Appendix A: Vertical Lines Analysis

As described in Section 4.3, CDFW's evaluation of anticipated take under an issued ITP requires accounting for both confirmed entanglements in California commercial Dungeness crab gear and entanglements which were classified as unidentified gear due to insufficient marking or documentation but were actually in California commercial Dungeness crab gear. For the purposes of apportioning entanglements classified as unidentified gear to the Covered Activities, CDFW assumes that entanglements occur proportionally to the presence of vertical lines within the Plan Area. Quantifying cumulative presence of vertical lines within the Plan Area therefore provides a correction factor to identify the proportion of unidentified gear entanglements which may have resulted from the Covered Activities. CDFW conducted the following analysis to determine the cumulative exposure of Covered Species to vertical lines from trap fisheries operating off California on an annual basis from 2014-2022, as measured in vertical line days.

C.1 Fisheries Included in Analysis

Fisheries considered for inclusion in the analysis were those which had a documented history of landings with trap gear, included traps as an authorized method of take, and had a minimum of five landings over the 2014-2022 period. Due to active tending requirements for hoop nets, CDFW considers hoop nets to be distinct from trap gear. Therefore, fisheries whose vertical line deployments are limited to hoop nets (e.g., recreational spiny lobster) were not considered further.

Of these fisheries, some had sufficient information on gear deployment and participation and were included in analysis. Fisheries included in the analysis were commercial Dungeness crab, recreational Dungeness crab (commercial passenger fishing vessel (CPFV) sector), commercial California spiny lobster, commercial rock crab, commercial hagfish, commercial spot prawn, and commercial coonstripe shrimp. Tanner crab was considered but ultimately excluded from analysis due to minimal effort in this fishery using trap gear.

Other fisheries did not have sufficient information and therefore were not included in the analysis. This included the commercial nearshore groundfish fishery and sablefish fisheries, and the recreational coonstripe shrimp, hagfish, spot prawn, Dungeness crab (private vessel sector) and rock crab fisheries. As necessary information becomes available, CDFW could incorporate these fisheries into analysis and refine estimates of total vertical line days as well as the relative contribution of the Covered Activity.

C.2 Calculating Vertical Line Days

CDFW used the metric Vertical Line Days to quantify cumulative entanglement risk over time. To calculate the number of vertical line days associated with each fishery operating within the Plan Area, CDFW used the following equation:

$$Active\ Participants \times Number\ of\ fishable\ days \times (Number\ of\ traps\ per\ participant \div Number\ of\ traps\ per\ vertical\ line) = Number\ of\ vertical\ line\ days$$

When quantifying fishery participants CDFW relied upon landings rather than permit issuance data to accommodate the fact that not all permittees fish in a given year. Active participants for each fishery were calculated by identifying the number of permittees who made at least one landing of that species with trap gear.

Once active participants were quantified, the number of fishable days was identified for each fishery per year. For fisheries which have a pre-soak period (commercial California spiny lobster and Dungeness crab) the number of fishable days included both the maximum pre-soak period and the open fishing season to capture all days when vertical lines could have been deployed. For the commercial California spiny lobster fishery, which has an established post-season gear clean up period, the clean-up period was also included in the number of fishable days. Closures for domoic acid, seasonal closures under RAMP, and closures for crab meat quality were quantified and incorporated into analysis for the commercial Dungeness crab fishery and the commercial rock crab fishery. Seasonal closures under RAMP and delays due to domoic acid were also included for the recreational Dungeness crab (CPFV sector) fishery.

Next, maximum trap usage was quantified. For the commercial Dungeness crab and spot prawn fisheries, which issue permits with multiple tiers specifying maximum numbers of traps, CDFW attributed the appropriate tier to each active participant. For the commercial spiny lobster fishery, CDFW also accounted for instances of permit stacking, where a given participant can fish multiple permits. Other fisheries, such as commercial coonstripe shrimp or rock crab, have no maximum trap limit. In cases where regulations were unclear or non-existent, CDFW relied on expert judgement from appropriate subject matter experts (SMEs) to determine average trap usage per participant.

In order to translate trap usage to vertical lines, CDFW evaluated whether gear was fished as single traps or strung together into multi-trap trawls via a common line (see Section 2.2.2, Figure 2-3). For example, the Dungeness crab fishery uses single traps, while the spot prawn fishery strings 10-50 traps together with two vertical lines to the surface. CDFW relied upon statutory and regulatory provisions, the NOAA Fixed Gear Report (NMFS 2014), and expert judgment from SMEs to determine appropriate conversions from traps to vertical lines.

The lack of data in some fisheries required CDFW to make multiple assumptions. An in-depth list of assumptions for each fishery is provided in Table C-2. However, the following were consistent across all fisheries:

1. Any fisher who made at least one landing of the target species with trap gear during a given year was considered an active participant.

2. Active fishery participants utilized their full gear allotment during each fishable day.

CDFW recognizes that fishery participation varies throughout the year for many fisheries such as commercial Dungeness crab, California spiny lobster, and hagfish. However, this analysis aims to determine the maximum contribution of each fishery to cumulative vertical line days. Therefore, CDFW assumed that all fishery participants utilized their full gear allotment during each fishable day.

CDFW has used the vertical line days metric to allow for comparisons across fisheries which deploy gear for different amounts of time during a given calendar year and to represent the relative entanglement risk (exposure to vertical lines) originating from a given fishery. Vertical line days are not equivalent to the number of vertical lines in the water at any given point in time. The vertical line days metric is most meaningful when comparing relative contributions between fisheries, or evaluating the contribution of California commercial Dungeness crab relative to other trap fisheries.

C.3 Findings

The estimated total number of vertical line days per year has been decreasing between 2014 and 2022 with the highest amount in 2014 and the lowest amount in 2022 (Figure C-1, Table C-1). While the annual percentage was variable (Table C-1), on average the commercial Dungeness crab fishery contributed 62.5% of the annual vertical line days from 2014-2022.

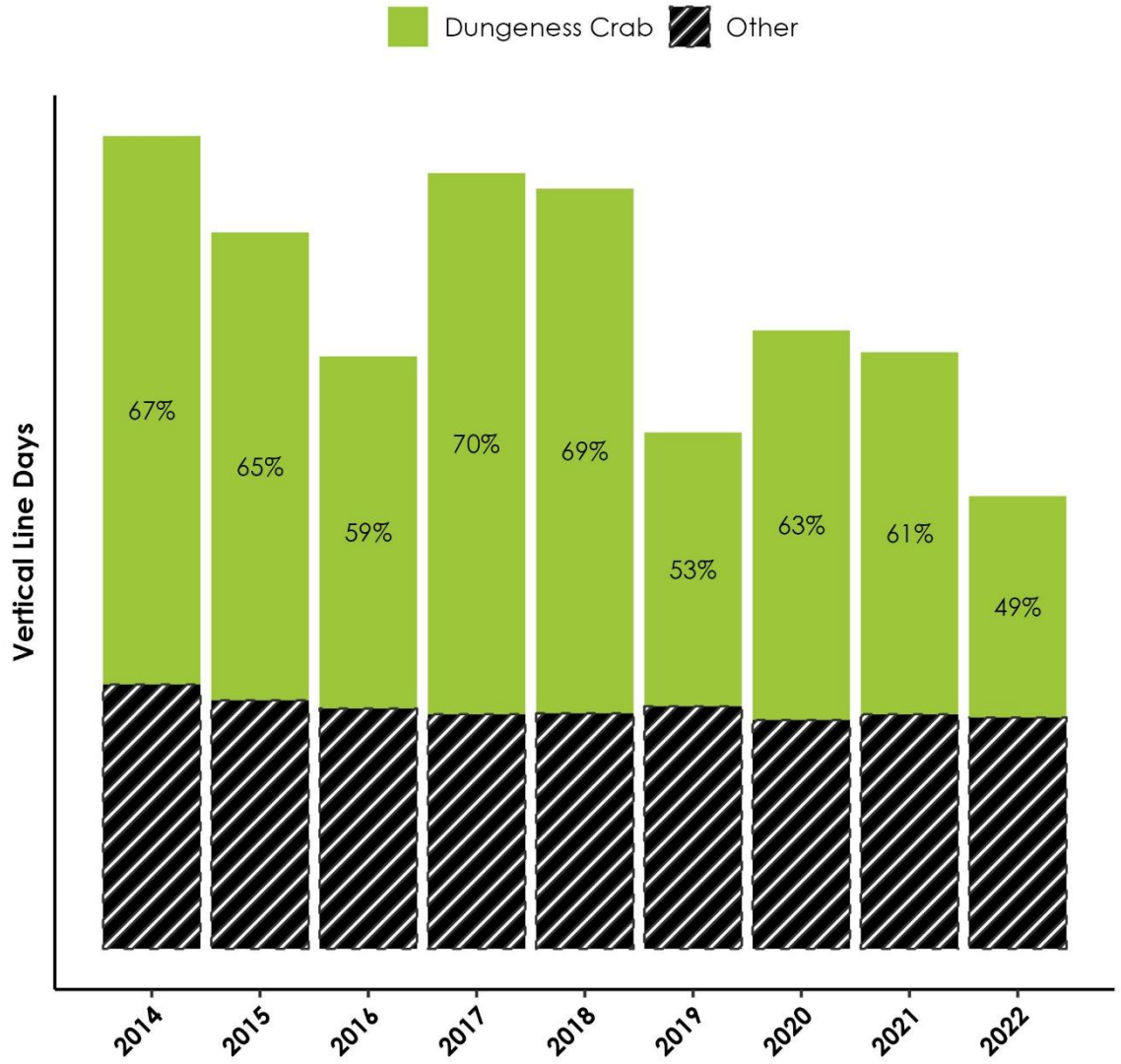

Figure C-1. Vertical line days contributed by California trap gear fisheries from the years 2014-2022. The percentage contributed by the commercial Dungeness crab fishery is shown on the light green section of each stacked column and all other fisheries included in analysis are represented by the black and white patterned section.

Table C-2. Estimated number of vertical line days contributed by the commercial Dungeness crab fishery for each year from 2014-2022, the estimated total number of vertical line days for all fisheries included in analysis by year, and the percentage of commercial Dungeness crab vertical line days on an annual basis.

Year	Percentage of total vertical line days contributed by the California commercial Dungeness crab fishery
2014	69.2%
2015	67.6%
2016	61.4%
2017	71.5%
2018	69.6%
2019	53.9%
2020	62.9%
2021	60.8%
2022	49.9%

To determine anticipated take (Section 4.3) CDFW took the average total vertical line days percentage from 2017-2022 and found the commercial Dungeness crab fishery contributed an annual average of 61.4% of the total vertical line days.

Table C-1. Data gaps and data assumptions or solutions for each fishery included in the analysis. Analysis also includes several assumptions present across all fisheries which are listed in the narrative above.

Fishery	Data Limitation	Solution/Assumption	Potential Refinements
Commercial coonstripe shrimp	No maximum trap limit, therefore, no maximum number of vertical lines in the water.	NOAA Fixed Gear Report states 10-15 traps per string, and 500 traps or less. Used average value of 12.5 traps per string, and a total of 500 traps.	Obtain data on typical number of traps used and whether traps are strung together in multi-trap trawls.
Commercial spot prawn	No specified bounds on traps per string.	NOAA Fixed Gear Report states 10-50 traps per string; CDFW SMEs confirmed this was reasonable. Used average value of 30 traps per string and two vertical lines (one at each end of the string).	Obtain more information on average number of traps strung together in multi-trap trawls.
Commercial spot prawn	Fishable days differ north and south of Point Arguello (274 days vs. 273 days).	Fishable days reflected the longer fishing season (274 days).	NA
Commercial California spiny lobster	Prior to 2017 there was no maximum trap limit.	CDFW SMEs estimated that between 2014-2016, 330 traps per participant was common.	NA
Commercial Dungeness crab	The commercial fishery was closed intermittently from 2014-2022 due to domoic acid, limiting fishable days. Furthermore, the number of fishable days differed between the NMA and CMA.	Fishable days were adjusted when a given management area was fully closed. For a given year, the number of fishable days was separately calculated for each management area, and the larger value selected.	Include data from bi-weekly reporting to more accurately account for trap usage.
CPFV Dungeness crab	The recreational fishery was closed intermittently during the 2015-16 season and the 2018-19 season due to domoic acid.	Fishable days were adjusted when a given management area was fully closed. For a given year, the number of fishable days was separately calculated for each management area, and the larger value was selected.	NA

CPFV Dungeness crab	Active participants and trap usage information is only available at the trip level.	To calculate active participants per year used number of unique vessels that submitted logbooks. Counted each vessel as one "participant" and used the maximum allowed 60 traps per vessel.	NA
CPFV Dungeness crab	Logbooks included effort south of Pt. Arguello, which would use hoopnets as traps are prohibited	Excluded trips which occurred south of Pt. Arguello.	NA
Commercial rock crab	Information on whether the fishery strings gear is variable and unclear.	CDFW SMEs indicated 100-200 traps per participant is common. Used 150 traps and one vertical line per active participant.	Obtain more information about typical number of traps used and multi-trap trawl usage per participant.
Commercial rock crab	Commercial fishery was closed intermittently from 2014-2022 due to domoic acid, limiting fishable days.	Fishable days were adjusted when a given management area (north vs. south of Lopez Point, Monterey County) was fully closed.	NA
Commercial hagfish	No specified bounds on traps per string when using either gear type (buckets or barrels).	CDFW SMEs indicated 20-30 buckets per vertical line is common. Used an average of 25 buckets per vertical line.	NA
Commercial hagfish	For the years 2016-2018 barrels were a legal form of gear, but couldn't quantify active participants using barrels because the gear code wasn't applicable on landing receipts.	CDFW SMEs stated that not many fishers used barrels until 2018 when regulations were refined. Assumed that all fishers between 2016 and 2018 were fishing buckets.	NA