The population was estimated to grow at 5.9 percent annually for the period 1984 to 2013 (García-Aguilar et al. 2018). Individuals are increasingly observed in Oregon and Washington waters, and standings have nearly become an annual phenomena along the coast of California (Carretta et al. 2020).

3.3.1.3. Marine Mammals Considered Not Likely to be Affected

A number of additional marine mammal species are known to occur in the Proposed Action Area, but have had no interactions to date in DSBG EFP fishing, and no additional concerns based on technical discussions with NMFS PRD (Christina Fahy, NMFS PRD, pers. comm. April 2019). Table 3-2 lists these species.

Table 3-2. Marine Mammals Considered Not Likely to be Affected by the Proposed Action

Bottlenose dolphin (*Tursiops truncatus*)—California/Oregon/Washington offshore stock
Short-beaked common dolphin (*Delphinus delphis*)—California/Oregon/Washington stock
Striped dolphin (*Stenella coeruleoalba*)—California/Oregon/Washington stock
Harbor porpoise (*Phocoena phocoena*)
California sea lion (*Zalophus californianus*)
Northern fur seal (*Callorhinus ursinus*)
Harbor seal (*Phoca vitulina*)
Short-finned pilot whale (*Globicephala macrorhynchus*)
Minke whale (*Balaenoptera acutorostrata*)
Long-beaked common dolphin (*Delphinus capensis*)—California stock
Northern right-whale dolphin (*Lissodelphis borealis*)
Pacific white-sided dolphin (*Lagenorhyncus obliquidens*)
Dall’s porpoise (*Phocoenoides dalli*)
Dwarf sperm whale (*Kogia sima*)
False killer whale (*Pseudorca crassidens*)
Pygmy sperm whale (*Kogia breviceps*)
Fin whale (*Balaenoptera physalus*)
Blue whale (*Balaenoptera musculus*)
Sei whale (*Balaenoptera borealis*)
Killer whale (*Orcinus orca*)
Northern fur seal (*Callorhinus ursinus*)
Steller sea lion (*Eumetopias jubatus*)

3.3.2. Reptiles

Four species of marine turtles may be found in the Proposed Action Area.

3.3.2.1. Reptiles Considered Likely to be Affected

This section describes marine reptiles in the Proposed Action Area that might have some potential for interaction with DSBG as would be introduced to the environment under the Proposed Action. We rely on data from the DSBG EFP trials to determine which species are considered likely to be affected.

Loggerhead sea turtle (*Caretta caretta*)—North Pacific Ocean DPS

On September 22, 2011, the U.S. Fish and Wildlife Service (USFWS) and NMFS published a final rule listing nine DPS of loggerhead sea turtles (76 FR 58868). Loggerhead sea turtles in the Proposed Action Area are considered part of the North Pacific Ocean DPS, which is listed as endangered.

Population estimates for this species are based on nesting activity occurring outside the Proposed Action Area. The North Pacific loggerhead DPS nests primarily in Japan (Kamezaki et al. 2003), although low-level nesting may occur outside of Japan in areas surrounding the South China Sea (Chan et al. 2007; Conant et al. 2009). Kamezaki et al. (2003) concluded a substantial decline (50 to 90 percent) in the size of the annual loggerhead nesting population in Japan since the 1950s. As discussed in the 2011 final ESA listing determination, current nesting in Japan represents a fraction of historical nesting levels (Conant et al. 2009; 76 FR 58868). Nesting declined steeply from an initial peak of approximately 6,638 nests in 1990 to 1991, to a low of 2,064 nests in 1997. During the past decade, nesting increased gradually to 5,167 nests in 2005 (Conant et al. 2009), declined, and then rose again to a record high of 11,082 nests in 2008, and then 7,495 and 10,121 nests in 2009 and 2010, respectively (Matsuzawa 2008, 2009, 2010). At the November 2011 Sea Turtle Association of Japan annual symposium, the 2011 nesting numbers were reported to be slightly lower at 9,011 (NMFS 2012, Asuka Ishizaki, pers. comm. November 2011).

Thus, for the 20-year period of 1990 to 2010, the total number of nests per year for the North Pacific DPS ranged between 2,064 and 11,082 nests. The total number of adult females in the population was estimated at 7,138 for the period of 2008 to 2010 by Van Houtan (2011).

Loggerheads that have been documented off the U.S. West Coast are primarily found south of Point Conception, California in the SCB. In Oregon and Washington, records have been kept since 1958, with nine stranded turtles recorded over approximately 54 years. This equates to less than one stranding every six years (NMFS Northwest Region stranding records database, 1958 to 2012, unpublished data). In 2014, NMFS designated a Loggerhead Conservation Area (LCA) off Southern California where DGN fishing is prohibited during certain specific El Nino conditions. From the 2001/2002 through the 2017/2018 fishing seasons, two loggerheads were observed caught in the DGN fishery, both of which were released alive (Carretta, et al. 2020).

One loggerhead turtle has been observed caught in DSBG EFP fishing. The turtle became entangled in surface lines and was disentangled and released alive. Following this event, NMFS amended the terms and conditions of its DSBG EFPs in an effort to eliminate sea turtle interactions of this nature. The gear specifications for the Proposed Action are consistent with the amended EFP terms and conditions.

3.3.2.2. Reptiles That May be Affected

This section describes marine reptiles that have had no interactions to date in DSBG EFP fishing, but that present additional concerns based on their presence in the Proposed Action Area, interactions with other HMS gear types, and technical advice of NMFS PRD. While projections of potential interactions between these species and DSBG (which are based on data from EFP trials) do not indicate that these species will interact with DSBG as would be authorized under the Proposed Action alternatives, we will discuss potential impacts qualitatively later in this document (see Section 4).

Leatherback sea turtle (*Dermochelys coriacea*)

The leatherback turtle is listed as endangered under the ESA throughout its global range (NMFS 2020). Leatherbacks are found throughout the world. Populations and trends vary in different regions and nesting beaches. A current global population estimate is not available at this time, but details on what is known of populations are provided below.

Satellite tracking of post-nesting females and foraging males and females, as well as genetic analyses, indicate that the leatherbacks found off the U.S. West Coast are from the western Pacific nesting populations. Tracking data from leatherbacks nesting on Western Pacific beaches or foraging off California indicates some leatherbacks will move into U.S. coastal waters as early as the spring, often coming directly from foraging areas in the eastern equatorial Pacific (Benson et al. 2011).

Three main areas of foraging have been documented on the U.S. West Coast: in California over the coastal shelf in waters of 14 to 16° C, particularly off of central California; along the continental shelf and slope off of Oregon and Washington, particularly off the Columbia River plume; and offshore of central and northern California at sea surface temperature fronts in deep offshore areas, although this area was not regularly used (Benson et al. 2011). Researchers estimated an average of 178 leatherbacks (CV=0.15) were present between the coast and roughly the 50-fathom isobath off California. Abundance over the study period was variable between years, ranging from an estimated 20 to 366 leatherbacks (Benson et al. 2007). Bioenergetics studies reveal that adults consume between 65 and 117 kilograms of jellyfish per day to meet their energetic demands (Jones et al. 2012). A 2020 5-year review found that all leatherback DPSs met the definition of high risk of extinction, per NMFS' Listing Guidance, as a result of reduced nesting female abundance, declining nest trends, and numerous severe threats (NMFS 2020).

In 2001, the Pacific Leatherback Conservation Area (PLCA) was established, which closes substantial areas of central and northern California waters to DGN fishing from August 15 to November 15 each

year. From the 2001/2002 through 2017/2018 fishing seasons, there have been two leatherback sea turtles observed caught in the DGN fishery. Both were released alive (Carretta, et al. 2020).

3.3.2.3. Reptiles Considered Not Likely to be Affected

Two species of marine reptiles are known to occur in the Proposed Action Area, but have had no interactions to date with DSBG and present no additional concerns based on their low presence in the Proposed Action Area and extremely low rates of interaction with other fisheries in the Proposed Action Area. These species include olive ridley sea turtles (*Lepidochelys olivacea*) and green sea turtles (*Chelonia mydas*). These species are not discussed further, as we anticipate no impacts resulting from any of the Proposed Action alternatives.

3.3.3. Seabirds

The USFWS maintains a list of endangered species by state, including bird species. Of the species of seabirds occurring in the Proposed Action Area, only the short-tailed albatross is listed as endangered. Short-tailed albatross are not likely to be caught by DSBG because baits are deployed and retrieved close to the vessel and sink rapidly to depth. This species is not discussed further, as we anticipate no impacts resulting from any of the Proposed Action alternatives.

3.4. Essential Fish Habitat and Critical Habitat

Essential fish habitat (EFH) for HMS species is described in Appendix F of the HMS FMP. EFH consists of the epipelagic and mesopelagic zones of neritic and oceanic waters (PFMC 2003). DSBG is pelagic fishing gear deployed in open water from the surface to 350 m depth and is not designed to contact the ocean bottom. Given the biophysical characteristics of the water column and the components of the fishing gear (i.e., lines, hooks, weights, lights, floats, radar reflectors), the gear does not affect biophysical habitat. For this reason, it is not likely that the action alternatives would impact EFH.

Critical habitat has not been designated or proposed within the Proposed Action Area for most ESA-listed marine mammals, sea turtles, fish, and invertebrates. Designated critical habitat for Steller sea lions (eastern DPS) is within the Proposed Action Area, including waters surrounding Año Nuevo Island, Sugarloaf Island, and the southeast Farallon Islands in California, and Pyramid Rock at Rogue Reef, and Long Brown Rock and Seal Rock at Orford Reef in Oregon (50 CFR part 226). Critical habitat includes associated aquatic zones 3,000 feet seaward in state- and federally-managed waters from the baseline of each rookery (50 CFR 226.202(b)). All of the DSBG effort to date has occurred well south of the islands that are designated as critical habitat. The Proposed Action is not likely to affect Steller sea lion critical

habitat because DSBG fishing is not likely to occur very close to shore (i.e., within 3,000 feet of these rookeries), and it will not be considered further in this document.

Critical habitat for leatherback sea turtles was designated off the U.S. West Coast in 2012 (77 FR 4170), and includes areas that would be open to the proposed DSBG fishery off the central coast of California. In the final rule designating leatherback critical habitat, NMFS identified one primary constituent element essential for the conservation of leatherbacks in marine waters off the U.S. West Coast: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., Chrysaora, Aurelia, Phacellophora, and Cyanea), of sufficient condition, distribution, diversity, abundance, and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks. However, the critical habitat designation does not specifically define or develop standards or measurable criteria for any of these particular aspects of prey occurrence. The critical habitat designation emphasizes that the preferred prey of leatherbacks off the California coast is jellyfish, with other gelatinous prey, such as salps (a pelagic tunicate), considered of lesser importance (77 FR 4170). It is highly unlikely that jellyfish bycatch would occur in DSBG fishing, due to the physical structure of the gear and the fact that jellyfish are not known to prey on baited hooks.

On April 21, 2021, NMFS designated critical habitat for humpback whales off the U.S. West Coast (86 FR 21082). Critical habitat applies to the Western North Pacific DPS, the endangered Central America DPS, and the threatened Mexico DPS. All of the designated areas serve as feeding habitat for the relevant listed DPSs and contain the essential biological feature of humpback whale prey, namely euphausiids (krill) and schools of small pelagic fish. While the Proposed Action area does overlap with the southernmost point of humpback critical habitat, it is unlikely that authorizing DSBG would affect this habitat, as the prey species in question generally do not occur at depths where DSBG hooks are set, and have not been caught in DSBG EFP trials to date.

The Proposed Action is not likely to affect EFH or critical habitat, and they will not be considered further in this document.

3.5. Socioeconomic Environment

Socioeconomic impacts of the Proposed Action will occur to three main distributional groups: fisheries in or near the Proposed Action Area, HMS fishermen and fishing communities, and downstream users of swordfish such as processors, restaurants, and consumers.

3.5.1. Fisheries in or Near the Proposed Action Area

Currently, landings of swordfish into U.S. West Coast ports come from the West Coast DGN and harpoon fleets that fish in the U.S. EEZ, from DSBG EFP vessels, and from U.S. longline vessels that fish on the high seas. However, the large majority of swordfish on the West Coast is supplied by imports from other nations.

Overall, swordfish fishing effort and landings have significantly declined on the U.S. West Coast. In 2019, 61 Federal DGN permits were issued, but only 15 of the permittees were active in the fishery. Much of the attrition in the DGN fleet is attributed to the designation of the PLCA in 2001, which closes a large portion of the EEZ off central and northern California to DGN fishing from August 15 to November 15 each year. Following designation of the PLCA, attrition in the fishery reached 100 percent in northern California ports and ranged from 55 to 75 percent in southern California ports. Other sources of uncertainty regarding the future of the DGN fishery are described in Section 5.1.3.

In recent years, the majority of swordfish landings in California have been from Hawaii longline vessels. In 2020, Hawaii longline vessels landed 203.76 mt of swordfish in southern California ports, while DGN landed 24.11 mt. DSBG EFP trials landed 85.46 mt in 2020. The harpoon and hook-and-line fisheries produce fewer swordfish landings (e.g., 4.31 and 0.51 mt, respectively, in 2018). The remaining demand for swordfish in southern California, over 1,738 mt, was met by imports.

3.5.1.1. U.S. West Coast Deep-set Buoy Gear Trials

DSBG was first used off the U.S. West Coast in a series of research fishing trials that began in 2011. PIER conducted the trials in consultation with the NMFS Southwest Fisheries Science Center (SWFSC). These research trials indicated that DSBG could be used to selectively target and harvest swordfish with minimal bycatch and protected species interactions. However, uncertainty remained regarding optimal gear configurations, timing of deployment, seasonality, and other factors. In 2015, NMFS issued five EFPs to PIER to further test DSBG.

In 2017, a total of five vessels fished DSBG in waters off Southern California, landing 30.25 mt of swordfish worth $440,234. Other marketable species landed in DSBG EFP trials in 2017 included escolar, bigeye thresher shark, and common thresher shark.

In 2018, NMFS issued 60 EFPs to fish DSBG (both SBG and LBG) in the waters off Southern California. For SBG EFPs, 100 percent observer coverage was required for at least the first ten days of fishing, after

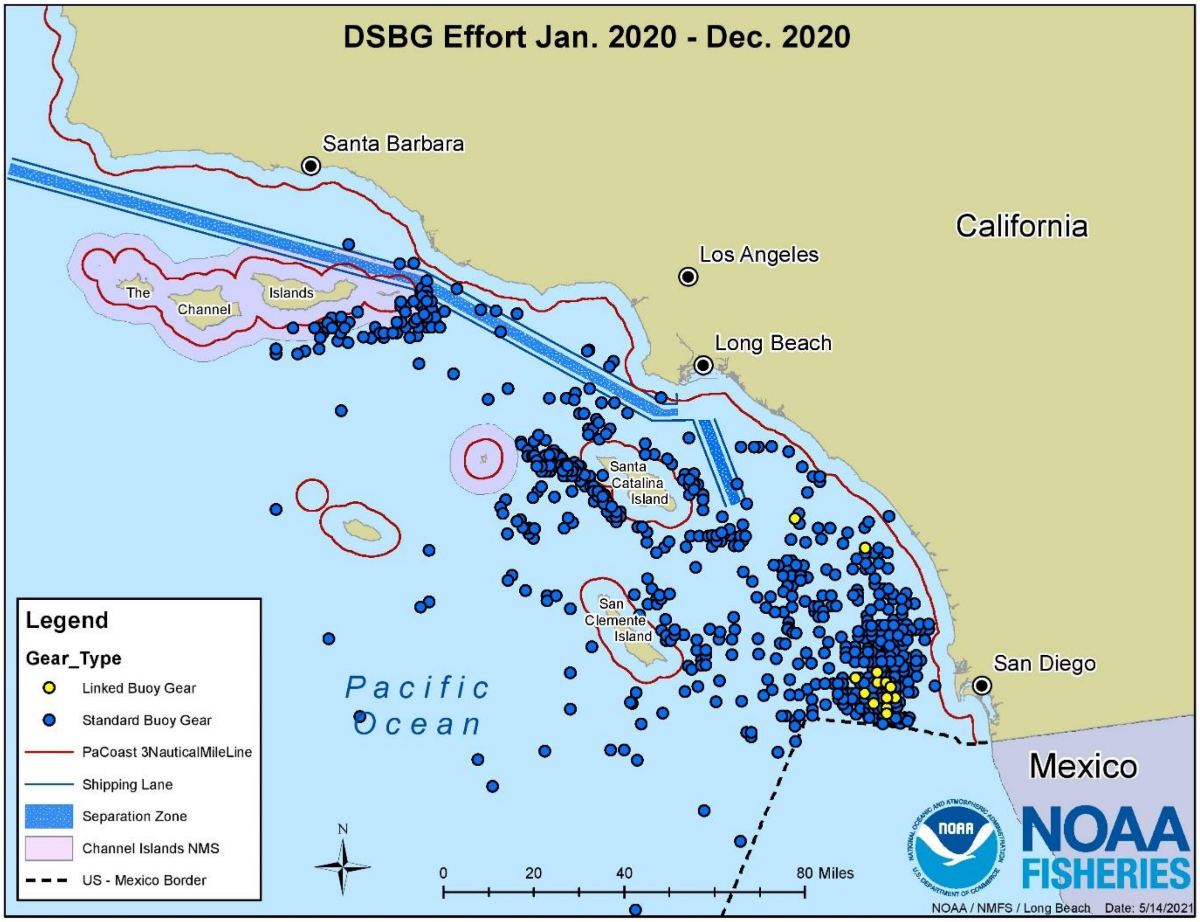
which observer coverage was reduced to 30 percent of trips. The West Coast Region Observer Program inspects all DSBG vessels to ensure adequacy of safety equipment, accommodations, and general vessel safety. Some vessels are limited to single-day trips due to lack of bunk space for an observer. For LBG EFPs, observers were required on 100 percent of trips, after which observer coverage was reduced to a minimum of 30 percent of trips.

In 2020, NMFS reduced the observer coverage requirements for DSBG EFP trials. This was necessary in order to prioritize NMFS' observer program budget and improve observer deployment flexibility among the various fleets covered by the West Coast Region Observer Program. The 2020-2021 observer coverage rates are as follows:

- For new standard DSBG EFPs, 100 percent for the first 3 fishing days and then a minimum of 10 percent;
- For linked DSBG EFPs with no effort to date, 100 percent in the first year and then a minimum of 10 percent in the second year; and
- For continuing standard and linked DSBG EFPs (i.e., those that had activity in 2018-2019), a minimum of 10 percent of fishing days.

Figure 3-1 shows the spatial distribution of effort from DSBG trials in January through December 2020. Note that, to date, most DSBG effort has been in waters off Southern California, with less than 1 percent of days fished taking place north of Point Conception. Although Oregon is within the Proposed Action Area, no effort or landings have occurred in Oregon waters.

Figure 3–1. Spatial Distribution of DSBG Trials, 2020



SBG EFPs issued in 2018 were considered valid for one year, after which they could be renewed for another year. LBG EFPs issued in 2018 were considered valid for two years. Table 3-3 displays information on DSBG EFPs in 2020, including number of permits issued, levels of observed effort, and incidences of observed protected species interactions.

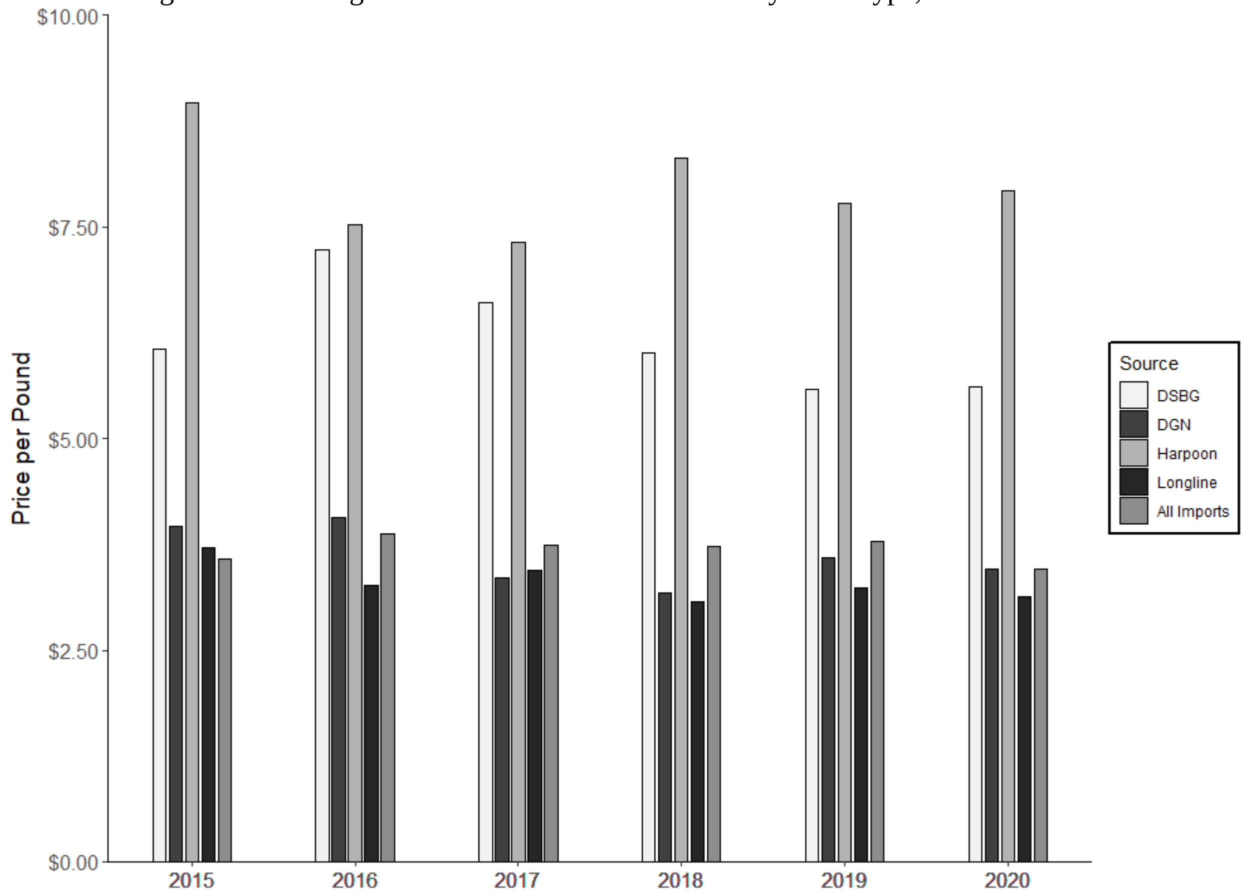
Table 3–3. Information on DSBG EFPs for Calendar Year 2020

Standard Deep-Set Buoy Gear (SBG)			Linked Deep-Set Buoy Gear (LBG)		
# of Vessels	27		**# of Vessels**	4	
# of Days Fished Reported	1062		**# of Days Fished Reported**	14	
Avg. Days Fished per Vessel	39.33		**Avg. Days Fished per Vessel**	3.50	
Overall Observer Coverage	19%		**Overall Observer Coverage**	7%	
Catch Composition			**Catch Composition**		
Swordfish	1257		Swordfish	25	
Bigeye Thresher Shark	51		Bigeye Thresher Shark	0	
Blue Shark	17		Blue Shark	0	
Unidentified Thresher Shark	18		Unidentified Thresher Shark	0	
Shortfin mako shark	1		Shortfin mako shark	0	
Pelagic thresher shark	0		Pelagic thresher shark	0	
Unidentified shark	2		Unidentified shark	0	
Common thresher shark	0		Common thresher shark	0	
Unidentified Mako Shark	5		Unidentified Mako Shark	0	
Salmon Shark	0		Salmon Shark	0	
Sixgill Shark	0		Sixgill Shark	0	
Northern elephant seal	0		Northern elephant seal	0	
Loggerhead sea turtle	0		Loggerhead sea turtle	0	
Humboldt squid	0		Humboldt squid	0	
Giant squid	0		Giant squid	0	
Opah	0		Opah	0	
Escolar	3		Escolar	1	
Common Mola	0		Common Mola	0	
Pacific Hake	1		Pacific Hake	0	
Unidentified Rockfish	1		Unidentified Rockfish	0	
Yelloweye Rockfish	0		Yelloweye Rockfish	0	
Vermillion Rockfish	1		Vermillion Rockfish	0	
Oilfish	2		Oilfish	0	
Unknown	1		Unknown	0	
Swordfish	1257	*92.4%*	Swordfish	25	*96.2%*
Bigeye Thresher Sharks	51	*3.7%*	Bigeye Thresher Sharks	0	*0.0%*
Other Sharks	43	*3.2%*	Other Sharks	0	*0.0%*
Other Finfish (Retained)	5	*0.4%*	Other Finfish (Retained)	1	*3.8%*
Other Finfish (Released)	4	*0.3%*	Other Finfish (Released)	0	*0.0%*
Protected Species	0	*0.0%*	Protected Species	0	*0.0%*

**Note that four vessels fished both standard and linked gear over the course of the season*

In EFP fishing to date, DSBG-caught swordfish has fetched a higher price (on average) than DGN and longline-caught swordfish, but lower than harpoon-caught swordfish. Figure 3-3 shows the average price of swordfish from various sources for the years 2015-2020.

Figure 3–3. Average Price of West Coast Swordfish by Gear Type, 2015-2020



3.5.1.2. Other Commercial Fleets

Commercial gear types, authorized under the HMS FMP, that are used to target swordfish in the Proposed Action Area include large-mesh DGN and harpoon gear. With regards to the Proposed Action to authorize DSBG under the HMS FMP, harpoon is considered the most similar in terms of bycatch impacts and socio-economic characteristics, as it is an artisanal gear type used to selectively target swordfish and typically garners a higher price for swordfish landings.

<u>Large Mesh DGN Fleet</u>

The DGN fleet developed in Southern California in the 1970s to target thresher sharks and experienced periods of rapid growth and attrition thereafter. Swordfish replaced thresher shark as the primary target species of the DGN fleet in 1981 because of the fourfold higher price per pound of swordfish (NMFS

2015). DGN quickly replaced harpoon as the primary method for catching swordfish because of the greater catch-per-unit-effort (CPUE); DGN has a swordfish catch rate about 2 to 3 times higher and reduced cost of fishing (Coan et al. 1998). The fleet size peaked in the mid-1980s with about 250 vessels participating. However, to reduce interactions with non-target fish, marine mammals, sea turtles, and sharks, regulations stipulating gear modification and area closures, such as the PLCA and the LCA, were enacted (50 CFR 660.713(c)((1) and (2)). In 2001, the PLCA time-area closure was put in place to protect leatherback sea turtles, and the LCA time-area closure (dependent on El Niño conditions) was put in place to protect loggerhead sea turtles (50 CFR 660.713(c)(2)). Since 2001, the number of active participants in the DGN fleet has remained under 50 vessels. Since 2013, fewer than 20 vessels have actively participated annually. This fleet deploys its gear in the U.S. EEZ off the coasts of California and Oregon, with a fishing season that runs from May through January. Between 2015 and 2020, the DGN fleet landed an average of 80 mt of swordfish per year, accounting for approximately 21 percent of domestic swordfish supply and 4 percent of the total supply on the U.S. West Coast.

Harpoon Fleet

California's modern harpoon fleet for swordfish developed in the early 1900s. Prior to 1980, harpoon and hook-and-line were the only legal gears for commercially harvesting swordfish. At that time, harpoon gear accounted for the majority of swordfish landings in California ports. Like DSBG, harpoon is a highly selective gear type. Harpoon fishermen typically target one swordfish at a time, resulting in zero bycatch.

In the early 1980s, DGN replaced harpoon as the primary gear type for catching swordfish. The number of harpoon permits subsequently decreased from a high of 1,223 in 1979 to a low of 25 in 2001. Between 2013 and 2017, an average of 15 harpoon vessels actively fished each season, landing an average of 13.6 mt of swordfish annually. Some vessel operators work in conjunction with a spotter airplane to increase the search area and to locate swordfish difficult to see from the vessel. This practice tends to increase the CPUE compared to vessels that do not use a spotter plane, but at a higher operating cost. Harpoon fishing takes place inside the SCB exclusively and typically from May to December, peaking in August, depending on weather conditions and the availability of fish in coastal waters.

Hawaii and West Coast-Based High-Seas Longline Fleets

The Hawaii longline fleets developed in the early 20th century. This gear is used to target swordfish and tuna and incidentally captures other marine species. The fleets deploy deep-set longline (DSLL) to target primarily tunas, and SSLL gear to target primarily swordfish year round. Both fleets mainly operate in the Northern Central Pacific Ocean. Although fishing activity does not occur in the Proposed Action Area,

swordfish caught by these fleets are landed to California ports. The Hawaii longline fleets landed between 114.79 and 347.16 mt of swordfish to California between 2015 and 2020.

A small West Coast-based longline fleet, which historically has included fewer than three vessels, targets tunas and other HMS outside of the West Coast EEZ using DSLL gear. This fishery incidentally landed small amounts of swordfish to Southern California ports between 2015 and 2020.

Hook and Line Fleet

The commercial hook and line fleet primarily targets tuna and has caught and landed swordfish in low volumes from 2015 through 2020. Average landings over this time period were 0.55 mt per year.

Recreational Fisheries

A large and economically important recreational and sport fishery is active in the Proposed Action Area. In 2017, marine recreational anglers in California and Oregon undertook 3.7 million trips, 95 percent of which took place in California. These trips resulted in a harvest of 8.4 million individual finfish, of which 5.4 million (63 percent) were released (NMFS 2018a). Albacore is a common target of U.S. West Coast recreational fisheries, primarily using rod-and-reel gear. Recreational anglers in California take the entire suite of HMS FMP management unit species, using rod-and-reel gear almost exclusively. In addition, a nominal amount of fish, primarily tunas and dolphinfish, are taken by free divers using spear guns. In Oregon, anglers only occasionally take HMS species other than albacore, including blue sharks (PFMC 2018b). Approximately 11 percent of the total West Coast recreational catch came from trips that fished primarily in Federal waters of the EEZ (i.e., within the Proposed Action Area), with the remainder coming from state territorial waters or inland waters (NMFS 2018a). Swordfish fishing is open year-round to commercial passenger fishing vessels and private recreational boats, both of which may catch a small amount of swordfish recreationally. Recent years have seen an uptick in “deep drop” fishing, a method which is used to target swordfish during the daytime.

3.5.2. Fishermen and Fishing Communities

HMS fishermen include all persons involved with commercial fishing for HMS species off the U.S. West Coast. This includes HMS permit holders, vessel operators, and crewmembers. These persons earn some or all of their annual income through HMS fishing in the Proposed Action Area, using gears that target swordfish. As such, their livelihoods are affected by factors such as stock status of target species, permitting of HMS gear types and associated management measures, the fixed and variable costs of HMS fishing, catchability and CPUE of target species, and the ex-vessel price of landed species. This EIS

focuses on DSBG swordfish price as a key indicator of the socioeconomic impacts of the Proposed Action to authorize DSBG fishing under the HMS FMP. Fishermen will only choose to fish this gear if it is profitable, a factor which directly relates to the price they will receive for DSBG-caught swordfish. The price of landed swordfish is variable across time and is influenced by a number of factors, including gear type. The price of swordfish caught using DSBG is related to the quantity of swordfish landed, as well as the quantity landed by other gear types or imported from foreign countries. The quantity landed of substitute species (i.e., species that restaurants or consumers might consider purchasing in lieu of swordfish) is another relevant factor influencing DSBG price. The price also varies from month to month and from year to year. Appendix B contains details on our DSBG price analysis, which accounts for many of these variables which influence DSBG price and, consequently, the profitability of the gear.

Table 3-4 presents summary statistics and data descriptions for all variables thought to impact DSBG swordfish price. The data source for all variables is from the confidential PacFIN HMS landings database, except for the imports data, which were sourced from NOAA Office of Science & Technology. Data are aggregated by month and refer to swordfish landings to Southern California ports, as DSBG has not been landed elsewhere to date.[1]

[1] Ports with DSBG landings include Long Beach, Newport Beach, Oceanside, Oxnard, Santa Barbara, San Diego, San Francisco/San Mateo, San Pedro, Ventura, and a grouping of other Los Angeles/Orange County ports.

Table 3-4. Data Summary for DSBG Price Analysis

Variable	Label	Mean	Min	Median	Max	Description
DSBG Price	$P_{DSBG,ij}$	$6.59	$4.65	$6.62	$9.00	Average price per pound paid for DSBG-supplied swordfish in a given month.
DSBG Landings	$Q_{DSBG,ij}$	12,682	67	8,082	47,616	Total volume (in pounds) of DSBG-supplied swordfish in a given month.
DGN Landings	$Q_{DGN,ij}$	27,176	22	11,084	121,163	Total volume (in pounds) of DGN-supplied swordfish in a given month.
Harpoon Landings	$Q_{HAR,ij}$	3,351	137	1,525	26,013	Total volume (in pounds) of harpoon-supplied swordfish in a given month.
Longline Landings	$Q_{LL,ij}$	30,124	42	5,062	197,800	Total volume (in pounds) of longline-supplied swordfish in a given month.
Hook & Line Landings	$Q_{LX,ij}$	346	70	322	880	Total volume (in pounds) of hook & line-supplied swordfish in a given month.
Fresh Imports	$Q_{DSBG,ij}$	217,397	129,250	223,934	297,617	Total volume (in pounds) of fresh swordfish imports in a given month.
Yellowfin Landings	$Q_{YF,ij}$	14,732	1,381	10,331	127,243	Total volume (in pounds) of yellowfin tuna landings from all domestic sources.
Dolphinfish Landings	$Q_{DF,ij}$	3,301	273	1,799	14,784	Total volume (in pounds) of dolphinfish landings from all domestic sources.
Month	η_i		January		December	Month in which DSBG was landed.
Year	ρ_j		2015		20120	Year in which DSGB was landed.

Fishing communities affected by the Proposed Action include regions with significant economic activity derived from swordfish fishing. At the regional level, landings and revenues from DSBG EFP fishing have been concentrated in Southern California, with the majority of revenues to San Diego County, Los Angeles County, and Orange County. Lower volumes of landings and associated revenues have occurred in Ventura and Santa Barbara Counties. No landings of DSBG-caught swordfish have occurred north of these regions, except for a single landing to San Francisco/San Mateo. For the purposes of this document, we consider DSBG landings and revenues in three regions (Los Angeles & Orange County, San Diego County, and Ventura, Santa Barbara, and San Francisco County). Figure 3-4 displays total annual swordfish landed weight deliveries for the three regions where DSBG has been landed, and Figure 3-5 displays total ex-vessel revenues.

Figure 3–4. Total DSBG Swordfish Landed Weight by County/Region, 2015-2020

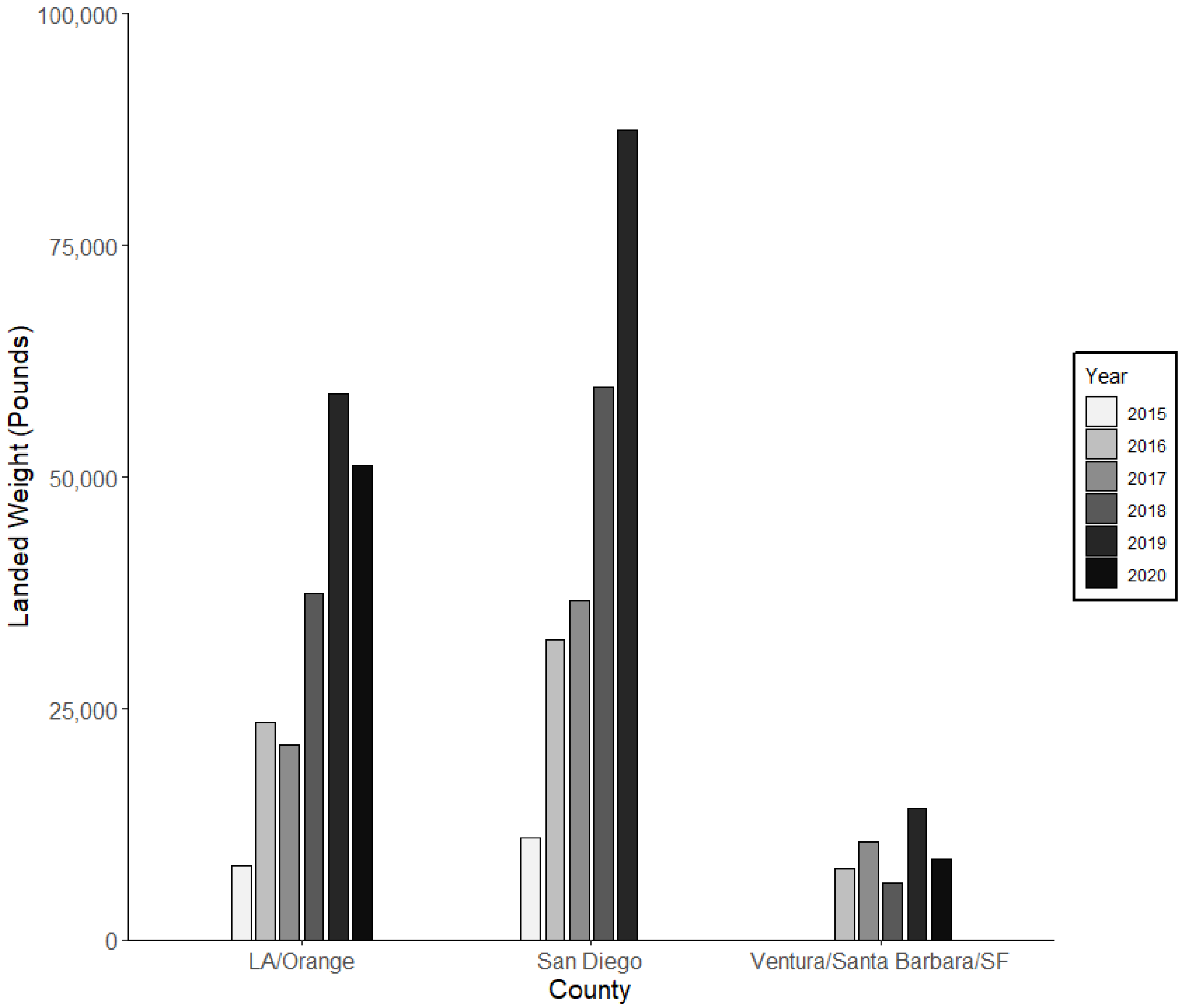
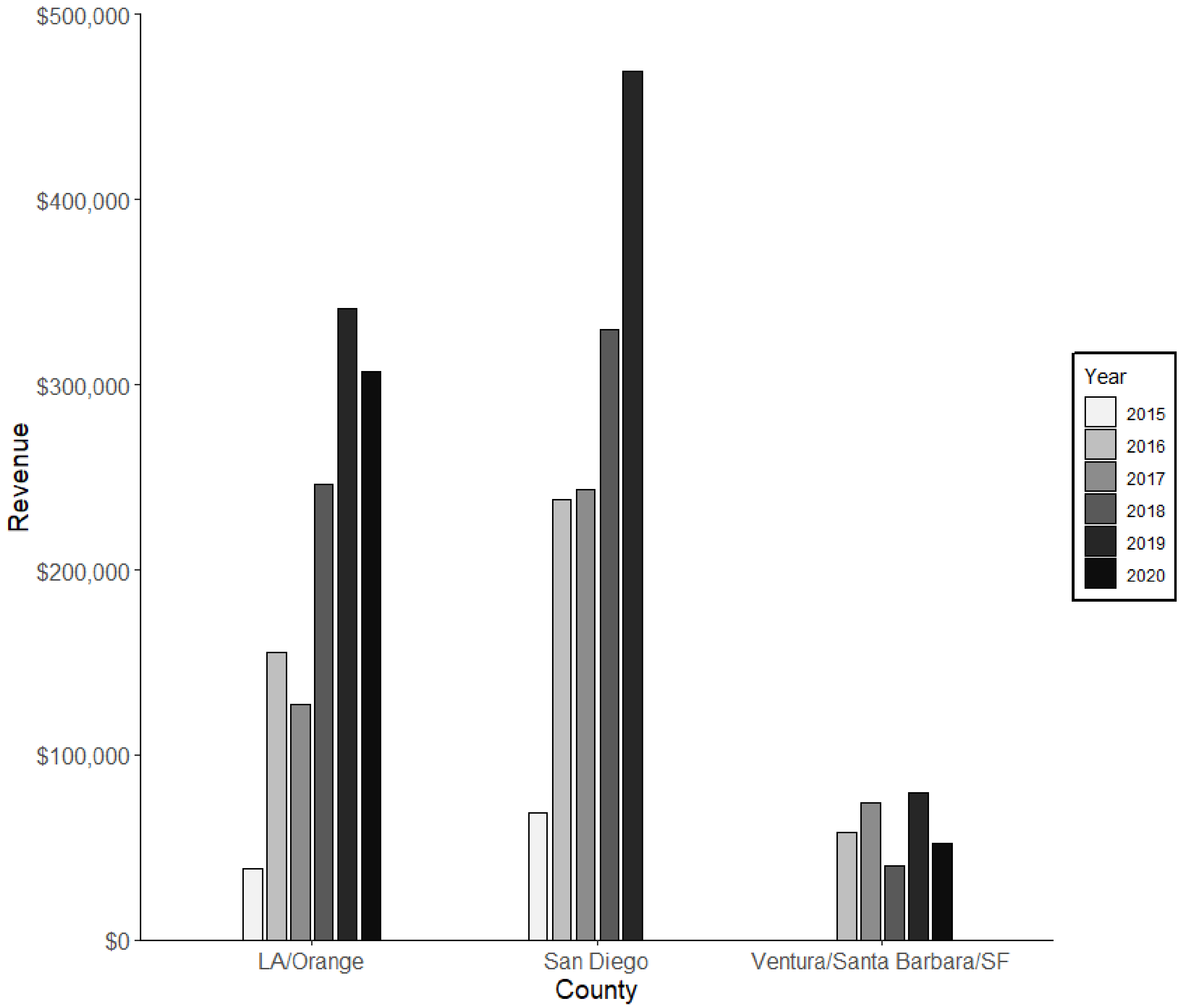


Figure 3–5. Total DSBG Revenues by County/Region, 2015-2020



3.5.3. Processors, Restaurants, & Consumers

Commercially-caught swordfish, once landed, is purchased, processed, and/or consumed by downstream users, including processors, restaurants, and consumers. Seafood processing companies purchase swordfish from HMS fishermen to prepare and package it for users further down the supply chain (i.e., restaurants and consumers). Restaurants and some consumers may themselves purchase swordfish directly from fishermen as well.

Different sources of swordfish are perceived as having varying levels of quality, as reflected by the range of average swordfish prices by source in Figure 3-3. For example, harpoon- and DSBG-caught swordfish are generally considered higher quality products than DGN- or longline-caught swordfish. Some

consumers are also willing to pay a higher price for swordfish caught by more environmentally sustainable methods, such as harpoon or DSBG, which have been shown to produce markedly lower rates of non-target fish bycatch and protected species interactions compared to DGN or longline.

4. ENVIRONMENTAL CONSEQUENCES AND OTHER IMPACTS

4.1. Introduction

This section analyzes the effects of the Proposed Action alternatives on the resources described in Section 3, Affected Environment, including fish species, protected non-fish species, and the socioeconomic environment. As noted in Section 3.4, the Proposed Action alternatives are not likely to affect EFH or critical habitat, so they are not discussed in this section. The analyses in this section are based on expected fishing effort under each of the alternatives. The analyses rely on observer and logbook records at the days-fished level from the DSBG EFP trials, from January 2015 through December 2020, to evaluate potential catch of target and non-target fish species, and potential interactions with protected and prohibited species. To maximize the accuracy of our estimates, we employ NMFS observer data wherever possible and logbook data for those days fished where an observer was not present onboard the vessel.

We estimate potential catch rates of species likely to be affected by the Proposed Action under each alternative, using a statistical methodology that accounts for uncertainty to produce a range of possible catch counts and the most likely value in a given year. We develop these estimates both for the twelve-year "ramp up" period and for each single year once the maximum number of permits is issued under each alternative. See Appendix A for details on the methodology used for the biological analysis. NMFS will conduct an ESA Section 7 consultation for the Proposed Action to assess potential impacts on endangered species, including the loggerhead sea turtle.

We estimate socioeconomic impacts of the Proposed Action alternatives using a statistical model that estimates the effect of various factors on DSBG price. We then use this estimated "price effect" to project the average price-per-pound of DSBG-caught swordfish under each of the alternatives. We also project landings and revenues under each of the alternatives for three regions where DSBG-caught swordfish have been landed to date. See Appendix B for details on the methodology used for the socioeconomic analysis.

4.2. Alternative 1—No Action

Under the No Action Alternative, DSBG would not be authorized under the HMS FMP and no DSBG permits would be issued under the FMP. The status quo of HMS fisheries off the U.S. West Coast would continue in the manner summarized in Section 3. Swordfish would continue to be supplied by other domestic HMS fisheries (e.g., harpoon, DGN, and longline) and foreign imports. NMFS may continue issuing EFPs to fish with DSBG, in lieu of the proposed action to authorize these activities under the HMS FMP. Under such circumstances, NMFS does not expect to issue DSBG EFPs at a significantly

higher rate than in recent years, nor do we expect significant increases in DSBG fishing effort. Applying for and obtaining EFPs, which are limited in duration, and fulfilling reporting requirements, are administratively burdensome processes for the EFP applicant and the agency. Additionally, EFPs and renewals are subject to review by the Council.

4.2.1. Target Species

Under the No Action Alternative, swordfish catch by authorized HMS fleets fishing off the U.S. West Coast is expected to continue and follow trends described in Section 3.5.1. While DSBG trials to target swordfish in the Proposed Action Area could continue under EFPs in the Proposed Action Area under the No Action Alternative, issuance of EFPs is a lengthier and more labor-intensive process than issuance of permits for fishing gear legally authorized under the HMS FMP. It is unlikely that levels of permit issuance and annual DSBG fishing effort under EFP fishing would approach the levels expected under authorized DSBG permits. Therefore, under this alternative it is expected that fewer swordfish would be caught in the Proposed Action Area and landed to the U.S. West Coast than under Action Alternative 2 or Alternative 3. As a result, the yield from the WCNPO swordfish stock found in the Proposed Action Area would likely continue to be suboptimal.

Section 3.5.1 describes current levels and trends in swordfish catch between the currently operating domestic swordfish fisheries on the U.S. West Coast. From 2015 through 2020, approximately 83 percent of the total swordfish supply on the U.S. West Coast has been from foreign imports. We expect this proportion of imported supply to continue or increase under the No Action Alternative due to a steady trend of attrition in the DGN fishery and a lack of viable alternative gears for U.S. fishermen to target swordfish inside the EEZ.

4.2.2. Non-Target, Prohibited, and Protected Species

Under the No Action Alternative, impacts to non-target, prohibited, and protected species would remain at the levels expected under the status quo. These impacts can be characterized based on non-target catch rates in existing domestic HMS fisheries that target swordfish, along with indirect effects of bycatch in foreign fleets which provide over 80 percent of the U.S. West Coast swordfish supply.

The DGN fleet targets swordfish and thresher shark. Approximately 44 percent of the total finfish caught in this fishery are common molas, 94 percent of which are released alive (Le Fol 2016). Other commonly caught finfish species include albacore, blue shark, shortfin mako shark, opah, skipjack tuna, common thresher shark, Pacific mackerel, and other tuna and shark species. Of these, all are generally retained and

brought to market except blue shark and Pacific mackerel, which have lower retention rates of 1 percent and 14 percent, respectively. Declining effort and effective regulations have drastically curtailed interaction rates with marine mammals, sea turtles, and reptiles; however, isolated interaction events with these protected species do occur occasionally, accounting for about 1 percent of total catch and interaction events from 2000 through 2017. The fishery is listed as Category II fishery under the MMPA. While we expect these general rates of non-target finfish catch and protected species interactions to persist under the No Action Alternative, ongoing attrition in the DGN fishery may reduce its biological impacts even further in the future regardless of whether an action alternative for this Proposed Action is implemented.

The Hawaii SSLL fishery, which lands approximately 10 percent of the total swordfish supply to the U.S. West Coast, experiences occasional unmarketable bycatch. The fishery is listed as Category II fishery under the MMPA. Gear and operational modifications such as the adoption of circle hooks, whole finfish bait, and seabird avoidance measures have reduced rates of reptile and seabird interactions in this fishery substantially. The fishery also operates under a hard caps rule for leatherback sea turtles, such that the fishery is shut down if more than 16 interactions with leatherback sea turtles are observed in a given season (85 FR 57988). Under the No Action Alternative the biological impacts of the Hawaii SSLL fishery and landings to the U.S. West Coast would likely continue or increase as has been the trend under status quo conditions. Because the majority of these vessels have home ports in other places and fish outside of the U.S. West Coast EEZ, they are unlikely to shift effort towards participation in an authorized DSBG fishery inside the EEZ. Therefore, the biological impacts of the Hawaii longline fishery are likely to be unaffected by this Proposed Action.

Other fisheries that land swordfish catches to the U.S. West Coast are listed as Category III fisheries under the MMPA, and records indicate few, if any, incidences of interactions with species listed as threatened or endangered under the ESA. The U.S. West Coast-based DSLL fishery consists of a small number of vessels which incidentally catch swordfish. Because of the low number of vessels, specific information on bycatch in this fishery is confidential for most recent years. Non-target finfish catch and protected species interactions are likely to continue under status quo conditions. The harpoon and hook-and-line fisheries employ selective and low-impact fishing methods.

Section 3.2 details current catch rates of non-target and protected species in DSBG EFP fishing, along with the current status of these species. It is unlikely that biological impacts from continued DSBG EFP fishing would approach those projected under authorized DSBG permits. Because U.S. fishermen could continue to fish with DGN and harpoon inside the EEZ and with longline outside of the EEZ, and would

not have an alternative gear option aside from EFPs, we expect non-target catch and protected species interaction rates from these fisheries to persist at current levels. In the case of DGN and longline fisheries, rates of non-target catch are generally higher than the rates observed in DSBG EFP trials. Any potential bycatch benefits from authorizing a DSBG fleet (i.e., from providing a secure alternative fishing method to current HMS fishermen) would not be realized under the No Action Alternative. Additionally, because we expect foreign imports will continue to fill a large gap in West Coast demand and supply of swordfish, indirect negative effects to biological resources, including transboundary protected species, are anticipated on a global scale to the extent that bycatch rates in foreign fisheries catching swordfish are higher than those of U.S. fisheries.

4.2.3. Socioeconomic Impacts

4.2.3.1. Impacts to Fisheries in or Near the Proposed Action Area

Under the No Action Alternative, fisheries in or near the Proposed Action Area would continue to operate under status quo conditions (see Section 3.5.1). We assume that 80 percent or more of the total swordfish supply to the U.S. West Coast would continue to be supplied by foreign imports instead of by U.S. fisheries, and that fishing effort by West Coast-based vessels would not meaningfully increase in the absence of a viable additional gear option. It is unlikely that levels of permit issuance and annual DSBG fishing effort under EFP fishing would approach the levels expected under an authorized fishery. U.S. West Coast swordfish fishermen who do not obtain DSBG EFPs could continue to fish with DGN and harpoon inside the EEZ and with longline outside of the EEZ under existing regulations.

4.2.3.2. Impacts to Fishermen & Fishing Communities

Under the No Action Alternative, U.S. West Coast commercial fishermen may continue to fish with DSBG in the Proposed Action Area under EFPs. The Council may recommend that NMFS issue additional DSBG EFPs in the absence of authorization; however, because fewer DSBG fishing trips are likely under EFPs than an authorized DSBG permit program, fewer opportunities for targeting and landing swordfish using DSBG are expected in comparison to an authorized fishery. The majority of swordfish supply to the U.S. West Coast would continue to come from other domestic HMS fleets and foreign imports.

4.2.3.3. Impacts to Processors, Restaurants, & Consumers

Under the No Action Alternative, processors, restaurants, or consumers are likely to continue to rely on foreign imports rather than locally-caught swordfish to meet demands.

4.3. Alternative 2—Authorize an Open Access Fishery

Under Alternative 2 (the Open Access Alternative), there would be no limit on the number of DSBG endorsements added to existing or future General HMS permits. Based on recommendations of the Council and its HMSMT, we use 500 permits as the basis for analysis.[2]

4.3.1. Target and Non-Target Species Considered Likely to be Affected

The tables below display the projected impacts to species likely to be affected by the Open Access Alternative, based on our biological analysis (see Appendix A for detail on how these estimates were calculated). The results for the Open Access Alternative are bordered for emphasis. Results are given as a range of possible catch counts with a 95 percent credible interval (CI, i.e., the range with a 95 percent probability of containing the true catch value). The tables display the mean, median, and mode of the calculated distributions of possible catch values under each alternative, as well as the range of the 95 percent credible interval. The mode is the most likely value in any one year, based on the probability distribution of possible catch counts. Note that while there is no true "ramp up" period under the Open Access Alternative (i.e., under open access the full amount of permits would be available immediately), we provide catch estimates for the first twelve years after authorization for the purpose of comparing the two action alternatives.

Although open access DSBG fishing would be permitted throughout the U.S. EEZ offshore California and Oregon under this Alternative, virtually all DSBG EFP effort has occurred inside the SCB to date. All the available information suggests that DSBG fishermen will concentrate effort within the SCB under an authorization scenario. Furthermore, we do not have data to analyze impacts of DSBG authorization outside the SCB.

Also note that the impacts detailed below are considered additional to the ongoing biological impacts of existing HMS gear types in the Proposed Action Area; that is, we do not assume that effort in these fisheries will decrease due to DSBG authorization (see Section 3.5.1 for detail on the status quo of fisheries in or near the Proposed Action Area and Section 4.2 for a synopsis of the expected ongoing impacts of these fisheries). Indirect effects of the Proposed Action on effort in other domestic HMS fisheries are speculative, and some specific potential cumulative impacts of such interactivity are discussed in Section 5.

[2] The HMSMT recommended 500 permits as the basis of analysis because this number is similar to the highest number of swordfish fishery participants in the past, when DGN and harpoon were at their peak.

4.3.1.1. Target Species

Swordfish (*Xiphias gladius*)

Table 4-1 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–1. Swordfish Catch (in Number of Individuals) Under Alternative 2

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.01878*	*0.01805*	*0.01877*	*0.01952*	
	Per Day Fished	*1.34198*	*1.29043*	*1.34175*	*1.39548*	
12 Year Ramp Up	Open Access	105,704	100,156	105,655	111,495	105,309
	LE 3.1	34,351	31,786	34,334	37,014	34,464
	LE 3.2	50,202	46,860	50,198	53,611	51,265
	LE 3.3	58,142	54,445	58,116	61,933	57,954
	LE 3.4	63,426	59,567	63,401	67,413	64,389
	LE 3.5	39,199	36,418	39,178	42,118	38,828
Ongoing Annual	Open Access	8,812	7,653	8,802	10,033	9,028
	LE (All)	5,286	4,409	5,276	6,221	5,311

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 105,704 individuals. The average catch in a given year is estimated at 8,812, an increase of approximately 7,600 individual swordfish over the amount caught in the most recent year of DSBG EFP trials. Because the swordfish stock off the U.S. West Coast is underutilized, and the WCNPO stock is not overfished or subject to overfishing, effects to the swordfish population are unlikely to affect the sustainability of the stock.

4.3.1.2. Non-Target Species

<u>Bigeye thresher shark (*Alopias superciliosus*)</u>

Table 4-2 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–2. Bigeye Thresher Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00134*	*0.00115*	*0.00133*	*0.00154*	
	Per Day Fished	*0.09554*	*0.08201*	*0.09536*	*0.11041*	
12 Year Ramp Up	Open Access	7,525	6,410	7,508	8,754	7,504
	LE 3.1	2,446	2,052	2,438	2,882	2,430
	LE 3.2	3,574	3,025	3,563	4,188	3,464
	LE 3.3	4,139	3,507	4,128	4,848	4,109
	LE 3.4	4,515	3,823	4,503	5,274	4,479
	LE 3.5	2,791	2,354	2,783	3,285	2,781
Ongoing Annual	Open Access	628	499	625	772	602
	LE (All)	376	287	374	480	358

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 7,525 individuals. The average catch in a given year is estimated at 628. Because this species is vulnerable to exploitation at relatively low levels of fishing mortality (Fu et al. 2016; Young et al. 2015), this may imply a significant impact at the population level. However, preliminary post-release mortality studies conducted by PIER have indicated that over 90 percent of bigeye thresher sharks caught and released in DSBG fishing survive the acute effects of capture (Sepulveda and Aalbers 2019).

<u>Blue shark (*Prionace glauca*)</u>

Table 4-3 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–3. Blue Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00015*	*0.00010*	*0.00015*	*0.00020*	
	Per Day Fished	*0.01075*	*0.00750*	*0.01064*	*0.01456*	
12 Year Ramp Up	Open Access	847	584	839	1,157	892
	LE 3.1	275	185	272	381	260
	LE 3.2	402	274	398	553	388
	LE 3.3	466	319	461	639	440
	LE 3.4	508	348	503	697	496
	LE 3.5	314	212	311	434	299
Ongoing Annual	Open Access	71	43	70	103	70
	LE (All)	42	24	42	65	40

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 847 individuals. The average catch in a given year is estimated at 71. The effects of this level of catch to the stock are likely to be minor.

Shortfin mako shark (*Isurus oxyrinchus*)

Table 4-4 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–4. Shortfin Mako Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00002*	*0.00001*	*0.00002*	*0.00005*	
	Per Day Fished	*0.00178*	*0.00066*	*0.00168*	*0.00346*	
12 Year Ramp Up	Open Access	140	50	132	276	121
	LE 3.1	46	15	43	92	38
	LE 3.2	67	23	63	132	53
	LE 3.3	77	27	73	153	59
	LE 3.4	84	29	79	167	75
	LE 3.5	52	17	49	104	44
Ongoing Annual	Open Access	12	3	11	25	9
	LE (All)	7	1	6	16	5

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 140 individuals. The average catch in a given year is estimated at 12. The effects of this level of catch to the stock are likely to be minor.

Pelagic thresher shark (*Alopias pelagicus*)

Table 4-5 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–5. Pelagic Thresher Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00182*	
12 Year Ramp Up	Open Access	52	6	44	144	31
	LE 3.1	17	1	14	48	7
	LE 3.2	25	2	21	69	12
	LE 3.3	29	3	24	80	16
	LE 3.4	31	3	26	88	16
	LE 3.5	19	2	16	55	9
Ongoing Annual	Open Access	4	0	4	14	2
	LE (All)	3	0	2	9	1

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 52 individuals. The average catch in a given year is estimated at 4. The effects of this level of catch to the stock are likely to be minor.

This species' presence off Southern California is highly seasonal. It is possible that the probability of catching this species in DSBG is dependent on seasonal conditions such as water temperature, and that the likelihood of its catch in a given year may be higher or lower than that reflected by the single interaction in the current dataset.

Common thresher shark (*Alopias vulpinus*)

Table 4-6 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–6. Common Thresher Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00121*	
12 Year Ramp Up	Open Access	27	1	19	98	2
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	1
	LE 3.4	16	0	12	59	1
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 27 individuals. The average catch in a given year is estimated at 2. The effects of this level of catch to the stock are likely to be minor.

Salmon shark (*Lamna ditropis*)

Table 4-7 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–7. Salmon Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	20	97	2
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 27 individuals. The average catch in a given year is estimated at 2. The effects of this level of catch to the stock are likely to be minor.

Sixgill shark (*Hexanchus griseus*)

Table 4-8 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–8. Sixgill Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	19	97	3
	LE 3.1	9	0	6	33	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	1
	LE 3.4	16	0	12	60	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 27 individuals. The average catch in a given year is estimated at 2. The effects of this level of catch to the stock are likely to be minor.

Humboldt squid (*Dosidicus gigas*)

Table 4-9 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–9. Humboldt Squid Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	19	97	5
	LE 3.1	9	0	6	33	1
	LE 3.2	13	0	9	47	2
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 27 individuals. The average catch in a given year is estimated at 2. The effects of this level of catch to the stock are likely to be minor.

Giant squid (Architeuthis dux)

Table 4-10 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–10. Giant Squid Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	1	19	97	5
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	3
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 27 individuals. The average catch in a given year is estimated at 2. The effects of this level of catch to the stock are likely to be minor.

Opah (*Lampris guttatus*)

Table 4-11 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–11. Opah Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00228*	
12 Year Ramp Up	Open Access	76	15	68	182	57
	LE 3.1	25	4	22	61	15
	LE 3.2	36	7	32	87	22
	LE 3.3	42	8	37	102	31
	LE 3.4	46	9	41	110	30
	LE 3.5	28	5	25	70	20
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 76 individuals. The average catch in a given year is estimated at 6. The effects of this level of catch to the stock are likely to be minor.

Escolar (*Lepidocybium flavobrunneum*)

Table 4-12 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–12. Escolar Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00013*	*0.00009*	*0.00013*	*0.00018*	
	Per Day Fished	*0.00950*	*0.00647*	*0.00938*	*0.01312*	
12 Year Ramp Up	Open Access	748	504	740	1,041	710
	LE 3.1	243	160	240	343	235
	LE 3.2	355	236	351	498	320
	LE 3.3	411	275	406	576	392
	LE 3.4	449	300	444	629	444
	LE 3.5	277	183	274	390	263
Ongoing Annual	Open Access	62	37	61	93	60
	LE (All)	37	21	37	58	36

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 748 individuals. The average catch in a given year is estimated at 62. The effects of this level of catch to the stock are likely to be minor.

Common mola (*Mola mola*)

Table 4-13 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–13. Common Mola Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00002*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00178*	
12 Year Ramp Up	Open Access	52	6	44	141	23
	LE 3.1	17	1	14	47	9
	LE 3.2	24	2	21	68	13
	LE 3.3	28	3	24	79	14
	LE 3.4	31	3	26	86	20
	LE 3.5	19	2	16	54	10
Ongoing Annual	Open Access	4	0	3	13	2
	LE (All)	3	0	2	9	1

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 52 individuals. The average catch in a given year is estimated at 4. The effects of this level of catch to the stock are likely to be minor.

Pacific hake (*Merluccius productus*)

Table 4-14 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–14. Pacific Hake Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00180*	
12 Year Ramp Up	Open Access	52	6	44	143	28
	LE 3.1	17	1	14	48	8
	LE 3.2	25	2	21	69	11
	LE 3.3	28	3	24	80	13
	LE 3.4	31	3	26	86	16
	LE 3.5	19	2	16	55	8
Ongoing Annual	Open Access	4	0	3	14	2
	LE (All)	3	0	2	9	1

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 52 individuals. The average catch in a given year is estimated at 4. The effects of this level of catch to the stock are likely to be minor.

Oilfish (*Ruvettus presiosus*)

Table 4-15 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–15. Oilfish Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00002*	
	Per Day Fished	*0.00065*	*0.00009*	*0.00055*	*0.00178*	
12 Year Ramp Up	Open Access	51	6	43	141	27
	LE 3.1	17	1	14	48	9
	LE 3.2	24	2	20	68	13
	LE 3.3	28	3	24	79	16
	LE 3.4	31	3	26	86	12
	LE 3.5	19	2	16	54	10
Ongoing Annual	Open Access	4	0	3	13	2
	LE (All)	3	0	2	9	1

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 51 individuals. The average catch in a given year is estimated at 4. The effects of this level of catch to the stock are likely to be minor.

Yelloweye rockfish (*Sebastes ruberrimus*)

Table 4-17 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–17. Yelloweye Rockfish Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00179*	
12 Year Ramp Up	Open Access	52	6	44	143	21
	LE 3.1	17	1	14	47	9
	LE 3.2	25	3	21	69	13
	LE 3.3	29	3	24	79	18
	LE 3.4	31	3	26	86	17
	LE 3.5	19	2	16	54	9
Ongoing Annual	Open Access	4	0	4	14	2
	LE (All)	3	0	2	9	1

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 52 individuals. The average catch in a given year is estimated at 4. The effects of this level of catch to the stock are likely to be minor.

Vermilion rockfish (*Sebastes miniatus*)

Table 4-18 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–18. Vermilion Rockfish Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00230*	
12 Year Ramp Up	Open Access	76	15	68	184	46
	LE 3.1	25	4	22	61	13
	LE 3.2	36	7	32	89	27
	LE 3.3	42	8	37	102	32
	LE 3.4	46	9	41	111	29
	LE 3.5	28	5	25	70	21
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2

Under the Open Access Alternative, the average of potential catch counts during the twelve year ramp up period is 76 individuals. The average catch in a given year is estimated at 6. The effects of this level of catch to the stock are likely to be minor.

4.3.2. Protected Species Considered Likely to be Affected

Northern elephant seal (*Mirounga angustirostris*)

Table 4-19 shows the estimated CPUE from our biological analysis and projected interaction counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–19. Northern Elephant Seal Interactions (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00232*	
12 Year Ramp Up	Open Access	76	15	68	184	50
	LE 3.1	25	4	22	61	15
	LE 3.2	36	7	32	88	25
	LE 3.3	42	8	37	102	31
	LE 3.4	46	8	41	112	33
	LE 3.5	28	5	25	70	18
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2

Under the Open Access Alternative, the average of potential interaction counts (i.e., any contact between a protected species and fishing gear) during the twelve year ramp up period is 76 individuals. The average number of interactions in a given year is estimated at 6. Because PBR for this stock is calculated to be 4,882 animals per year (Carretta et al. 2020), the effects of this level of interaction on the stock are likely to be minor. Because of the low number of protected species interactions with DSBG to date, we are not able to project the disposition status (i.e., mortality, injury, live release, etc.) of any potential future interactions.

Loggerhead sea turtle (*Caretta caretta*)—North Pacific Ocean DPS

Table 4-20 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 2 are outlined for emphasis.

Table 4–20. Loggerhead Sea Turtle Interactions (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00121*	
12 Year Ramp Up	Open Access	27	0	19	97	5
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	58	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Under the Open Access Alternative, the average of potential interaction counts during the twelve year ramp up period is 27 individuals. The average number of interactions in a given year is estimated at 2. The effects of this level of interaction on the stock are likely to be minor, because any loggerhead sea turtle caught is likely to be released alive and in good condition. Strike detection, active DSBG tending, and required circle hooks would minimize the severity of any interactions and increase the likelihood of animals being released alive and in good condition.

Note that the projections for loggerhead sea turtle are based on a single interaction which occurred in 2018, when a turtle was entangled in surface lines under a configuration of DSBG which is no longer allowed. The turtle was released alive and uninjured. NMFS modified the Terms and Conditions of the DSBG EFPs in response to this incident, including requirement of shorter and stiffer surface lines. The impact of this change to the EFP Terms and Conditions to the loggerhead interaction rate is not captured by the current analytical methodology. Therefore, we expect the interaction rate with loggerhead sea turtles in the future may be lower than that indicated by the current analysis.

4.3.3. Protected Species That May be Affected

Catch predictions are not provided for protected species that may be affected by the Proposed Action alternatives, as these species have not been reported caught in DSBG to date. These species are discussed qualitatively based on technical discussions with NMFS PRD (Christina Fahy, NMFS PRD, pers. comm. April 2019). These species dive deep and/or feed on squid like those used as bait in DSBG fishing (i.e.,

Risso's dolphin, beaked whales, sperm whale) or have been documented entangled by other fisheries that employ vertical lines (i.e., humpback whale, gray whale). Interactions with these species could include hooking while feeding on bait or entanglement in vertical lines of SBG and LBG or the horizontal lines linking sections of LBG. Strike detection and active DSBG tending would minimize the severity of any future interactions and increase the likelihood of animals being released alive and in good condition. Required circle hooks would reduce the severity of any hooking for the species in question (Sales et al. 2010, Cooke & Suski 2004).

4.3.4. Socioeconomic Impacts

The socioeconomic impacts of the action alternatives are considered in three categories: impacts to other fleets or fisheries in the Proposed Action Area, impacts to fishermen and fishing communities, and downstream impacts to processors, restaurants, and consumers. Due to lack of data representative of the expected of a fully-scale DSBG fleet, impacts to other fleets or fisheries in the Proposed Action Area are considered qualitatively with regards to the theoretical effects of open access authorization of DSBG, as are downstream impacts. Impacts to fishermen and fishing communities are analyzed both qualitatively and quantitatively, using data from HMS fisheries imports and landings during the period for which DSBG EFP fisheries have been active.

4.3.4.1. Impacts to Fisheries in or Near the Proposed Action Area

Other fisheries or fleets operating in or near the Proposed Action Area that may be impacted by the authorization of DSBG include other U.S. domestic swordfish fleets with landings to Southern California ports (the California-based harpoon and DGN fleets and the Hawaii and West Coast-based longline fleets), as well as the Southern California recreational fishing fisheries. Note that because there has been no DSBG fishing to date in either Northern California or Oregon, we do not have data for these regions. DSBG-caught swordfish are a close substitute for swordfish caught by other domestic fisheries. Therefore, the predicted decrease in the price received for DSBG-caught swordfish under the action alternatives with significant predicted increases in swordfish landings may negatively impact the revenues generated by other fleets or fisheries with landings to the same ports. The negative price effect may be more pronounced on harpoon-caught swordfish, which is a close substitute for high-quality fresh DSBG-caught swordfish due to the way it is caught and the limited time between catching and landing the fish.

Depending on how DSBG effort distributes spatially over the Proposed Action Area at larger scales of operation, there is a potential for overlap with fishing areas of recreational fisheries. Given that the DSBG EFP trials have thus far only operated at small-scale, there is no way to predict how effort might distribute

at larger-scale of operation. Any economic impact of DSBG operation on recreational fishing in the Proposed Action Area is anticipated to be negative but minimal, due to limited spatial overlap between locations where recreational fisheries operate and areas currently shown to be favorable for DSBG fishing for swordfish.[3]

4.3.4.2. Impacts to Fishermen & Fishing Communities

NMFS conducted an analysis of DSBG price to estimate the influence of several factors on the price per pound of DSBG-caught swordfish. Factors thought to influence DSBG price include landings (in pounds) of DSBG-caught swordfish; the volume of swordfish landings by DGN, harpoon, and longline fisheries; the volume of fresh swordfish imports to Southern California ports; and landings of potential substitute species including yellowfin tuna (YF) and dolphinfish (DF). The analysis also controls for variation in DSBG from month to month and from year to year.

Based on this analysis, we estimate a weak negative price effect of increased DSBG landings, when holding all other factors constant. Our analysis indicates that increasing DSBG landings by one percent results in a drop in DSBG price of 0.04 percent. See Appendix B for detail on the data, methods, results, and interpretations of the price analysis.

Between 2018 and 2020, 3,061 swordfish were recorded caught in DSBG EFP fishing, and a total landed weight of 204.07 mt was delivered to California ports. The average weight of a DSBG-caught swordfish was 0.07 mt. Based on the results of our Bayesian biological analysis (see Section 4.3.1), DSBG swordfish catch in a given calendar year would increase to an ongoing annual mean of 8,812 swordfish under Alternative 2. Assuming that the average weight of a DSBG-caught swordfish is constant, we project an ongoing annual mean of 587.48 mt in landed swordfish weight under Alternative 2.

Based on the estimated price effect, and on the projected landings estimated using the biological analysis, we calculate an estimated average annual price of $5.18 per pound, which is $0.47 lower than the average price from 2018 through 2020.

Note that this estimate is dependent on the effort assumptions of the biological analysis (i.e., the ratio of active to inactive DSBG permits and the average days fished per active permit) holding constant under the

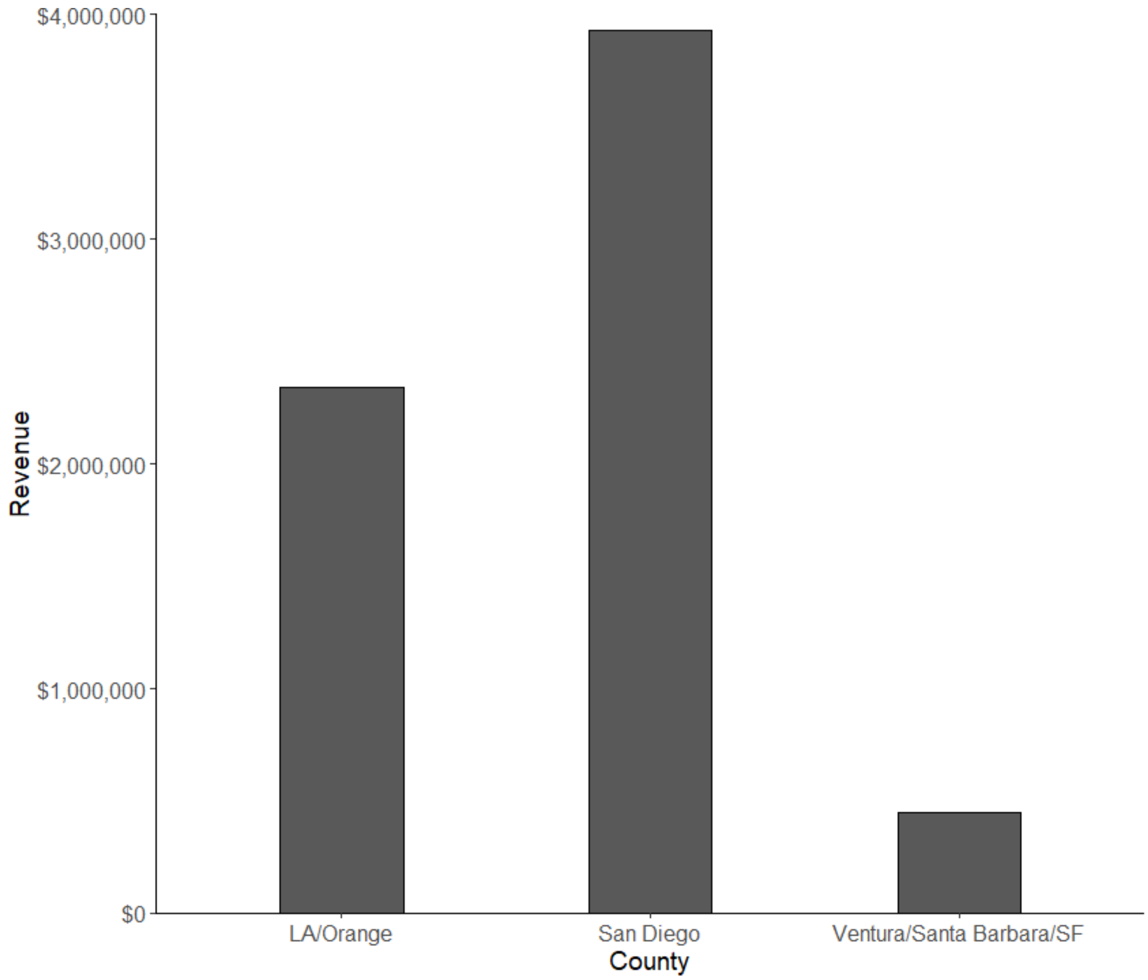
[3] It is possible that popular recreational and sport fishing areas, and areas which are favorable for DSBG fishing, may shift spatially over time, which may affect the potential impact of the Proposed Action alternatives on recreational fishing.

Proposed Action. It also relies on the assumption that DSBG swordfish CPUE (and, therefore, landings) scale proportionally with effort.[4] If actual DSBG effort under the Proposed Action is less than that projected by assumptions based on levels from 2018 through 2020, or if CPUE declines with increasing fishing effort, annual landings would be less than that predicted by the biological analysis, and DSBG swordfish price would be higher than the above estimate.

At the regional level, we estimate revenues under Alternative 2 by distributing projected DSBG swordfish landings under the Proposed Action (587.48 mt) to three regions, in the same proportions seen from 2018 through 2020, and multiplying by the estimated average price per pound ($5.18) to arrive at average annual revenues. Figure 4-1 displays the results of these projections.

[4] Based on very limited data, CPUE did in fact decline with increased effort when the Council authorized a higher number of EFPs. From 2017 to 2018, effort increased from 324 days fished to 616 days fished, while swordfish CPUE declined from 1.71 individual fish per day to 1.03 individual fish per day, representing a "CPUE elasticity" of -0.43%. However, in 2019, total effort was somewhat greater than 2018 (764 days fished) and CPUE rose to 1.46 swordfish per day. In 2020, effort increased to 1,076 days fished with a CPUE of 1.19 swordfish per day. Overall it is unclear how CPUE scales with effort given the limited effort and data in DSBG fishing to date.

Figure 4-1. Projected Annual Average Revenues under Alternative 2



These estimates account for the price effect estimated in the price analysis; however, they rely on the assumption that effort and swordfish CPUE will remain constant from year to year for a full-scale fleet. The estimates also assume that the distribution of landings by region will remain the same as what was recorded from 2018 through 2020. Actual revenues occurring under the action alternatives will vary based on these factors. Projections based on inferences that use a limited amount of data from DSBG EFP trials may not accurately represent the eventual operating characteristics of a full-scale DSBG fleet. However, it is likely that the action alternatives will result in some net increase in DSBG revenues to all three regions analyzed, despite the negative price effect of increased landings. Limited data at this time creates uncertainty in predictions about the economic viability of this gear type. However, based on our analysis, and in keeping with the Council's purpose and need for this action, we expect that authorizing DSBG will have positive impacts for the U.S. West Coast swordfish fishery as a supplementary source of domestically-caught swordfish, which may reduce reliance on imports for meeting domestic demands.

4.3.4.3. Impacts to Processors, Restaurants, & Consumers

Authorizing a DSBG fishery is anticipated to have positive impacts on processors, restaurants, and consumers in the Proposed Action Area, due to increased availability of locally-sourced, high-quality fresh swordfish. Processors will benefit from the increased landings projected under Alternative 2, by acquiring an additional source of high-quality swordfish to process, package, and sell to retail outlets and restaurants. Restaurants will benefit due to the increased availability of high-quality raw swordfish which provides the principal ingredient in high-value seafood entrées. Consumers will benefit due to the availability of an additional source of fresh swordfish, whether for purchase at a retail outlet to support home meal preparation, or as an entrée selection at a restaurant. To the extent that fishermen are able to profitably catch and land DSBG-caught swordfish, the additional supply will generate positive economic benefits at all stages of the supply chain, including producer surplus for processors and restaurants and consumer surplus for retail shoppers and restaurant diners.

4.4. Alternative 3—Authorize a Limited Entry Fishery

Under Alternative 3, NMFS would issue a limited number of permits to fish DSBG in the SCB, under one of the five options for permit issuance described in Section 2. DSBG fishing would be allowed on an open access basis outside the SCB; however, our analysis of Alternative 3 does not account for any potential DSBG fishing outside the SCB. This is because less than 1 percent of DSBG fishing has occurred outside of the SCB to date, and therefore there are insufficient data to support analysis of catch outside of the SCB. Though both Action Alternatives analyze DSBG effort concentrated in the SCB, Alternative 3 involves a lower level of potential effort, as well as a slower ramp-up of available DSBG permits (see Section 2). Any additional open access fishing beyond the 300 available LE permits is speculative, and data suggest this activity would be unlikely to occur due to the startup costs of DSBG fishing and less favorable oceanographic conditions for fishing DSBG north of the SCB. This subsection details the projected impacts to species likely to be affected by the Proposed Action for Alternative 3.

The tables below display the results of our biological analysis (see Appendix A) in the same manner as the tables in Section 4.3.1. The projections for Alternative 3are bolded for emphasis. The mode is the most likely value in any one given year, based on the probability distribution of possible catch counts. Note that the ongoing annual catch after the twelve year ramp up period is the same for all LE options. As with the tables for Alternative 2, “LE 3.1” etc. refer to the limited entry sub-options defined in Section 2. “CI” refers to the credible interval of each projected catch count, i.e., the range with a 95 percent probability of including the actual catch, given the effort assumptions and level of uncertainty in the analysis. Note that the impacts detailed below are considered additional to the ongoing biological impacts

of existing HMS gear types in the Proposed Action Area (see Section 3.5.1 for detail on the status quo of fisheries in or near the Proposed Action Area and Section 4.2 for a synopsis of the expected ongoing impacts of these fisheries).

4.4.1. Target and Non-Target Species Considered Likely to be Affected

4.4.1.1. Target Species

Swordfish (*Xiphias gladius*)

Table 4-21 shows the estimated CPUE from our biological analysis, and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–21. Swordfish Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.01878*	*0.01805*	*0.01877*	*0.01952*	
	Per Day Fished	*1.34198*	*1.29043*	*1.34175*	*1.39548*	
12 Year Ramp Up	Open Access	105,704	100,156	105,655	111,495	105,309
	LE 3.1	34,351	31,786	34,334	37,014	34,464
	LE 3.2	50,202	46,860	50,198	53,611	51,265
	LE 3.3	58,142	54,445	58,116	61,933	57,954
	LE 3.4	63,426	59,567	63,401	67,413	64,389
	LE 3.5	39,199	36,418	39,178	42,118	38,828
Ongoing Annual	Open Access	8,812	7,653	8,802	10,033	9,028
	LE (All)	5,286	4,409	5,276	6,221	5,311

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of swordfish takes during the twelve year ramp up period is 34,351 individuals.
- Under the LE 3.2 option, the average number of swordfish takes during the twelve year ramp up period is 50,202 individuals.
- Under the LE 3.3 option, the average number of swordfish takes during the twelve year ramp up period is 58,142 individuals.
- Under the LE 3.4 option, the average number of swordfish takes during the twelve year ramp up period is 63,426 individuals.
- Under the LE 3.5 option, the average number of swordfish takes during the twelve year ramp up period is 39,199 individuals.
- Under all LE options, the average number of swordfish takes in each year once the maximum number of permits is issued is 5,286 individuals.

Because the swordfish stock off the U.S. West Coast is underutilized, and the WCNPO stock is not overfished or subject to overfishing, effects to the swordfish population are likely to be minor and are unlikely to affect the sustainability of the stock under any LE option.

4.4.1.2. Non-Target Species

Bigeye thresher shark (*Alopias superciliosus*)

Table 4-22 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–22. Bigeye Thresher Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00134*	*0.00115*	*0.00133*	*0.00154*	
	Per Day Fished	*0.09554*	*0.08201*	*0.09536*	*0.11041*	
12 Year Ramp Up	Open Access	7,525	6,410	7,508	8,754	7,504
	LE 3.1	2,446	2,052	2,438	2,882	2,430
	LE 3.2	3,574	3,025	3,563	4,188	3,464
	LE 3.3	4,139	3,507	4,128	4,848	4,109
	LE 3.4	4,515	3,823	4,503	5,274	4,479
	LE 3.5	2,791	2,354	2,783	3,285	2,781
Ongoing Annual	Open Access	628	499	625	772	602
	LE (All)	376	287	374	480	358

Based on these projections, we estimate the impact of each LE option included under Alternative 3:

- Under the LE 3.1 option, the average number of bigeye thresher shark takes during the twelve year ramp up period is 2,446 individuals.
- Under the LE 3.2 option, the average number of bigeye thresher shark takes during the twelve year ramp up period is 3,574 individuals.
- Under the LE 3.3 option, the average number of bigeye thresher shark takes during the twelve year ramp up period is 4,139 individuals.
- Under the LE 3.4 option, the average number of bigeye thresher shark takes during the twelve year ramp up period is 4,515 individuals.
- Under the LE 3.5 option, the average number of bigeye thresher shark takes during the twelve year ramp up period is 2,791 individuals.
- Under all LE options, the average number of bigeye thresher shark takes in each year once the maximum number of permits is issued is 376 individuals.

Because this species is vulnerable to exploitation at relatively low levels of fishing mortality (Fu et al. 2016; Young et al. 2015), these catch counts may imply a significant impact at the population level. However, studies conducted by PIER have indicated that over 90 percent of bigeye thresher sharks caught and released in DSBG fishing survive the acute effects of capture (Sepulveda and Aalbers 2019).

Blue shark (*Prionace glauca*)

Table 4-23 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–23. Blue Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00015*	*0.00010*	*0.00015*	*0.00020*	
	Per Day Fished	*0.01075*	*0.00750*	*0.01064*	*0.01456*	
12 Year Ramp Up	Open Access	847	584	839	1,157	892
	LE 3.1	275	185	272	381	260
	LE 3.2	402	274	398	553	388
	LE 3.3	466	319	461	639	440
	LE 3.4	508	348	503	697	496
	LE 3.5	314	212	311	434	299
Ongoing Annual	Open Access	71	43	70	103	70
	LE (All)	42	24	42	65	40

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of blue shark takes during the twelve year ramp up period is 275 individuals.
- Under the LE 3.2 option, the average number of blue shark takes during the twelve year ramp up period is 402 individuals.
- Under the LE 3.3 option, the average number of blue shark takes during the twelve year ramp up period is 466 individuals.
- Under the LE 3.4 option, the average number of blue shark takes during the twelve year ramp up period is 508 individuals.
- Under the LE 3.5 option, the average number of blue shark takes during the twelve year ramp up period is 314 individuals.
- Under all LE options, the average number of blue shark takes in each year once the maximum number of permits is issued is 42 individuals.

The effects of this level of catch to the stock are likely to be minor.

Shortfin mako shark (*Isurus oxyrinchus*)

Table 4-24 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–24. Shortfin Mako Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00002*	*0.00001*	*0.00002*	*0.00005*	
	Per Day Fished	*0.00178*	*0.00066*	*0.00168*	*0.00346*	
12 Year Ramp Up	Open Access	140	50	132	276	121
	LE 3.1	46	15	43	92	38
	LE 3.2	67	23	63	132	53
	LE 3.3	77	27	73	153	59
	LE 3.4	84	29	79	167	75
	LE 3.5	52	17	49	104	44
Ongoing Annual	Open Access	12	3	11	25	9
	LE (All)	7	1	6	16	5

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of shortfin mako shark takes during the twelve year ramp up period is 46 individuals.
- Under the LE 3.2 option, the average number of shortfin mako shark takes during the twelve year ramp up period is 67 individuals.
- Under the LE 3.3 option, the average number of shortfin mako shark takes during the twelve year ramp up period is 77 individuals.
- Under the LE 3.4 option, the average number of shortfin mako shark takes during the twelve year ramp up period is 84 individuals.
- Under the LE 3.5 option, the average number of shortfin mako shark takes during the twelve year ramp up period is 52 individuals.
- Under all LE options, the average number of shortfin mako shark takes in each year once the maximum number of permits is issued is 7 individuals.

The effects of this level of catch to the stock are likely to be minor.

Pelagic thresher shark (*Alopias pelagicus*)

Table 4-25 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–25. Pelagic Thresher Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00182*	
12 Year Ramp Up	Open Access	52	6	44	144	31
	LE 3.1	17	1	14	48	7
	LE 3.2	25	2	21	69	12
	LE 3.3	29	3	24	80	16
	LE 3.4	31	3	26	88	16
	LE 3.5	19	2	16	55	9
Ongoing Annual	Open Access	4	0	4	14	2
	LE (All)	3	0	2	9	1

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of pelagic thresher shark takes during the twelve year ramp up period is 17 individuals.
- Under the LE 3.2 option, the average number of pelagic thresher shark takes during the twelve year ramp up period is 25 individuals.
- Under the LE 3.3 option, the average number of pelagic thresher shark takes during the twelve year ramp up period is 29 individuals.
- Under the LE 3.4 option, the average number of pelagic thresher shark takes during the twelve year ramp up period is 31 individuals.
- Under the LE 3.5 option, the average number of pelagic thresher shark takes during the twelve year ramp up period is 19 individuals.
- Under all LE options, the average number of pelagic thresher shark takes in each year once the maximum number of permits is issued is 3 individuals.

The effects of this level of catch to the stock are likely to be minor. A discussion of factors that could affect catch rates of pelagic thresher shark is provided in Section 4.3.1.

Common thresher shark (*Alopias vulpinus*)

Table 4-26 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–26. Common Thresher Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00121*	
12 Year Ramp Up	Open Access	27	1	19	98	2
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	1
	LE 3.4	16	0	12	59	1
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of common thresher shark takes during the twelve year ramp up period is 9 individuals.
- Under the LE 3.2 option, the average number of common thresher shark takes during the twelve year ramp up period is 13 individuals.
- Under the LE 3.3 option, the average number of common thresher shark takes during the twelve year ramp up period is 15 individuals.
- Under the LE 3.4 option, the average number of common thresher shark takes during the twelve year ramp up period is 16 individuals.
- Under the LE 3.5 option, the average number of common thresher shark takes during the twelve year ramp up period is 10 individuals.
- Under all LE options, the average number of common thresher shark takes in each year once the maximum number of permits is issued is 1 individual.

The effects of this level of catch to the stock are likely to be minor.

Salmon shark (*Lamna ditropis*)

Table 4-27 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–27. Salmon Shark Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	20	97	2
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of salmon shark takes during the twelve year ramp up period is 9 individuals.
- Under the LE 3.2 option, the average number of salmon shark takes during the twelve year ramp up period is 13 individuals.
- Under the LE 3.3 option, the average number of salmon shark takes during the twelve year ramp up period is 15 individuals.
- Under the LE 3.4 option, the average number of salmon shark takes during the twelve year ramp up period is 16 individuals.
- Under the LE 3.5 option, the average number of salmon shark takes during the twelve year ramp up period is 10 individuals.
- Under all LE options, the average number of salmon shark takes in each year once the maximum number of permits is issued is 1 individual.

The effects of this level of catch to the stock are likely to be minor.

Sixgill shark (*Hexanchus griseus*)

Table 4-28 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–28. Sixgill Shark Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	19	97	3
	LE 3.1	9	0	6	33	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	1
	LE 3.4	16	0	12	60	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of sixgill shark takes during the twelve year ramp up period is 9 individuals.
- Under the LE 3.2 option, the average number of sixgill shark takes during the twelve year ramp up period is 13 individuals.
- Under the LE 3.3 option, the average number of sixgill shark takes during the twelve year ramp up period is 15 individuals.
- Under the LE 3.4 option, the average number of sixgill shark takes during the twelve year ramp up period is 16 individuals.
- Under the LE 3.5 option, the average number of sixgill shark takes during the twelve year ramp up period is 10 individuals.
- Under all LE options, the average number of sixgill shark takes in each year once the maximum number of permits is issued is 1 individual.

The effects of this level of catch to the stock are likely to be minor.

Humboldt squid (*Dosidicus gigas*)

Table 4-29 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–29. Humboldt Squid Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	19	97	5
	LE 3.1	9	0	6	33	1
	LE 3.2	13	0	9	47	2
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of Humboldt squid takes during the twelve year ramp up period is 9 individuals.
- Under the LE 3.2 option, the average number of Humboldt squid takes during the twelve year ramp up period is 13 individuals.
- Under the LE 3.3 option, the average number of Humboldt squid takes during the twelve year ramp up period is 15 individuals.
- Under the LE 3.4 option, the average number of Humboldt squid takes during the twelve year ramp up period is 16 individuals.
- Under the LE 3.5 option, the average number of Humboldt squid takes during the twelve year ramp up period is 10 individuals.
- Under all LE options, the average number of Humboldt squid takes in each year once the maximum number of permits is issued is 1 individual.

The effects of this level of catch to the stock are likely to be minor.

Giant squid (*Architeuthis dux*)

Table 4-30 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–30. Giant Squid Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	1	19	97	5
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	3
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of giant squid takes during the twelve year ramp up period is 9 individuals.
- Under the LE 3.2 option, the average number of giant squid takes during the twelve year ramp up period is 13 individuals.
- Under the LE 3.3 option, the average number of giant squid takes during the twelve year ramp up period is 15 individuals.
- Under the LE 3.4 option, the average number of giant squid takes during the twelve year ramp up period is 16 individuals.
- Under the LE 3.5 option, the average number of giant squid takes during the twelve year ramp up period is 10 individuals.
- Under all LE options, the average number of giant squid takes in each year once the maximum number of permits is issued is 1 individual.

The effects of this level of catch to the stock are likely to be minor.

Opah (*Lampris guttatus*)

Table 4-31 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–31. Opah Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00228*	
12 Year Ramp Up	Open Access	76	15	68	182	57
	LE 3.1	25	4	22	61	15
	LE 3.2	36	7	32	87	22
	LE 3.3	42	8	37	102	31
	LE 3.4	46	9	41	110	30
	LE 3.5	28	5	25	70	20
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of opah takes during the twelve year ramp up period is 25 individuals.
- Under the LE 3.2 option, the average number of opah takes during the twelve year ramp up period is 36 individuals.
- Under the LE 3.3 option, the average number of opah takes during the twelve year ramp up period is 42 individuals.
- Under the LE 3.4 option, the average number of opah takes during the twelve year ramp up period is 46 individuals.
- Under the LE 3.5 option, the average number of opah takes during the twelve year ramp up period is 28 individuals.
- Under all LE options, the average number of opah takes in each year once the maximum number of permits is issued is 4 individuals.

The effects of this level of catch to the stock are likely to be minor.

Escolar (*Lepidocybium flavobrunneum*)

Table 4-32 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–32. Escolar Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00013*	*0.00009*	*0.00013*	*0.00018*	
	Per Day Fished	*0.00950*	*0.00647*	*0.00938*	*0.01312*	
12 Year Ramp Up	Open Access	748	504	740	1,041	710
	LE 3.1	243	160	240	343	235
	LE 3.2	355	236	351	498	320
	LE 3.3	411	275	406	576	392
	LE 3.4	449	300	444	629	444
	LE 3.5	277	183	274	390	263
Ongoing Annual	Open Access	62	37	61	93	60
	LE (All)	37	21	37	58	36

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of escolar takes during the twelve year ramp up period is 243 individuals.
- Under the LE 3.2 option, the average number of escolar takes during the twelve year ramp up period is 355 individuals.
- Under the LE 3.3 option, the average number of escolar takes during the twelve year ramp up period is 411 individuals.
- Under the LE 3.4 option, the average number of escolar takes during the twelve year ramp up period is 449 individuals.
- Under the LE 3.5 option, the average number of escolar takes during the twelve year ramp up period is 227 individuals.
- Under all LE options, the average number of escolar takes in each year once the maximum number of permits is issued is 37 individuals.

The effects of this level of catch to the stock are likely to be minor.

Common mola (*Mola mola*)

Table 4-33 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–33. Common Mola Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00002*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00178*	
12 Year Ramp Up	Open Access	52	6	44	141	23
	LE 3.1	17	1	14	47	9
	LE 3.2	24	2	21	68	13
	LE 3.3	28	3	24	79	14
	LE 3.4	31	3	26	86	20
	LE 3.5	19	2	16	54	10
Ongoing Annual	Open Access	4	0	3	13	2
	LE (All)	3	0	2	9	1

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of common mola takes during the twelve year ramp up period is 17 individuals.
- Under the LE 3.2 option, the average number of common mola takes during the twelve year ramp up period is 24 individuals.
- Under the LE 3.3 option, the average number of common mola takes during the twelve year ramp up period is 28 individuals.
- Under the LE 3.4 option, the average number of common mola takes during the twelve year ramp up period is 31 individuals.
- Under the LE 3.5 option, the average number of common mola takes during the twelve year ramp up period is 19 individuals.
- Under all LE options, the average number of common mola takes in each year once the maximum number of permits is issued is 3 individuals.

The effects of this level of catch to the stock are likely to be minor.

Pacific hake (*Merluccius productus*)

Table 4-34 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–34. Pacific Hake Catch (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00180*	
12 Year Ramp Up	Open Access	52	6	44	143	28
	LE 3.1	17	1	14	48	8
	LE 3.2	25	2	21	69	11
	LE 3.3	28	3	24	80	13
	LE 3.4	31	3	26	86	16
	LE 3.5	19	2	16	55	8
Ongoing Annual	Open Access	4	0	3	14	2
	LE (All)	3	0	2	9	1

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of Pacific hake takes during the twelve year ramp up period is 17 individuals.
- Under the LE 3.2 option, the average number of Pacific hake takes during the twelve year ramp up period is 25 individuals.
- Under the LE 3.3 option, the average number of Pacific hake takes during the twelve year ramp up period is 28 individuals.
- Under the LE 3.4 option, the average number of Pacific hake takes during the twelve year ramp up period is 31 individuals.
- Under the LE 3.5 option, the average number of Pacific hake takes during the twelve year ramp up period is 19 individuals.
- Under all LE options, the average number of Pacific hake takes in each year once the maximum number of permits is issued is 3 individuals.

The effects of this level of catch to the stock are likely to be minor.

Oilfish (*Ruvettus presiosus*)

Table 4-35 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–35. Oilfish Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00002*	
	Per Day Fished	*0.00065*	*0.00009*	*0.00055*	*0.00178*	
12 Year Ramp Up	Open Access	51	6	43	141	27
	LE 3.1	17	1	14	48	9
	LE 3.2	24	2	20	68	13
	LE 3.3	28	3	24	79	16
	LE 3.4	31	3	26	86	12
	LE 3.5	19	2	16	54	10
Ongoing Annual	Open Access	4	0	3	13	2
	LE (All)	3	0	2	9	1

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of oilfish takes during the twelve year ramp up period is 17 individuals.
- Under the LE 3.2 option, the average number of oilfish takes during the twelve year ramp up period is 24 individuals.
- Under the LE 3.3 option, the average number of oilfish takes during the twelve year ramp up period is 28 individuals.
- Under the LE 3.4 option, the average number of oilfish takes during the twelve year ramp up period is 31 individuals.
- Under the LE 3.5 option, the average number of oilfish takes during the twelve year ramp up period is 19 individuals.
- Under all LE options, the average number of oilfish takes in each year once the maximum number of permits is issued is 3 individuals.

The effects of this level of catch to the stock are likely to be minor.

Yelloweye rockfish (*Sebastes ruberrimus*)

Table 4-37 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–37. Yelloweye Rockfish Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00179*	
12 Year Ramp Up	Open Access	52	6	44	143	21
	LE 3.1	17	1	14	47	9
	LE 3.2	25	3	21	69	13
	LE 3.3	29	3	24	79	18
	LE 3.4	31	3	26	86	17
	LE 3.5	19	2	16	54	9
Ongoing Annual	Open Access	4	0	4	14	2
	LE (All)	3	0	2	9	1

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of yelloweye rockfish takes during the twelve year ramp up period is 17 individuals.
- Under the LE 3.2 option, the average number of yelloweye rockfish takes during the twelve year ramp up period is 25 individuals.
- Under the LE 3.3 option, the average number of yelloweye rockfish takes during the twelve year ramp up period is 29 individuals.
- Under the LE 3.4 option, the average number of yelloweye rockfish takes during the twelve year ramp up period is 31 individuals.
- Under the LE 3.5 option, the average number of yelloweye rockfish takes during the twelve year ramp up period is 19 individuals.
- Under all LE options, the average number of yelloweye rockfish takes in each year once the maximum number of permits is issued is 3 individuals.

The effects of this level of catch to the stock are likely to be minor. A discussion of factors that could affect catch rates of yelloweye rockfish is provided in Section 4.3.1.

Vermillion rockfish (*Sebastes miniatus*)

Table 4-38 shows the estimated CPUE from our biological analysis and projected catch counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–38. Vermilion Rockfish Catch (in Number of Individuals)

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00230*	
12 Year Ramp Up	Open Access	76	15	68	184	46
	LE 3.1	25	4	22	61	13
	LE 3.2	36	7	32	89	27
	LE 3.3	42	8	37	102	32
	LE 3.4	46	9	41	111	29
	LE 3.5	28	5	25	70	21
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of vermilion rockfish takes during the twelve year ramp up period is 25 individuals.
- Under the LE 3.2 option, the average number of vermilion rockfish takes during the twelve year ramp up period is 36 individuals.
- Under the LE 3.3 option, the average number of vermilion rockfish takes during the twelve year ramp up period is 42 individuals.
- Under the LE 3.4 option, the average number of vermilion rockfish takes during the twelve year ramp up period is 46 individuals.
- Under the LE 3.5 option, the average number of vermilion rockfish takes during the twelve year ramp up period is 28 individuals.
- Under all LE options, the average number of vermilion rockfish takes in each year once the maximum number of permits is issued is 4 individuals.

The effects of this level of catch to the stock are likely to be minor.

4.4.2. Protected Species Considered Likely to be Affected

Northern elephant seal (*Mirounga angustirostris*)

Table 4-39 shows the estimated CPUE from our biological analysis and projected interaction counts for this species. Results for Alternative 3 are outlined for emphasis.

Table 4–39. Northern Elephant Seal Interactions (in Number of Individuals)

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00232*	
12 Year Ramp Up	Open Access	76	15	68	184	50
	LE 3.1	25	4	22	61	15
	LE 3.2	36	7	32	88	25
	LE 3.3	42	8	37	102	31
	LE 3.4	46	8	41	112	33
	LE 3.5	28	5	25	70	18
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2

Based on these projections, we estimate the impact of each LE option included under Alternative 3 as follows:

- Under the LE 3.1 option, the average number of northern elephant seal interactions during the twelve year ramp up period is 25.
- Under the LE 3.2 option, the average number of northern elephant seal interactions during the twelve year ramp up period is 36.
- Under the LE 3.3 option, the average number of northern elephant seal interactions during the twelve year ramp up period is 42.
- Under the LE 3.4 option, the average number of northern elephant seal interactions during the twelve year ramp up period is 46.
- Under the LE 3.5 option, the average number of northern elephant seal interactions during the twelve year ramp up period is 28.
- Under all LE options, the average number of northern elephant seal interactions in each year once the maximum number of permits is issued is 4.

Because PBR for this stock is calculated to be 4,882 animals per year (Carretta et al. 2020), the effects of this level of interactions to the stock are likely to be minor. Because of the low number of protected species interactions with DSBG to date, we are not able to project the disposition status (i.e., mortality, injury, live release, etc.) of any potential future interactions.

Loggerhead sea turtle (*Caretta caretta*)—North Pacific Ocean DPS

Table 4-40 above shows the estimated CPUE from our biological analysis and projected interaction counts for this species under Alternative 3.

Table 4–40. Loggerhead Sea Turtle Interactions (in Number of Individuals) Under Alternative 3

		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00121*	
12 Year Ramp Up	Open Access	27	0	19	97	5
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	58	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0

Based on these projections, we estimate the impact of each LE option included under Alternative 3:

- Under the LE 3.1 option, the average number of loggerhead sea turtle interactions during the twelve year ramp up period is 9.
- Under the LE 3.2 option, the average number of loggerhead sea turtle interactions during the twelve year ramp up period is 13.
- Under the LE 3.3 option, the average number of loggerhead sea turtle interactions during the twelve year ramp up period is 15.
- Under the LE 3.4 option, the average number of loggerhead sea turtle interactions during the twelve year ramp up period is 26.
- Under the LE 3.5 option, the average number of loggerhead sea turtle interactions during the twelve year ramp up period is 10.
- Under all LE options, the average number of loggerhead sea turtle interactions in each year once the maximum number of permits is issued is 1.

The effects of this level of interactions to the stock are likely to be minor, because any loggerhead sea turtle caught is likely to be released alive and in good condition. Strike detection, active DSBG tending, and required circle hooks would minimize the severity of any future interactions and increase the likelihood of animals being released alive and in good condition.

A discussion of factors that could affect catch rates of loggerhead sea turtles is provided in Section 4.3.2.

4.4.3. Protected Species That May be Affected

Catch predictions are not provided for protected species that may be affected by the Proposed Action alternatives but have not been reported caught in DSBG to date. These species are analyzed qualitatively based on technical discussions with NMFS PRD (Christina Fahy, NMFS PRD, pers. comm. April 2019). These species dive deep and/or feed on squid like those used as bait in DSBG fishing (i.e., Risso's dolphin, beaked whales, sperm whale) or have been entangled by other fisheries that employ vertical lines (i.e., humpback whale, gray whale). Interactions with these species could include hooking while feeding on bait, or entanglement in vertical lines of SBG and LBG or the horizontal lines linking sections of LBG. Strike detection and active DSBG tending would minimize the severity of any future interactions and increase the likelihood of animals being released alive and in good condition. Required circle hooks would reduce the severity of any hooking. Again, NMFS will further assess potential impacts to these protected species pursuant to a Section 7 consultation under the ESA.

4.4.4. Socioeconomic Impacts

4.4.4.1. Impacts to Fisheries in the Proposed Action Area

Impacts to other fisheries in or near the Proposed Action Area under Alternative 3 are expected to be similar to those described for Alternative 2 (see Section 4.3.4.1). The lower amount of maximum effort under Alternative 3 may mitigate potential negative impacts to, or reduced effort in, other fisheries.

4.4.4.2. Impacts to Fishermen & Fishing Communities

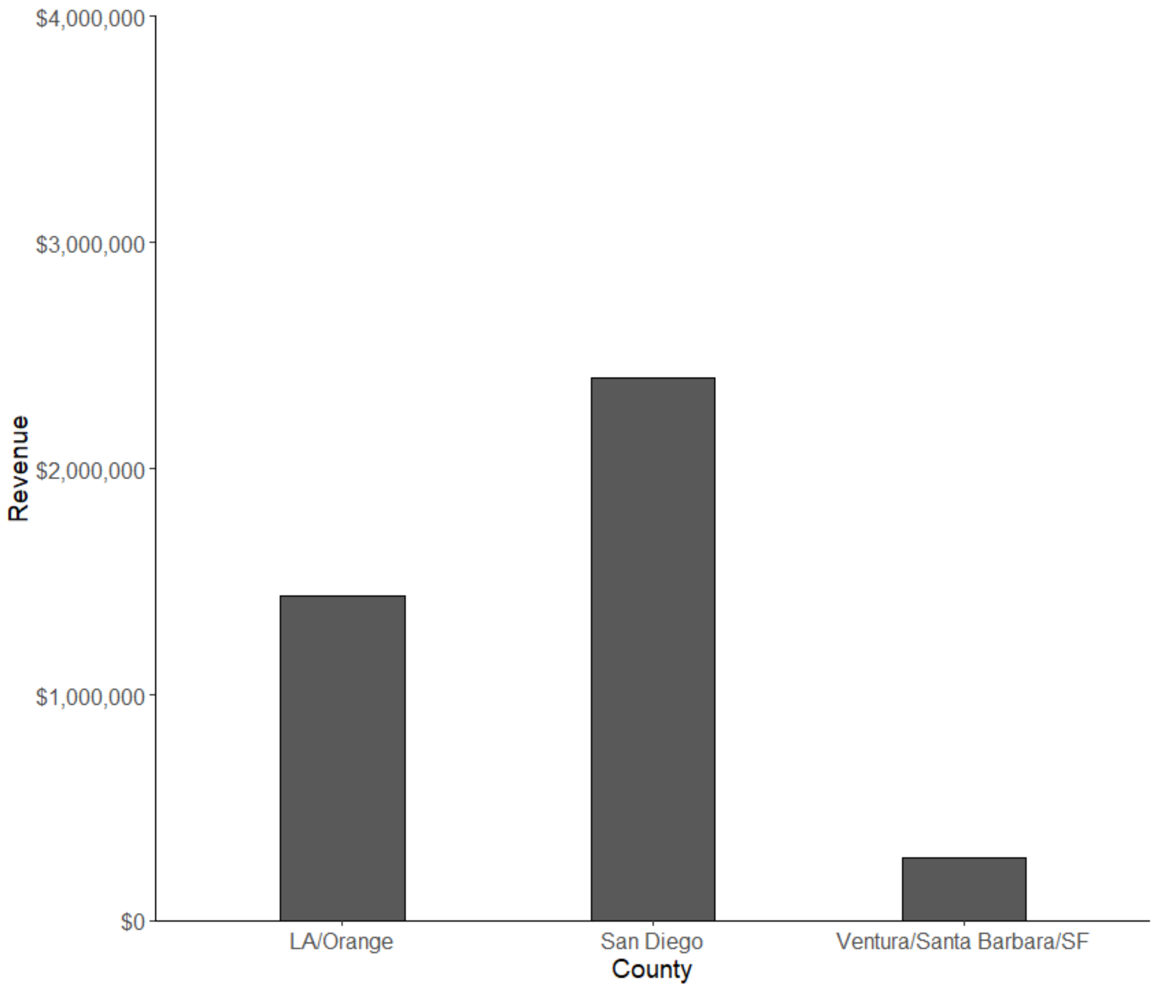
Our analysis indicates that increasing DSBG landings by one percent would result in a drop in DSBG price of 0.11 percent. See Appendix B for detail on the methodology and results of the price analysis. Using the calculated price effect, we estimate the impact on DSBG price of authorizing an LE fishery under Alternative 3 on an ongoing annual basis (i.e., the effect each year once the maximum number of LE permits are issued). Based on the results of our Bayesian biological analysis (see Section 4.3.1), DSBG swordfish catch in a given calendar year would increase to an ongoing annual mean of 5,286 swordfish under Alternative 3. Assuming that the average weight of a DSBG-caught swordfish is constant at 0.07 mt per fish (see Section 4.3.4), we project an ongoing annual mean of 352.41 mt in landed swordfish weight under the Proposed Action.

Based on the estimated price effect, and on the projected landings estimated using the biological analysis, we calculate an estimated average annual price of $5.28 per pound, which is $0.36 lower than the average price from 2018 through 2020.

This estimate is dependent on the effort assumptions of the biological analysis (i.e., the ratio of active to inactive DSBG permits and the average days fished per active permit) holding constant under the Proposed Action. It also relies on the assumption that DSBG swordfish CPUE (and, therefore, landings) scale proportionally with effort. If actual DSBG effort under the Proposed Action is less than that projected by assumptions based on levels from 2018 through 2020, or if CPUE declines with increasing fishing effort, annual landings would be less than that predicted by the biological analysis, and the overall effect on average DSBG price would be mitigated.

At the regional level, we estimate revenues under Alternative 3 by distributing projected DSBG swordfish landings under the Proposed Action (352.41 mt) to three regions, in the same proportions seen from 2018 through 2020, and multiplying by the estimated average price per pound ($5.28) to arrive at average annual revenues. Figure 4-2 displays the results of these projections.

Figure 4-2. Projected Annual Average Revenues under Alternative 3



Note that the five sub-options under Alternative 3 reach the maximum level of permit issuance and associated potential annual average revenues on different timescales:

- LE option 3.1 may reach maximum annual revenues after 12 years.
- LE option 3.2 may reach maximum annual revenues after 6 years.
- LE option 3.3 may reach maximum annual revenues after 3 years.
- LE option 3.4 may reach maximum annual revenues after 1 year.
- LE option 3.5 may reach maximum annual revenues after 11 years.

One result of this "ramp up" effect may be that fishermen receive a higher price in earlier years under Alternative 3, at the cost of lower revenue overall.
These estimates are subject to the same assumptions, caveats, and uncertainties as those discussed in Section 4.3.4.2 for Alternative 2. We stress that projections based on inferences that use a limited amount of data from DSBG EFP trials may not accurately represent the eventual operating characteristics of a fully-scale DSBG fleet. However, it is likely that increased DSBG effort under Alternative 3 will result in a net increase in DSBG revenues to all three regions analyzed, despite the negative price effect of increased landings.

Limited data at this time creates uncertainty in predictions about the economic viability of this gear type. However, based on our analysis, and in keeping with the Council's purpose and need for this action, we expect that authorizing DSBG will have positive impacts for the U.S. West Coast swordfish fishery as a supplementary source of domestically-caught swordfish, which may reduce reliance on imports for meeting domestic demands. We note that the results of our price analysis indicates a higher price per pound under Alternative 3. That is, the negative price effect is less severe with lower landings. This finding, if it holds true, suggests that Alternative 3 may improve economic viability for a smaller number of fishermen participating in the LE program, despite projections of lower revenues overall relative to Alternative 2. As discussed in Section 2, we consider Alternative 3 our preferred alternative as it was developed over a multi-year Council process with substantial public input, including consideration of this price analysis and potential economic viability of the gear. The ability to garner a higher price per pound is an important factor influencing fishermen's decisions to fish with lower-volume gear, like DSBG.

4.4.4.3. Impacts to Processors, Restaurants, & Consumers

Impacts to processors, restaurants, and consumers under Alternative 3 are expected to be similar to Alternative 2 (see Section 4.3.3.3). Our analysis indicates that the lower amount of maximum effort under Alternative 3 may result in lower levels of domestically-caught swordfish relative to Alternative 2.

5. CUMULATIVE IMPACTS

This section addresses the significance of expected cumulative impacts on the affected environment. Cumulative impacts result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. 40 C.F.R 1508.7

5.1. Past, Present, and Future Foreseeable Actions

The scope of past and present actions encompasses actions that occurred after implementation of the HMS FMP in 2004. Implementation of the HMS FMP and associated regulations represents a milestone in establishing the management framework for U.S. West Coast HMS fisheries and rules for their operations. For endangered species and other protected resources, the scope of past and present actions is determined by analysis pursuant to the ESA and MMPA, including biological opinions for HMS fisheries and marine mammal stock assessment reports. The temporal scope of future actions for all affected resources extends about 12 years into the future. We chose this period to characterize conditions during the ramp up period to full-scale DSBG fleet operations, which reflects differences in the speed and timing of limited entry permit issuance (under Alternative 3) among the different options. We also consider cumulative impacts that might occur on an ongoing basis once the maximum number of DSBG permits are issued under either action alternative.

5.1.1. Active and Pending EFPs

In addition to the fisheries in or near the Proposed Action Area described in Section 3, the Council and NMFS have considered other EFPs to target HMS that may have cumulative effects through shared pressure on target and non-target finfish stocks and similar concerns regarding bycatch of protected species. In spring 2019, NMFS issued two EFPs to fish SSLL and DSLL gear inside the U.S. West Coast EEZ. In 2020, NMFS issued a single EFP to fish deep-set shortline gear inside the EEZ, as well as a single EFP to fish DSBG at night using a modified gear configuration. Additionally, the Council and NMFS continue to review and consider issuance of the EFP applications proposing to target swordfish and other marketable HMS in the Proposed Action Area. Information on catch of target and non-target species in these EFPs is sparse, as the longline EFPs were discontinued shortly after issuance, and data on deep-set shortline and nighttime DSBG configurations are not yet available. Fishing under such EFPs may result in catching some of the same species as in proposed fully-authorized DSBG fishing, and may contribute to some unknown biological impacts in the Proposed Action Area.

5.1.2. Other Fisheries

Other fisheries and fleets that operate in the vicinity of the Proposed Action and may incidentally catch the same species as DSBG include the California set gillnet fleet for halibut and white seabass, the small

mesh DGN fishery, and illegal, unreported, and unregulated (IUU) fishing. The California set gillnet and small mesh DGN fleet target non-HMS species, generally in nearshore state waters outside of the Proposed Action Area. However, these fisheries may incidentally catch some of the same species as the proposed DSBG fishery, to the extent that stocks caught in DSBG range in both federal and state waters. Some IUU fishing may occur in the vicinity of the Proposed Action Area, with some effects to species likely to be affected by DSBG authorization. Information on catch, effort, and protected species interactions for IUU activities is sparse and difficult to obtain. Nonetheless, it is expected that these activities likely contribute some unknown negative impacts on management unit species of the HMS FMP.

5.1.3. Pending Changes to the DGN Fleet

A number of bills and regulations that are actively being discussed or are pending implementation would result in changes to the future status of the DGN fleet. These bills and regulations may have cumulative effects with the Proposed Action by affecting effort and catch by the DGN fleet or by incentivizing fishermen to switch from DGN to DSBG fishing.

5.1.3.1. Council Consideration of Hard Caps

In 2016, the Council recommended NMFS evaluate restrictions on bycatch and bycatch mortality beyond those legally required for the DGN fleet. NMFS published a proposed rule in the *Federal Register* on October 13, 2016 (81 FR 70660) to implement the Council's recommendation, which included closure periods for up to two years upon exceedance of a hard cap. NMFS accepted public comment on the proposed rule and associated draft Environmental Assessment, Initial Regulatory Flexibility Analysis, and draft Regulatory Impact Review through December 28, 2016. Following public comment on the proposed rule and associated analyses, NMFS conducted further analysis of the economic effects of the action. This new analysis indicated significant adverse short-term economic effects that were not identified at the proposed rule stage. Citing inconsistency with the purpose and need for the action and MSA National Standard 7 (i.e., conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication), NMFS withdrew the proposed rule on June 12, 2017. This prompted litigation challenging the withdrawal, citing NMFS' initial determination under MSA §304(b)(1)(A) that the proposed regulations comported with applicable law. In October 2018, the court found that NMFS had exceeded its authority under the MSA and the Administrative Procedure Act by making a negative determination on the regulations after the proposed rule stage. The court held that NMFS could not withdraw the rule after its preliminary approval at the proposed rule stage and remanded to NMFS for further action. In advance of scheduled discussion on the matter at the March 2020 Council meeting, the

plaintiff moved to enforce the order, and on January 8, 2020, the court ordered NMFS to publish a final rule for hard caps. NMFS published this rule to the *Federal Register* on February 7, 2020, prompting another round of litigation, this time by California DGN fishermen who challenged the statutory and constitutional validity of the hard caps final rule. In November 2020, the Council considered potential revisions to the hard caps regulation to alleviate the potential economic burden on fishery participants while still accomplishing its purpose and need. On February 18, 2021, the court found the hard caps final rule conflicted with MSA National Standard 7 and vacated the rule without remand. The Council revisited their recommendation for hard caps, and the economic burden of the resulting regulations on fishermen, during its June 2021 meeting.

5.1.3.2. California State Law

In 2018, Senate Bill (SB) 1017 became law in the State of California. Regulations to implement the legislation establish a transition program for the DGN fishery by providing funding to reimburse fishermen who surrender their Federal DGN permits and DGN gear. Under this program, California set aside $1 million in public money for the program and sought an additional $1 million from other sources. This program is being implemented, but is not sufficiently funded to purchase gear from all willing participants. Any Federal DGN LE permit holder that does not participate will have their State of California LE DGN permit revoked in 2024, but would not be prevented by this State legislation from continuing to be able to renew their Federal DGN LE permit.

5.1.3.3. Proposed Federal Bills

In 2019, during the 116th Congress, U.S. Senator Diane Feinstein introduced S.906, the Driftnet Modernization and Bycatch Reduction Act. Similar to the state transition program outlined in California SB 1017, S.906 would prohibit large-mesh DGN fishing nationwide and implement a federal program to fund transition of DGN fishermen to alternative gear types. This bill passed the Senate Legislative Calendar on July 22, 2020, and passed the House of Representatives with more than two-thirds vote on December 10, 2020. On January 1, 2021, President Donald J. Trump vetoed the legislation asserting that the proposed legislation “will not achieve its purported conservation benefits” and that “alternative gear … has not proven to be an economically viable substitute for gillnets,” while citing concerns for circumventing consultation with the Council to terminate a fishery and increasing reliance on imported seafood. The 116th Congress adjourned on January 3, 2021, without overriding the President’s veto. The Driftnet Modernization and Bycatch Reduction Act was reintroduced in the House (H.R. 404) and Senate (S. 273) during the early days of the 117th Congress.

5.1.4. Climate Change

Two mesoscale climate phenomena likely affect frontal activity and the distribution of swordfish, tuna, other non-target finfish, and protected species found in the Proposed Action Area. The first is the El Niño-Southern Oscillation (El Niño), which is characterized by a relaxation of the Indonesian Low and subsequent weakening or reversal of westerly trade winds that cause warm surface waters in the western Pacific to shift eastward. An El Niño event brings warm waters and a weakening of coastal upwelling off the West Coast. Tunas and billfish are found farther north during El Niño years (Field and Ralston 2005). La Niña, a related condition, results in inverse conditions, including cooler water in the eastern tropical Pacific and California Current System (CCS).

The second mesoscale climate phenomenon likely to affect the distribution of species in the Proposed Action Area is the Pacific Decadal Oscillation (PDO), which has important ecological effects in the CCS. Regime shifts indicated by the PDO have a periodicity operating at both 15- to 25-year and 50- to 70-year intervals (Schwing 2005). The PDO indicates shifts between warm and cool phases. The warm phase is characterized by warmer temperatures in the northeast Pacific (including the West Coast), as well as cooler-than-average sea surface temperatures and lower-than-average sea level air pressure in the central north Pacific; opposite conditions prevail during cool phases.

Recent reports by the Intergovernmental Panel on Climate Change (IPCC) have made it clear that the Earth's climate is changing, and with it the environmental conditions in the ocean are also changing (IPCC 2014). Climate change affects the marine environment by raising water temperatures, impacting the established hydrologic cycle (precipitation and evaporation rates) and increasing the incidence of disease in aquatic organisms (Roessig et al. 2004). Other climate change impacts to the marine environment include changes in ice cover, salinity, oxygen levels, and circulation (IPCC 2014). These effects are leading to shifts in the range of species; changes in algal, plankton, and fish abundance (IPCC 2014); and damage to coral reefs (Scavia et al. 2002). Plankton studies demonstrate that climate change is affecting phytoplankton, copepod herbivores, and zooplankton carnivores, which affect ecosystem services (e.g., oxygen production, carbon sequestration, and biogeochemical cycling). Fish, seabirds, and marine mammals will need to adapt to changing spatial distributions of primary and secondary production within pelagic marine ecosystems (Richardson et al. 2004).

The CCS has large natural variability in its oceanography and coastal pelagic species abundance, which may directly impact the abundance and location of Pacific bluefin in the EPO. Baumgartner et al. (1992) and Field et al. (2009) examined deposits of coastal pelagic fish scales and were able to identify historic

periods or regimes of anchovy and sardine abundance that they suggest are linked to large-scale climate phenomena. For example, during the 1930s through the 1950s when the California Current was undergoing a warm period as reflected in the PDO (Mantua et al. 1997), sardines were highly abundant; however, these populations experienced steep declines as the California Current and the North Pacific entered a cool period.

Studies conducted by Perry et al. (2005) indicate that climate change is affecting marine fish distributions in ways that impact fish as well as commercial fisheries. Impacts to commercial fisheries include: (1) increases in ocean stratification leading to less primary production, which leads to less overall energy for fish production; (2) shifts in mixing areas of water zones leading to decreases in spawning habitat and decreased stock sizes; and (3) changes in currents that may lead to changes in larval dispersals and retention among certain habitats, which could lead to decreases in stock sizes and availability of resources to certain fisheries (Roessig et al. 2004). Few studies have reported on climate change impacts specific to Pacific swordfish fisheries. Silva et al. (2015) developed a forecasting model for analyzing impacts of climate change to pelagic fisheries and found that the IPCC's high-CO2 scenario may produce a slight decline in the relative abundance of swordfish off Chile by 2065, but that warmer waters may produce higher abundance of swordfish nearest the coast.

5.2. Effects of Past, Present, and Future Foreseeable Actions

5.2.1. Alternative 1—No Action

Alternative 1 would not introduce any additional impacts to the human environment than what may be expected based on past, present, and reasonably foreseeable future actions other than the Proposed Action. These expectations are described below.

Active and pending EFPs listed above operate in the Proposed Action Area and may incidentally catch some of the same species as DSBG. Other fisheries listed above operate in the vicinity of the Proposed Action Area and may incidentally catch some of the same species as DSBG.

Potential changes to regulations on large-mesh DGN gear may have positive impacts on the biological resources (described in Section 3) when they are inside the Proposed Action Area, by incentivizing reductions in DGN effort and associated catch of target and non-target species. These same reductions may have negative economic impacts on U.S. fishermen and fishing communities by reducing or eliminating the opportunity to fish DGN gear. At this time, the Council has not decided to transition or ban DGN, and proposed federal legislation to do so has not become law. The Council has scheduled

consideration of revisions to DGN hard caps regulations in the future. Therefore the precise impacts of these considerations are unclear. The State of California's regulations implementing a transition program for DGN gear include a sunset date. If DGN fishermen operating in the Proposed Action Area would no longer be permitted to land their catch in California, the effect would be to force DGN fishermen wishing to continue to target swordfish in the Proposed Action Area to fish with a different type of federally-authorized gear. Without implementing the Proposed Action, those options are harpoon or hook-and-line gear. Because these gear types are low-volume in comparison to DGN gear, we expect that swordfish landings and revenue by U.S. West Coast vessels would continue to decline, with importation of swordfish products likely increasing as a result.

Climate change and water pollution would likely have negative effects on the affected resources and fisheries in the affected environment, over the long term, whereas the actions taken to protect resiliency of the Pacific Coast would likely have minor positive and incremental effects, which could become major over the long term. The magnitude of these effects would depend on the ability of these resources and fisheries to adapt to such changes. It is unlikely that water pollution would have major effects because of the highly migratory nature of the fish, protected species, and seabirds in the affected environment. Fisheries that target highly migratory species tend to occur further offshore, whereas water pollution concerns tend to be more severe in nearshore environments. Climate change will likely require fisheries to invest additional search time and/or the ability to shift fishing and processing effort with changes in the distribution of customary target species. However, climate change may also cause warmer-water HMS and other species to inhabit customary fishing grounds in higher abundances. Therefore, effects to fisheries and fishing communities may depend on the degree to which fisheries and fishing communities are able to offset potential losses in catches of more temperate-water species with gains in catches of warmer-water species.

Other than preventing some economic gains that might be realized by DSBG fishermen under the action alternatives, the No Action Alternative would not yield additional impacts on the human environment.

5.2.2. Alternative 2—Authorize an Open Access Fishery

Under Alternative 2, an open access DSBG fishery would be authorized in the EEZ off California and Oregon with the terms and conditions specified in Section 2 of this document.

Volatility in future DGN fishing opportunity and the potential for season-long fishery closures resulting from current or pending regulations on the DGN fleet (e.g., a DGN transition program, Council

reconsideration of hard caps, etc.) may have cumulative impacts with the Proposed Action to authorize DSBG by encouraging HMS fishermen to transition from DGN to DSBG, increasing the interest and potential effort during the ramp-up period of an authorized DSBG fishery. The resulting impacts to target and non-target species or to the socioeconomic environment are somewhat unclear. If DGN fishermen are prohibited from landing their catch in California, DSBG could not be used as a complement to DGN gear (i.e., fished on the same trip) as would otherwise be permitted under the Proposed Action. However, Alternative 2 would give DGN fishermen another federally-authorized gear option in comparison to Alternative 1. While swordfish landings and revenue to southern California ports are projected to increase under Alternative 1, those projections would be dampened by a reduction in the baseline swordfish revenues and landings by vessels that typically fished DGN gear. Because DGN is a high-volume gear used to target other marketable HMS in addition to swordfish, there may be fewer impacts in the U.S. West Coast EEZ to species identified as non-targets for the Proposed Action. However, preliminary analysis indicates that revenue per vessel per year may be, on average, 65 percent lower for vessels fishing with DSBG compared to DGN gear.[5]

Authorizing an open access DSBG fishery may have cumulative impacts with climate change in terms of increasing fishing pressure on both swordfish and non-target species. DSBG is a highly selective gear with relatively low bycatch impacts compared to other HMS gears; therefore, to the extent that authorizing DSBG encourages fishermen to fish DSBG in lieu of other gears with a greater relative impact, bycatch in the U.S. West Coast EEZ may be reduced. It is also possible that climate change will cause species range shifts and changes in spawning stock biomass which could impact the economic viability of a DSBG fleet; however, the specific impacts of climate change to swordfish populations in the Proposed Action Area are unclear.

5.2.3. Alternative 3—Authorize a Limited Entry Fishery

Under Alternative 3, DSBG fishing would be authorized in the EEZ off California and Oregon under a limited entry permit with the terms and conditions specified in Section 2 of this document.

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[5] We compared revenues (in 2018 dollars) per day of fishing effort for the DGN and DSBG fisheries from 2015 through 2018. Revenues from a day of DSBG had a profitability ratio of between 41 percent and 89 percent relative to DGN during this time period, with an overall average profitability ratio of 65 percent. We note that the viability of both gear types can vary significantly due to a number of factors including weather conditions, regulatory time and area closures, potential spatial crowding of productive fishing areas, market demand for domestic swordfish product, and the highly migratory nature of swordfish stocks. We also note that this comparison does not account for the price effect we anticipate in a full scale DSBG fleet.

Volatility in future DGN fishing opportunity and the potential for season-long fishery closures resulting from current and pending regulations on the DGN fishery (e.g., DGN transition program, hard caps regulations, etc.) may have cumulative impacts with the Proposed Action to authorize DSBG by encouraging HMS fishermen to transition from DGN to DSBG, increasing interest and potential effort during the ramp-up period of an authorized DSBG fishery. The resulting impacts to target and non-target species are unclear. The cumulative impacts to target and non-target species of Alternative 3 would likely be less than Alternative 2, due to lower maximum fishing effort under a limited entry program. Under Alternative 3, DGN fishermen participating in a gear transition program are given preference for obtaining a limited entry DSBG permit. While we projected that a full-scale DSBG fleet may realize a higher price per pound for swordfish under Alternative 3 than under Alternative 2, it is not expected that difference will be enough to offset potential losses in revenue from no longer being permitted to land swordfish to California following the sunset date for those activities in state regulations.

Authorizing a limited entry DSBG fishery may have cumulative impacts with climate change in terms of increasing fishing pressure on both swordfish and non-target species. DSBG is a highly selective gear with relatively low bycatch impacts compared to other HMS gears; therefore, to the extent that authorizing DSBG encourages fishermen to fish DSBG in lieu of other gears with a greater relative impact on the species in question, bycatch in the U.S. West Coast EEZ may be reduced. It is also possible that climate change will cause species range shifts and changes in spawning stock biomass which could impact the economic viability of a DSBG fishery; however, the specific impacts of climate change to swordfish populations in the Proposed Action Area are unclear at this time. The cumulative impacts of Alternative 3 would likely be less than Alternative 2 due to lower maximum fishing effort under a limited entry program.

6. LISTS

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Preparer Name and Affiliation	Responsibility
Karter M. Harmon, Contractor, NMFS WCR	Primary author, biological analysis, socioeconomic analysis, edits, and revisions
Lyle Enriquez, HMS Branch Chief, NMFS WCR	Document structure, edits, and revisions
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Shelby Mendez, NEPA Coordinator, NMFS WCR	Scoping, document review, edits, and revisions

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Person or Organization Contacted	Responsibility
PFMC Highly Migratory Species Management Team	Review of Preliminary Draft EIS
Jenny Suter, HMS Statistician, Pacific States Marine Fisheries Commission	Provision and review of landings data
Jeffrey E. Moore, Marine Mammal and Turtle Division, NMFS SWFSC	Review of biological analysis
Tonya Wick, Contractor, NMFS WCR	Document review
Charles Villafana, Observer Program Coordinator, NMFS WCR	Review of integrated observer and logbook dataset and biological analysis

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APPENDICES

Appendix A: Methods and Results of Biological Impact Analysis

To develop projections of catch under each of the Proposed Action alternatives, NMFS conducted a statistical analysis using data collected from DSBG EFP trials. NMFS processed data from observer records and fisher logbooks for DSBG EFP activity, including both SBG and LBG, from January 2015 through December 2020. These data are derived from an integrated dataset that includes observer records for observed trips and logbook data for trips where an observer was not present. NMFS used this dataset to analyze the impact of the proposed alternatives on species that occur in the Proposed Action Area. Table A-1 displays reported total catch to date in DSBG EFP trials.

Table A-1. Summary of Reported DSBG Trials Catch, in Number of Individuals

	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Swordfish	136	474	645	606	1072	1257
Bigeye Thresher Shark	66	57	46	34	40	51
Blue Shark	3	4	2	1	6	17
Shortfin mako shark	0	0	0	1	3	1
Pelagic thresher shark	0	0	0	2	0	0
Common thresher shark	0	0	0	1	0	0
Salmon Shark	0	0	0	0	1	0
Sixgill Shark	0	0	0	0	1	0
Humboldt squid	0	0	1	0	0	0
Giant squid	0	0	1	0	0	0
Opah	2	1	0	0	0	0
Escolar	4	4	3	4	10	3
Common Mola	0	0	0	1	1	0
Pacific Hake	0	0	0	0	1	1
Oilfish	0	0	0	0	0	2
Yelloweye Rockfish	0	0	2	0	0	0
Vermillion Rockfish	0	0	0	0	2	1
Northern elephant seal	1	0	0	1	1	0
Loggerhead sea turtle	0	0	0	1	0	0
Total Days Fished	132	283	377	627	764	1076

We use these data to estimate catch rates, and used the rates to predict catch under the proposed alternatives. However, because the Proposed Action would authorize much higher levels of DSBG fishing effort than have occurred to date in the EFP trials, any analysis of potential catch rates using EFP data

introduces a large degree of uncertainty into the resulting estimates of biological impacts. Given this uncertainty, simple ratio estimates are not appropriate for predicting catch under the proposed alternatives. Instead, we adapt a methodology that addresses uncertainty, while producing a range of estimates for catch under each of the alternatives. We employ a statistical approach based on Bayesian inference which uses the existing catch data to estimate the posterior distribution of CPUE, and then simulates the posterior predictive distribution (PPD) of catch under assumed levels of effort for each alternative (Martin et al. 2015). The PPDs are calculated by simulating draws from the posterior distribution 20,000 times under the simulated levels of effort anticipated under each alternative. We then use these PPDs to produce a 95 percent credible interval for total catch (i.e., the range with a 95 percent probability of including the actual catch, given the effort assumptions and level of uncertainty in the analysis), as well as summary statistics such as the mean (i.e., expected annual average takes) and mode (i.e., most likely catch in a given year) for each species under each alternative.

Table A-2 shows the timing and maximum amount of permit issuance under each alternative of the Proposed Action. Note that ‘LE 3.5’ has been designated as the Council’s preliminary preferred alternative (PPA). While the LE regimes under the Proposed Action only apply to the Southern California Bight (SCB), with open access allowed elsewhere in the Proposed Action Area, over 99 percent of the total DSBG effort to date has been within the LE SCB area. Therefore, we analyze the maximum number of LE permits (i.e., 300) for these alternatives. We use 500 permits per year as our analytical basis for the Open Access Alternative, based on Council recommendations. However, more than 500 permits could be issued under the Open Access Alternative.

Table A-2. Maximum Annual Permit Issuance under the Proposed Action Alternatives

Alternative	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**
Open Access	500	500	500	500	500	500	500	500	500	500	500	500
LE 3.1	25	50	75	100	125	150	175	200	225	250	275	300
LE 3.2	50	100	150	200	250	300	300	300	300	300	300	300
LE 3.3	100	200	300	300	300	300	300	300	300	300	300	300
LE 3.4	300	300	300	300	300	300	300	300	300	300	300	300
LE 3.5 (PPA)	50	75	100	125	150	175	200	225	250	275	300	300

For each alternative, we estimate total catch during the 12 year “ramp-up” period following authorization (i.e., the length of time for the maximum number of permits to be issued under every alternative), as well as ongoing annual estimates for each year after the maximum number of permits is issued.

The levels of effort under each alternative rely on assumptions made using data from 2018 through 2020, which we regard as the fishing years that serve as the best available proxy for a year of authorized DSBG fishing. This is because 2018 saw an increased amount of DSBG EFP applications, issued permits, and fishing effort in a complete year. In 2018, the Council recommended 60 permits be issued, NMFS issued 29 permits, and 26 were ultimately fished (i.e., 43 percent of Council-recommended EFPs were actively fished), at an average effort rate of 23.69 days fished per active vessel for the year. In 2019, 60 permits were again issued and available to be fished, 24 of which were ultimately fished (i.e., 40 percent of Council-recommended EFPs were actively fished), at an average effort rate of 27.96 days fished per active vessel for the year. In 2020, 27 out of 60 available permits ultimately fished (i.e., 45 percent of Council-recommended EFPs were actively fished), at an average effort rate of 39.85 days fished per active vessel for the year.

We assume that, in an authorized DSBG fishery, each active vessel will fish an average of 30.69 days per year (i.e., the average effort per active vessel from 2018-2020). We also assume that 43 percent of all available permits will be fished in a given year, based on the ratio of active to Council-recommended permits for the 2018-2020 DSBG EFP fishing seasons. Table A-3 summarizes these effort assumptions.

Table A-3. Effort Assumptions for Biological Analysis

Active Fishing	43%	of available permits will be acquired & fished
Average Effort	30.69	days fished per active vessel

Based on the aforementioned assumptions, we estimate a level of assumed effort for each alternative based on the following formula:

$$\text{Assumed Effort} = \text{Total Permits} \times \text{Active Fishing Percentage} \times \text{Average Days Fished per Vessel}$$

For the purposes of comparing the LE alternatives, we analyze total effort over the 12-year “ramp up” period. To compare the proposed open access and LE regimes over the long term, we also analyze levels of ongoing annual effort in each year after the maximum number of permits is issued. Table A-4 displays our assumed levels of effort for each alternative.

Table A-4. Assumed Effort (Days Fished) for Each Alternative

Alternative	12-Yr Ramp Up	Ongoing Annual
Open Access	79,075	6,590
LE 3.1	25,699	3,954
LE 3.2	37,561	3,954
LE 3.3	43,491	3,954
LE 3.4	47,445	3,954
LE 3.5	29,324	3,954

These assumptions are made based on the available information to approximate the effort characteristics of a hypothetical authorized fleet. In reality, effort by a future DSBG fleet will depend on factors such as gear preference, opportunity costs of fishing, availability of other sources of fishing and non-fishing revenue, the future status of other West Coast swordfish fisheries, and other unknown factors. To incorporate uncertainty about how much vessels will actually fish in an authorized fishery into our analysis, we eschew use of a point estimate for days fished per vessel, and instead employ a sampling procedure that draws from the empirical distribution of days fished per vessel per year, and uses these d to estimate a range of possible days fished in a given season. In other words, re replace the "Average Days Fished per Vessel" component of the above formula with an empirical sample-based estimate, for each simulated catch prediction (see the Sensitivity Analysis and Alternative Model Specifications subsection below for more detail on our effort estimation methodology). As more data become available, we hope to update our analysis to improve the reliability of our assumptions and the resulting predictions.

We derive estimates of CPUE using Hamiltonian Markov Chain Monte Carlo sampling on a Poisson model with uninformative priors[6] (Martin et al. 2015). The estimates are based on data for both gear types, and control for variation in daily fishing effort, as measured in buoy-hours (i.e., the total soak time for all buoys deployed of a given gear type in a given fishing day). For comparison purposes, we provide predictions for both the entire 12-year ramp-up period and for each year once the maximum number of permits are available. These predictions include the mean and mode of the probability distribution of predicted catch, as well as the quantiles at 2.5 percent, 50 percent, and 97.5 percent (i.e., the lowest, median, and highest values of the 95 percent credible interval of possible catch values).

[6] We evaluated three likelihood models for all species: the Poisson, the zero-inflated Poisson, and the negative binomial. Posterior predictive checking indicated that the Poisson was the best fit for uncommonly caught species, whereas for more commonly caught species (i.e., swordfish and bigeye thresher shark) the negative binomial model was a better fit. See the final subsection of this appendix for a summary of our posterior predictive checking and model evaluation.

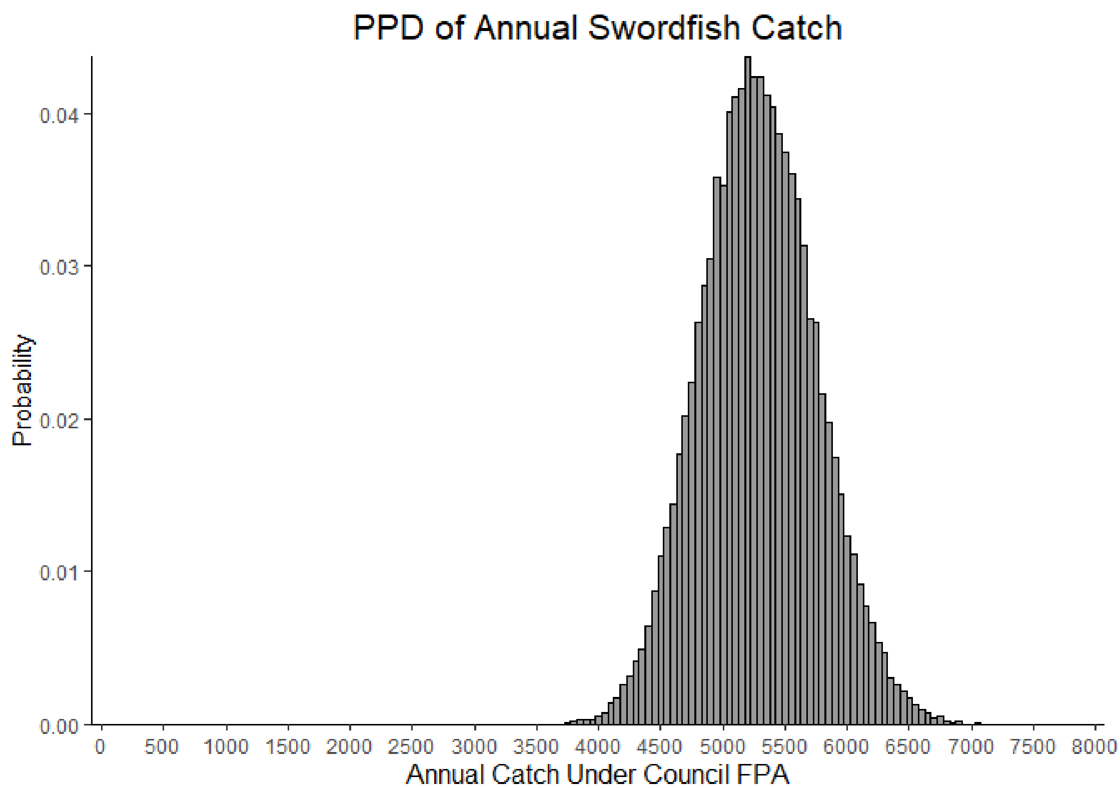
The catch predictions include total numbers of animals but do not describe the disposition of the catch (i.e., kept, released alive, released dead, released unknown, released injured). Swordfish and other marketable fish species are most often kept and experience mortality. Species that are released are most often alive, due to DSBG strike detection and active tending of the gear. Required circle hooks minimize injury to animals that are released alive.

The tables and figures below display the estimated CPUE from our biological analysis, projected catch counts for this species under each of the proposed alternatives, and a histogram of the PPD of projected ongoing annual catch under Alternative 3, the Limited Entry Alternative (i.e., under the projected annual catch under the Council's PPA, once the maximum number of permits are made available for issuance).

Swordfish (Xiphias gladius)

Table A-5. Swordfish Catch (in Number of Individuals) Under Each Alternative

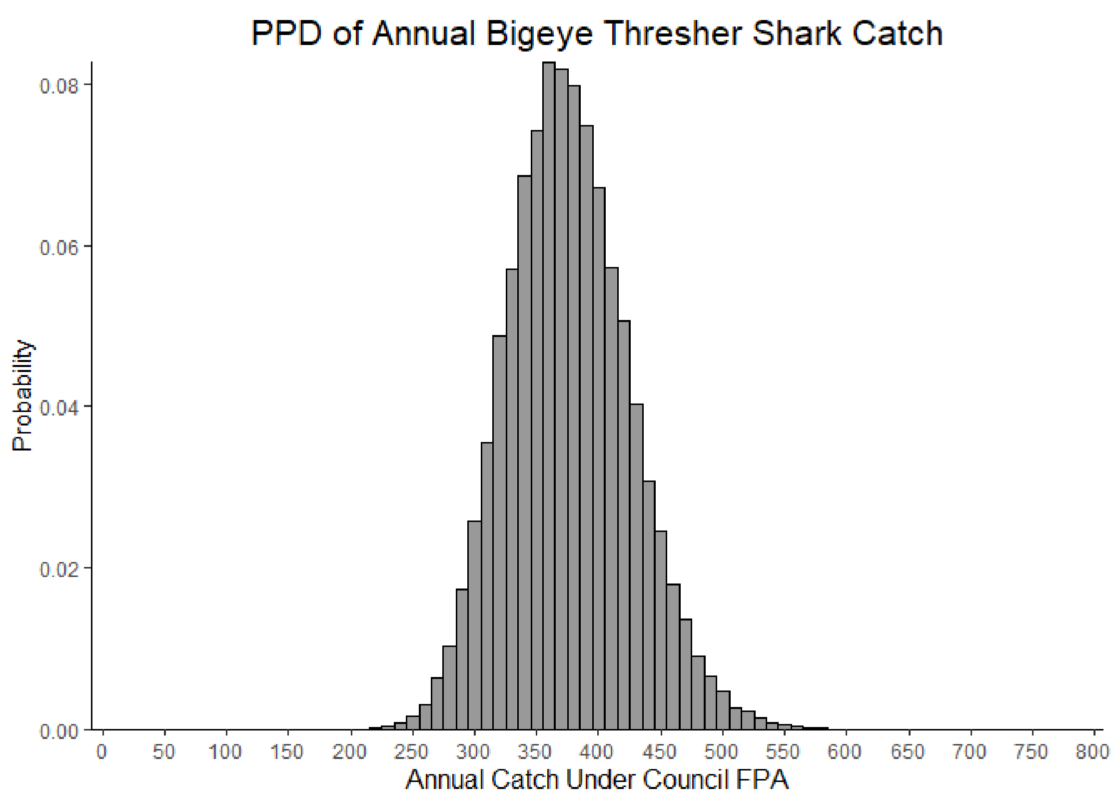
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.01878*	*0.01805*	*0.01877*	*0.01952*	
	Per Day Fished	*1.34198*	*1.29043*	*1.34175*	*1.39548*	
12 Year Ramp Up	Open Access	105,704	100,156	105,655	111,495	105,309
	LE 3.1	34,351	31,786	34,334	37,014	34,464
	LE 3.2	50,202	46,860	50,198	53,611	51,265
	LE 3.3	58,142	54,445	58,116	61,933	57,954
	LE 3.4	63,426	59,567	63,401	67,413	64,389
	LE 3.5	39,199	36,418	39,178	42,118	38,828
Ongoing Annual	Open Access	8,812	7,653	8,802	10,033	9,028
	LE (All)	5,286	4,409	5,276	6,221	5,311



Bigeye thresher shark (*Alopias superciliosus*)

Table A-6. Bigeye Thresher Shark Catch (in Number of Individuals) Under Each Alternative

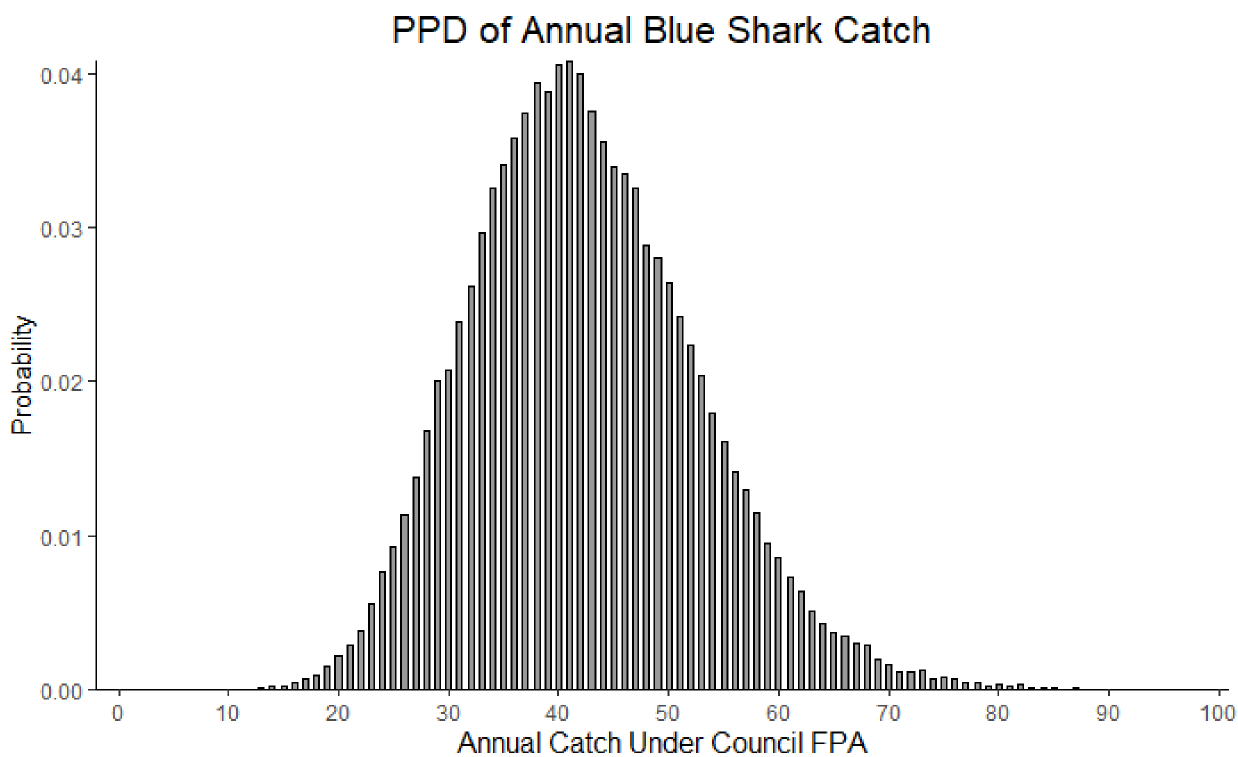
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00134*	*0.00115*	*0.00133*	*0.00154*	
	Per Day Fished	*0.09554*	*0.08201*	*0.09536*	*0.11041*	
12 Year Ramp Up	Open Access	7,525	6,410	7,508	8,754	7,504
	LE 3.1	2,446	2,052	2,438	2,882	2,430
	LE 3.2	3,574	3,025	3,563	4,188	3,464
	LE 3.3	4,139	3,507	4,128	4,848	4,109
	LE 3.4	4,515	3,823	4,503	5,274	4,479
	LE 3.5	2,791	2,354	2,783	3,285	2,781
Ongoing Annual	Open Access	628	499	625	772	602
	LE (All)	376	287	374	480	358



Blue shark (*Prionace glauca*)

Table A-7. Blue Shark Catch (in Number of Individuals) Under Each Alternative

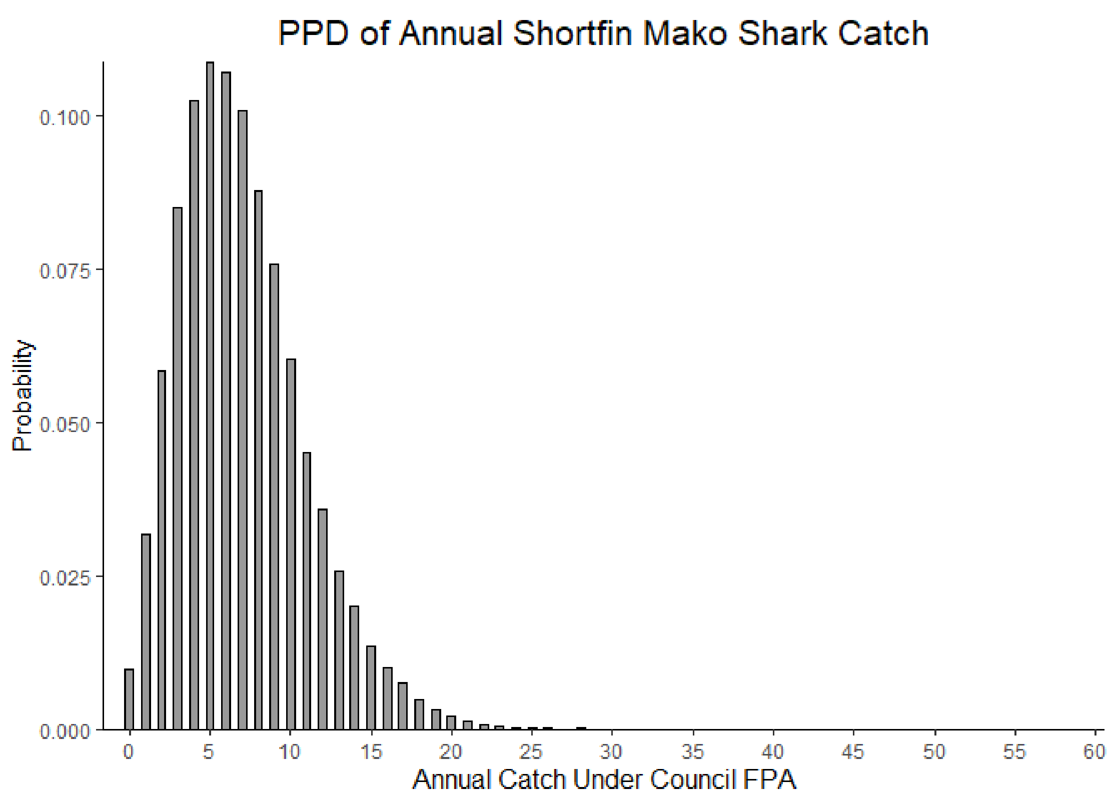
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00015*	*0.00010*	*0.00015*	*0.00020*	
	Per Day Fished	*0.01075*	*0.00750*	*0.01064*	*0.01456*	
12 Year Ramp Up	Open Access	847	584	839	1,157	892
	LE 3.1	275	185	272	381	260
	LE 3.2	402	274	398	553	388
	LE 3.3	466	319	461	639	440
	LE 3.4	508	348	503	697	496
	LE 3.5	314	212	311	434	299
Ongoing Annual	Open Access	71	43	70	103	70
	LE (All)	42	24	42	65	40



Shortfin mako shark (*Isurus oxyrinchus*)

Table A-8. Shortfin Mako Shark Catch (in Number of Individuals) Under Each Alternative

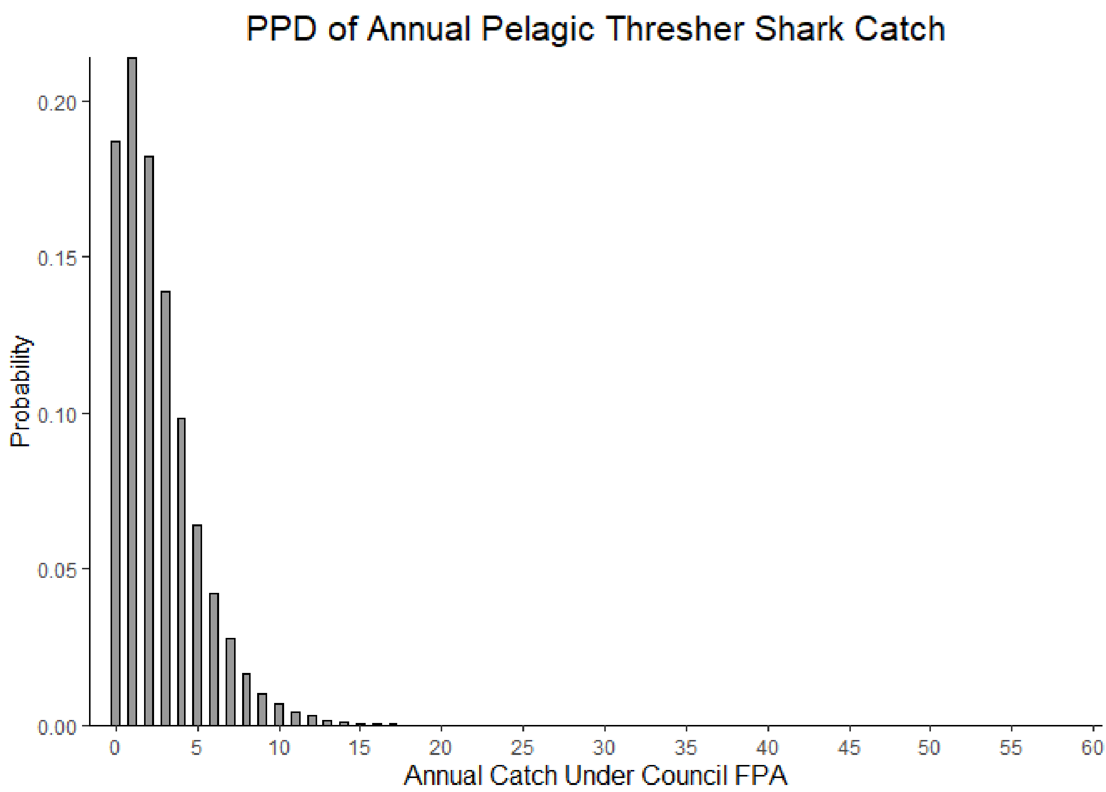
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00002*	*0.00001*	*0.00002*	*0.00005*	
	Per Day Fished	*0.00178*	*0.00066*	*0.00168*	*0.00346*	
12 Year Ramp Up	Open Access	140	50	132	276	121
	LE 3.1	46	15	43	92	38
	LE 3.2	67	23	63	132	53
	LE 3.3	77	27	73	153	59
	LE 3.4	84	29	79	167	75
	LE 3.5	52	17	49	104	44
Ongoing Annual	Open Access	12	3	11	25	9
	LE (All)	7	1	6	16	5



<u>Pelagic thresher shark (*Alopias pelagicus*)</u>

Table A-9. Pelagic Thresher Shark Catch (in Number of Individuals) Under Each Alternative

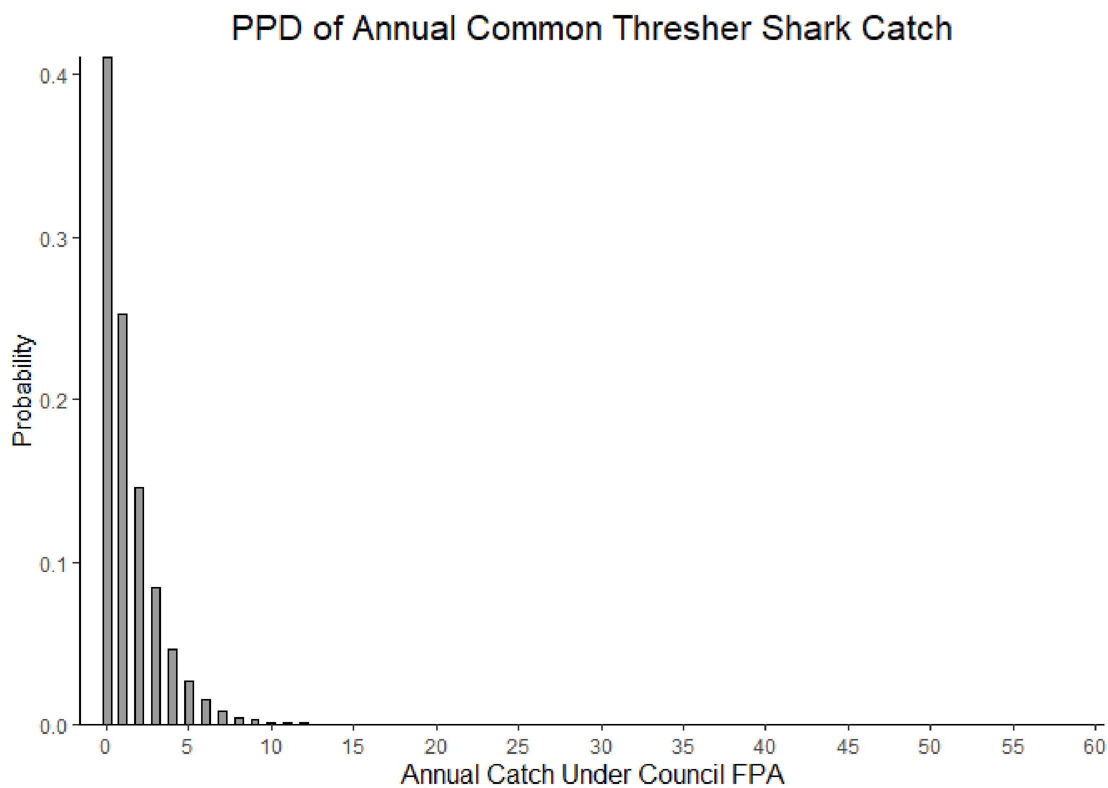
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00182*	
12 Year Ramp Up	Open Access	52	6	44	144	31
	LE 3.1	17	1	14	48	7
	LE 3.2	25	2	21	69	12
	LE 3.3	29	3	24	80	16
	LE 3.4	31	3	26	88	16
	LE 3.5	19	2	16	55	9
Ongoing Annual	Open Access	4	0	4	14	2
	LE (All)	3	0	2	9	1



Common thresher shark (*Alopias vulpinus*)

Table A-10. Common Thresher Shark Catch (in Number of Individuals) Under Each Alternative

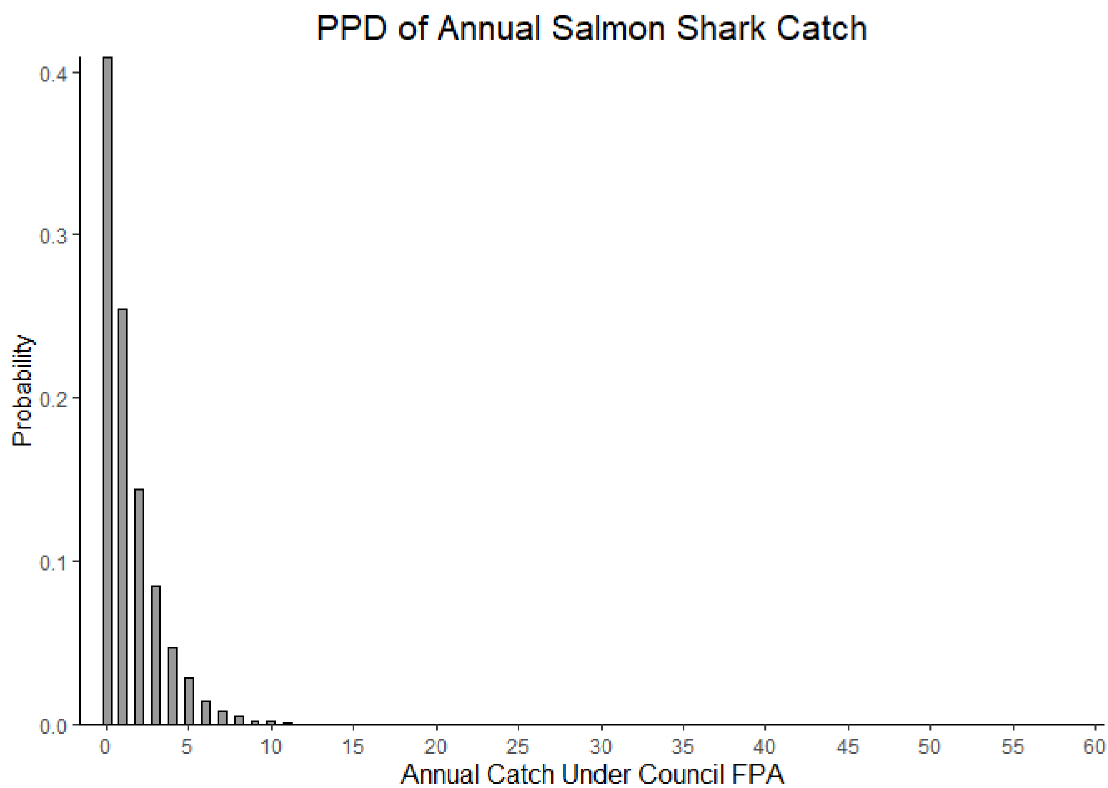
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00121*	
12 Year Ramp Up	Open Access	27	1	19	98	2
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	1
	LE 3.4	16	0	12	59	1
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0



Salmon shark (*Lamna ditropis*)

Table A-11. Salmon Shark Catch (in Number of Individuals) Under Each Alternative

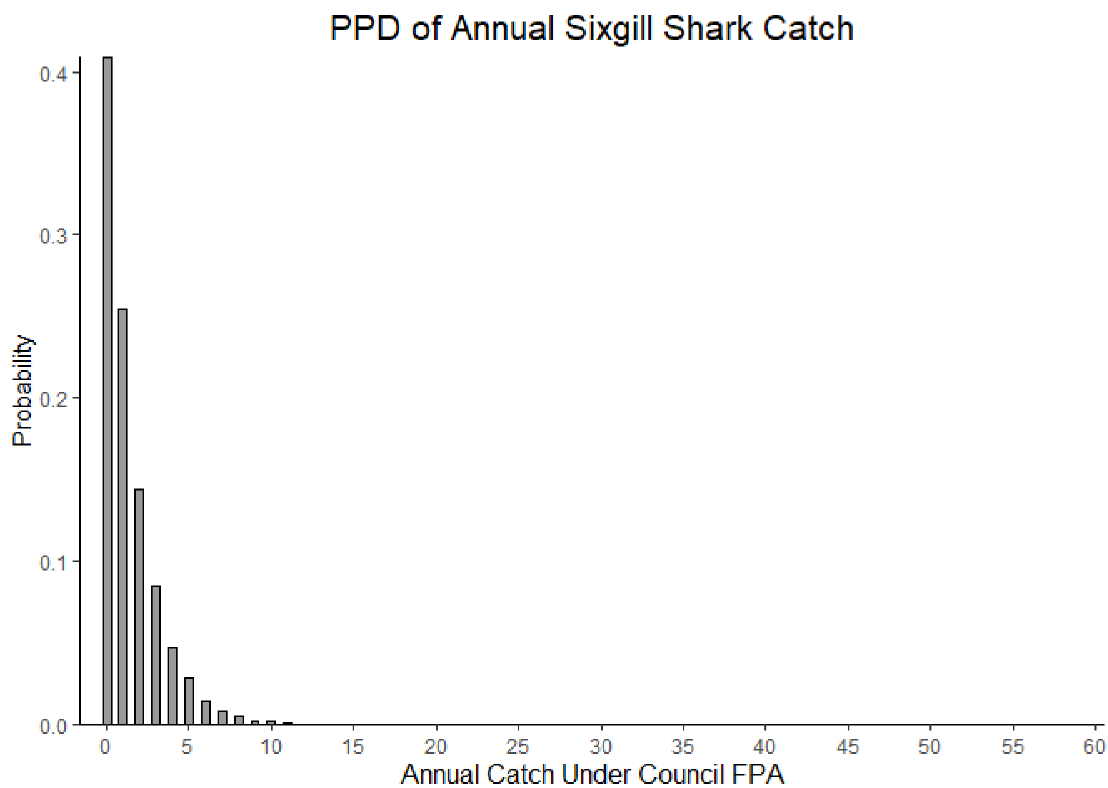
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	20	97	2
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0



Sixgill shark (*Hexanchus griseus*)

Table A-12. Sixgill Shark Catch (in Number of Individuals) Under Each Alternative

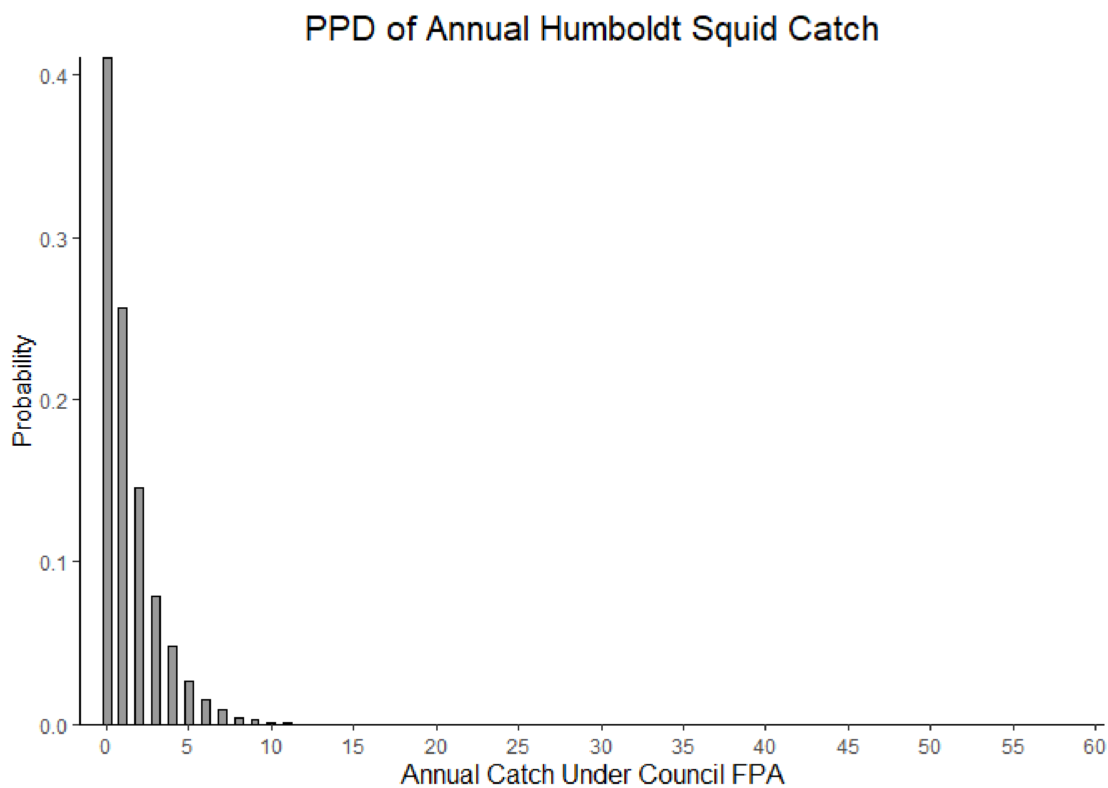
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	19	97	3
	LE 3.1	9	0	6	33	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	1
	LE 3.4	16	0	12	60	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0



Humboldt squid (*Dosidicus gigas*)

Table A-13. Humboldt Squid Catch (in Number of Individuals) Under Each Alternative

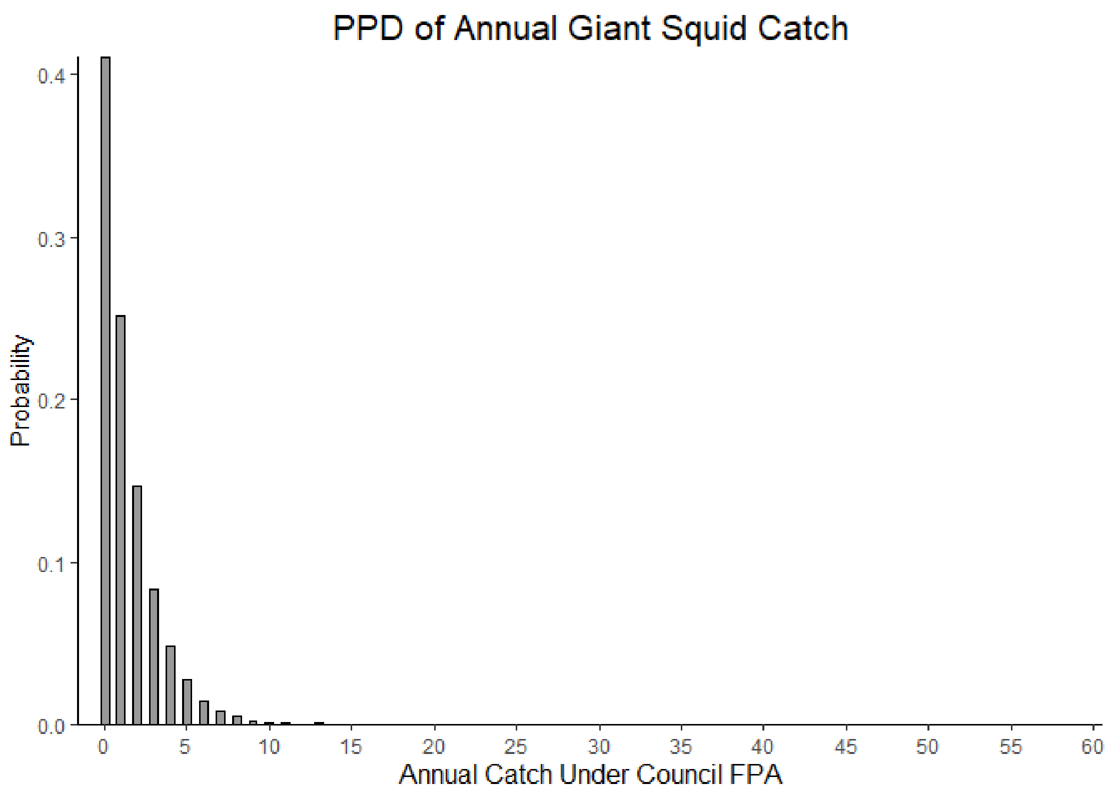
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	0	19	97	5
	LE 3.1	9	0	6	33	1
	LE 3.2	13	0	9	47	2
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0



Giant squid (*Architeuthis dux*)

Table A-14. Giant Squid Catch (in Number of Individuals) Under Each Alternative

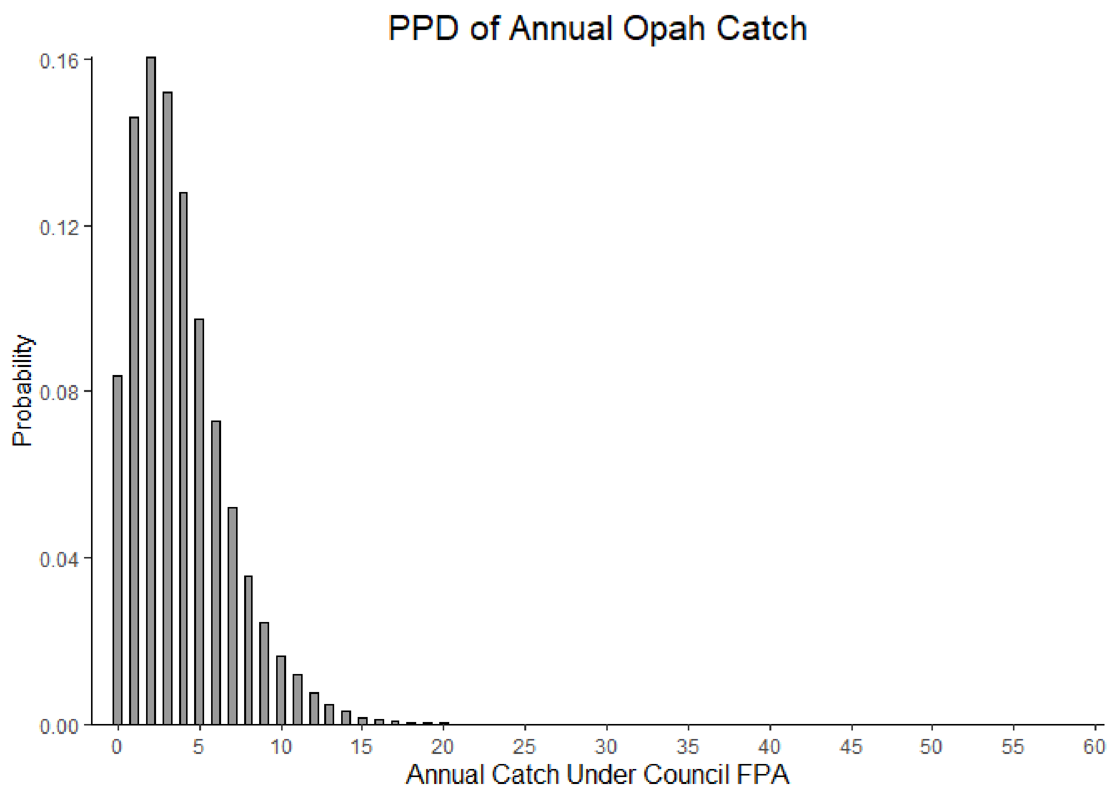
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00122*	
12 Year Ramp Up	Open Access	27	1	19	97	5
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	3
	LE 3.4	16	0	12	59	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0



Opah (*Lampris guttatus*)

Table A-15. Opah Catch (in Number of Individuals) Under Each Alternative

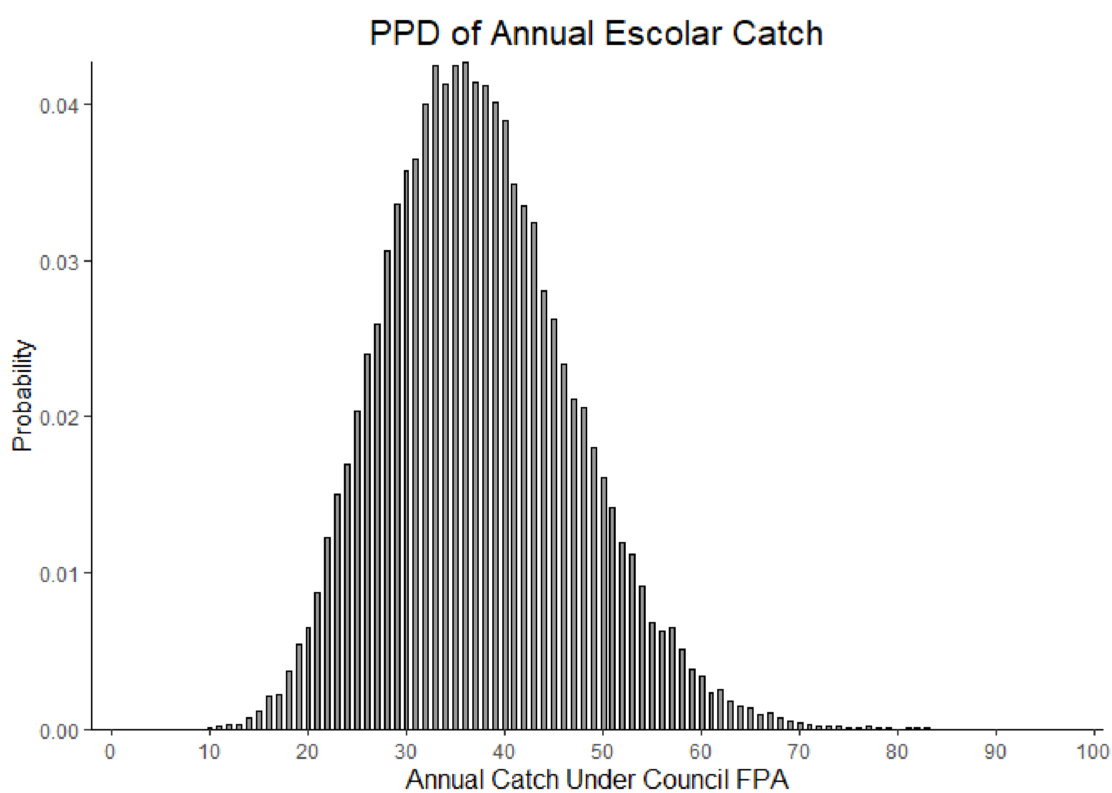
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00228*	
12 Year Ramp Up	Open Access	76	15	68	182	57
	LE 3.1	25	4	22	61	15
	LE 3.2	36	7	32	87	22
	LE 3.3	42	8	37	102	31
	LE 3.4	46	9	41	110	30
	LE 3.5	28	5	25	70	20
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2



Escolar (*Lepidocybium flavobrunneum*)

Table A-16. Escolar Catch (in Number of Individuals) Under Each Alternative

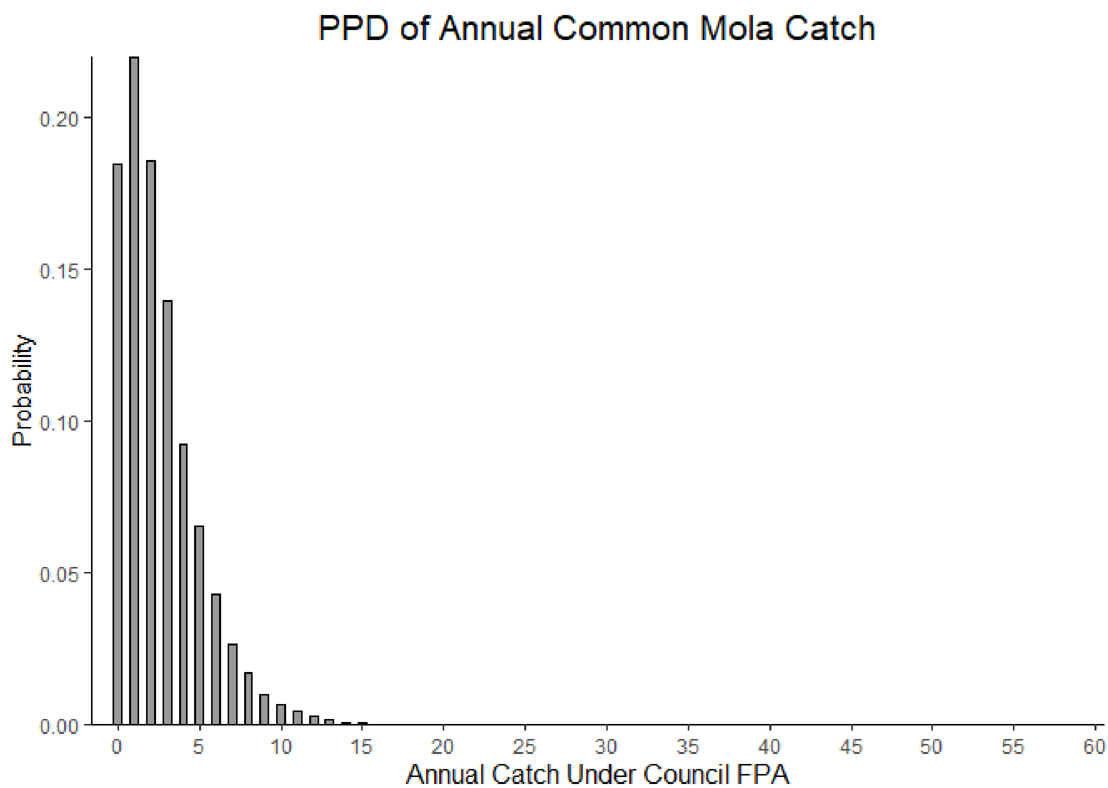
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00013*	*0.00009*	*0.00013*	*0.00018*	
	Per Day Fished	*0.00950*	*0.00647*	*0.00938*	*0.01312*	
12 Year Ramp Up	Open Access	748	504	740	1,041	710
	LE 3.1	243	160	240	343	235
	LE 3.2	355	236	351	498	320
	LE 3.3	411	275	406	576	392
	LE 3.4	449	300	444	629	444
	LE 3.5	277	183	274	390	263
Ongoing Annual	Open Access	62	37	61	93	60
	LE (All)	37	21	37	58	36



Common mola (*Mola mola*)

Table A-17. Common Mola Catch (in Number of Individuals) Under Each Alternative

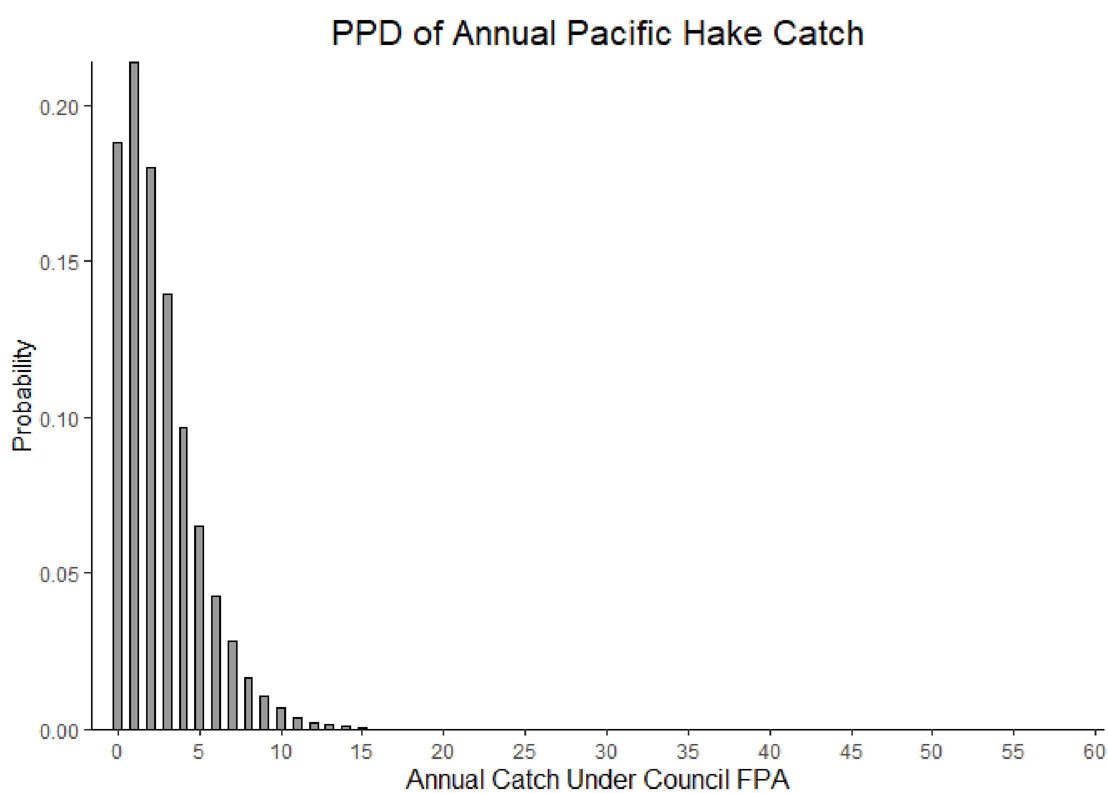
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00002*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00178*	
12 Year Ramp Up	Open Access	52	6	44	141	23
	LE 3.1	17	1	14	47	9
	LE 3.2	24	2	21	68	13
	LE 3.3	28	3	24	79	14
	LE 3.4	31	3	26	86	20
	LE 3.5	19	2	16	54	10
Ongoing Annual	Open Access	4	0	3	13	2
	LE (All)	3	0	2	9	1



Pacific Hake (*Merluccius productus*)

Table A-18. Pacific Hake Catch (in Number of Individuals) Under Each Alternative

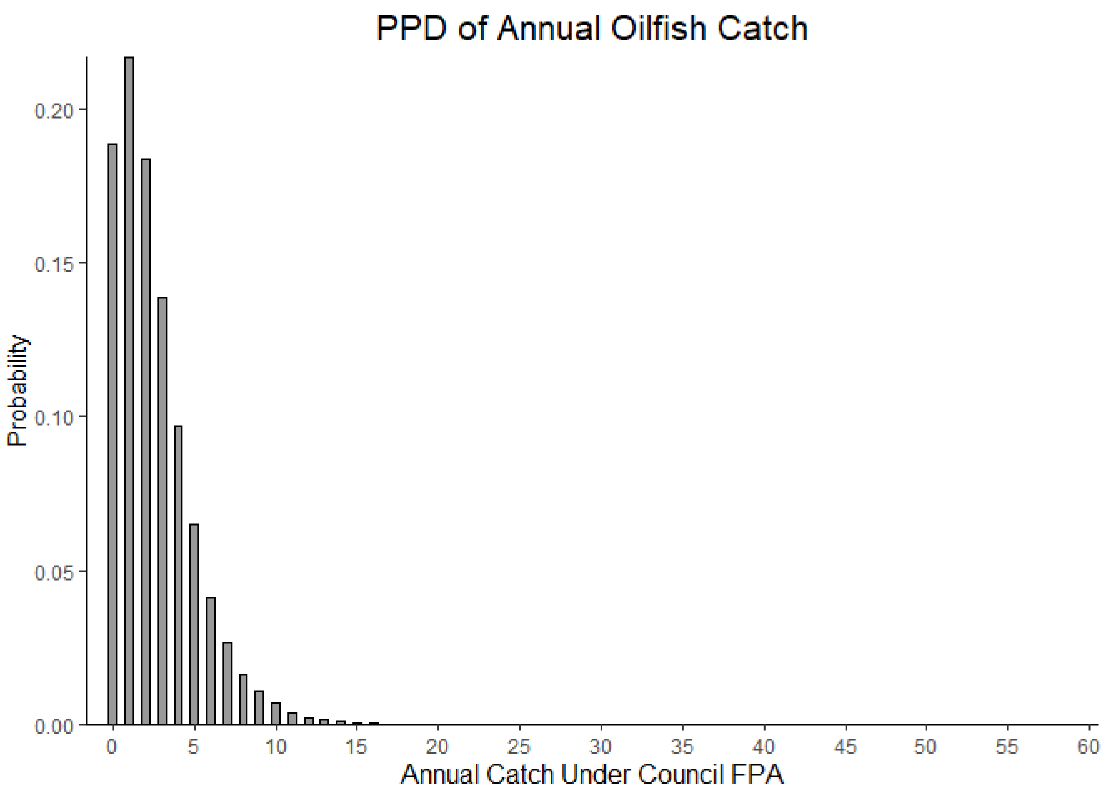
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00180*	
12 Year Ramp Up	Open Access	52	6	44	143	28
	LE 3.1	17	1	14	48	8
	LE 3.2	25	2	21	69	11
	LE 3.3	28	3	24	80	13
	LE 3.4	31	3	26	86	16
	LE 3.5	19	2	16	55	8
Ongoing Annual	Open Access	4	0	3	14	2
	LE (All)	3	0	2	9	1



Oilfish (*Ruvettus presiosus*)

Table A-19. Oilfish Catch (in Number of Individuals) Under Each Alternative

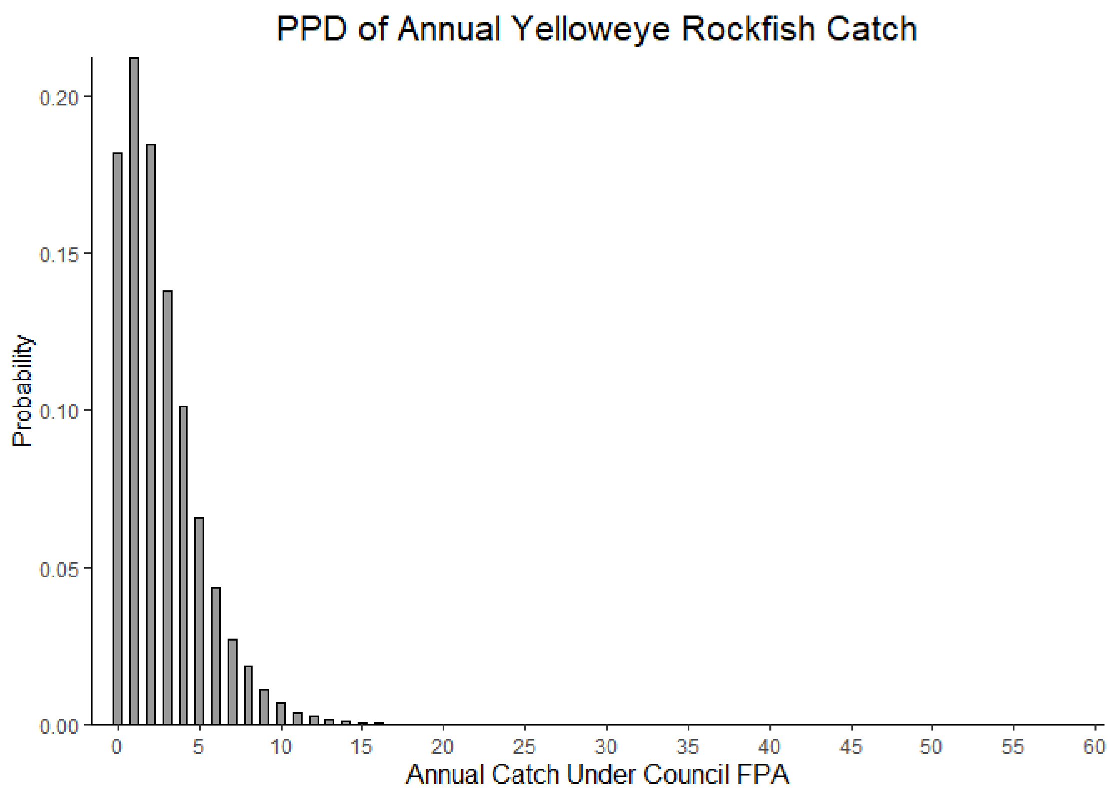
		Mean	CI 2.5%	Median	CI 97.5%	Mode
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00002*	
	Per Day Fished	*0.00065*	*0.00009*	*0.00055*	*0.00178*	
12 Year Ramp Up	Open Access	51	6	43	141	27
	LE 3.1	17	1	14	48	9
	LE 3.2	24	2	20	68	13
	LE 3.3	28	3	24	79	16
	LE 3.4	31	3	26	86	12
	LE 3.5	19	2	16	54	10
Ongoing Annual	Open Access	4	0	3	13	2
	LE (All)	3	0	2	9	1



Yelloweye rockfish (*Sebastes ruberrimus*)

Table A-21. Yelloweye Rockfish Catch (in Number of Individuals) Under Each Alternative

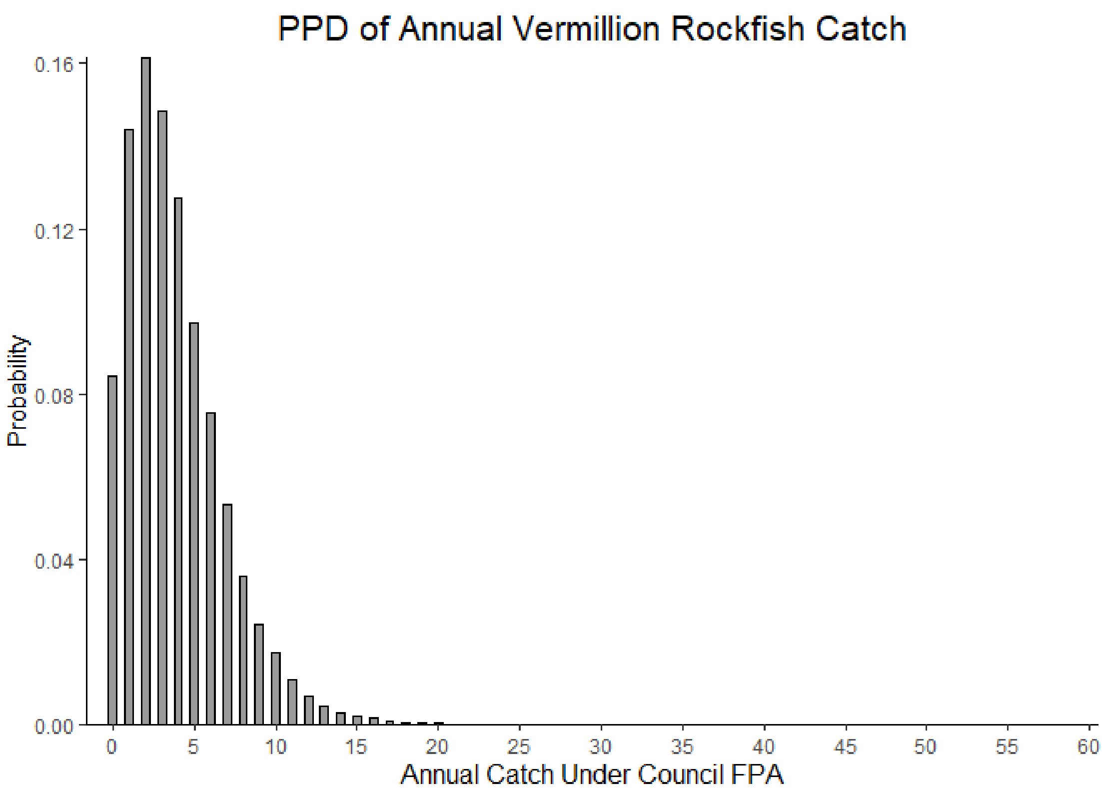
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00066*	*0.00009*	*0.00056*	*0.00179*	
12 Year Ramp Up	Open Access	52	6	44	143	21
	LE 3.1	17	1	14	47	9
	LE 3.2	25	3	21	69	13
	LE 3.3	29	3	24	79	18
	LE 3.4	31	3	26	86	17
	LE 3.5	19	2	16	54	9
Ongoing Annual	Open Access	4	0	4	14	2
	LE (All)	3	0	2	9	1



Vermilion rockfish (*Sebastes miniatus*)

Table A-22. Vermilion Rockfish Catch (in Number of Individuals) Under Each Alternative

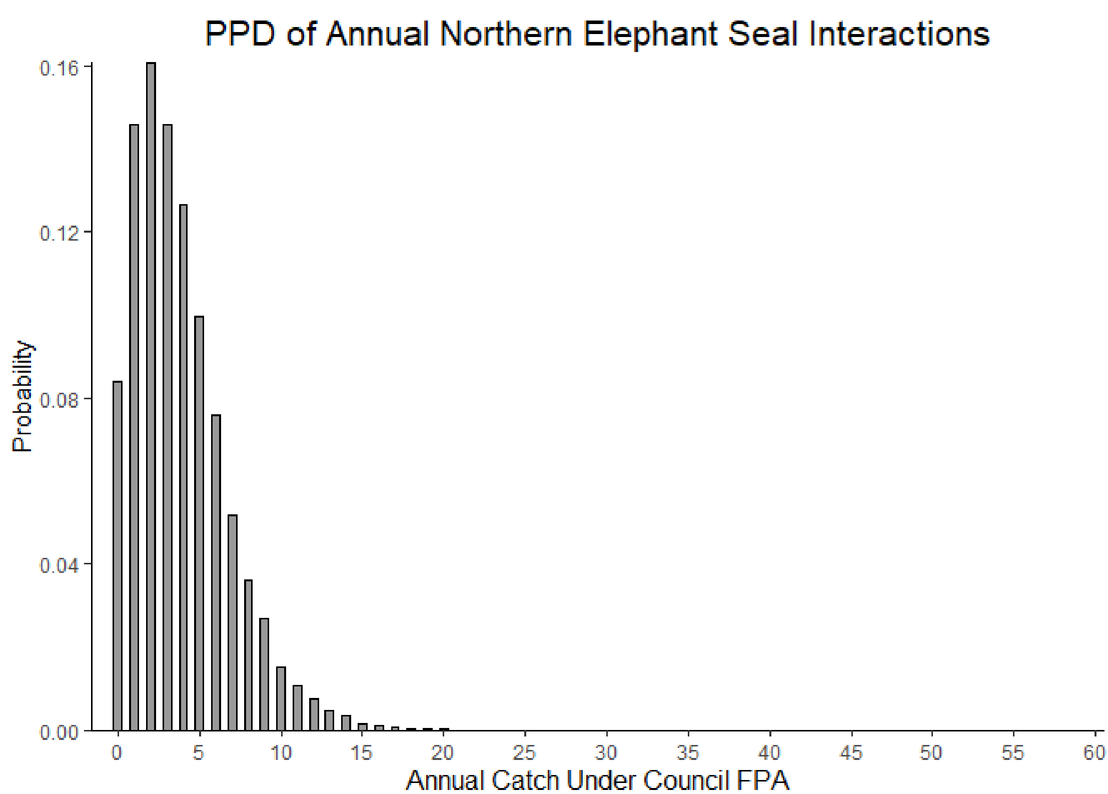
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00230*	
12 Year Ramp Up	Open Access	76	15	68	184	46
	LE 3.1	25	4	22	61	13
	LE 3.2	36	7	32	89	27
	LE 3.3	42	8	37	102	32
	LE 3.4	46	9	41	111	29
	LE 3.5	28	5	25	70	21
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2



Northern elephant seal (*Mirounga angustirostris*)

Table A-23. Northern Elephant Seal Interactions (in Number of Individuals) Under Alternative 3

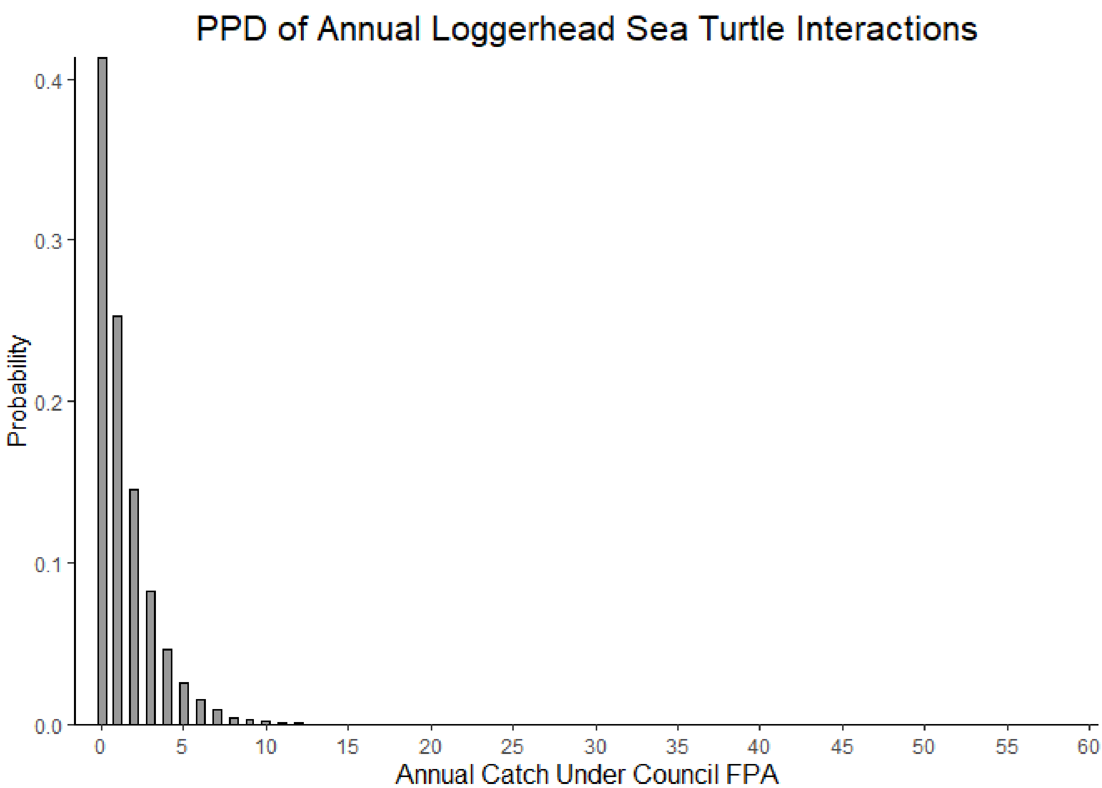
		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00001*	*0.00000*	*0.00001*	*0.00003*	
	Per Day Fished	*0.00096*	*0.00021*	*0.00086*	*0.00232*	
12 Year Ramp Up	Open Access	76	15	68	184	50
	LE 3.1	25	4	22	61	15
	LE 3.2	36	7	32	88	25
	LE 3.3	42	8	37	102	31
	LE 3.4	46	8	41	112	33
	LE 3.5	28	5	25	70	18
Ongoing Annual	Open Access	6	0	6	17	4
	LE (All)	4	0	3	11	2



Loggerhead sea turtle (*Caretta caretta*)—North Pacific Ocean DPS

Table A-24. Loggerhead Sea Turtle Catch (in Number of Individuals) Under Each Alternative

		Mean	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
CPUE	*Per Buoy Hour*	*0.00000*	*0.00000*	*0.00000*	*0.00002*	
	Per Day Fished	*0.00034*	*0.00001*	*0.00025*	*0.00121*	
12 Year Ramp Up	Open Access	27	0	19	97	5
	LE 3.1	9	0	6	32	1
	LE 3.2	13	0	9	47	1
	LE 3.3	15	0	11	54	2
	LE 3.4	16	0	12	58	2
	LE 3.5	10	0	7	37	1
Ongoing Annual	Open Access	2	0	1	9	0
	LE (All)	1	0	1	6	0



Sensitivity Analysis and Alternative Model Specifications

A preliminary draft of the above analysis was reviewed by the PFMC's Scientific and Statistical Committee (SSC) during the June 2019 PFMC meeting. Following this review, the SSC noted five main comments on the approach used for analyzing biological impacts of DSBG authorization:

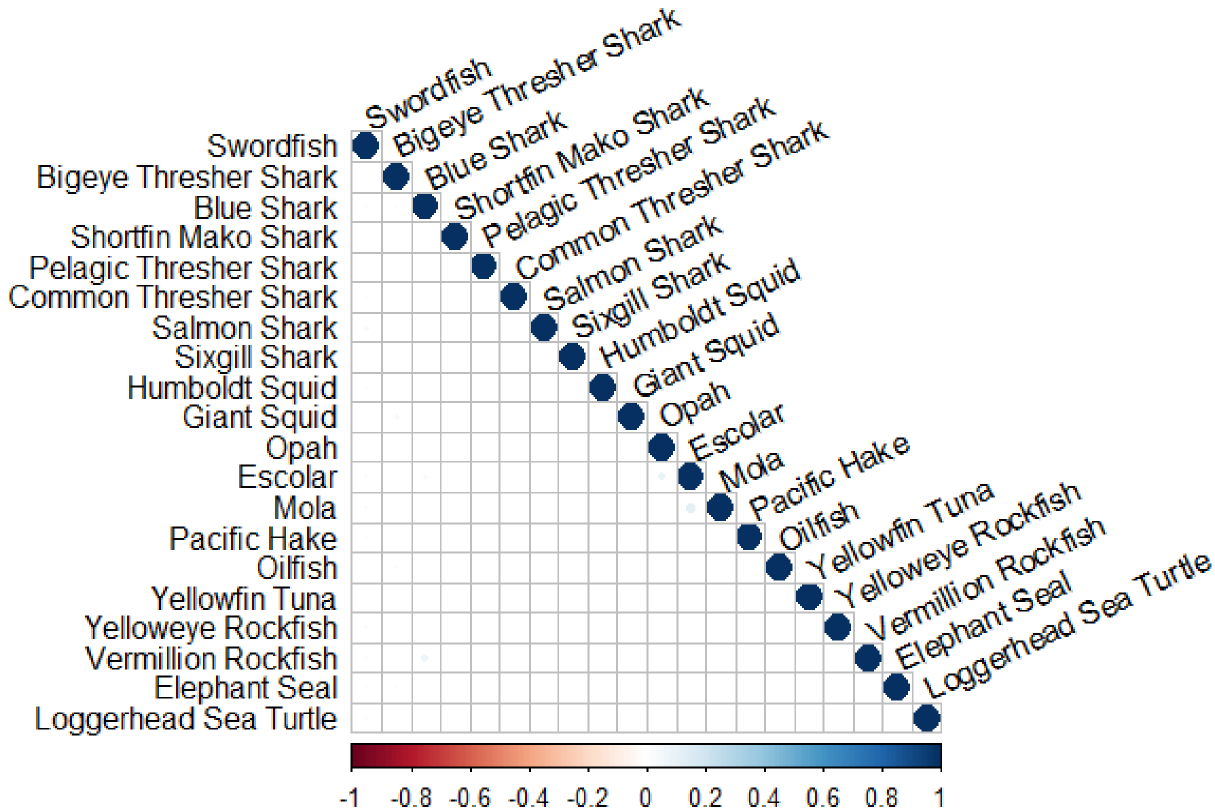
- The underlying Poisson probability model assumes that catch events are fully independent, which would not be the case for species that tend to occur in aggregations.
- Although the report provided predictions from the Bayesian analysis, it did not include fits to the observed data or diagnostics to support the assumed probability model.
- Predictions from the model may not apply in the future if there are changes in fishing behavior.
- The current analysis makes rigid assumptions about fishing effort (Table 3). If these assumptions were represented as probability distributions, uncertainty regarding future effort could be incorporated into the resulting model predictions.
- Data from observed sets of linked buoy gear, which have not yet been analyzed, may be limited and have characteristics that are different from the standard DSBG. It is not clear how best to analyze data from linked buoy gear, e.g., whether or not to pool it with standard DSBG.

The following section addresses these issues in detail, in the order specified above.

Independence of Catch Events

The methodology employed for the biological analysis assumes that catch events are independent; i.e., we assume that catching one species on a given day does not affect the likelihood of catching another species. The SSC notes that some species may occur in aggregations, which calls this assumption into question. To examine this, we calculated a correlation matrix showing the strength of relationships between catch rates of various species in our analytical dataset, at the day fished level. Figure 1 provides a visual representation of the correlation matrix.

Figure A-1. Correlation Matrix of DSBG Catch Data



Based on this correlation matrix, we believe we can conduct our analysis of catch rates on the assumption that catch of any one species does not influence catch of another species within a given day of fishing. The only nonzero correlations are between escolar and mola (on one of the 3,258 days of fishing in our dataset, an escolar and a mola were caught in the same day), and between escolar and opah (on one of the 3,258 days of fishing in our dataset, an escolar and an opah were caught in the same day). Otherwise, the data do not suggest that catching one species on a given day is positively or negatively associated with catching any other species.

We note that this does not account for possible significant relationships between catch rates across vessels or within species over time. However, most of these species are uncommonly caught in DSBG, and only 8 percent of days fished in our dataset had multiple species observed caught. Therefore, we consider it appropriate to assume catch is independent between species for the purposes of our analysis.

Model Fit Diagnostics and Posterior Predictive Checks

The biological analysis presented to the SSC in June 2019 assumed a Poisson distribution as the underlying probability model used to estimate the posterior distribution of catch rates for each species. The SSC noted that this model may not be the best fit for all species and suggested that NMFS more thoroughly evaluate the fit of the assumed model to the observed data. To accomplish this, we repeated our analysis using three probability models: Poisson, Zero-inflated Poisson, and negative binomial. These models are theoretically appropriate for non-negative count data and have been used in published research estimating catch rates in other fisheries (Moore & Curtis 2016, Martin et al. 2015).

For all three probability models, we apply the same Bayesian statistical methodology. We estimate the posterior distribution of the catch rate parameter for each species at the day fished level, controlling for the variation in buoy-hours from day to day and for gear type. We fit each model using Hamiltonian Markov Chain Monte Carlo sampling and an uninformative prior, as described in Martin et al. (2015).

After estimating the posterior distribution of the catch rate parameter using each of these models, we compare their fit to the observed data using posterior predictive checks (PPCs). These PPCs compare the estimated posterior distribution of catch rates to the distribution of catch rates in the observed data. We employ three types of PPC for each species and model: a visual comparison of distribution of the observed data to 50 simulated datasets sampled from the conditional likelihood function, a histogram comparing the observed distribution to 5 histograms of simulated datasets, and a histogram of the proportion of zeros in 50 simulated distributions compared with the proportion of zeros in the observed dataset. We also perform a simple calculation of the proportion of zeros in the simulated distributions to the proportion of zeros in the observed data, to evaluate whether our simulated posterior distribution is over- or under-estimating the amount of days fished with zero catch.

As an example, we show our PPCs for three models of swordfish catch in a series of charts below. For each model, the first chart compares the observed distribution (y) to 50 simulated distributions drawn from the conditional likelihood function (y_{rep}). The second chart compares a histogram of the observed distribution (y) to five histograms drawn from the conditional likelihood function (y_{rep}). The third chart compares the proportion of zeros in 50 simulated distributions to with the proportion of zeros in the observed dataset.

Poisson Model

Our Poisson model of catch per day has the following functional form:

$$f\,(y_i \mid \lambda_i) = \text{Poisson}(x_i\, \lambda_i)$$

$$\text{where } \ln(\lambda_i) = \beta_1 + \beta_2 g_i$$

In this model, y_i is the number of takes, λ_i is the per-buoy-hour take rate parameter, and x_i is the number of buoy-hours on day *i*. The per-buoy-hour take rate parameter, λ_i, includes a base level parameter β_1 to model the standard buoy gear per-buoy-hour take rate plus an offset β_2 multiplied by an indicator variable for linked buoy gear (g_i = 0 for SBG, = 1 for LBG), to model the difference between LBG and SBG take rates. We use a weakly informative normal prior on both the catch rate parameter and the gear type parameter. Figure A-2 shows the PPCs comparing datasets simulated using this model with the observed data.

Figure A-2. PPCs for Poisson Model of Swordfish Catch

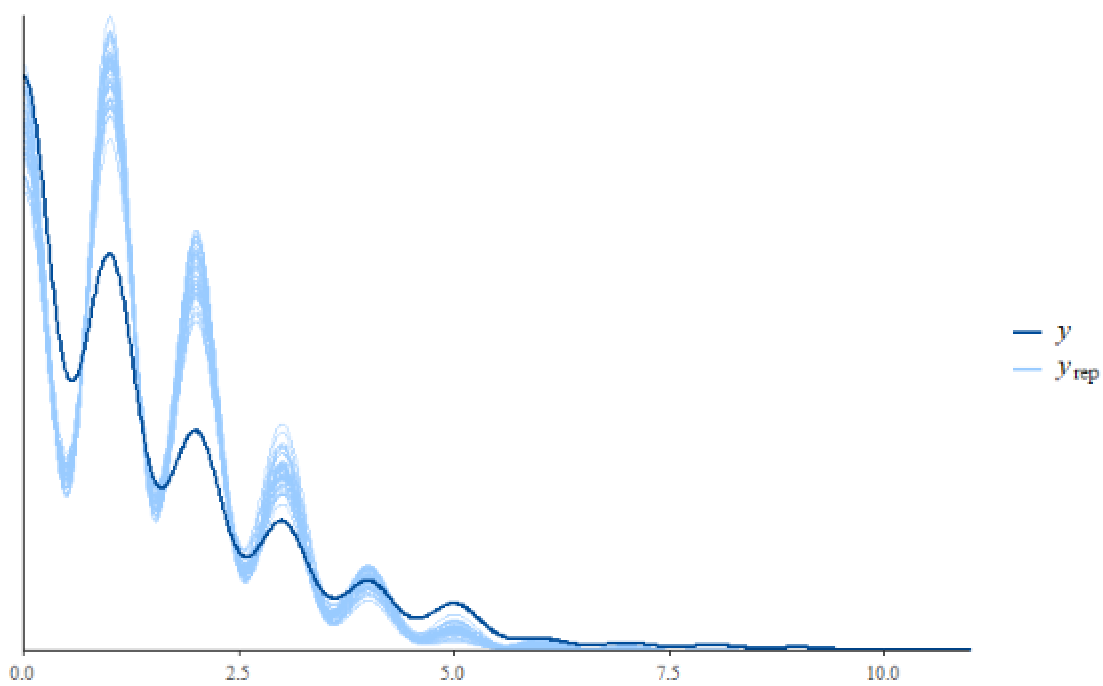
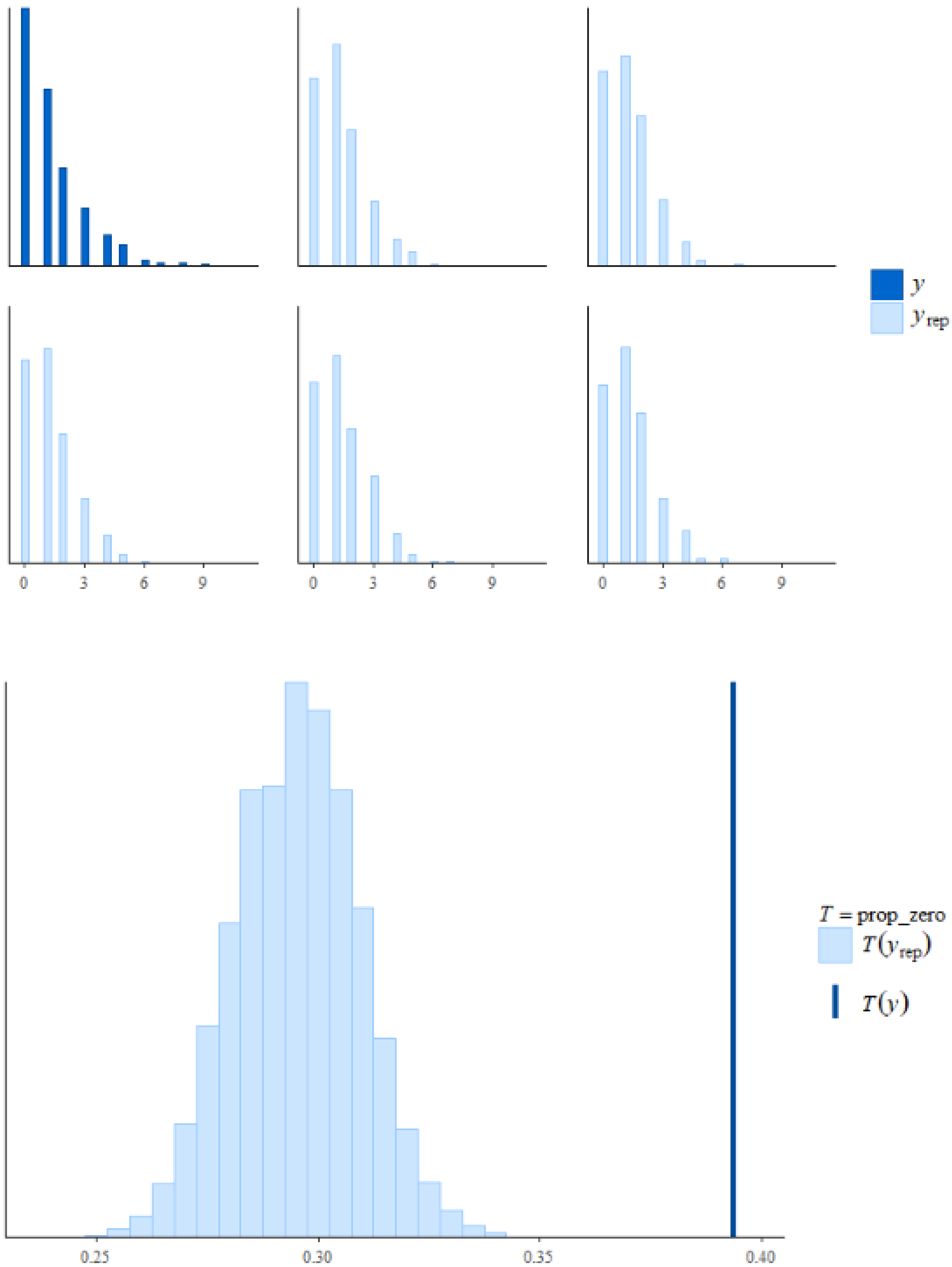


Figure A-2 (continued). PPCs for Poisson Model of Swordfish Catch



Based on these PPCs, it appears that the Poisson likelihood results in a conditional likelihood which underestimates the proportion of days fished with positive (nonzero) catch counts. The simulated datasets have a higher proportion of days fished with a catch count of 1, 2, or 3 compared to the observed data.

Zero-inflated Poisson

Our zero-inflated Poisson model has the following functional form:

$$g\ (y_i \mid \lambda_i) = p\ \mathit{Poisson}(x_i\ \lambda_i) + (1\text{-}p)\ 0$$
$$\text{where } \ln(\lambda_i) = \beta_1 + \beta_2 g_i$$

This is an extension of the standard Poisson likelihood function, with an added parameter p to introduce a degree of zero-inflation. This assumes two separate processes determining the catch rate, such that some portion p of days fished has no potential positive catch (e.g., due to the absence of target species in the area fished) and the remaining portion 1- p has a nonzero probability of positive catch. We again use a weakly informative normal prior on both the catch rate and gear type parameters. Figure A-3 shows the PPCs comparing datasets simulated using this model with the observed data.

Figure A-3. PPCs for Zero-Inflated Poisson Model of Swordfish Catch

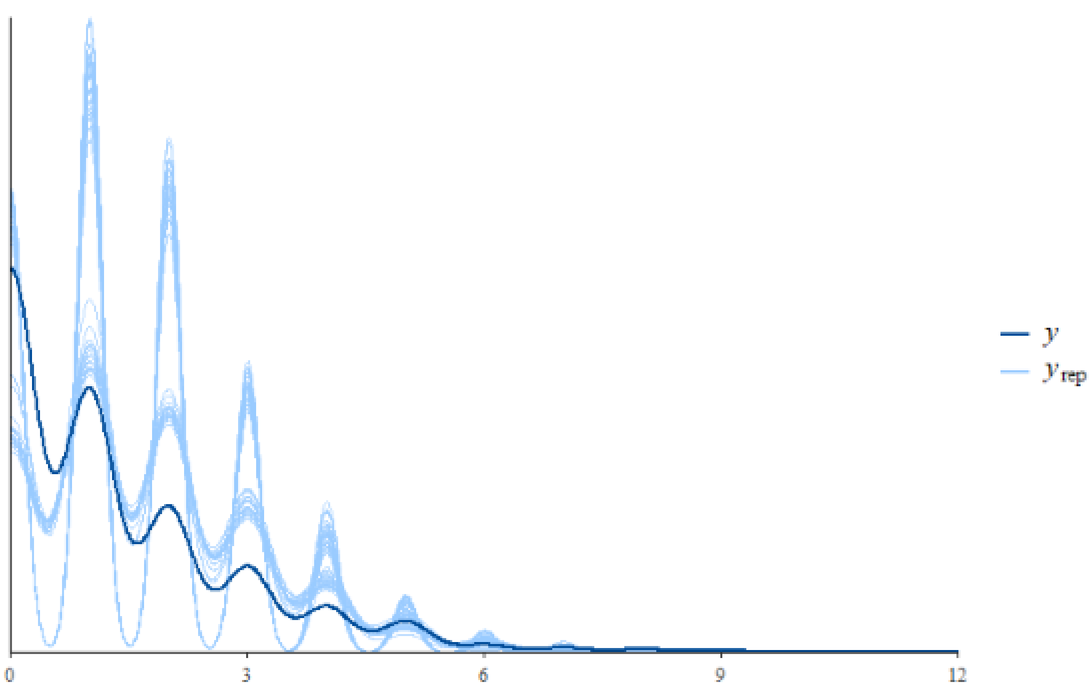
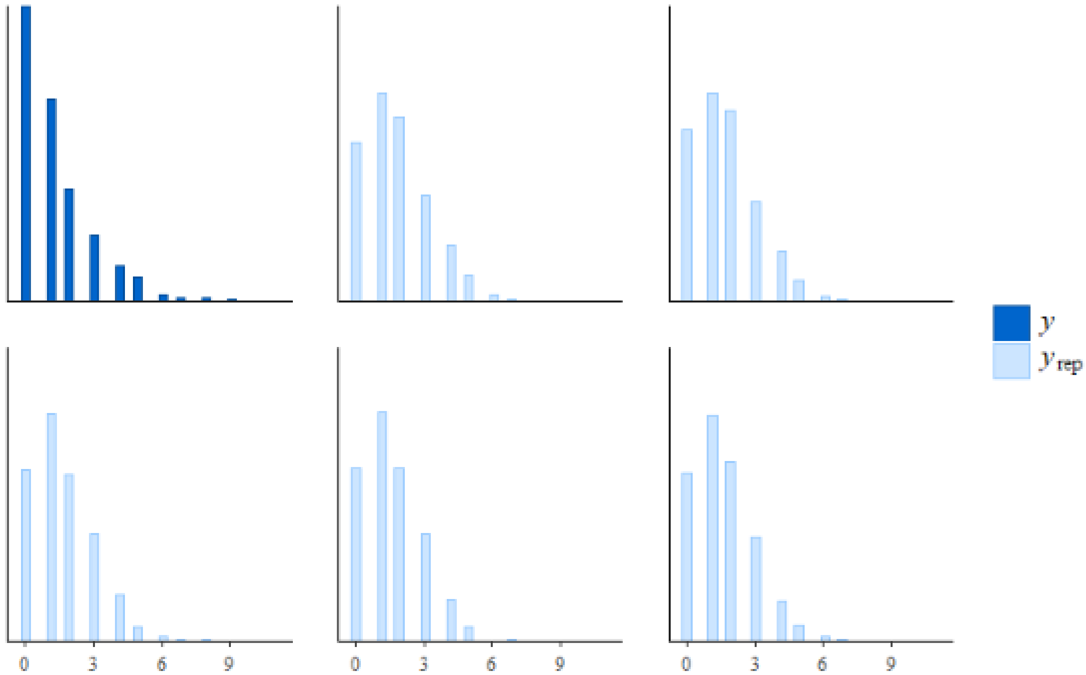
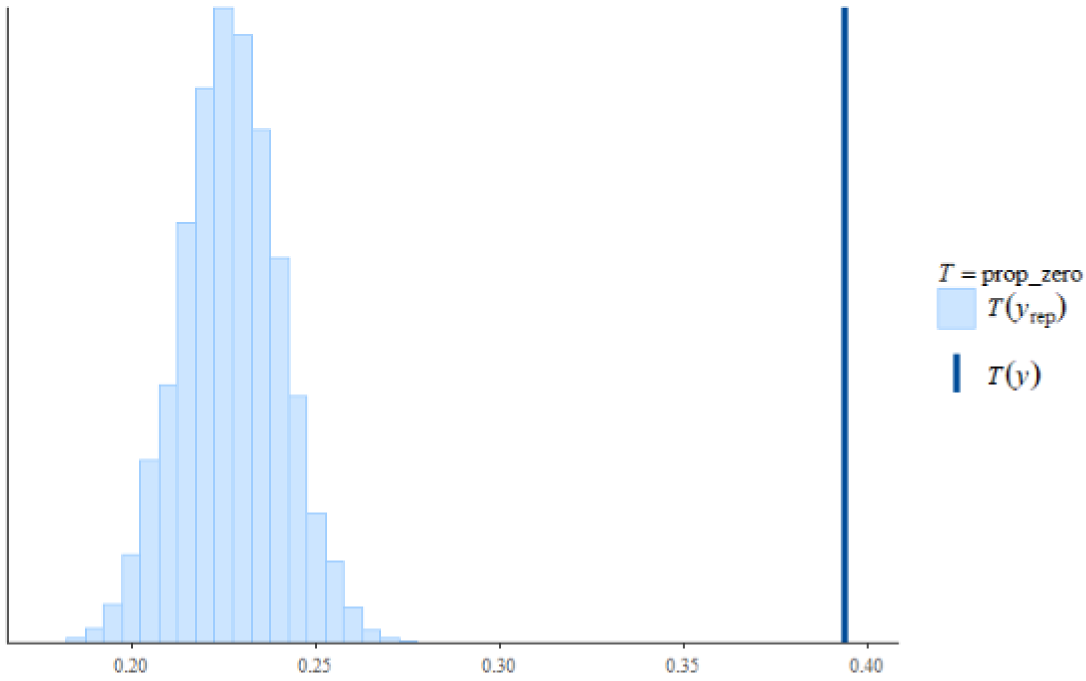


Figure A-3 (continued). PPCs for Zero-Inflated Poisson Model of Swordfish Catch





These PPCs indicate that the zero-inflated Poisson model also underestimates the proportion of days fished with zero catch relative to the observed data. It also seems to produce less regular simulated datasets than the Poisson model, which may negatively impact its ability to predict the number of takes.

Negative binomial

The negative binomial model used in our analysis has the following functional form:

$$h\ (y_i \mid \mu_{i,}\ \phi) = \mathit{Neg\text{-}bin}(x_i\ \mu_{i,}\ \phi)$$
$$\text{where } \ln(\mu_i) = \beta_1 + \beta_2 g_i$$

This likelihood function can be viewed as a generalization of the Poisson likelihood, with mean μ_i and variance $\mu_i + \mu_i{}^2/\phi$. This relaxes the Poisson assumption that the mean is equal to the variance by including an additional dispersion parameter, ϕ; for sufficiently large values of ϕ, the right term in the expression for the variance approaches 0, and the model effectively reduces to Poisson. The Poisson assumption is violated for the two commonly caught species in our analysis, swordfish and bigeye thresher shark, both of which have a variance higher than their mean. We use a weakly informative normal prior on both the (logged) catch rate parameter and the gear type parameter, and add an uninformative normal prior on the dispersion parameter.

Figure A-4 shows the PPCs comparing datasets simulated using this model with the observed data.

Figure A-4. PPCs for Negative Binomial Model of Swordfish Catch

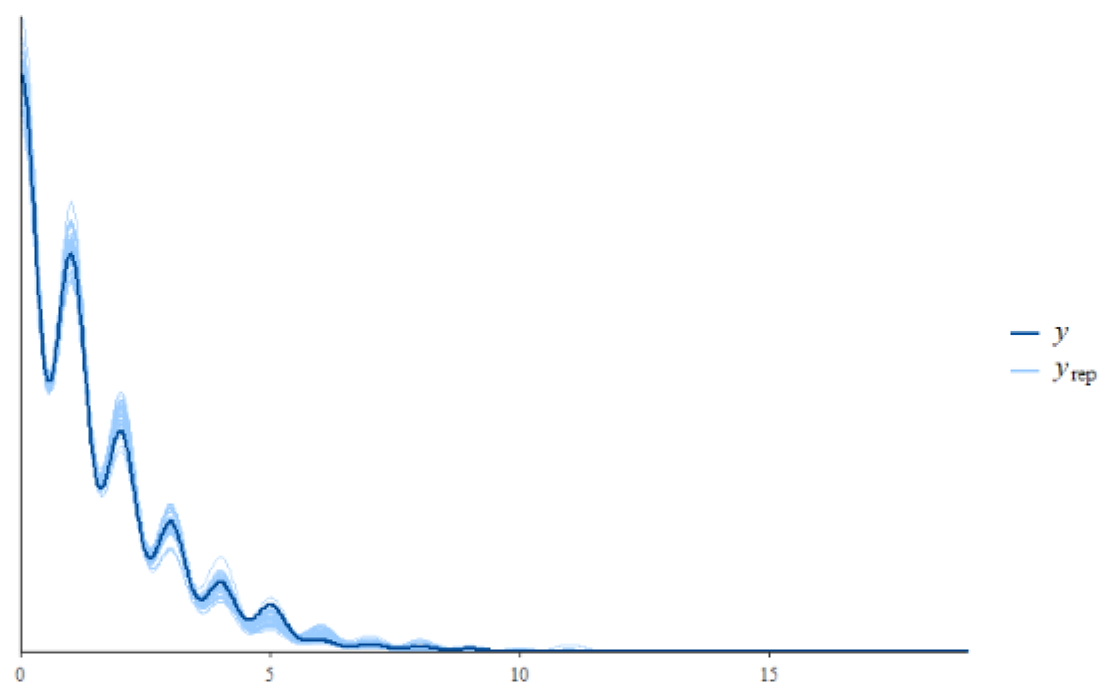
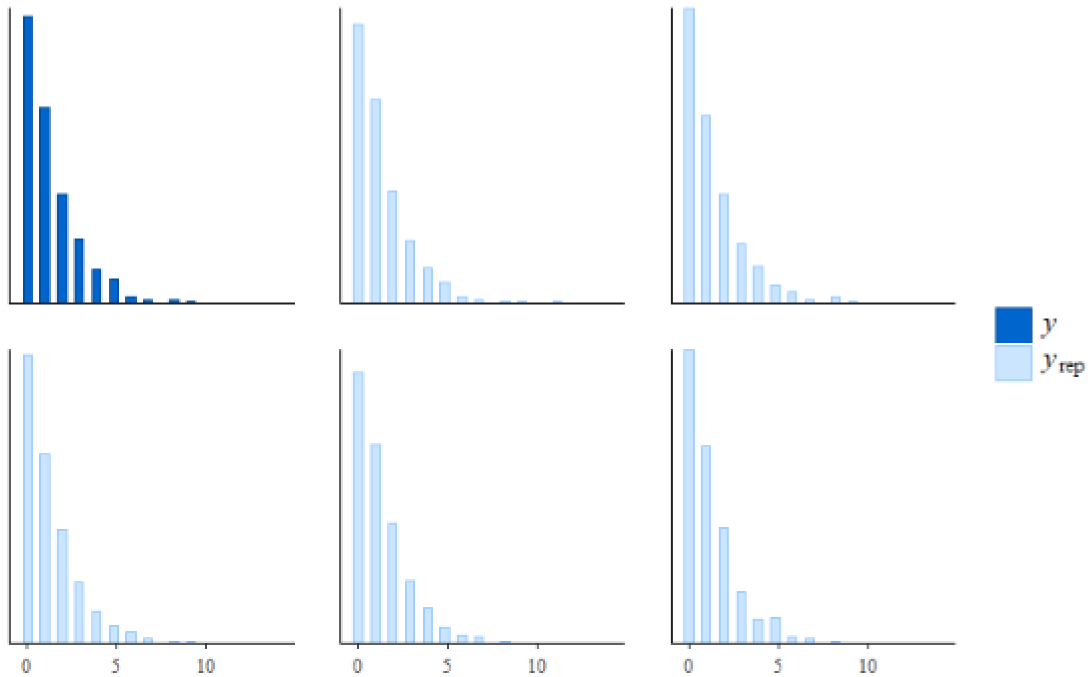
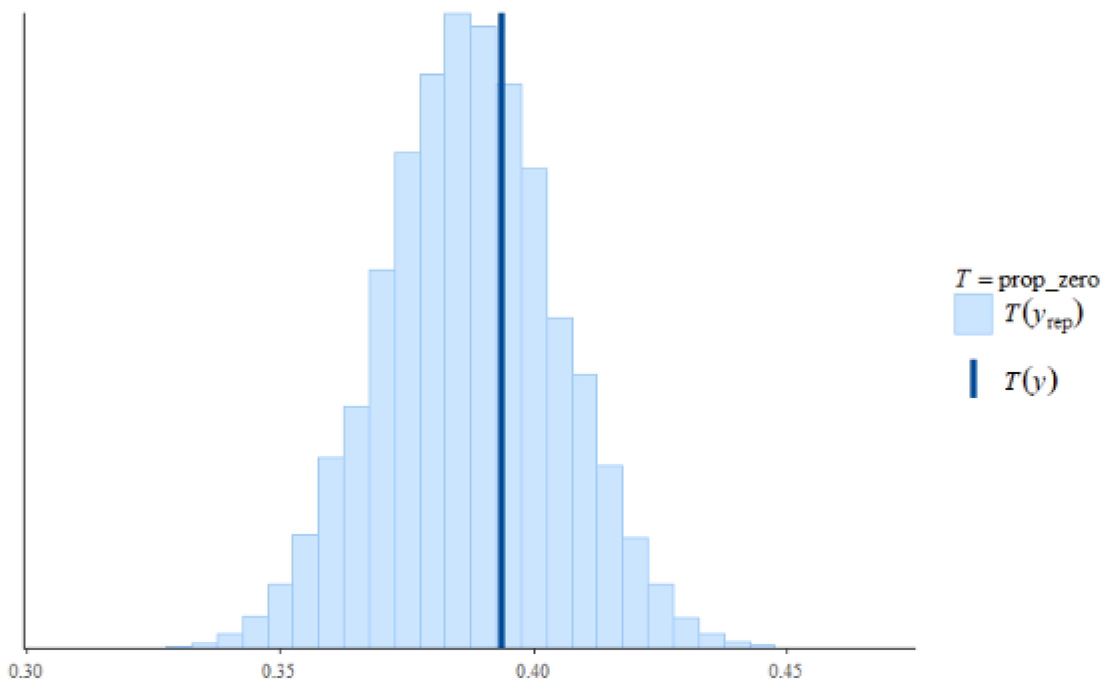


Figure A-4 (continued). PPCs for Negative Binomial Model of Swordfish Catch

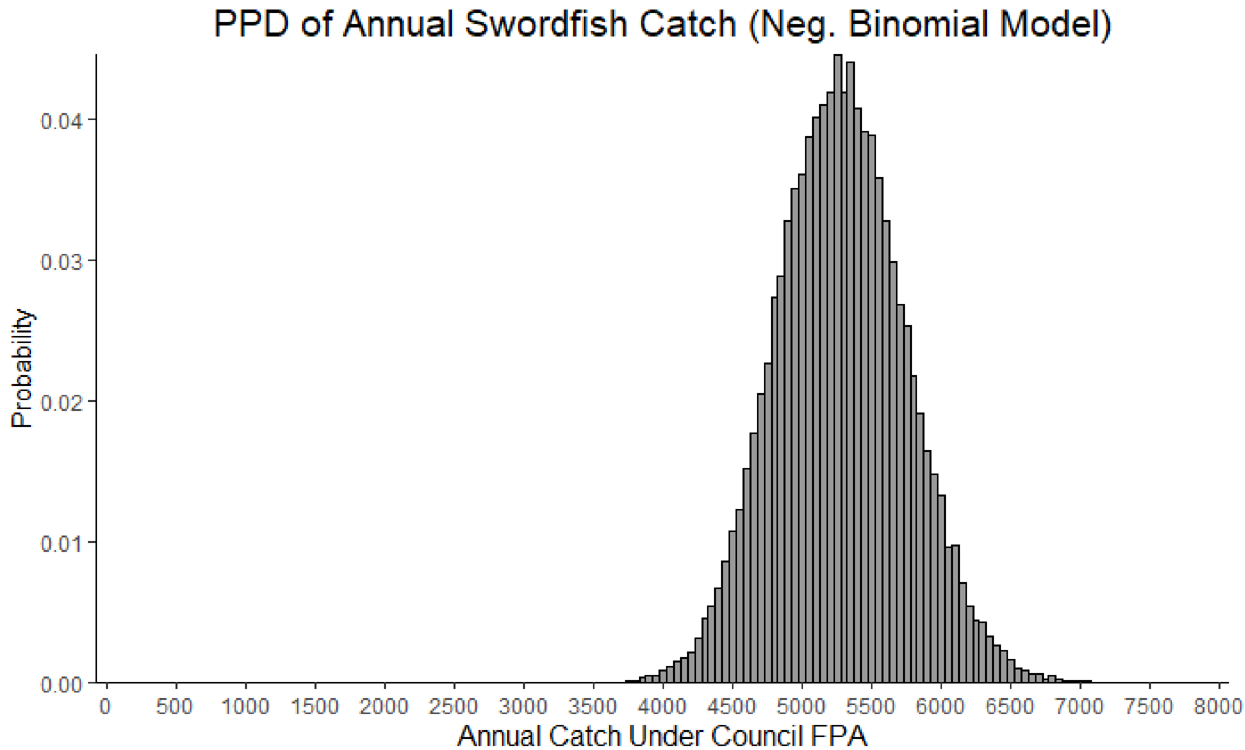




Based on these PPCs, the negative binomial model appears to produce simulated datasets that very closely fit the observed data. Additionally, the proportion of zeros in the observed data falls near the median of a histogram of the proportion of zeros in 50 simulated datasets from the negative binomial model.

After comparing these models using the above PPCs, we find the negative binomial model to be the best fit for the observed data of swordfish catch. Because we had initially selected a Poisson model to generate the predictions, we simulate draws from the negative binomial model to calculate a PPD for the Council's final preferred alternative, using the same effort assumptions used with the Poisson model. Figure A-5 compares this PPD with the PPD derived using the Poisson model.

Figure A-5. Comparison of Swordfish Catch PPDs from Two Likelihood Models



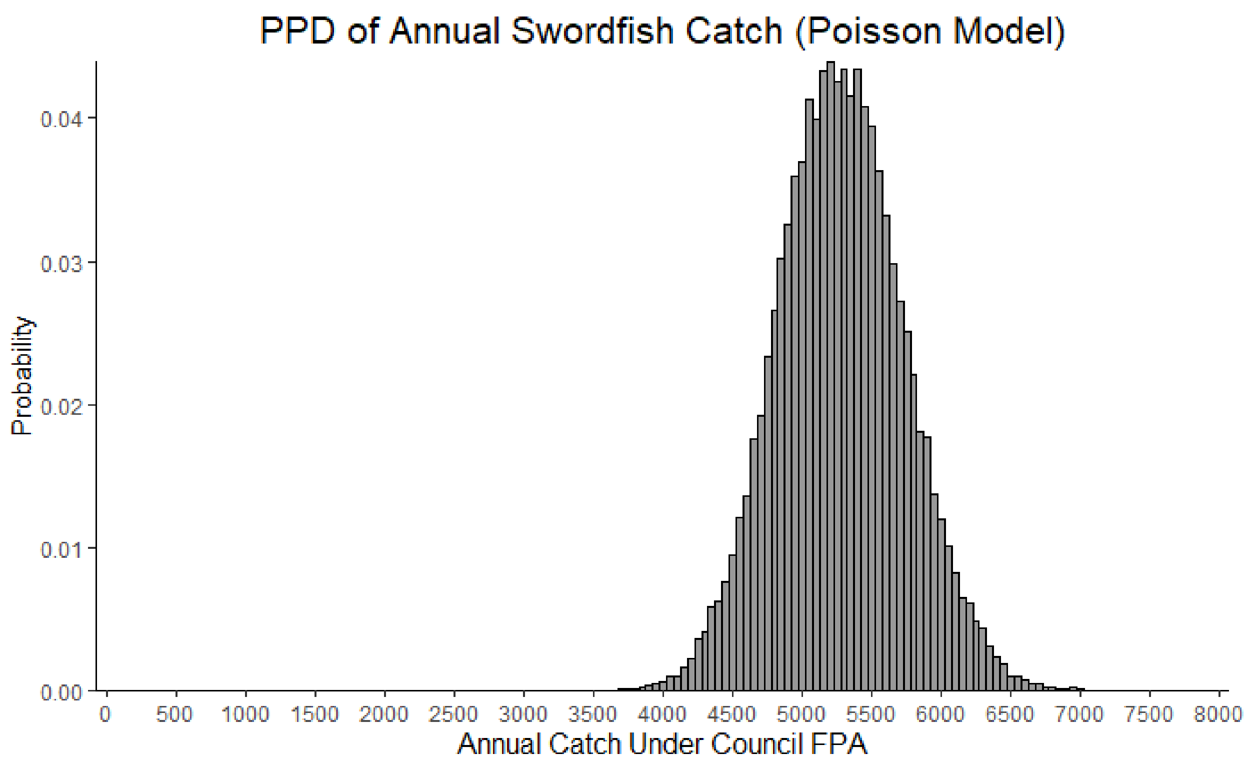


Table A-25 below compares summary statistics for the PPDs produced by the two models. The mean is the average of the PPD, the median is the point between the highest and lowest values, and the mode is the most likely value. The range of the 95% credible interval (CI) is also reported.

Table A-25. Comparison of Swordfish Catch PPDs from Two Likelihood Models

Model	**Mean**	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
Neg. Binomial	4,539	3,752	4,528	5,400	4,680
Poisson	4,559	3,774	4,549	5,405	4,599

As shown in Figure A-5, the Poisson and negative binomial models produce similar posterior predictive distributions for swordfish. Overall this sensitivity analysis indicates that the negative binomial is a better fit for the source data than the Poisson though both approaches produce similar results.

We applied the same PPC approach to models for all species included in our biological analysis (i.e., all species which have been caught to date in DSBG EFP fishing). For the sake of brevity we do not reproduce the above charts for all species; however, one metric which allows for quick and easy model comparison is the proportion of zeros in model-simulated data versus the observed data. If the data simulated by drawing from a given model have a lower proportion of zeros than the observed data, the model may overestimate potential catch rates. Conversely, if simulated data have a higher proportion of zeros, the model may underestimate catch rates. Table A-26 shows the percentage of zero-catch observations in 50 simulated datasets from each model with the observed percentage of zero-catch observations. For each species, the model with the closest percentage of zeros to the observed data is highlighted.

For uncommonly-caught species (i.e., species besides swordfish and bigeye thresher shark), the negative binomial failed to converge, even at very high levels of sampling iterations (i.e., our Hamiltonian Monte Carlo procedure produced too many poorly fitted values). This implies that the negative binomial model as specified above is overparameterized for rare event catch species with a high number of zeros and very infrequent single-catch events. Additionally, we note that the zero-inflated Poisson model is weakly identified for species with a distribution of catch counts spanning 0 and 1 individuals per day only (i.e., there is insufficient variation in the data to fit a multilevel model with one level corresponding to whether catch occurred and a second level corresponding to the amount of catch).

Table A-26. PPC Summaries for All Species

Species	% Zeros (Source Data)	% Zeros (Poisson)	% Zeros (Zero-Inflated Poisson)	% Zeros (Neg. Binomial)
Swordfish	0.3937409	0.2940466	0.2269476	0.3874294
Bigeye Thresher Shark	0.8973799	0.8687191	0.5586690	0.8968138
Blue Shark	0.9919942	0.9924745	Unidentified	No Convergence
Shortfin Mako Shark	0.9978166	0.9974381	Unidentified	No Convergence
Pelagic Thresher Shark	0.9990143	0.9982387	Unidentified	No Convergence
Common Thresher Shark	0.9995071	0.9992431	Unidentified	No Convergence
Salmon Shark	0.9995071	0.9994480	Unidentified	No Convergence
Sixgill Shark	0.9995071	0.9995761	Unidentified	No Convergence
Humboldt Squid	0.9995071	0.9991703	Unidentified	No Convergence
Giant Squid	0.9995071	0.9990975	Unidentified	No Convergence
Opah	0.9985214	0.9982678	Unidentified	No Convergence
Escolar	0.9876787	0.9889083	Unidentified	No Convergence
Common Mola	0.9990143	0.9993013	Unidentified	No Convergence
Pacific Hake	0.9995071	0.9993593	Unidentified	No Convergence
Oilfish	0.9995071	0.9990728	Unidentified	No Convergence
Yellowfin Tuna	0.9995071	0.9990345	Unidentified	No Convergence
Vermilion Rockfish	0.9990143	0.9989354	Unidentified	No Convergence
Yelloweye Rockfish	0.9995071	0.9994905	Unidentified	No Convergence
Northern Elephant Seal	0.9985444	0.9980932	Unidentified	No Convergence
Loggerhead Sea Turtle	0.9995071	0.9993450	Unidentified	No Convergence

Changes in Fishing Behavior

NMFS agrees that this analysis may not apply to a future DSBG fleet if the behavior of participating fishermen changes over time. For example, there may be differences in the cost of fishing, including opportunity costs, which influence the decision to fish; or in selection of gear type (i.e., SBG or LBG); or

in fisher experience resulting in differences in catch composition. While our analysis does help to quantify the level of uncertainty coming from limited data and the inherently stochastic nature of catch events, it does not account for uncertainty in these aforementioned factors of fishing behavior. However, one advantage of this approach is that it can be readily updated as new data become available from fishing under EFPs or authorized permits. Updating the analysis as DSBG fishing develops will allow for estimates that may more accurately characterize and predict the impacts of the DSBG fleet.

Analysis Using Distribution of Effort

This analysis presented to the SSC in June 2019 calculated PPDs of catch by applying the effort characteristics of EFP fishing in 2018 to the levels of permit issuance proposed under the Council's ROA. This approach rendered a point estimate of total days fished for each alternative, which was then applied to our simulated posterior distributions of catch rates to arrive at a PPD of catch for each species and alternative.

The SSC noted in its review that our effort assumptions may be better represented using a probability distribution of effort. To incorporate this suggestion, our calculations in this document incorporate the empirical distribution of days fished per vessel per season over the course of EFP fishing to date. Rather than plugging in point estimates for the expected levels of effort under each alternative in the Council's ROA, we sample from this distribution for each draw used to calculate the PPD. This incorporates an additional dimension of uncertainty into the models by treating the number of days fished per vessel as a range of possible values, rather than a point estimate based on the average. Because we do not have data to construct a distribution of the other components of our effort assumptions (i.e., the number of permits that would be available under each alternative, and the percentage of these permits that might be actively fished), we use point estimates for these components of fishing effort.

There are multiple ways to incorporate the empirical distribution of days fished per vessel per season into our analysis. One is to simply sample a random number from the distribution at each simulation draw. Under this method, each observation of the PPD can be understood as a simulated season of DSBG fishing with effort equal to the observed effort level of a single specific vessel selected at random. This sampled effort per vessel value is then multiplied by the number of vessels expected in a season of fishing for the selected alternative and finally by the average number of buoy-hours per vessel since our posterior distributions of the take rate parameters are calculated at the buoy hour level. Other than the changes to the calculation of the effort variable, the modeling approach is the same as described earlier in this document.

Another approach to incorporating uncertainty in days fished per vessel is to sample, with replacement, from the empirical distribution of annual days fished per vessel, with the number of samples equal to the number of expected active permits. That is, after determining how many active permits we expect under a given alternative, we draw a random sample for each permit to estimate how many days it will fish. Summing this vector of days fished per active vessel and multiplying by average soak hours generates a sample of potential effort in soak-hours for a given number of active permits.

To compare predictions resulting from these approaches, we calculate PPDs for the Council's PPA, for swordfish (i.e., the target species) and humboldt squid (i.e., an uncommonly caught species with only one observed take in DSBG EFP fishing to date). For each species, we use the model indicated as the best fit for the source data in Table A-2 above. Figure A-6 shows the PPDs resulting from these calculations for swordfish.

Figure A-6. Swordfish PPDs Using Distributions of Effort

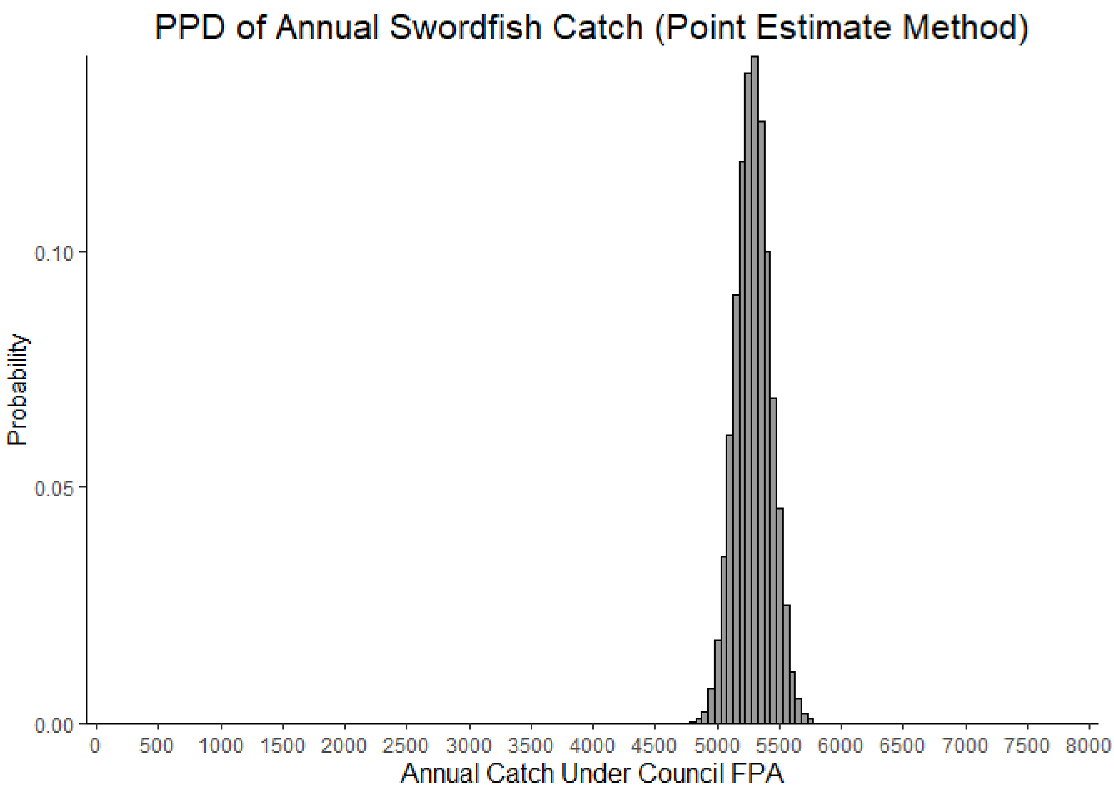
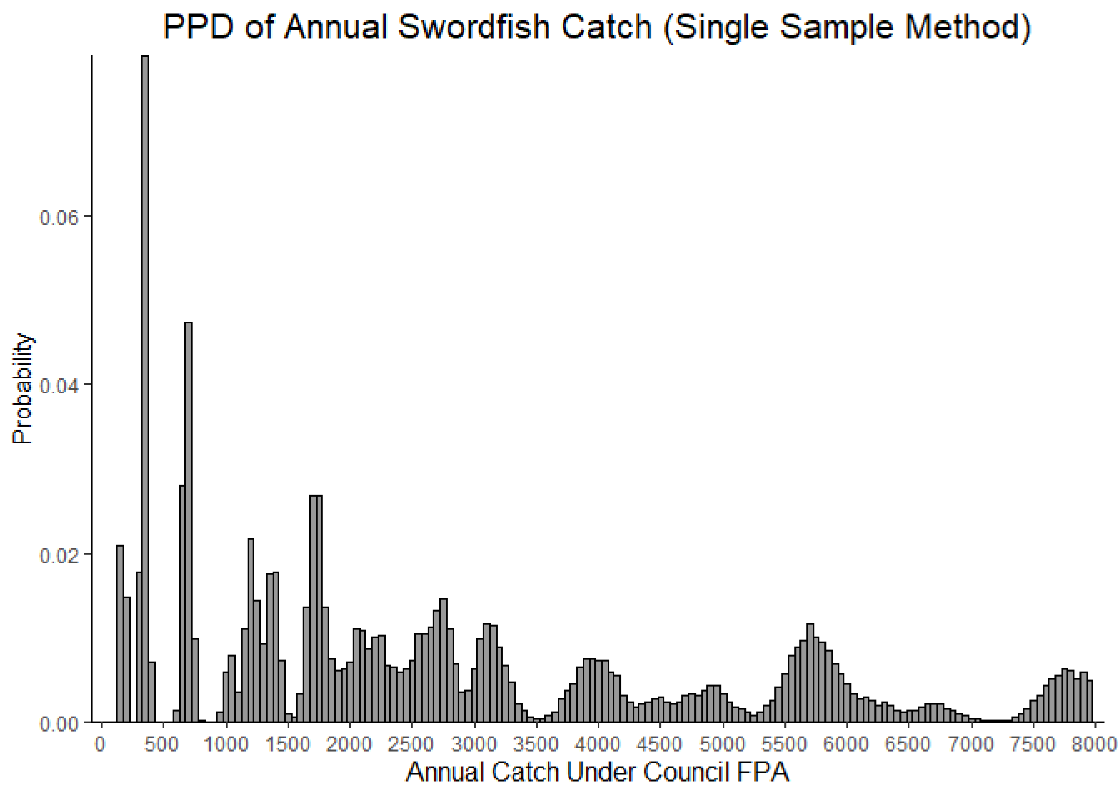


Figure A-6 (continued). Swordfish PPDs Using Distributions of Effort



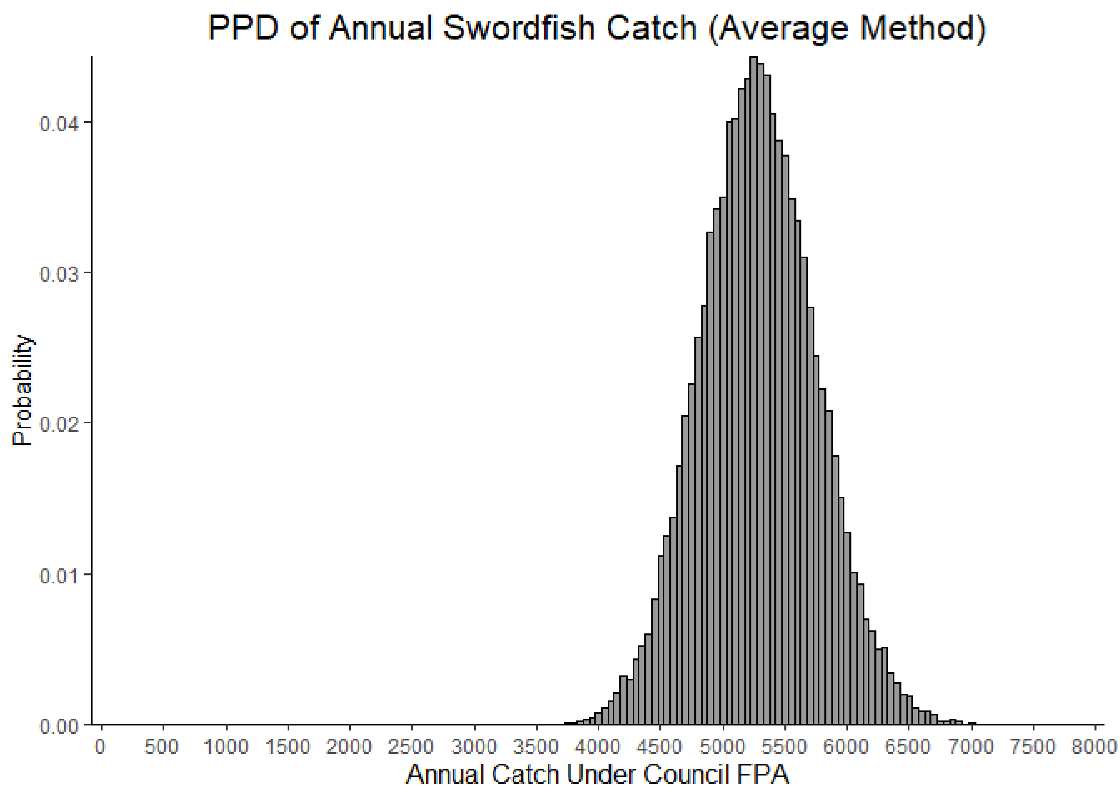


Table A-27 shows the summary statistics for the above PPDs.

Table A-27. Comparison of Swordfish Catch PPDs Using Three Effort Assumptions

Model	**Mean**	**CI 2.5%**	**Median**	**CI 97.5%**	**Mode**
Point Estimate	5,286	5,017	5,285	5,562	5,272
Single Sample	5,271	192	3,159	17,948	3,44
Average of Samples	5,285	4,399	5,276	6,223	5,368

Based on the above PPDs of annual catch under the Council's PPA, sampling from the empirical distribution of effort appears to result in a wider range of possible values, as expected. The predicted mean of the PPDs generated using both sampling methods is similar to the mean of the PPD derived using a single point estimate of effort at every draw. The single sample method produces a drastically right-skewed PPD with high probabilities at low values of swordfish catch, while the average-of-samples method seems to result in a wider version of the point estimate PPD, indicating that uncertainty in the amount of effort per vessel is incorporated without affecting convergence of the Hamiltonian Monte Carlo method for estimating the posterior distribution.

Figure A-8 shows the PPDs resulting from these calculations for Humboldt squid.

Figure A-8. Humboldt Squid PPDs Using Distributions of Effort

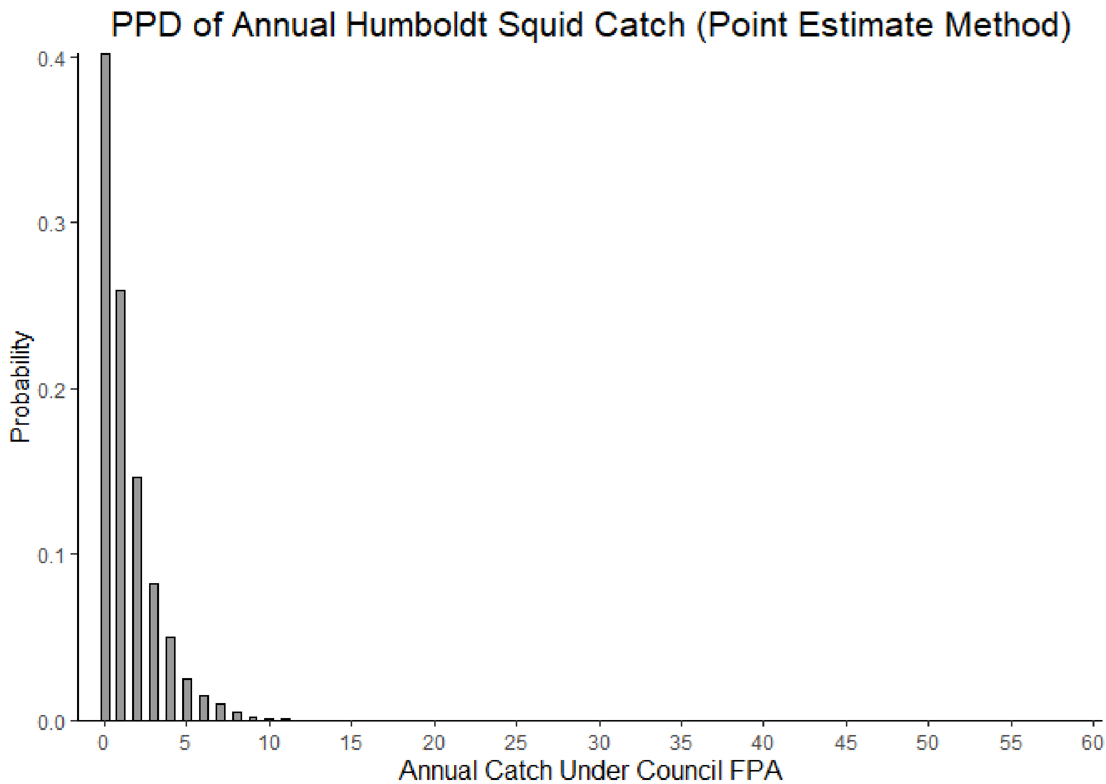
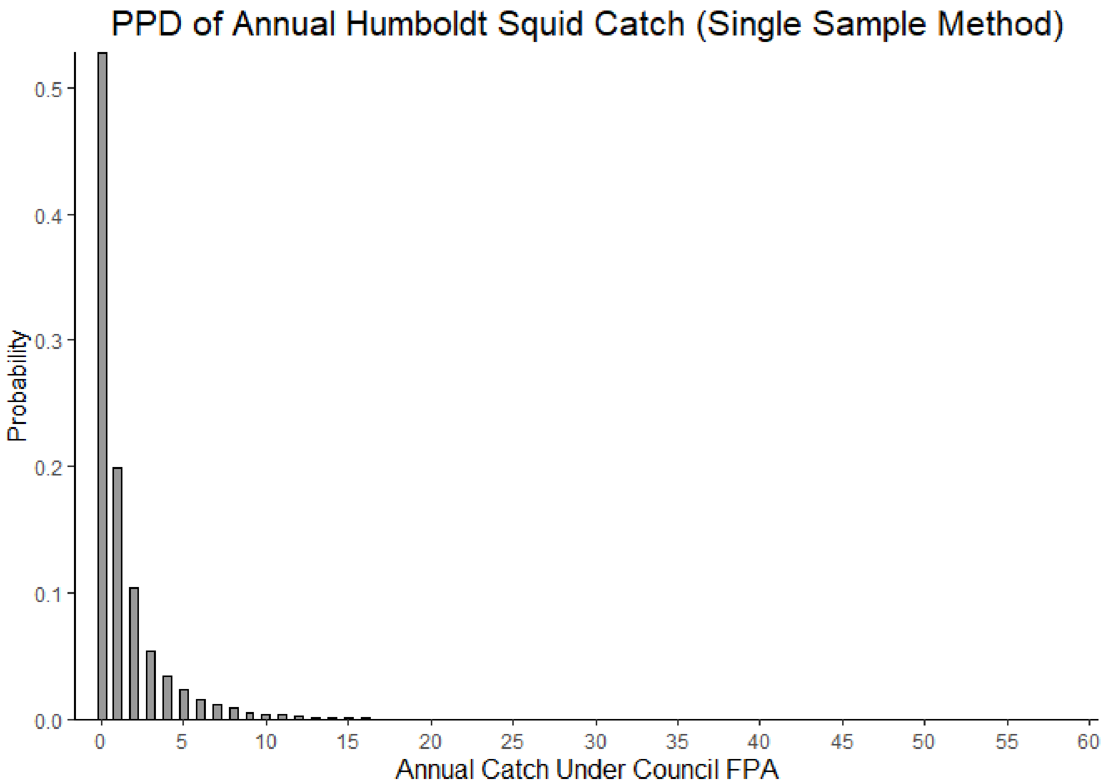


Figure A-8 (continued). Humboldt Squid PPDs Using Distributions of Effort



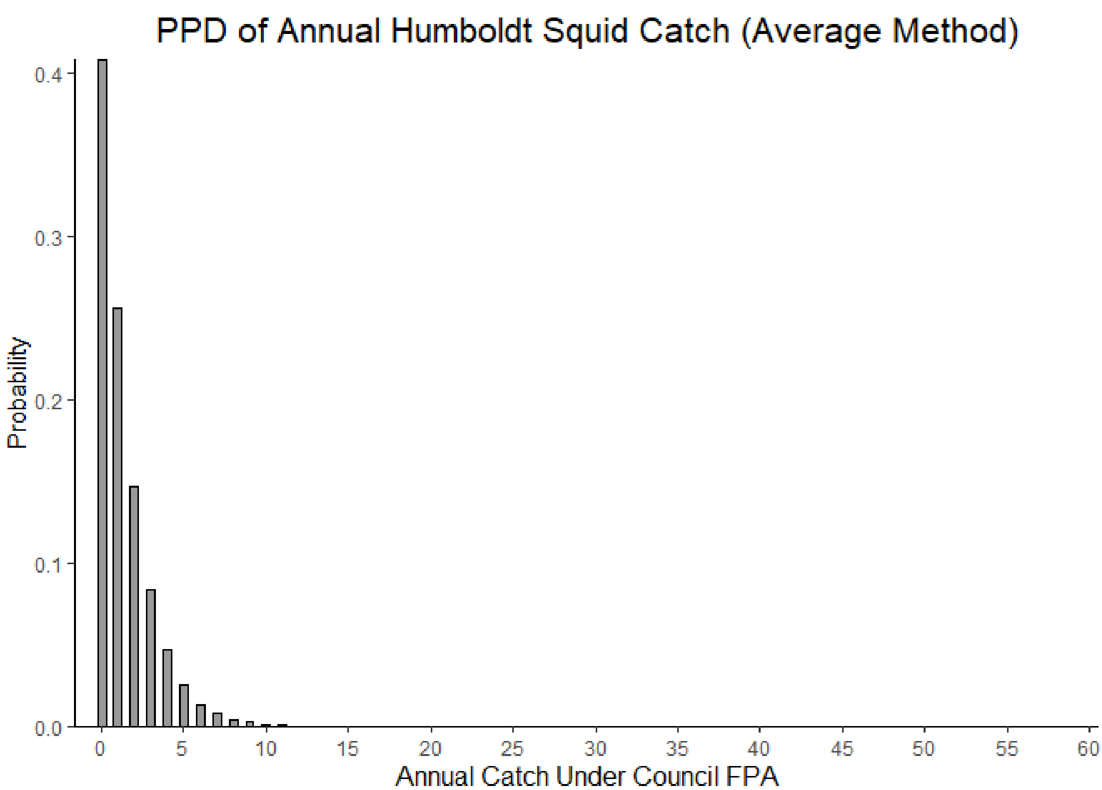


Table A-28 shows the summary statistics for the above PPDs.

Table A-28. Comparison of Humboldt Squid Catch PPDs Using Three Effort Assumptions

Model	Mean	CI 2.5%	Median	CI 97.5%	Mode
Point Estimate	1	0	1	6	0
Single Sample	1	0	0	8	0
Average of Samples	1	0	1	6	0

For this uncommonly-caught species, the various effort estimation methods produce similar PPDs of annual catch under the Council's PPA. Summary statistics (mean, median, and mode) are similar or identical across the three methods.

Based on this sensitivity analysis, we elected to use the average-of-samples method to evaluate the biological impacts of DSBG authorization. This incorporates uncertainty about how much each vessel will fish under an authorized fishery, while avoiding overdispersed results.

Addressing Different Gear Types

Since the presentation of the initial analysis in June 2019, we have undertaken several approaches to address differences in DSBG gear type (i.e., SBG and LBG) in the biological analysis. The analysis presented in June 2019 was for SBG only, as data on LBG were not yet available at that time. The updated analysis in this document includes both SBG and LBG in a combined analysis which estimates the range of potential biological impacts for the entire DSBG fishery.

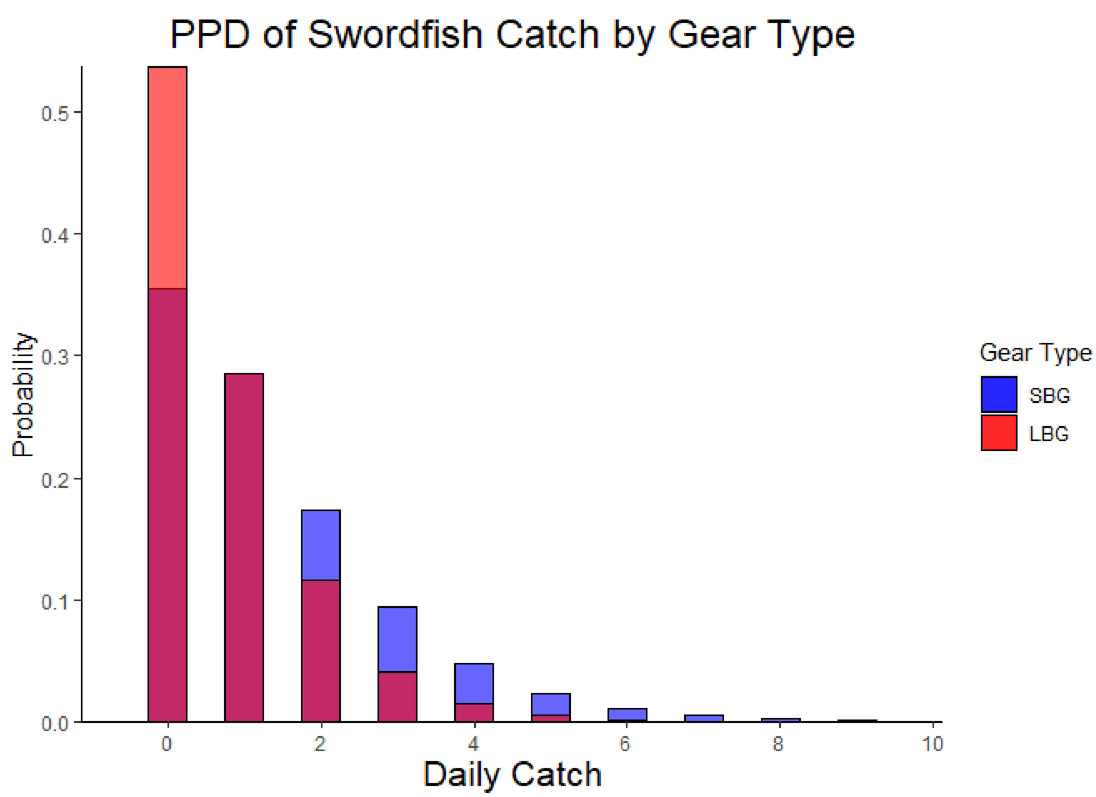
This updated analysis includes in each model a "gear shift" parameter which explicitly controls for gear type. We include this because there is some preliminary evidence to suggest that catch rates may not be equivalent between the two gear types. For example, there are several species which have been caught in SBG but not in LBG—this may be due to the much lower levels of LBG effort to date, but it may also suggest that LBG is a more selective gear type. Additionally, swordfish CPUE from 2018 through 2020 was slightly higher for LBG than for SBG. While our previous analysis relied on the assumption that differences in catch rates between the two gear types was due to differences in buoy soak hours between SBG and LBG days fished (i.e., LBG incorporates a higher number of hooks in each link, and therefore has more buoy-hours on average than SBG), addressing gear type more explicitly through the use of a

dummy variable allows us to control for differences in catch rates beyond what is attributable to the higher daily buoy-hours of LBG.

Because of the very limited data available on LBG thus far (only 97 days fished), we are not analyzing it separately as part of our biological analysis. However, to evaluate the extent of differences in catch rates between the two gear types at the day fished level, holding variation in buoy soak hours constant, we calculated PPDs of a single day fished for each gear type. We perform this comparative analysis for swordfish and bigeye thresher shark. These comparisons use the negative binomial model for swordfish, and the Poisson likelihood model for bigeye thresher shark. They also use a point estimate effort assumption rather than a distributional approach to modeling effort.

Figure A-9 shows an overlay of swordfish catch PPDs for a day fished with each gear type. The blue represents the probability of catching a given number of swordfish in a day of SBG fishing, while the red corresponds to a day of LBG fishing.

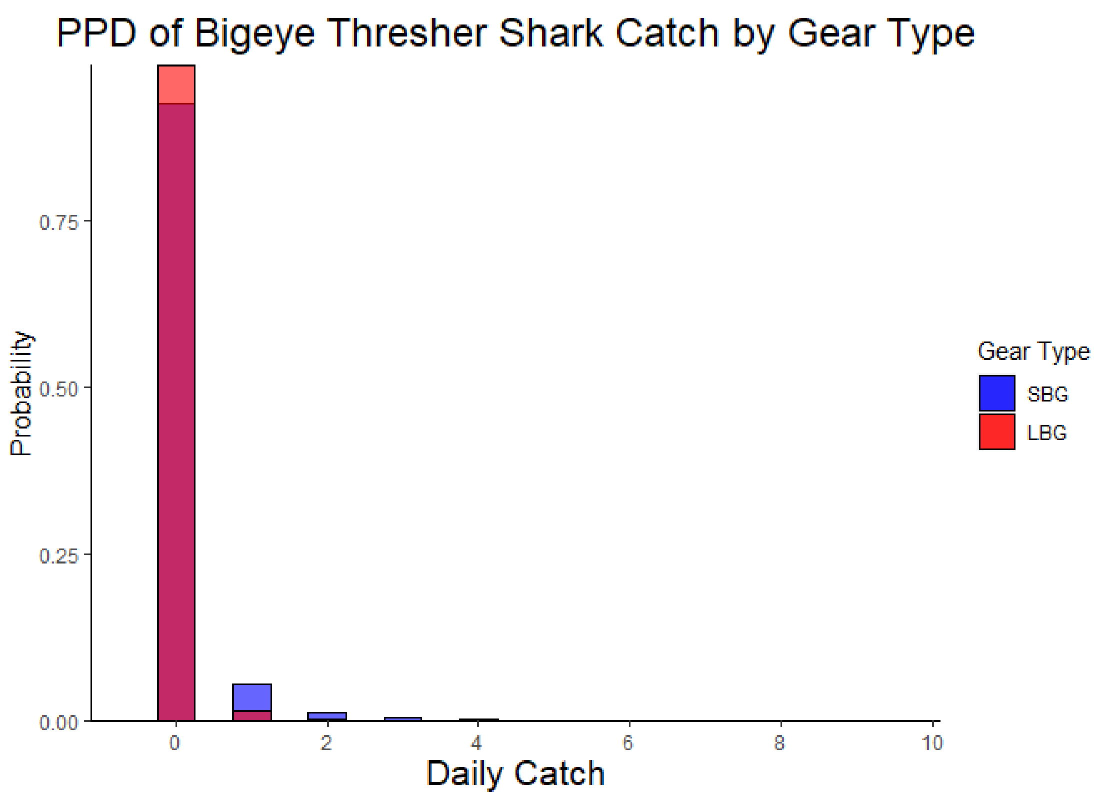
Figure A-9. Swordfish PPD Comparing Gear Types



As shown above, our analysis indicates that, holding buoy-hours constant, LBG has a higher probability of catching 0 swordfish in a given day than SBG. Both gear types have a similar probability of catching exactly one swordfish, and SBG has a slightly higher probability of catching higher numbers of swordfish. Although this analysis is based on very limited data for LBG, it does provide some evidence of a difference in target species catch rates between the two gear types. This may be due to differences in fishermen's levels of experience in the two gear types, physical differences in the gear resulting in different likelihoods of catching swordfish, or other factors.

Figure A-10 shows an overlay of bigeye thresher shark catch PPDs for a day fished with each gear type.

Figure A-10. Bigeye Thresher Shark PPD Comparing Gear Types



Similar to swordfish, this analysis indicates that LBG has a higher probability of catching 0 bigeye thresher sharks in a given day compared to SBG. LBG has a near-zero probability of catching one bigeye thresher shark in a given day, suggesting that catch is a very rare event with this gear type; however the probability is approximately 9% for SBG.

Discussion

The methodology presented by NMFS to the PFMC's SSC in 2019[7] used a Poisson likelihood function for all species and a point estimate of fishing effort based on the observed effort characteristics in the 2018 year of DSBG EFP fishing. In addition, the initial method did not explicitly control for gear type, only for variation in buoy-hours between individual days of fishing. The SSC noted in its June 2019 review of the methodology that the Poisson likelihood function may not be the best fit for the data for all species. Our sensitivity analysis confirms that, for the more commonly caught species (swordfish and bigeye thresher shark), the source data violate the Poisson assumption that the mean is equal to the variance, and the negative binomial model fits the source data better than the Poisson. For uncommonly caught species the Poisson model appears to be the best fit for the source data. Our analysis also indicates that the summary statistics for swordfish catch are very similar whether using the Poisson or negative binomial models. Therefore, we believe the information available to the Council when selecting its FPA in September 2019 adequately reflected our expectation of potential swordfish catch under the action alternatives, despite using a likelihood model with a slightly worse fit to the source data than the model employed in this document.

Incorporating the empirical distribution of days fished per vessel into our effort assumptions affects the estimates by introducing an additional layer of uncertainty into the predictions. This results in a wider range of possible catch values with lower probabilities of each. In the case of the single-sample method, the calculated PPD for swordfish is drastically skewed and does not converge to a normal distribution, and therefore may not be useful for the purpose of making management decisions. In contrast, the average-of-samples method results in fairly well converged PPDs, but may not fully capture the full uncertainty surrounding how much effort may actually occur in a full-scale fleet. The point estimate method was used in the preliminary draft EIS which the Council reviewed in September 2019 while selecting its FPA (we note that the mean, median, and mode are similar between the point estimate method considered by the Council and the average of samples method used in this document). The analysis presented in this document uses the average of samples method, to incorporate some uncertainty in the expected fleet-level effort while still providing catch projections that follow directly from the effort assumptions in the action alternatives. This may not capture the full extent of uncertainty regarding how much fishing will actually occur in a full-scale DSBG fleet.

[7] See PFMC June 2019 Meeting Briefing Book, Agenda Item J.6, NMFS Report 1.

Regarding differences between gear types, we do find evidence that there are differences in catch rates between SBG and LBG that are not fully attributable to differences in average daily buoy-hours. For this reason, we do feel it appropriate to explicitly control for gear type when estimating our posterior distributions of catch rates for each species. This was done in all models presented in the preliminary draft EIS presented to the Council during its September 2019 meeting. However, it is worth noting that the specific differences in catch rates by gear type identified in this document are not necessarily constant over time and may themselves be influenced by other factors. For example, our analysis uses data from the entire time period of DSBG EFP fishing (i.e., January 2015 through December 2020), but LBG fishing did not occur until 2018. There was also a marked increase in the number of vessels fishing using DSBG in 2018 and a drop in overall swordfish CPUE relative to earlier years. While the analysis using the whole dataset appears to indicate that LBG has a lower chance of catching more than one swordfish on a given day, it is important to consider that LBG was not fished in earlier years when swordfish CPUE was relatively high. Therefore, because of the timing and limited number of days fished using LBG in our dataset, we do not make conclusions regarding specific differences in catch rates using the two gears, but we do find evidence that controlling for differences in gear type should increase the accuracy of predictions made using our analysis. The analysis presented in this document controls for differences in gear type using a gear shift parameter in the likelihood functions which captures the "additional offset" in catch rates when using LBG rather than SBG. Our catch projections incorporate these differences based on the ratio of SBG to LBG fishing in the source data.

Appendix B: Methods and Results of Socioeconomic Impact Analysis

The impact of the Proposed Action on the socioeconomic environment will depend on a number of economic factors including effort, catch rates, and the price of swordfish landed by DSBG. Because of the limited scope of DSBG EFP fishing contributing to the available data, it is difficult to estimate the relationship of increasing volumes of DSBG-caught swordfish to the overall socioeconomic environment. For DSBG-caught swordfish to effectively supplant imports to meet domestic demand, it must be competitive in price or attain preferred status as a superior-quality product.

To estimate the effect of increasing DSBG-caught swordfish volume on DSBG-caught swordfish price, we undertake a Bayesian statistical analysis which controls for the volume of swordfish landed by other fisheries, the volume of swordfish imports, and the volume of landings of two common substitute species, dolphinfish and yellowfin tuna. This analysis consists of an inverse demand model where the monthly price per pound of DSBG-caught swordfish is a function of the landings (in pounds) of DSBG-caught swordfish; the volume of swordfish landings by DGN, harpoon, and longline fisheries; the volume of fresh swordfish imports to Southern California ports,[8] and landings of potential substitute species including yellowfin tuna (YF) and dolphinfish (DF). The model also controls for month (η_i) and year (ρ_j) effects. The functional form of this model is as follows:

$$\begin{aligned}\log(P_{DSBG,ij}) = {} & \beta_1 \log(Q_{DSBG,ij}) + \beta_2 \log(Q_{DGN,ij}) + \beta_3 \log(Q_{HAR,ij}) \\ & + \beta_4 \log(Q_{LL,ij}) + \beta_5 \log(Q_{LX,ij}) + \beta_6 \log(Q_{IMP,ij}) + \beta_7 \log(Q_{YF,ij}) \\ & + \beta_8 \log(Q_{DF,ij}) + \eta_i + \rho_j\end{aligned}$$

Table A-29 presents summary statistics and data descriptions for all variables thought to impact DSBG swordfish price. The data source for all variables is from the confidential PacFIN HMS landings database, except for the imports data, which were sourced from NOAA Office of Science & Technology. Data are aggregated by month and refer to swordfish landings to California ports.[9]

[8] We assume that fresh imports are a potential substitute for DSBG-supplied swordfish but that frozen imports arrive at a later point on the supply chain and are not likely to crowd out processor capacity for receiving DSBG-caught swordfish.

[9] Ports with DSBG landings include Long Beach, Newport Beach, Oceanside, Oxnard, Santa Barbara, San Diego, San Francisco/San Mateo, San Pedro, Ventura, and a grouping of other Los Angeles/Orange County ports.

Table A-29. Data Summary for DSBG Price Analysis

Variable	Label	Mean	Min	Median	Max	Description
DSBG Price	$P_{DSBG,ij}$	$6.59	$4.65	$6.62	$9.00	Average price per pound paid for DSBG-supplied swordfish in a given month.
DSBG Landings	$Q_{DSBG,ij}$	12,682	67	8,082	47,616	Total volume (in pounds) of DSBG-supplied swordfish in a given month.
DGN Landings	$Q_{DGN,ij}$	27,176	22	11,084	121,163	Total volume (in pounds) of DGN-supplied swordfish in a given month.
Harpoon Landings	$Q_{HAR,ij}$	3,351	137	1,525	26,013	Total volume (in pounds) of harpoon-supplied swordfish in a given month.
Longline Landings	$Q_{LL,ij}$	30,124	42	5,062	197,800	Total volume (in pounds) of longline-supplied swordfish in a given month.
Hook & Line Landings	$Q_{LX,ij}$	346	70	322	880	Total volume (in pounds) of hook & line-supplied swordfish in a given month.
Fresh Imports	$Q_{DSBG,ij}$	217,397	129,250	223,934	297,617	Total volume (in pounds) of fresh swordfish imports in a given month.
Yellowfin Landings	$Q_{YF,ij}$	14,732	1,381	10,331	127,243	Total volume (in pounds) of yellowfin tuna landings from all domestic sources.
Dolphinfish Landings	$Q_{DF,ij}$	3,301	273	1,799	14,784	Total volume (in pounds) of dolphinfish landings from all domestic sources.
Month	η_i		January		December	Month in which DSBG was landed.
Year	ρ_j		2015		2020	Year in which DSGB was landed.

The purpose of this analysis is to estimate the price effect[10] of increasing DSBG landings, holding other factors that may influence DSBG price constant. The Proposed Action would authorize levels of DSBG fishing significantly higher than those seen in the DSBG EFP trials, and the increased participation and landings may reduce the price of DSBG-caught swordfish. This could influence the economic viability of the fishery, as HMS fishermen may choose not to participate if the price falls too low.

Because of the small sample size (a total of 47 months with DSBG landings between 2015 and 2020), traditional linear regression methods are not appropriate to estimate this demand model. Therefore, we employ a Bayesian approach which enables us to obtain estimates despite a limited number of observations. We began with a simple model, which included only the DSBG price and DSBG quantity variables, and then added relevant covariates in a bottom-up approach. We apply the results of this

[10] Price effect is reflected by the scale flexibility estimated by the inverse demand model; i.e., the percent variation in price expected from a one-percent increase in quantity.

analysis to both Alternative 2 (Open Access) and Alternative 3 (Limited Entry), with the assumption that higher levels of ongoing permit issuance (as in the Open Access Alternative) will perpetuate a greater overall price effect than would a lower number of permits (as in the Limited Entry Alternative). Table A-30 displays the results of the price analysis. The coefficients labeled "mean" represent the average expected percent change in DSBG price given a one-percent increase in each of the variables thought to affect DSBG price. The other fields in the table represent the standard deviation, the quantiles of the distribution of the estimates, and model diagnostics.[11]

Table A-30. Results of DSBG Price Analysis

Variable	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
DSBG	-0.04	0	0.02	-0.09	-0.05	-0.04	-0.02	0.01	24663	1
DGN	-0.02	0	0.01	-0.04	-0.02	-0.02	-0.01	0.01	30762	1
Harpoon	-0.01	0	0.01	-0.02	-0.01	-0.01	0	0.01	28183	1
Longline	0	0	0.01	-0.03	-0.01	0	0	0.02	41541	1
Hook & Line	0.01	0	0.01	-0.01	0	0.01	0.01	0.02	28109	1
Fresh Imports	0.12	0	0.08	-0.05	0.06	0.12	0.17	0.28	6335	1
Yellowfin Tuna	0	0	0.01	-0.03	-0.01	0	0.01	0.03	33462	1
Dolphinfish	0.01	0	0.04	-0.07	-0.01	0.01	0.04	0.1	21586	1

The mean coefficient for DSBG quantity (-0.04) suggests that increasing the quantity of DSBG landings by one percent lowers the price of DSBG by 0.04 percent on average. This suggests a weak negative price effect of increased DSBG landings.

Between 2018 and 2020, 3,061 swordfish were recorded caught in DSBG EFP fishing, and a total landed weight of 204.07 mt was delivered to California ports. The average weight of a DSBG-caught swordfish was 0.07 mt. Based on the results of our Bayesian biological analysis (see Section 4.3.1), DSBG swordfish catch in a given calendar year would increase to an ongoing annual mean of 8,812 swordfish under Alternative 2. Assuming that the average weight of a DSBG-caught swordfish is constant, we project an ongoing annual mean of 587.48 mt in landed swordfish weight under Alternative 2.

We estimate the average annual price under Alternative 2, given the projected increase in landings, using the following formula:

[11] "n_eff" refers to the effective sample size which estimates the amount of independent information in the simulated sample from the posterior distribution. "Rhat" is a measure of convergence between four Markov Chains used to simulate the posterior distribution; Rhat < 1.1 is generally considered to indicate convergence of the chains.

$$\log P_{OA} - \log P_{1820} = \beta_1 * (\log Q_{OA} - \log Q_{1820})$$

Where:

P_{OA} = Average annual price under Alternative 2;

P_{1820} = Average annual price from 2018 through 2020 ($5.64);

β_1 = Price effect calculated in the price analysis (-0.04%);

Q_{OA} = Projected annual landings under Alternative 2 (587.48 mt);

Q_{1820} = Average annual landings from 2018 through 2020 (68.02 mt).

Solving for P_{OA} returns an estimated average annual price of $5.18 per pound, which is $0.47 lower than the average price from 2018 through 2020.

Note that these estimates are dependent on the effort assumptions of the biological analysis (i.e., the ratio of active to inactive DSBG permits and the average days fished per active permit) holding constant under the Proposed Action. It also relies on the assumption that DSBG swordfish CPUE (and, therefore, landings) scale proportionally with effort.[12]

Based on the results of our Bayesian biological analysis (see Section 4.3.1), DSBG swordfish catch in a given calendar year would increase to an ongoing annual mean of 5,286 swordfish under Alternative 3. Assuming that the average weight of a DSBG-caught swordfish is constant, we project an ongoing annual mean of 352.41 mt in landed swordfish weight under the Proposed Action.

We estimate the average annual price under Alternative 3, given projected increasing landings, using the following formula:

[12] Based on very limited data, CPUE did in fact decline with increased effort when the Council authorized a higher number of EFPs. From 2017 to 2018, effort increased from 324 days fished to 616 days fished, while swordfish CPUE declined from 1.71 individual fish per day to 1.03 individual fish per day, representing a "CPUE elasticity" of -0.43%. However, in 2019, total effort was somewhat greater than 2018 (764 days fished) and CPUE rose to 1.46 swordfish per day. In 2020, effort increased to 1,076 days fished with a CPUE of 1.19 swordfish per day. Overall it is unclear how CPUE scales with effort given the limited effort and data in DSBG fishing to date.

$$\log P_{LE} - \log P_{1820} = \beta_1 * (\log Q_{LE} - \log Q_{1820})$$

Where:

P_{LE} = Average annual price under Alternative 2;

P_{1820} = Average annual price from 2018 through 2020 ($5.64);

β_1 = Price effect calculated in the price analysis (-0.04%);

Q_{LE} = Projected annual landings under Alternative 2 (352.41 mt);

Q_{1820} = Total annual landings from 2018 through 2020 (68.02 mt).

Solving for P_{LE} returns an estimated average annual price of $5.28 per pound, which is $0.36 lower than the average price from 2018 through 2020. Note that the five sub-options under Alternative 3 reach the maximum level of permit issuance, and associated DSBG price effects, on different timescales:

- LE option 3.1 may reach this maximum price effect after 12 years.
- LE option 3.2 may reach this maximum price effect after 6 years.
- LE option 3.3 may reach this maximum price effect after 3 years.
- LE option 3.4 may reach this maximum price effect after 1 year.
- LE option 3.5 may reach this maximum price effect after 11 years.

These estimates are dependent on the same assumptions, limitations, and levels of uncertainty as the estimates for Alternative 2.

We also estimate socioeconomic impacts of the alternatives at the regional level, to determine the effect of the alternatives on fishing communities as a whole. Using the average of 2018-2020 DSBG landings and revenues, the calculated own-price effect of increasing DSBG landings, and the amount of projected swordfish catch under each alternative, we estimate aggregate revenues for the three regions where DSBG swordfish has been landed to date: Ventura, Santa Barbara, and San Francisco Counties;[13] Los Angeles and Orange Counties; and San Diego County. Figures A-11 and A-12 display the results of these projections for Alternative 2 and 3, respectively.

[13] Note that only one DSBG landing has been made in San Francisco to date, in 2019. All other landings have been to Southern California ports.

Figure A-11. Projected Revenues under Open Access Alternative

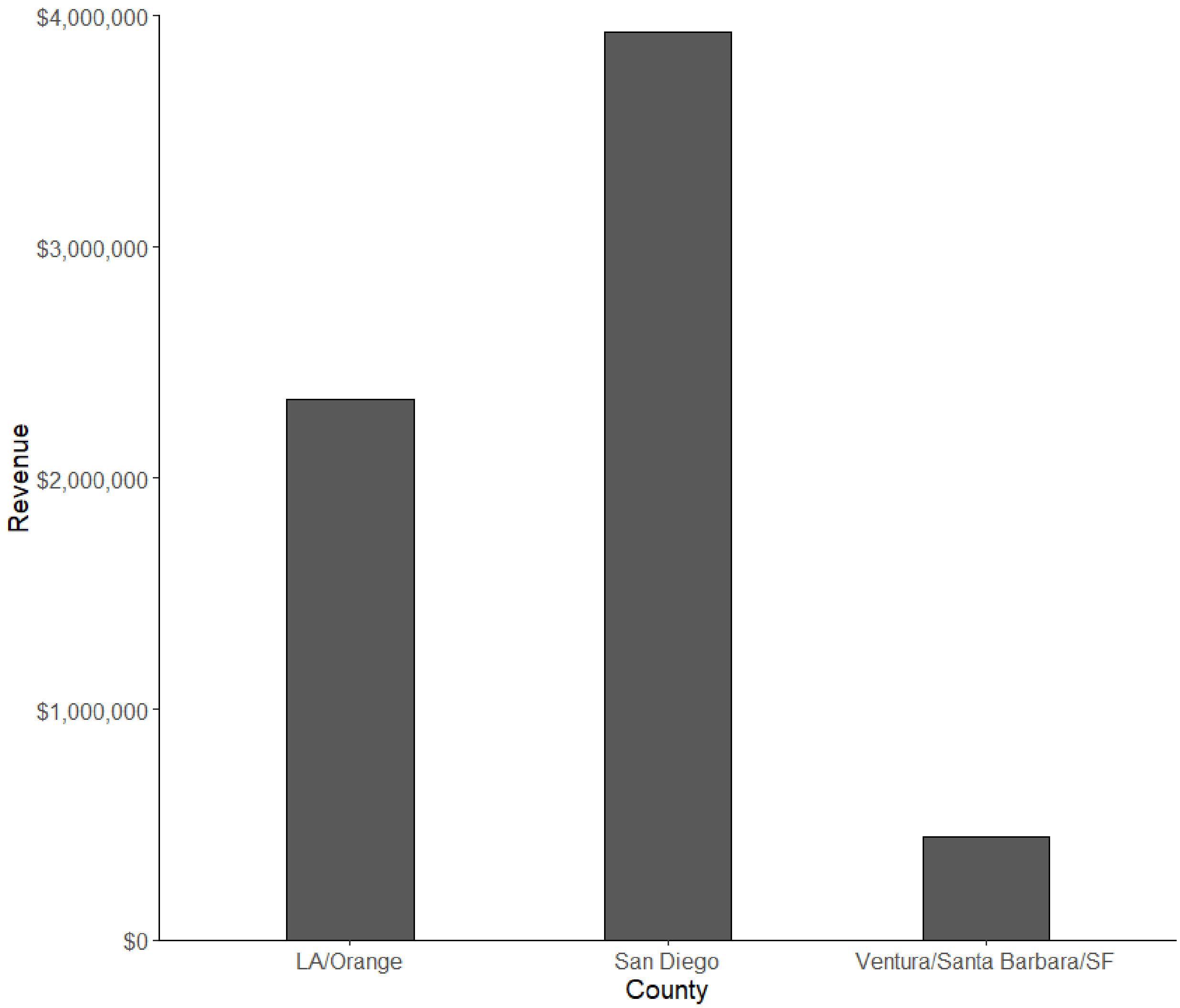
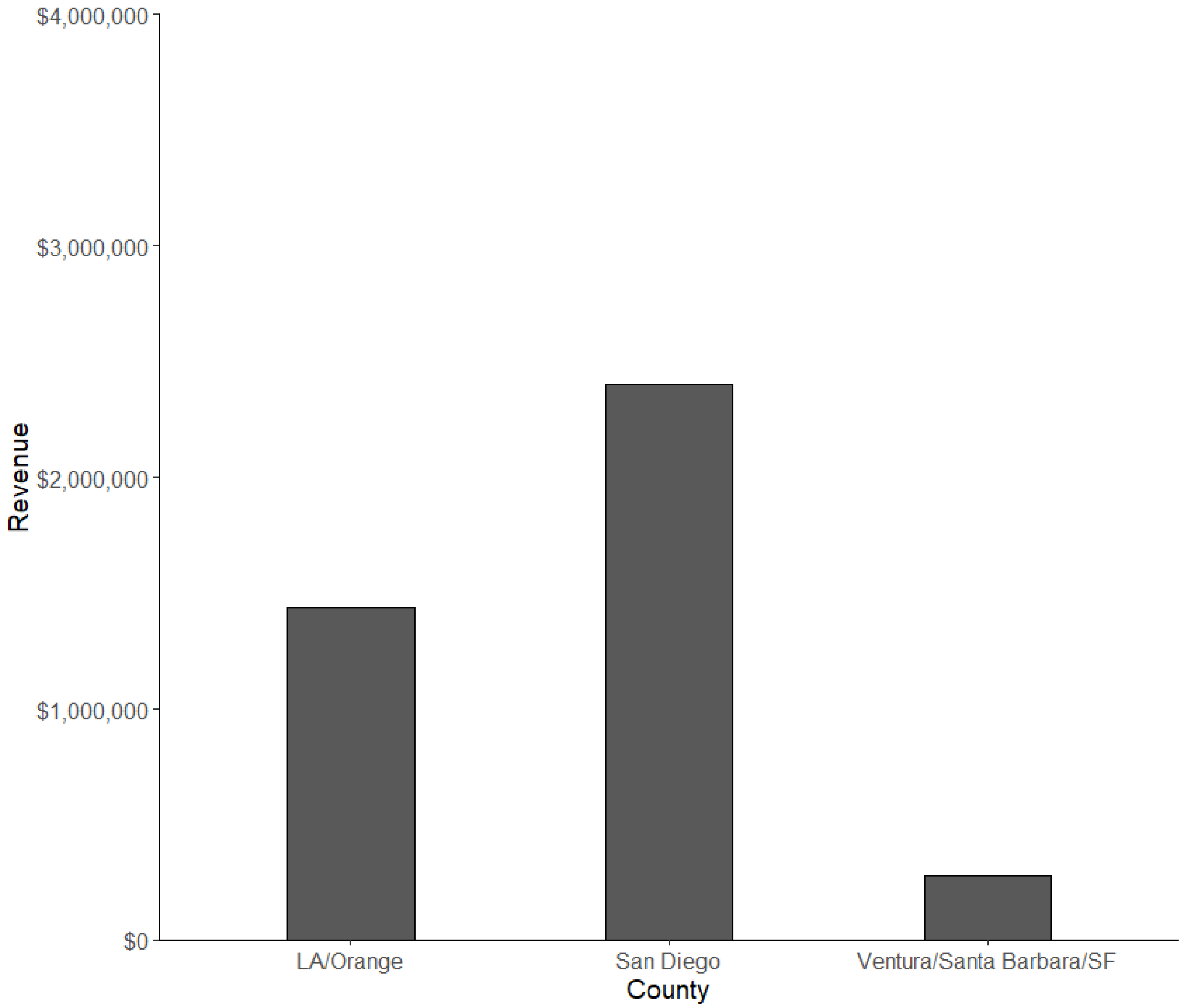


Figure A-12. Projected Revenues under Limited Entry Alternative



Sensitivity Analysis of Alternative CPUE Scenarios

The above analysis includes estimates of average future DSBG price, and the distribution of estimated DSBG landings and revenues by region, given estimates of effort under each alternative. This analysis relies on a number of assumptions, including that swordfish CPUE will continue at a similar rate to that observed during DSBG EFP fishing. However, if swordfish CPUE declines with increasing levels of DSBG effort, this assumption is likely to result in an overestimate of landings and revenues under the action alternatives. Declines in CPUE may occur due to spatial crowding-out of vessels from optimal fishing locations, or differences in the experience levels and chance of fishing success among individual fishermen as DSBG fishing levels expand. Swordfish CPUE is also influenced by other factors which are not constant over time, such as sea surface temperature, prey availability, effort and catch by other fisheries, and the highly migratory nature of the species.

Because we lack the necessary data to empirically estimate potential declines in swordfish CPUE and resulting effects on catch, landings, price, and revenues, we developed a scenario where CPUE declines with increasing effort to the rate observed during the 2018 calendar year of EFP fishing. This scenario may be useful for evaluating the economic performance of DSBG fishing in the event that CPUE does decline as effort increases.

Reduced CPUE Scenario Analysis

Between January 2015 and December 2020, DSBG EFP vessels undertook 3,127 days fished and caught 4,180 swordfish. Table A-31 shows the number of days fished, the total swordfish catch and resulting CPUE, and the number of vessels fishing in each year. The bottom row shows the total number of unique vessels and the average CPUE for the whole time period, based on the total days fished and total swordfish catch. It also shows the number of unique vessels that fished over the whole time period. Note the decline in CPUE from 2017 to 2018, when the number of active vessels rose from 5 to 26.

Table A-31. DSBG EFP **S**wordfish CPUE and Number of Vessels by Year

Swordfish CPUE by Year				
Year	**Days Fished**	**Swordfish Catch**	**Swordfish CPUE**	**Number of Vessels**
2015	132	136	1.030	4
2016	283	474	1.675	7
2017	377	645	1.711	8
2018	627	654	1.043	27
2019	764	1125	1.473	24
2020	1076	1282	1.191	27
TOTAL	**3127**	**4180**	**1.337**	

Table A-32 reports the estimated levels of annual effort, swordfish catch, and swordfish CPUE. These effort levels are for both proposed permit regimes (i.e., open access and limited entry) in each year once the maximum number of permits under each alternative are made available.

Table A-32. DSBG EFP Swordfish CPUE and Number of Vessels Under Authorization Alternatives

Swordfish Catch Estimated for Authorization				
Alternative	**Days Fished**	**Swordfish Catch***	**Swordfish CPUE**	**Number of Vessels****
Open Access	6,590	8,812	1.337	215
Limited Entry	3,954	5,286	1.337	129

**Swordfish catch based on the estimated annual average (mean)*

***Number of vessels based on number of available permits, and assumed 42% active fishing ratio*

Note that our estimates of effort are based on the characteristics of DSBG EFP fishing from 2018 through 2020 (e.g., the percentage of available permits that were actively fished and the average days fished per active vessel), as these years had the highest level of DSBG fishing effort to date and therefore may most closely resemble the effort characteristics of fully authorized DSBG fishing. However, our estimates of catch are based on the full dataset, which is why the estimated CPUE in Table A-32 resembles the "total" CPUE from Table A-31 as opposed to the CPUE in any one year.

The estimates of swordfish catch and landings in the PDEIS are based on the entire time period DSBG has been fished, and they assume a constant CPUE based on the average CPUE from EFP fishing to date, despite higher levels of projected effort. To evaluate a "reduced CPUE" scenario, we re-estimate swordfish catch using data from 2018 through 2020 only, so that the landings and revenue estimates are based on catch rates which occurred under higher levels of effort. Table A-33 reports the estimated levels of annual effort, swordfish catch, and swordfish CPUE under this scenario.

Table A-33. DSBG EFP Swordfish CPUE and Number of Vessels Under Authorization Alternatives (Reduced CPUE Scenario)

Swordfish Catch Estimated for Authorization (Reduced CPUE)				
Alternative	**Days Fished**	**Swordfish Catch***	**Swordfish CPUE**	**Number of Vessels****
Open Access	6,590	8,290	1.258	215
Limited Entry	3,954	4,975	1.258	129

**Swordfish catch based on the estimated annual average (mean)*

***Number of vessels based on number of available permits, and assumed 42% active fishing ratio*

Under this scenario, swordfish CPUE is reduced to approximately 1.26 fish per day (similar to the average from 2018 through 2020) and total catch falls by 5.9 percent. In other words, our analysis suggests that if swordfish CPUE under fully authorized DSBG fishing more closely resembles that seen from 2018 through 2020, the expected annual average swordfish catch would be 5.9 percent lower than if CPUE resembles the average CPUE from the entirety of DSBG EFP fishing to date.

Using these estimates of average annual swordfish catch, we re-estimate socioeconomic impacts under a scenario with reduced swordfish CPUE. As described above, our analysis indicates that increasing DSBG landings by one percent would result in a drop in DSBG price of 0.04 percent.

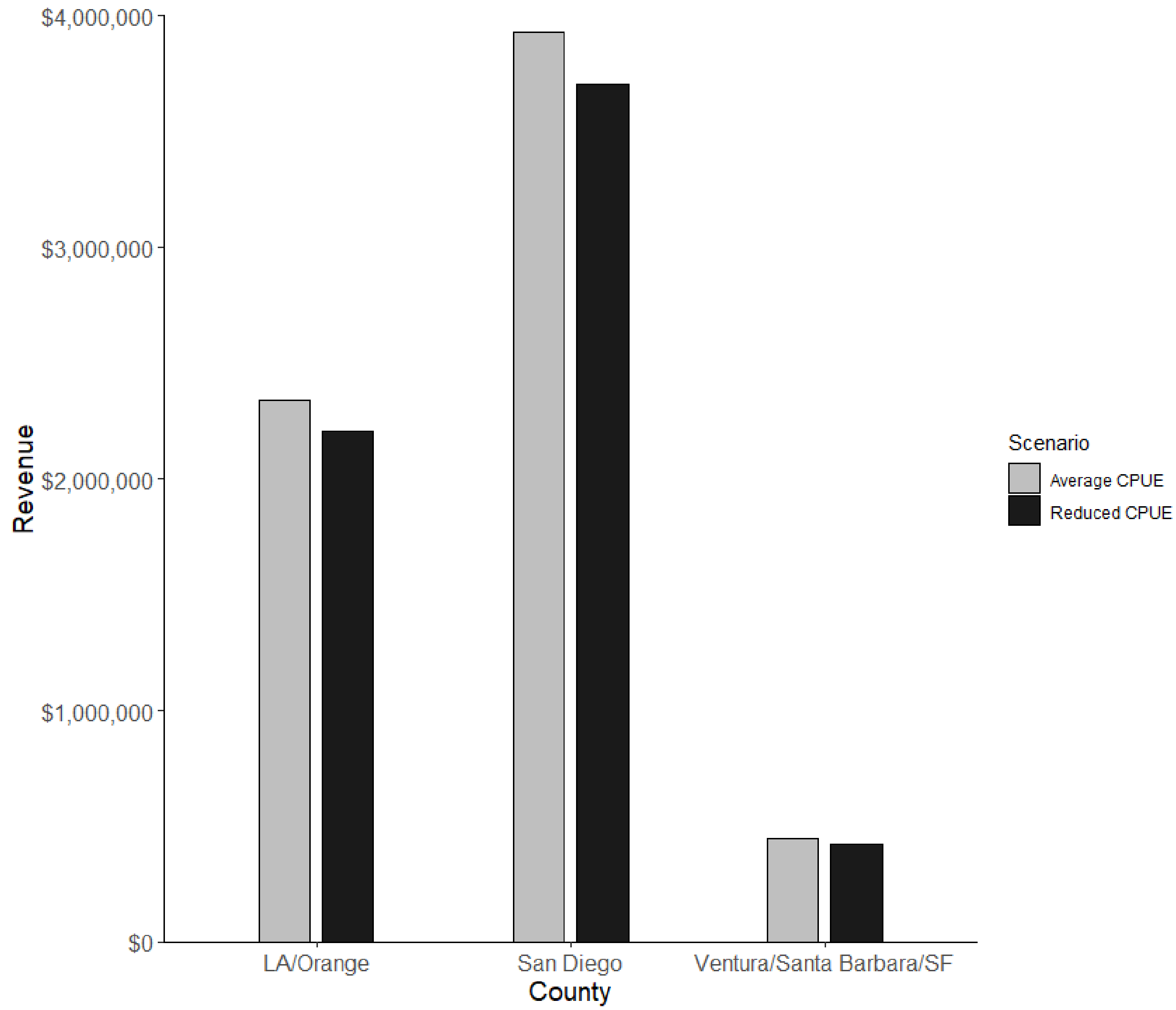
From 2018 through 2020, 3,061 swordfish were recorded caught in DSBG EFP fishing, and a total landed weight of 204.07 mt was delivered to California ports. The average weight of a DSBG-caught swordfish

was 0.07 mt. Based on the results of our reduced CPUE scenario catch estimates, DSBG swordfish catch in a given calendar year would reach an ongoing annual mean of 8,290 swordfish under Alternative 2. Assuming that the average weight of a DSBG-caught swordfish is constant, we project an ongoing annual mean of 552.68 mt in landed swordfish weight under Alternative 2. This is 34.80 mt (5.9 percent) lower than the projected landed weight under the average CPUE scenario.

Based on the estimated price effect, and on the projected landings estimated under the reduced CPUE scenario, we calculate an estimated average annual price of $5.19 per pound under Alternative 2, which is $0.45 lower than the average price from 2018 through 2020.

At the regional level, we estimate revenues under Alternative 2 for the reduced CPUE scenario by distributing projected DSBG swordfish landings under the Proposed Action (552.68 mt) to three regions, in the same proportions seen from 2018 through 2020, and multiplying by the estimated average price per pound ($5.19) to arrive at average annual revenues. Figure A-13 displays the results of these projections, along with the projections from the constant CPUE scenario (i.e., where CPUE is based on the average CPUE across the entirety of EFP fishing).

Figure A-13. Projected Revenues under Open Access Alternative (Two CPUE Scenarios)

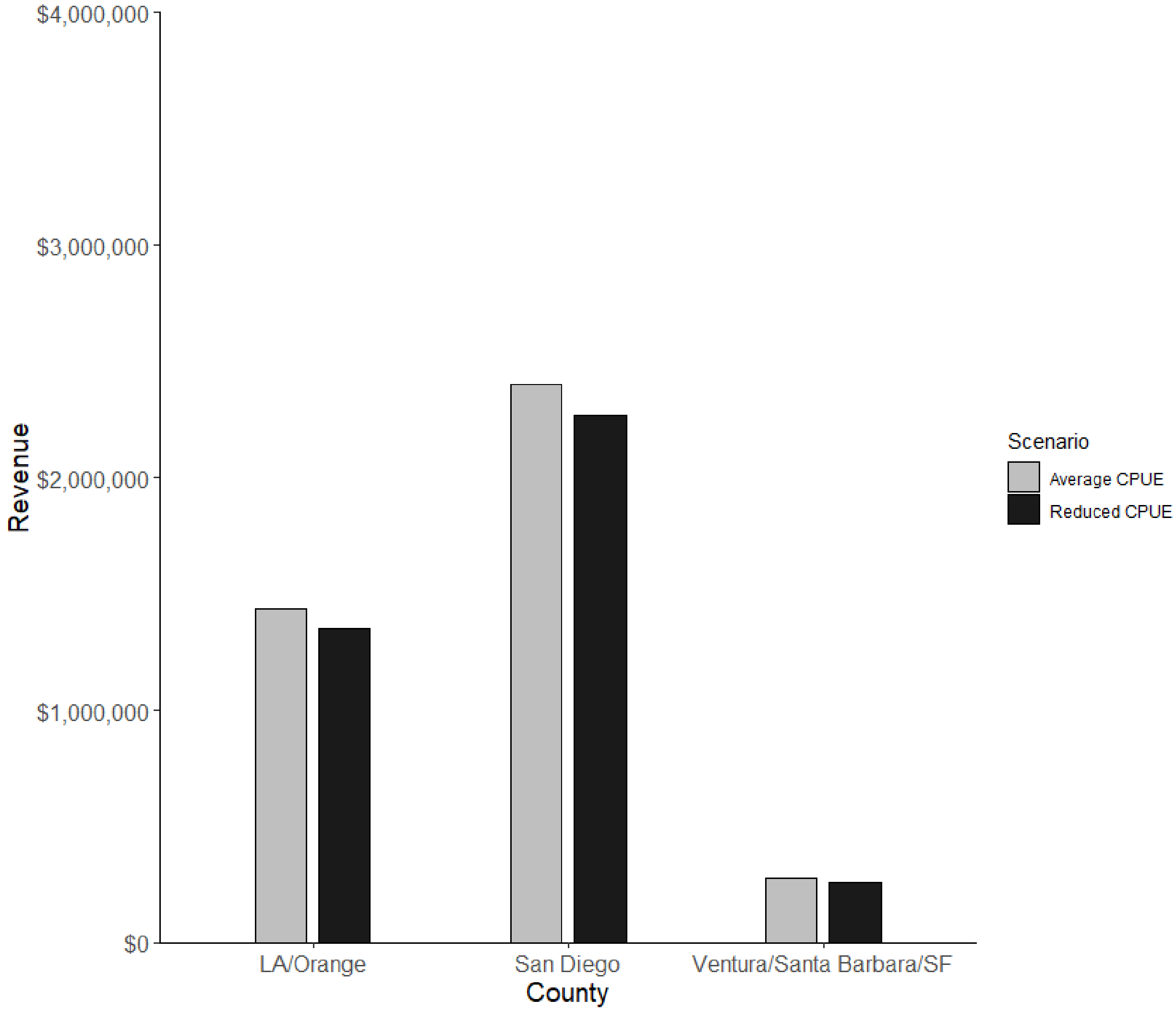


Based on the results of our reduced CPUE scenario catch estimates, DSBG swordfish catch in a given calendar year would reach an ongoing annual mean of 4,975 swordfish under Alternative 3. Assuming that the average weight of a DSBG-caught swordfish is constant, we project an ongoing annual mean of 331.67 mt in landed swordfish weight under Alternative 3. This is 20.73 mt (5.9 percent) lower than the projected landed weight under the average CPUE scenario.

Based on the estimated price effect, and on the projected landings estimated under the reduced CPUE scenario, we calculate an estimated average annual price of $5.30 per pound under Alternative 3, which is $0.35 lower than the average price from 2018 through 2020.

At the regional level, we estimate revenues under Alternative 3 for the reduced CPUE scenario by distributing projected DSBG swordfish landings under the Proposed Action (331.67 mt) to three regions, in the same proportions seen from 2018 through 2020, and multiplying by the estimated average price per pound ($5.30) to arrive at average annual revenues. Figure A-14 displays the results of these projections, along with the projections from the constant CPUE scenario.

Figure A-14. Projected Revenues under Limited Entry Alternative (Two CPUE Scenarios)



Discussion

For both Alternatives 2 and 3, revenues are understandably lower when swordfish catch is based on reduced CPUE. However, this reduction is mitigated to a small degree by the effect of DSBG quantity on price (i.e., reduced catch and landings results in a higher average price per pound).

We note that these estimates of revenue by region are based on swordfish CPUE as estimated using only data from 2018 through 2020, years which saw a reduction in CPUE relative to previous years, along with an increase in participating vessels. However, this supposed effect of increased effort on swordfish CPUE may not necessarily persist under authorized DSBG fishing. It may be that the drop in CPUE from 2017 to 2018 was driven in part by non-fishery-related factors, such as weather conditions or the natural migration of swordfish. This is partly evidenced by the "bounce back" in CPUE seen in 2019. On the other hand, it is possible that a negative relationship between effort and CPUE would perpetuate under authorization, as higher numbers of vessels participate. In this case, swordfish catch, landings, and revenues may be even lower than the 'Reduced CPUE' scenario presented in this report.

In addition to the assumptions and data limitations mentioned here, the issue of vessel-level profitability also adds uncertainty to projections of landings and revenues under authorized DSBG fishing. Our socioeconomic analyses thus far have assumed that the same proportion of available permits that was fished from 2018 through 2020 will be fished under fully authorized DSBG fishing. However, participation may be constrained by the profitability of DSBG fishing. If DSBG is not expected to be profitable (e.g., due to low CPUE, low price, high cost of fishing, or better opportunities elsewhere), permit holders or potential permit holders may choose not to participate. In this case, the proportion of permits that are actively fished and/or the number of days fished per vessel may fall below the estimates in the current analysis, resulting in lower revenues than the above projections. The addition of more data will allow a more thorough analysis of the relationship between DSBG effort, CPUE, vessel-level profitability, and total revenues over time.