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North Pacific Observer Program 2019 Annual Report

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Executive Summary

This Annual Report provides information, analysis, and recommendations based on the deployment of observers and Electronic Monitoring (EM) systems by the North Pacific Observer Program (Observer Program) during 2019.

Section 313 of the Magnuson-Stevens Act (16 U.S.C. 1862) authorizes the North Pacific Fishery Management Council (Council), in consultation with National Marine Fisheries Service (NMFS), to prepare a fishery research plan for the purpose of stationing observers and EM systems to collect data necessary for the conservation, management, and scientific understanding of the commercial groundfish and Pacific halibut fisheries of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) management areas. Observers and EM systems collect fishery-dependent information used to estimate total catch and interactions with protected species. Managers use these data to manage groundfish and prohibited species catch within established limits and to document and reduce fishery interactions with protected resources. Scientists use fishery-dependent data to assess fish stocks, to provide scientific information for fisheries and ecosystem research and fishing fleet behavior, to assess marine mammal interactions with fishing gear, and to assess fishing interactions with habitat.

Each year, the Annual Deployment Plan (ADP) describes the science-driven method for deployment of observers on vessels in the partial coverage category (50 CFR 679.51(a)) in the halibut and groundfish fisheries off Alaska. The agency subsequently provides an Annual Report with descriptive information and scientific evaluation the deployment of observers and EM. The ADP and Annual Report process provides information to assess whether the objectives of the Observer Program have been met and a process to make recommendations to improve implementation of the program to further these objectives.

Program Summary

- Overall, for all federal fisheries off Alaska, 4,497 trips (43.3%) and 510 vessels (47.0%) were monitored by either an observer or EM system in 2019.
- 404 individual observers were trained, briefed, and equipped for deployment to vessels and processing facilities operating in the BSAI and GOA groundfish and halibut fisheries.
- Observers collected data on board 398 fixed gear and trawl vessels and at seven processing facilities for a total of 39,989 observer days (36,068 full coverage days on vessels and in plants; and 3,921 observer deployment days in partial coverage).
- NMFS approved 168 eligible vessels in the 2019 EM selection pool. Of these, 146 vessels fished at least 1 trip but not all vessels were selected to turn on their EM system. In 2019, EM data were collected from 116 unique vessels on a total of 357 trips. EM data from both hook-and-line and vessels were incorporated into the Catch Accounting System and used for management.
- 27 Fisheries Monitoring and Analysis Division (FMA) staff completed 121 debriefings in Anchorage, Alaska; 1 debriefing in Kodiak, Alaska; and 559 debriefings in Seattle, Washington.

- The agency continues to find outreach to be a valuable way to share information with fishery participants, to answer their questions, and to get their input on areas of concern and potential solutions. In 2019, NMFS' outreach efforts occurred in various locations in Seattle, Washington; Alaska; and via telephone. Throughout the year, extensive coordination and collaboration continued between NMFS and the Alaska Seafood Cooperative regarding the management and implementation of the 2019 Exempted Fishing Permit evaluating the feasibility of reducing halibut mortality on designated trawl catcher processor vessels in the Bering Sea. In addition to weekly phone and in-person discussions, FMA field staff assisted with EM camera chute data pulls and troubleshooting chute system issues, conducting deck safety plan assessments and approvals, and held several public meetings in Seattle in April and October.

Fees, Budget, and Costs

- The expenditures for observer deployment in 2019 in the partial coverage category was $4,342,098 for 3,316 days (Table 2-1).
- Fee billing statements for 2019 were mailed to 106 processors and registered buyers in January 2020 for a total of $2,895,377 in observer fees. (Section 2.1).
- The breakdown in contribution to the 2019 observer fees by species was: 40% Pacific halibut, 34% sablefish, 12% Pacific cod, 11% pollock, and 3% all other groundfish species (Table 2-1).
- The average cost per observer sea day in the partial coverage category in 2019 was $1,309 (based on the cost of $4,342,098 to procure 3,316 observer days) (Section 2.3.2).
- The average cost per EM sea day in the partial coverage category in 2019 was $607 (based on $1,102,666 adjusted annual cost for 1,817 EM sea days) (Section 2.3.4).

Deployment Performance Review

A review of the deployment of observers and EM in 2019 relative to the intended sampling plan and goals of the Observer Program is provided in Chapter 3. A set of performance metrics was used to assess the efficiency and effectiveness of observer deployment, with emphasis on the partial coverage category. These metrics provide a method to evaluate the quality of data being collected under the restructured Observer Program.

Did We Meet Anticipated Deployment Goals?

Effort Predictions

Based on simulations of annual fishing effort from for the final 2019 ADP, NMFS expected to observe 3,109 fishing days in 2019. The actual number of observer days purchased in 2019 was 3,316, which was 6.6% greater than predicted greater, but well within the range of possibilities predicted in the ADP.

Observer Declare and Deploy System (ODDS) Performance

Random selection of trips in the trip selection stratum is facilitated by the ODDS. Users of the system are given flexibility to accommodate their fishing operations; up to three trips may be logged in advance of fishing and trips can be cancelled to accommodate changing plans.

- Logged trips can be either closed (marked as complete) or cancelled. Of the 5,513 total trips logged, 1,264 were selected, and 226 were cancelled: three by ODDS (0.24%) and 223 by users (17.6%). The cancellation rate for selected trips ranged from 3.8% for in the EM hook-and-line stratum to 37.5% for Trawl Tender stratum.
- If a trip is selected for observer coverage and cancelled, then the vessel's next logged trip is automatically selected for coverage. The "inherited" trips preserve the *number* of selected trips in the year, however they can cause *delay* of selected trips during the year and result in temporal bias. The relative percentage of selected trips that inherited their final selected-status due to a previous cancellation ranged from 3.8% in EM pot stratum to 26.7% in the Tender Pot stratum. Within the same gear-type, cancellation rates and the proportion of inherited trips were much larger for strata that used observers for at-sea monitoring than those that used EM (Section 3.6.2).

Evaluation of At-sea Deployment

There were 10 deployment strata evaluated in 2019 (Section 3.6.3). A summary of the number of vessels and trips in each strata and realized coverage rates in 2019 are as follows:

Coverage category	Strata	Total vessels	Total trips	Sampled trips	Expected coverage rate	Realized coverage rate	Met expectations? *
Full coverage	Full	161	3,343	3,338	100.0	99.9	No**
Partial coverage	Hook-and-Line	318	1,744	307	17.7	17.6	Yes
	Pot	73	916	291	15.4	14.0	Yes
	Tender Pot	30	44	13	16.1	29.5	Higher than expected
	Trawl	78	1,568	395	23.7	25.2	Yes
	Tender Trawl	26	56	20	27.1	35.7	Yes
	EM Hook-and-Line	138	916	291	30.0	31.8	Yes
	EM Pot	21	165	60	30.0	36.4	Yes
No selection	Zero Coverage	393	2,005	0	0.0	0.0	Yes
	Zero Coverage- EM Research	4	29	0	0.0	0.0	Yes

*The expectation for partial coverage strata is that selection rates are within the 95% confidence intervals of realized deployment rates. The expectation for full and zero coverage strata are that coverage rates are exactly 100% and 0%, respectively.
** Five full coverage trips were unmonitored due to a fixed gear catcher vessel that due to vessel size and target fishery was in full coverage, but mistakenly logged trips as partial coverage.

Dockside Monitoring

The sampling design used for dockside monitoring in 2019 remained unchanged from previous years. All vessels participating in the BSAI pollock fisheries are in the full coverage category and dedicated plant observers monitor all deliveries to account for salmon bycatch. In the GOA, all pollock trawl catcher vessels are in the partial coverage category and observers deployed on selected trips monitor the delivery at the shoreside processors to obtain counts of salmon caught as bycatch within the trawl pollock fishery and to obtain tissue samples to enable stock of origin to be determined using genetic techniques. When an observed trawl vessel in the GOA delivers its pollock catch to a tender vessel instead of a shoreside processor, the observer is unable to monitor the delivery and collect additional tissue samples. In this situation, the trip would be monitored, but there is no offload monitoring.

A total of 2,371 pollock deliveries to shoreside processors were monitored for salmon in 2019. Of those, 2,092 occurred in ports in the Bering Sea and 279 occurred in ports in the Gulf of Alaska (Table 3-8).

Was the Coverage Representative?

Temporal Patterns

Section 3.7.1 evaluated the possibility for temporal bias in each observed stratum. Coverage rates were outside of 95% confidence intervals in the EM pot (for 9.3% of the year) and tender pot (for 28.2% of the year) strata. The EM hook-and-line, pot, and trawl strata were outside of the expected range earlier in the year but fell within the expected range by the end of April. At the end of year, the number of observed trips was outside of the expected range in only one of the seven partial coverage strata: the tender pot stratum. Overall, there appeared to be less temporal bias in 2019 than in 2018.

Spatial Representativeness

Section 3.7.2 evaluated the spatial distribution of observed trips to determine if they reflect the spatial distribution of all trips. The expected number of trips was compared with the observed number of trips in each NMFS Reporting Area and stratum combination (Fig. 3-4). In most cases, the realized number of monitored trips was close to the expected result and results do not indicate a large source of spatial bias in 2019.

Trip Metrics

Section examined six trip metrics including the following: the number of NMFS areas visited in a trip, trip duration (days), the weight of the landed catch (in metric tons [t]), the vessel length (m), the number of species in the landed catch, and the proportion (0 to 1) of the landed catch that was due to the most predominant species (pMax). The trip metrics were used to evaluate observer effects to determine if observed trips are similar to unobserved trips (Table 3-10):

- In the EM hook-and-line stratum, one metric had low *p*-value; monitored trips in this stratum landed 13.4% (0.52) more species than unmonitored trips.

- In the hook-and-line stratum, two metrics had low *p*-values; observed trips in this stratum were 12.3% (0.66 days) shorter in duration and landed catch that weighed 13.6% (0.90 t) less than unobserved trips.
- In the tender pot stratum, one metric had a low *p*-value. Observed trips in this stratum landed catch that weighed 100.1% (175.76 t) more than unobserved trips.
- In the trawl stratum, two metrics had low *p*-values; observed trips in this stratum occurred in 4.4% (0.05) fewer areas and landed 11.9% (0.73) fewer species than unobserved trips.
- In both the tender trawl and the pot strata there were no metrics with low *p*-values, so there was no significant differences detected between observed and unobserved trips.

In most cases the effect size of the metrics with low *p*-values is small. The exception is the result in the tender pot stratum, which had a large magnitude of difference. Landings of tendered trips can be quite large on rare occasions, and when rare large landings occur, whether they are observed or unobserved, these single trips can 'tip the scales' for permutation tests across the entire strata. In 2019, one of these very large-landing trips was observed.

Was There an Adequate Sample Size?

In a well-designed sampling program, the observer coverage rate should be large enough to reasonably ensure that the range of fishing activities and characteristics are represented in the sample data. The Catch Accounting System (CAS) post-stratifies data into groups of fishing activities with similar trip characteristics such as gear, trip targets, and area. At low numbers of trips and low sampling rates, the probability of no observer data within a particular post-stratum is increased and may result in expansions of bycatch rates from one type of fishing activity against landings for a different type of fishing activity. This will result in biased estimates of bycatch. For this reason, it is important to have a large enough sample (observed trips and vessels) to have reasonable expectation of observing all types of fishing. The results in 2019 were similar to previous years and illustrated that 1) the likelihood of at least one observation is increased with fishing effort and 2) is also increased with an increase in the selection rate. Given our sampling rates in the seven partial coverage trip-selection strata, the probability of having no monitored trips in a NMFS Reporting Areas increases quickly above 0.05 when there are fewer than 8 trips in the EM hook-and-line stratum, 6 trips in the EM pot stratum, 15 trips in the hook-and-line stratum, 19 trips in the pot stratum, 7 trips in tender pot stratum, 10 trips in the trawl stratum, and 6 trips in the tender trawl stratum in a given area.

Compliance and Enforcement

The Office of Law Enforcement, Alaska Division (AKD), works closely with the U.S. Coast Guard (USCG), Alaska Wildlife Troopers (AWT), industry, Observer Program, and observer providers to address incidents that affect observers and observer work environments, safety, and sampling. In 2019, AKD received 906 statements filed by observers. Each statement is evaluated and prioritized, and most are forwarded for investigation. AKD also utilizes observer statements to track compliance trends. Trend analysis helps focus and prioritize enforcement efforts, outreach, education, and compliance assistance.

1. Introduction

This annual report provides information, analysis, and recommendations based on deployment of observers and Electronic Monitoring (EM) systems under the North Pacific Observer Program (Observer Program) during 2019. Section 313 of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. 1862) authorizes the North Pacific Fishery Management Council (Council), in consultation with National Marine Fisheries Service (NMFS), to prepare a fishery research plan. NMFS implemented the Council's fisheries research plan through the North Pacific Observer Program (Observer Program). The Observer Program provides the regulatory framework for stationing observers and EM systems to collect data necessary for the conservation, management, and scientific understanding of the commercial groundfish and Pacific halibut fisheries of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) management areas.

Observers and EM systems collect fishery-dependent information used to estimate total catch and interactions with protected species. Managers use these data to manage groundfish and prohibited species catch within established limits and to document and reduce fishery interactions with protected species. Scientists use fishery-dependent data to assess fish stocks, provide data for fisheries and ecosystem research and fishing fleet behavior, assess marine mammal interactions with fishing gear, and characterize fishing impacts on habitat.

All vessels and processors that participate in federally managed or parallel groundfish and halibut fisheries off Alaska (except catcher vessels delivering unsorted codends to a mothership) are assigned to one of two categories: 1) the full observer coverage category (full coverage), or 2) the partial observer coverage category (partial coverage). Vessels and processors in the full coverage category have at least one observer present during all fishing or processing activity. Vessels and processors in the partial coverage category are assigned observer or EM coverage according to the scientific sampling plan described in the Annual Deployment Plan (ADP) developed by NMFS in consultation with the Council. Since 2013, observers have been deployed in the partial coverage category using established random sampling methods to collect data on a statistically reliable sample of fishing vessels in the partial coverage category. Some vessels and processors may be in full coverage for part of the year and partial coverage at other times of the year depending on the observer coverage requirements for specific fisheries.

Observer coverage in the full coverage category is industry-funded through a pay-as-you-go system whereby fishing vessels procure observer services through NMFS-permitted observer service providers. Observer coverage in the partial coverage category is funded through a system of fees collected under Section 313 of the Magnuson-Stevens Act. The fee is based on the ex-vessel value of groundfish and Pacific halibut and is assessed on landings by vessels not included in the full coverage category. The system of fees fairly and equitably distributes the cost of observer coverage among all vessels and processors in the partial coverage category.

The current structure of the Observer Program, including the definition of full and partial coverage, random deployment methods, and the fee system has been in place since 2013 when the Observer Program was restructured and changes were implemented under Amendment 86 to the Fishery Management Plan (FMP) for Groundfish of the BSAI Management Area and Amendment 76 to the FMP for Groundfish of the GOA (Amendments 86/76)[1]. Since 2013, a series of regulatory and Fishery Management Plan (FMP) amendments have been implemented to amend the Council's fisheries research plan and make specific modifications to observer coverage requirements under the Observer Program:

- BSAI Amendment 112 and GOA Amendment 102 revised observer coverage requirements catcher/processors (81 FR 17403, 29 March 2016). This rule allowed small, non-trawl catcher/processor that met specific criteria to choose to be in the partial observer coverage category. Effective 29 March 2016.

- BSAI Amendment 109 revised observer coverage requirements and placed catcher vessels less than or equal to 46 ft LOA when groundfish fishing under a Community Development Quota (CDQ) into the partial coverage category (81 FR 26738, 4 May 2016). Effective 3 June 2016.

- A regulatory amendment (81 FR 67113, 30 September 2016) revised observer coverage requirements for BSAI trawl catcher vessels and allows the owner of a trawl catcher vessel to request, on an annual basis, placement in the full observer coverage category for all directed fishing for groundfish using trawl gear in the BSAI for one year. Effective 31 October 2016.

- BSAI Amendment 114 and GOA Amendment 104 integrated EM into the North Pacific Observer Program (82 FR 36991, 7 September 2017). The rule established a process for owners or operators of vessels using non-trawl gear to request to participate in the EM selection pool and the requirements for vessel owners or operators while in the EM selection pool.

- A regulatory amendment (84 FR 55044, 15 October 2019) implemented regulations for catch handling and monitoring requirements to allow halibut bycatch to be sorted on the deck of trawl catcher/processors and motherships when operating in the non-pollock groundfish fisheries off Alaska. This rule allows halibut to be returned to the water faster while also ensuring that observer data continue to result in reliable estimates of halibut incidental catch rate and viability. This rule also changed observer sampling station inspection requirements in Federal groundfish fisheries and made minor changes to bin monitoring requirements for the Amendment 80 fleet. Effective 14 November 2019. Implemented 1 January 2020.

- A regulatory amendment (84 FR 55044, 15 October 2019) implemented regulations for catch handling and monitoring requirements to allow halibut bycatch to be sorted on the

[1] The final rule for Amendments 86/76 was published in the Federal Register on November 21, 2012 (77 FR 70062).

deck of trawl catcher/processors and motherships when operating in the non-pollock groundfish fisheries off Alaska. This rule allows halibut to be returned to the water faster while also ensuring that observer data continue to result in reliable estimates of halibut incidental catch rate and viability. Effective 14 November 2019. Implemented 1 January 2020.

1.1. Observer Coverage Categories and Coverage Levels

1.1.1. Full Coverage

Vessels and processors in the full observer coverage category must comply with observer coverage requirements at all times when fish are harvested or processed. Specific requirements are defined in regulation at 50 CFR § 679.51(a) (2). The full coverage category includes the following:

- Catcher/processors (with limited exceptions).
- Motherships.
- Catcher vessels participating in programs that have transferable prohibited species catch (PSC) allocations as part of a catch share program.
- Catcher vessels using trawl gear that have requested placement in the full coverage category for all fishing activity in the BSAI for one year; and
- Inshore processors receiving or processing Bering Sea pollock.

Independent estimates of catch, at-sea discards, and PSC -- among other data -- are collected aboard all catcher/processors and motherships in the full observer coverage category. Requiring at least one observer on every catcher/processor means that at-sea discards and PSC estimates are not based on self-reported data or extrapolated observer data from other vessels. Catcher vessels participating in programs with transferable PSC allocations as part of a catch share program also are included in the full coverage category. These programs include Bering Sea pollock (both American Fisheries Act and CDQ programs), the groundfish CDQ fisheries (CDQ fisheries other than Pacific halibut and fixed gear sablefish; only vessels greater than 46 ft LOA), and the Central GOA Rockfish Program.

Independent observer data are important under these catch share programs because quota share recipients are prohibited from exceeding any allocation, including, in many cases, transferable PSC allocations. Allocations of exclusive harvest privileges can create increased incentive to misreport as compared to open-access or limited-access fisheries. Transferable PSC allocations also present challenges for accurate accounting because these species are not retained for sale and they represent a potentially costly limitation on the full harvest of the target species. To enforce a prohibition against exceeding a transferable target species or PSC allocation, NMFS must demonstrate that the quota holder had catch that exceeded the allocation. Supporting a quota overage case for target species or PSC that could be discarded at sea from an unobserved vessel requires NMFS to rely on either industry reports or estimated catch based on discard rates from other similar observed vessels. These indirect data sources create additional challenges to NMFS in an enforcement action. In addition, the smaller the pool from which to draw similar observed vessels and trips, the more difficult it is to construct representative at-sea discard and PSC rates for individual unobserved vessels.

Inshore processors receiving deliveries of Bering Sea pollock are in the full coverage category because of the need to monitor and count salmon under transferable PSC allocations.

1.1.2. Partial Coverage

The partial observer coverage category includes the following:

- Catcher vessels designated on a Federal Fisheries Permit when directed fishing for groundfish in federally managed or parallel fisheries, except those in the full coverage category.
- Catcher vessels when fishing for halibut individual fishing quota (IFQ) or Sablefish IFQ (there are no PSC limits for these fisheries).
- Catcher vessels when fishing for halibut CDQ, fixed-gear sablefish CDQ, or groundfish CDQ using pot or jig gear; or catcher vessels less than or equal to 46 ft LOA using hook-and-line gear fishing for groundfish.
- Catcher/processors that meet criteria that allows assignment to the partial coverage category.
- Shoreside or stationary floating processors, except those in the full coverage category.

Each year, the ADP describes the science-driven method for deployment of observers on vessels in the partial coverage category (50 CFR 679.51(a)) in the Pacific halibut and groundfish fisheries off Alaska. The 2019 ADP (NMFS 2018) is summarized in Section 1.3.

1.2. Annual Planning and Reporting Process

Amendments 86/76 established an annual process of 1) developing an ADP that describes plans and goals for observer deployment in the partial coverage category in the upcoming year, and 2) preparing an annual report providing information and evaluating performance in the prior year.

The Annual Deployment Plan (ADP) describes how observer coverage and EM will be assigned to vessels and processors in the partial observer coverage category in the upcoming year. NMFS develops each ADP in consultation with the Council after reviewing an evaluation of deployment performance for the previous year. NMFS and the Council created the ADP process to provide flexibility in the deployment of observers and EM to gather reliable data for estimation of catch in the groundfish and halibut fisheries off Alaska. The ADP process ensures that the best available information is used to evaluate deployment, including scientific review and Council input, to annually determine deployment methods. The 2019 ADP is summarized in Section 1.3 of this report.

The Annual Report provides descriptive information, analysis, and recommendations based on observer deployment in the previous year. An important component of the annual report is Chapter 3, the "deployment performance review" chapter, which statistically evaluates the deployment of observers and EM in the previous year. The purpose of the deployment performance review is to evaluate whether observer deployment and monitoring goals detailed in regulation and the ADP were achieved and to identify recommendations for observer deployment in order to promote the collection of data necessary to conserve and manage the groundfish and halibut fisheries.

The annual report is an important source of information in developing the proposed ADP for the next year and informing potential regulatory changes to the Observer Program. The annual planning and reporting process is described below:

- **February – May**: NMFS staff compile the annual report for the previous year. Chapter 3 (the deployment performance review) is prepared by the Observer Science Committee, which is described in more detail in Chapter 3.
- **May – June**: Normally, the 2019 Annual Report would have been published in June of 2020 and the report would have been presented to the Council (including the Council's Monitoring Committee, Advisory Panel, and Scientific and Statistical Committee) and to the public. The publication of the 2019 Annual report was delayed and in June 2020, NMFS met with the Fishery Monitoring and Advisory Committee (FMAC) and discussed COVID-19 issues related to observer deployment and data collection in the full and partial coverage fleets. The meeting served as a forum for dialogue among multiple stakeholders and agency staff to address challenges.
- **June – August**: NMFS prepares a draft ADP for the upcoming year.
- **September**: NMFS releases the draft ADP in early September each year to allow review by the Groundfish and Crab Plan Teams. The Council's Monitoring Committee also reviews the draft ADP prior to the Council's October meeting and provides written recommendations to the Council.
- **October**: The Council and its Advisory Panel and Scientific and Statistical Committee review the analysis used to prepare the draft ADP as well as Plan Team and Monitoring Committee recommendations and any input from the public. NMFS reviews and considers comments made by the Council and its committees, however extensive revisions to the analysis used to prepare the draft ADP are not feasible between October and December.
- **December**: NMFS finalizes the ADP by computing the selection rates for the upcoming year using a refined estimate of the total budget and expected fishing effort. Ideally the final ADP will be released to the public prior to the December Council meeting. NMFS also evaluates whether the Environmental Assessment (EA) prepared for Observer Program Restructuring (NPFMC and NMFS 2011) needs to be supplemented for the ADP. In 2014, NMFS prepared a Supplementary Information Report explaining why the EA did not need to be supplemented. In 2015, NMFS prepared a Supplemental Environmental Assessment (NMFS 2015) in response to a Court Order to consider whether the restructured Observer Program would yield reliable, high-quality data given likely variations in costs and revenues.

1.3. Summary of the 2019 Annual Deployment Plan

The 2019 ADP outlined the sampling plan for 2019 (NMFS 2018). The most important goal of the ADP is to randomize observer deployment in the partial coverage category. Sampling that incorporates randomization is desirable at all levels of the sampling design because 1) sampling theory dictates that randomization at all levels allows for unbiased estimation, and 2) sampling is generally preferential over a census because it is more cost-efficient, is less prone to bias than an imperfectly implemented census (one subject to logistical constraints), and can result in greater data quality (Cochran 1977).

Since 2008 the Observer Program has employed a hierarchical (nested) sampling design (Cahalan et al. 2014). Starting in 2013, randomization of samples occurs at all levels of sampling. The ADP sets forth the sampling plan with the goal of randomization of observer deployment at the first level of the sampling design — the trip or vessel level. Since 2017, trip-selection has been the sole method to deploy observers into the fishery. The other sampling levels, including sampling the haul (or set) for species composition, and sampling individual fish to collect lengths, weights, and tissue samples, are achieved through observer sampling methods described in the observer sampling manual (AFSC 2018).

Stratified random sampling, such as is described in the ADP, requires that sample units (such as trips), be assigned to a single stratum and that within a stratum a single sampling design and estimation process is used. Hence, the partial coverage strata are separate from each other and separate from the full coverage stratum and estimation calculations will reflect this. By definition, each trip must be assigned to a stratum before any fishing occurs, the probability of selection must be based on the stratum, and this probability must be known for all observed and unobserved trips.

Following the Council's recommendation, the 2019 ADP allocated partial coverage observer effort to at-sea deployments on trips belonging to five strata that were defined by gear type and tender delivery status (Table 1-1).

Starting in 2018, EM has been integrated into the North Pacific Observer Program under a regulated program. NMFS approved 168 eligible vessels in the EM selection pool in 2019 and the EM data from both hook-and-line and vessels were incorporated into the CAS and used for management.

To determine the 2019 selection rates for observed strata, NMFS used an anticipated budget of 3,110 days as the basis for generating cost estimates under a variety of sampling rates, stratification schemes, and optimization targets (NMFS 2018). NMFS and the Council supported a five strata design for observers, with an optimal allocation strategy based on discarded groundfish and halibut and Chinook PSC (NMFS 2018).

The selection rates described in the 2019 ADP and programmed into the Observer Declare and Deploy System (ODDS) application were as follows:

- No selection (*zero coverage*) – 0%.
- Electronic Monitoring (*EM*) – 30%.
- Trawl (*TRW – No Tender*) – 24%.
- Hook-and-line (*HAL*) – 18%.
- Pot (*POT – No Tender*) – 15%.
- Tender trawl (*TRW - Tender*) – 27%.
- Tender pot (*POT - Tender*) – 16%.

Evaluation of deployment in each strata is described in Chapter 3 (note that the strata naming convention utilized in Chapter 3 is listed above in italics).

Under regulations published in 2016, 19 catcher vessels were placed in the full coverage category for all directed fishing for groundfish using trawl gear in the Bering Sea and Aleutian Islands management area (BSAI) for the 2019 calendar year.

1.4. Changes Since the 2019 ADP

The focus of this Annual Report is on performance in 2019. However, there were changes to the partial observer coverage sampling plan in 2020 and 2021, so we provide a brief summary here of the changes that occurred under the 2020 ADP (Table 1-1).

- 2020 was the first year of an Exempted Fishing Permit (EFP) to evaluate the efficacy of EM on pollock catcher vessels using pelagic trawl gear in the Bering Sea and Gulf of Alaska.

- The Draft 2020 ADP (NMFS 2019a) provided an evaluation of the tendering strata (tender pot and tender trawl) and showed that the implementation of tender strata did not substantially change the expected rates of coverage. Ultimately, NMFS did not implement tender-based strata in 2020.

- The following stratification scheme with sample sizes allocated according to the 15% plus optimization based on discarded groundfish, Pacific halibut, and Chinook salmon were implemented under the 2020 ADP (NMFS 2019b):

    - No selection – 0%.
    - Fixed-Gear EM – 30%.
    - Trawl – 20%.
    - Hook-and-line – 15%.
    - Pot – 15%.Trawl EM EFP–100% at-sea EM; plus: 30% shoreside monitoring in Gulf of Alaska and 100% shoreside monitoring in the Bering Sea.

- Starting in March 2020, the COVID-19 pandemic created limitations on available air travel and "shelter in place" restrictions, particularly in many remote Alaskan communities. The situation impacted observer deployment and the agency responded in order to protect public health and to ensure the safety of fishermen and observers, while maintaining an ongoing supply of fish to markets. More information on the changes that occurred throughout 2020 and the impact of the pandemic are described in the 2020 Observer Program Annual Report (AFSC and AKRO, 2021).

Table 1-1. -- Sampling strata and selection pools in the partial coverage category from 2013 to the 2020. The partial coverage selection rates set through the Annual Deployment Plan since 2013 are noted and the realized coverage rates evaluated in the Annual Report are noted in parentheses. CP = catcher/processor vessel; CV = catcher vessel; GOA= Gulf of Alaska; BS = Bering Sea; H&L = hook-and-line gear; LOA = vessel length overall.

Year	**Observer trip selection pool** Observer coverage required on all randomly selected trips	**EM trip selection pool** EM required on randomly selected	**Trawl EM**	**Observer vessel selection pool**	**No selection pool** Observer coverage not required	
2020	Trawl: 20%; H&L: 15%; Pot: 15%	Fixed gear (H&L and Pot) EM: EM required on randomly selected 30% of trips	100% at-sea EM; 30% shoreside monitoring in GOA and 100% shoreside monitoring in BS	n/a	Vessels <40' LOA and Jig gear	EM Innovation Research 4 vessels
2019	Trawl: 24% (25.2); Trawl Tender: 27% (35.7); H&L: 18% (17.6); Pot: 15% (14.0); Tender Pot: 16% (29.5)		n/a			
2018	Trawl: 20% (20.3); Trawl Tender: 17% (35.0); H&L: 17% (15.5); Pot: 16% (15.5); Tender Pot: 17% (29.0)	H&L EM: 30%; Pot EM Pre-implementation: 30%				
2017	Trawl: 18% (20.7); Trawl Tender: 14% (18.8); H&L: 11% (12.0); H&L Tender: 25% (0); Pot: 4% (7.7); Pot Tender: 4% (5.3)	n/a				Voluntary EM Pre-implementation ~90 vessels
2016	Trawl: 28% (28.0); H&L: 15% (15.0); Pot: 15% (14.7)					Voluntary EM Pre-implementation 60 vessels
2015	Large Vessel: 24% (23.4) Trawl CVs, Small CPs, H&L/Pot CVs ≥ 57.5'; Small Vessel: 12% (11.2) H&L/Pot CVs >40' and <57.5'					Voluntary EM Pre-implementation 12 vessels
2014	All Trawl CVs and H&L/Pot vessels ≥ 57.5' LOA: 16% (15.1)			H&L/Pot CVs >40' and <57.5': 12% (15.6)		Voluntary EM
2013	All Trawl CVs and H&L/Pot vessels ≥ 57.5' LOA: 14.5% (14.8)			H&L/Pot CVs >40' and <57.5': 11% (10.6)	Vessels <40' LOA and Jig gear	

2. Fees and Budget

2.1. Budget for Partial Coverage Category in 2019

Section 313(d) of the Magnuson-Stevens Act authorizes the creation of the North Pacific Fishery Observer Fund ("Observer Fund") within the U.S. Treasury. This was the seventh year that fees were collected from the partial coverage fleet. The following section provides information on the amount of fees that accrued on landings made in 2019 that are anticipated to be collected in 2020, as well as the amount of fees collected in 2019 that were obligated to the partial coverage contract to pay for sea days in 2019.

Fee billing statements for 2019 were mailed to 106 processors and registered buyers in January 2020. All but nine bills were paid in full by 15 February 2020. A total of $2,895,377 in observer fees will be collected once all bills are paid. At the time of this publication, six processors had not yet paid observer fees totaling $335. In order to collect delinquent fees, nine 30-day notices were mailed in March and six 60-day notices were mailed in April. Additional notices will be mailed as needed. Processors or registered buyers submitting late fee payments were charged an administrative fee of $25 plus interest on the observer fees with each notice.

The sequestration of funds initiated under the 2011 Budget Control Act continues to affect the Observer Fund. Each year, the Observer Fund is subject to sequestration, meaning a percentage of the fee revenue is held in the Fund. However, each year we also receive the sequestered funds from the previous year.

A total authorized transfer from the Observer Fund of $3,742,510 was made to the Alaska Fisheries Science Center (AFSC) to be used to support the final option of the observer deployment contract in fiscal year 2018 from 17 June 2018 to 16 June 2019.

In fiscal year 2018, no additional federal funds were obligated to the observer contract, but we were able to carryover some federal funds to support this need in fiscal year 2019 (Table 2-1). While 2019 contract obligations are outside the time scope of this report, they are included to show the carryover into 2019 fishing year which is encompassed by the final option year of the contract.

2.2. Fees Collected from 2019, Summarized by Species, Gear, and Area

Observer coverage for the partial coverage category is funded through a system of fees based on the ex-vessel value of groundfish and Pacific halibut, with potential supplements from Federal appropriations. The observer fee is assessed on landings accruing against a Federal total allowable catch (TAC) for groundfish or a commercial halibut quota made by vessels that are subject to Federal regulations and not included in the full coverage category. Therefore, a fee is only assessed on landings of groundfish from vessels designated on a Federal Fisheries Permit or from vessels landing IFQ or CDQ Halibut or IFQ Sablefish. Within the subset of vessels subject to the observer fee, only landings accruing against the Federal TAC are included in the fee assessment.[2]

A fee equal to 1.25% of the ex-vessel value is assessed on the landings of groundfish and halibut subject to the fee. Ex-vessel value is determined by multiplying the standard price for groundfish by the round weight equivalent for each species, gear, and port combination, and the standard price for halibut by the headed and gutted weight equivalent. The standard ex-vessel prices used for 2019 fee assessments were published in the Federal Register on 19 December 2018 (83 FR 65146).[3] Table 2-2, Table 2-3, and Table 2-4 summarize the observer fees that accrued for 2019.

2.3. Cost

2.3.1. Program Structure

The Fisheries Monitoring and Analysis Division (FMA) at the Alaska Fisheries Science Center (AFSC) oversees the Observer Program and is responsible for a suite of activities that support the overall observer data collection in the groundfish and halibut fisheries in Alaska. FMA has staff located in Seattle, Washington, and in Anchorage, Kodiak and Dutch Harbor, Alaska. The AFSC allocates a budget to FMA each fiscal year to support these activities. FMA staff are responsible for training, briefing, debriefing, and oversight of observers who collect catch data on board fishing vessels and at shoreside processing plants. FMA is also responsible for quality control/quality assurance of observer data, conducting research and development of fishery monitoring technologies, and providing a host of fishery-dependent data products and services.

The FMA Division is organized into four programs: Observer Training and Curriculum Development; Debriefing and Data Quality Control; Application Development and Data Presentation; and Division Management and Analytic Services.

Observer Training and Curriculum Development ensures that observers are properly trained and equipped for their deployments. Observers are trained to follow FMA's established data collection procedures while deployed on commercial fishing vessels or stationed at processing facilities. Training materials are regularly updated and created in response to changes in regulations and data needs for stock assessment and ecosystem-based fishery modeling efforts. Training methods are routinely updated to best convey the complex topics and concepts to the observer work force. Program staff also manage FMA's extensive gear inventory to ensure a sufficient supply for observers throughout the year at all FMA office locations and develop inventory control systems and policies to maintain safety equipment, provide sampling equipment readiness, and monitor equipment losses.

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[2] A table with additional information about which landings are and are not subject to the observer fee is in NMFS regulations at 679.55(c) (CFR 679.55 Observer Fees) and shown on page 2 of an informational bulletin available online at: Observer Fee Collection.

[3] Available online in the Federal Register at: 83 FR 65146.

Debriefing and Quality Control assures FMA's established data collection procedures were properly followed during observer deployments to commercial fishing vessels and processing facilities. Staff members assist at-sea observers through communications (referred to as in-season advising) available through custom software for answering questions, correcting data errors, and ensuring safety concerns are addressed. Data quality control activities, both in-season and post-deployment include data entry, data validation, and observer support, as well as industry, interagency, and interdivisional support. Staff members install and maintain custom software which is used to transmit observer information and data, ensure observers are trained on the use and configuration of software, and provide near real-time data quality control and guidance for observers using these systems. In addition, they document and evaluate each observer's data collection methodologies through interviews, electronic vessel surveys, and written descriptions submitted the observer. Staff conduct data quality control checks on data collected by fishery observers by verifying the accuracy of recorded data, identifying errors, and ensuring observers make the necessary corrections.

Application Development and Data Presentation develops custom software that supports the recording of fishing effort, location, species composition and biological data collected by fishery observers from North Pacific commercial fisheries. This software enables the transmission, validation, and loading of those data, the editing and reporting of current and vetted data sets; observer logistics and contract management; and the recording of bird and marine mammal data collections for both internal and external use. In collaboration with FMA analysts, staff working under this activity developed and continue to support ODDS which allows vessel owners to register, edit, and close fishing trips. This application was developed with independent modules for FMA management and the observer coverage services provider, which includes the ODDS call center, and each vessel owner.

Division Management emphasizes coordinating and prioritizing resources across programs and activities, as well as managing links between the programs and overall costs. In addition, overall management and supervision of staff, budget, and contracting is required to ensure resources are appropriately allocated and staff understand their responsibilities and priorities. Staff provide advice to support policy development, decision-making, and regulatory and program development by NMFS and the Council. They also provide guidance and advice on policy issues, monitoring programs, and related topics at the regional, national, and international level.

Analytic Services collaborates with scientists throughout the AFSC to ensure that observer data meet the needs of stock assessment and ecosystem-based fishery modeling efforts. In addition, analysts perform independent research aimed at identifying bias and variances associated with fishery-dependent sampling. Analysts work closely with the Alaska Regional Office and Council staff to ensure that FMA provides relevant, high-quality information for fisheries management and in support of requests from the Council and other constituents.

Division Management also oversees the partial coverage deployment and funding to ensure the infrastructure and contracts are in place to meet the observer deployment requirements of BSAI Amendment 86 and GOA Amendment 76. FMA staff provide oversight of the fishery observer services provider contract, serving as the primary point of contact for the contract provider and FMA. The contract provider and FMA staff coordinate with industry, schedule vessel inspections as needed, and participate in decision- making for partial coverage vessels that are selected for coverage but request a release from the requirement.

EM was formed as a unique activity within FMA under Division Management starting in 2013 and has continued to dedicate staff time to the development and integration of electronic technologies in Alaska fisheries. In April 2014, the Council convened an EM Workgroup to develop alternatives for EM in the small hook-and-line fleet. Several FMA staff participated in the workgroup and have a lead role in planning and executing coordinated research activities that will advance the science of EM and increase efficiencies in interpreting resulting data. In 2018 a total of $2,300,677 in NMFS funds were obligated towards EM in Alaska supporting both operational and innovation programs. Additional funds were also provided by the National Fish and Wildlife Foundation (NFWF) in support of EM deployment.

Program Field Offices

The Anchorage Field Office ensures FMA's established data collection procedures were properly followed during observer deployments to commercial fishing vessels and processing facilities as well as provides observers with support in the field during their deployment. Staff assist at-sea observers through in-season advising and mid-cruise debriefings. In addition, they document and evaluate each observer's data collection methodologies through interviews, electronic vessel surveys, and written descriptions submitted by observers, as well as conduct data quality control checks to verify data accuracy by identifying errors and ensuring the observer makes the necessary corrections. Staff conduct 1- and 2-day briefings at this field office and maintain an inventory of complete sampling and safety gear sets for observers redeploying directly from the Anchorage office.

The Kodiak Field Office provides support to observers primarily assigned to vessels in the GOA. Support includes conducting pre-cruise briefings with vessel representatives and observers prior to the observer's first trip aboard, conducting mid-cruise debriefings with observers to address any safety concerns on their vessels, reviewing their data collection methodology and recorded data, providing in situ problem resolution, and issuing sampling and safety equipment. In addition, staff receive, track, and ship biological samples that are collected by observers in support of resource management, scientific research, and observer training. Staff also serve as the primary FMA contact for observed vessels and processing facilities in the GOA.

The Dutch Harbor Field Office provides support primarily to observers assigned to vessels in the Bering Sea and Aleutian Islands. Support includes conducting pre-cruise briefings with vessel representatives and observers prior to the observer's first trip aboard, conducting mid-cruise debriefings with observers to address any safety concerns on their vessels, reviewing data collection methodology and recorded data, providing in situ problem resolutions, and issuing sampling and safety equipment. In addition, staff conduct observer sample station and scale inspections on board commercial fishing vessels to ensure the sample stations meet the standards required in federal regulations. Staff also serve as the primary FMA contact for observed vessels and processing facilities in the Bering Sea and Aleutian Islands.

2.3.2. Contract Costs for Partial Coverage

NOAA's Acquisition and Grants Office (AGO) secures and administers contracts for NMFS. FMA staff participate in contracting by initiating requirements documents, providing funding, and participating in the contract review and award process through formal source evaluation boards. The processes for Federal contracts follow the Federal Acquisition Regulations (FAR) and Commerce Acquisition Regulations (CAR). NMFS receive legal guidance on the FAR and CAR through NOAA contract attorneys and AGO staff.

After NOAA awards a contract, FMA staff participate by assigning a Contracting Officer Representative (COR) to the contract. The COR provides direct technical oversight of the contract by monitoring contract performance, identifying and resolving operational issues, and reviewing and approving invoices. While FMA is directly involved in day-to-day contract management through its assigned COR, NOAA retains full authority over the contract through their appointed Contract Officer (CO). The NOAA CO can modify, extend, cancel, and award contracts.

Contracts for observer services are awarded through a competitive process, allowing any company that provides these services to bid. The observer coverage for the first two years (2013 and 2014) of the program was procured through a 2-year contract awarded to AIS, Inc. A second contract was awarded for the subsequent 5 years of the program to AIS, Inc. in April 2015. A third contract was competed and subsequently awarded for up to five years of the program to AIS, Inc. in July of 2019.

Table 2-1 provides a summary of funds expended and observer days used since 2013. Note that past Annual Reports used funds obligated instead of funds expended to calculate an average sea day cost. An obligation of funds is a legal liability to disburse funds upon receiving the service – in this case the provision of observer coverage. Obligations of funds therefore reflect the potential quantities of service, not the cost of the realized service. Expenditures are the disbursement of funds and are directly related to the service.

The average annual cost per sea day in partial coverage have ranged between $895 and $1,380 since 2014 (Table 2-5). Much of this variation is associated with number of sea days used each year, as the cost of "optional" sea days are less expensive than "guaranteed" sea days under the federal contract. Additionally, there is variation from year-to-year in travel costs which, for Alaska, tend to be higher per trip than other regions of the country.

While past Annual Reports have included observer sea day costs from other federal observer programs around the Nation, this information was not available for 2019. The National Observer Program has convened a small working group comprised of regional observer program managers to better describe observer sea day costs – or other metric – such that cost comparisons can be made not just year-over-year in one region, but among regions with similar cost models.

2.3.3. Costs for Full Coverage

The costs associated with the full coverage category are paid by the commercial fishing industry directly to certified observer providers. This cost structure is sometimes referred to as "pay as you go." The services carried out by observer providers include paying observers, deploying observers to vessels and shoreside processors, recruiting, training and debriefing. There are currently four active certified providers in Alaska.

Since 2011, certified observer providers have been required to submit to NMFS copies of all of their invoices for observer coverage. The regulations require the submission of the following:

- Vessel or processor name.
- Dates of observer coverage.
- Information about any dates billed that are not observer coverage days.
- Rate charged for observer coverage in dollars per day (the daily rate).
- Total amount charged (number of days multiplied by daily rate).
- Amount charged for air transportation.
- Amount charged for any other observer expenses with each cost category separated and identified.

The invoices data were used to calculate the average cost of observer coverage in the full coverage category for 2019. The observer invoice data are confidential under section 402(b)(1) of the Magnuson-Stevens Act. Therefore, summarized information may be provided in this report only when the data used in the summary statistic derives from invoices submitted by at least three observer providers. This confidentiality requirement limits the detail of the average cost data that may be reported to the public, as noted below.

Table 2-6 lists total and average costs in the full coverage sector for each year 2014-2020. In 2019, the total cost billed to 170 vessels and processing facilities for observer coverage in the full coverage category was $14,004,293. The total number of observer days represented by these invoices was 36,375. Based on this information, the overall average cost per day of observer coverage in the full coverage category in 2019 was $385. This average combines invoiced amounts for the daily rate per observer day (variable cost) plus all other costs for transportation and other expenses (fixed costs). The average cost per day in 2019 compares with an average cost of $382 in 2018 and $385 in 2017.

Figure 2-1 and Figure 2-2 summarize the average costs to fishing and processing vessels in the full coverage category by sector and gear type in 2019. These sector and gear type categories are catcher/processors and motherships (CP/MS) with hook-and-line gear, CP/MS with pot gear, CP/MS with non-pelagic trawl gear, CP/MS with pelagic trawl gear, catcher vessels using non-pelagic trawl gear, catcher vessels using pelagic trawl gear, and shoreside processing plants (both floating and stationary). Costs include a daily observer rate, charged for every day an observer is assigned, as well as "incidental" costs, which are typically one-time charges to cover airfare, lodging, and logistics.

Figure 2-1 shows the average number of observer days per vessel in each sector and gear type category[4], the average fully-loaded cost per day of observer coverage[5], the average daily rate observer providers charged for observer coverage[6], and the average percent incidental costs per day. Days may include days by more than one observer in a year, and person-days of coverage for an operation may exceed 365 days in a year if multiple observers were present. The highest average number of days was on CP/MS with non-pelagic trawl gear (551), and the lowest average number of days was on catcher vessels using non-pelagic trawl gear (17). The high number of days in the non-pelagic trawl CP/MS category is explained by the year-round operation of these vessels, the two-observer requirement while operating in the BSAI, and in some cases, a third observer while operating under the halibut deck-sorting Exempted Fishing Permit (EFP).

The average daily observer rate (not including incidental costs) across all sectors and gear types was $348 (up from approximately $345 in 2018). The highest daily rate was for shoreside processors ($362) and the lowest daily rate was for CP/MS with pelagic trawl gear ($345); however, it should be noted that this rate was similar across all gear and sector categories.

The average fully-loaded daily rate (which includes all incidental costs) across all sectors and gear types was $385. The highest rate was for catcher vessels using non-pelagic trawl gear ($419, with 18% incidental costs) and the lowest rate was for CP/MS using both non-pelagic trawl gear ($379, with 9% incidental costs). The overall average percentage of incidental costs per day to the total cost per day across all gear types and sectors is 9.5%.[7] These differences in overall daily costs (from incidental costs) between sectors may be explained by operational processes. For example, several trawl CP/MS elected to carry their observers up to the fishing grounds in Alaska from Seattle at the beginning of the season, keeping their airfare costs lower. In contrast, some trawl catcher vessels fish in remote areas and may incur higher airfare charges to get observers to those locations.

Figure 2-2 shows the estimated average annual incidental and daily observer costs for observer coverage for vessels and processors. Daily observer costs equal the product of the daily rate for an observer and the number of days of observer coverage. Incidental costs equal total invoiced expenses minus the daily observer costs, and are primarily costs of transporting observers to and from their stations, including airfare, ground transportation, lodging etc. More information about

[4] The average number of observer days per vessel is calculated by dividing total observer days in each gear and sector category by the total number of vessels in that category. For vessels that fished multiple gear types, total observer days was calculated by weighting the proportion of hauls in each category to sum to 1 for each observer-day.

[5] For a vessel within a gear and sector category, the vessel's annual total daily rate is calculated by dividing the total cost for observer coverage (inclusive of costs paid for observers, airfare, and other incidental costs) by the number of observer days. The average total daily rate is calculated as a simple average of each vessel's annual total daily rate.

[6] For a vessel within a gear and sector category, the vessel's annual daily observer rate is calculated by dividing the costs paid for observers (excluding airfare and other incidental costs) by the number of observer days. The average daily observer rate is calculated by as a simple average of each vessel's annual daily observer rate.

[7] Calculated as total incidental costs divided by the total cost of coverage.

the comparison of costs per observer day for full and partial coverage is described in Section 2.4.3.

2.3.4. Costs for Electronic Monitoring

The EM costs are dependent on the number of vessels participating in the fixed gear EM program, the number of systems that need to be purchased and/or replaced on an annual or recurrent basis deployment rates, field support services, video review, and other factors. Table 2-7 reflects the costs of the fixed gear EM program in 2019. Much of the cost structure was designed by the EM Workgroup and categorizes one-time, amortized (for infrastructure, equipment, and capacity building, where the benefit extends over several years and the cost is proportioned among each of those years), and recurring costs. Amortized costs are largely the cost of installed EM equipment and assumes a 5-year life, recognizing that the actual equipment life may be longer. A simplified fully-loaded daily rate was calculated for the EM program that included amortized equipment costs, recurring operational costs, and video review. In 2019, the average cost per EM sea day in the partial coverage category was $607 (based on $1,102,666 adjusted annual cost for 1,817 EM sea days).

2.4. Cost Savings and Efficiencies

2.4.1. Partial Coverage

The second observer service provider contract was awarded on 22 April 2015. The rates that NMFS pays the observer services contractor were established through a competitive bidding process. This contract has several components designed to improve efficiency and reduce costs. For example, the new contract requires that a partially observed sea day (i.e., a day that begins after 1200 (noon) or returns to port before 1201) is paid at an amount equal to one-half the daily rate. The lower rate applies to all days completed by the contractor in which an observed vessel leaves or arrives in port before or after the designated times.

Similar to the previous contract, NMFS included the provision for observers to participate in NMFS fishery-independent surveys using funds made available through AFSC. This allows AIS, Inc. to provide additional work to their employees during the summer season when observer opportunities as part of the ADP are more limited. This provides their employees continuity in employment, additional experience, and may help to reduce employee turnover, thereby increasing overall efficiency. NMFS benefits from trained observers with sea experience to help to conduct their survey fieldwork.

2.4.2. Full Coverage

NMFS has implemented regulations that govern the terms of observer deployment (e.g., limiting deployment the duration, setting minimum qualifications, requiring specific experience for observers assigned to certain deployments, etc.). Efficiencies could potentially be gained by increasing competition, reducing constraints, or increasing efficiency of activities supported by NMFS.

The majority of full coverage business is conducted by three of the four NMFS-permitted observer providers. The most recent newly permitted observer provider was AIS, Inc., which received a permit to deploy observers in the full coverage category in August 2016. This pool is down from a high of ten permitted providers in 1991. It is NMFS' understanding that the pool was reduced due to competition, so it is uncertain if additional providers could be competitive, or if the impact would result in substantial increases in efficiency.

2.4.3. Comparing Costs Between the Full and Partial Coverage Categories

There are several factors that impact how comparable the average observer coverage costs per day are between in the partial coverage category and the full coverage category.

- The partial coverage contract is a federal contract between NMFS and the observer provider company, whereas the full coverage observer providers do not operate under a federal contract. Instead, full coverage observer providers are permitted by NMFS and contract observer services directly with vessels.
- Federal contracts are subject to Federal Acquisition Regulations, Fair Labor Standards Act, and Service Contract Act requirements, and applicable Department of Labor Wage Rate Determination which establish, among other things, minimum wage and benefits for observers, including overtime. Some of these same regulations and requirements can also apply to full coverage observer providers depending on the size of the companies.
- All travel costs and expenses incurred in partial coverage are reimbursed in accordance with the Government's Travel Regulations. These include specified per diem rates which are paid regardless of actual expenses.
- The costs associated with the partial coverage component are a daily fee NMFS pays for each sea day, and a reimbursable cost for travel as defined in the NOAA contract. Because NMFS only pays for sea days, the daily rate charged to NMFS must factor in an estimate for the contractor's fixed costs for unobserved days. Increasing the proportion of time spent at sea would increase the efficiency of the overall program since it would lower fixed costs to the contractor and allow for a newly negotiated lower daily rate charged to NMFS. Higher coverage rates equate to greater efficiency and lower costs per day, while lower coverage costs equate to lower efficiency and greater costs per day.
- Observers in the partial coverage category are often deployed out of many small, remote port locations which increases travel and lodging costs.
- Observers in the partial coverage category are often only deployed on a vessel for one trip which is significantly shorter (1 to 5 days) than the typical vessel deployment for full coverage observers (60 to 90 days), requiring more travel between vessels.
- Partial coverage by its very nature is inefficient on a cost per unit basis compared to full coverage. This is because partial coverage samples the fleet, such that gains are made in overall costs in monitoring. However, predicting where observers will be deployed and in

what amount is difficult with random selection procedures. The risk and uncertainty regarding the number of observed days is borne solely by the partial coverage observer provider and increase costs on a per unit (daily rate) basis.

Due to the inherent differences between the full and partial coverage categories, the most salient comparison of costs is a "fully loaded" daily rate, which is calculated as the total funds expended divided by the number of observed days.

The fully loaded rate for each year of the partial coverage contract is presented in Table 2-5. For example, in 2019, the fully loaded rate was $4,425,144 ÷ 3,207 days = $1,380 per day. This calculation is appropriate for partial coverage since most trips in this category have a similar duration ranging between 1 and 5 days.

The average daily observer rate (variable costs only) for full coverage was similar across all gear and sector categories at approximately $348 per day. Compared to a partial coverage observer that may be deployed onto multiple vessels for 1 to 5 days at a time, an observer deployed onto a full coverage vessel boards once and may stay on that vessel for a month or more. Assuming the costs of paying an observer for a day and maintaining an observer provider infrastructure are constant, the fixed costs are likely to be dominated by travel and temporary housing. These fixed costs as a proportion of the total cost for an observer deployment will decline with increased deployment duration. Therefore, the fully loaded rate of an observer day will also decline with an increase in the number of invoiced days for a given vessel in a given month. We can illustrate this phenomenon using the full coverage invoice database maintained by FMA. The per-day base rate for observer coverage per permitted provider is known. Therefore, this value multiplied by the total number of invoiced days yields the total base invoice cost. Since the total invoice amounts are known, a subtraction of the total base invoice from the total invoice amount will either yield a zero, or a positive value. Only those invoices that included travel costs and therefore "fully loaded" and were considered further. The fully loaded invoice value was divided by the number of days on the invoice, yielding a fully loaded daily rate for each invoice. The fully loaded rate as a function of the total number of observed days in the invoice does in fact decline as expected.

Table 2-1. -- Summary of the fees and Federal funding for partial coverage observer sea days from 2013 to 2019.

Calendar year	Funding category	Observer fees received	Funds sequestered	Prior year sequester funds received	Funds obligated to contract	Observer sea days at start of the year	Observer sea days purchased during year	Total observer sea days used during year
2013	Fees					4,535	1,913	3,533
	Federal Funds				$1,885,166			
2014	Fees	$4,251,452	($306,105)		$3,044,606	2,915	4,368	4,573
	Federal Funds				$1,892,808			
2015	Fees	$3,451,478	($251,958)	$306,105	$3,058,036	2,710	5,330	5,318
	Federal Funds				$2,700,000			
2016	Fees	$3,775,522	($256,735)	$251,958	$5,144,983	2,722	5,277	4,749
	Federal Funds				$390,800			
2017	Fees	$3,592,750	($247,900)	$256,735	$3,542,196	3,322	5,285	2,591
	Federal Funds				$1,398,531			
2018	Fees	$3,799,560	($250,771)	$247,900	$2,396,040	5,858	2,350	3,207
	Federal Funds				$0			
2019	Fees	$3,244,801	($201,178)	$250,771	$2,412,611	5,001	4,600	3,316
	Federal Funds				$2,135,670			
2020	Fees					2,266		
	Federal Funds							

Table 2-2. -- Observer fees[8] in 2019 by gear, vessel size category, and species or species group for *all areas combined*.

Vessel length category	Halibut	Sablefish	Pacific cod	Pollock	All other groundfish	Total all species
HOOK AND LINE						
<40	$214,805	$18,556	$5,739	$2	$462	$239,564
40 - 57.5	$437,164	$321,249	$11,962	$19	$8,200	$778,594
>57.5	$506,249	$410,114	$2,022		$5,872	$924,257
Gear Subtotal	$1,158,218	$749,919	$19,723	$20	$14,535	$1,942,415
JIG						
<40	$205		$99		$91	$396
40 - 57.5	$849		$1,426		$275	$2,550
>57.5			$48			$48
Gear Subtotal	$1,054		$1,574		$366	$2,994
POT						
<40			$147		$51	$197
40 - 57.5	$1,071	$38,653	$11,758		$308	$51,790
>57.5	$3,274	$196,554	$187,560	$1	$2,602	$389,991
Gear Subtotal	$4,344	$235,207	$199,465	$1	$2,961	$441,978
TRAWL						
40 - 57.5		$230	$10	$6,696	$253	$7,189
>57.5		$12,787	$121,041	$306,279	$60,695	$500,802
Gear Subtotal		$13,016	$121,051	$312,975	$60,948	$507,991
TOTAL ALL GEAR	**$1,163,616**	**$998,142**	**$341,813**	**$312,997**	**$78,809**	**$2,895,378**
PERCENT BY SPECIES	**40%**	**34%**	**12%**	**11%**	**3%**	**100%**

Rounding error sometimes results in slight differences in row and column totals.

[8] The unpaid portion of the observer fees are included. Administrative fees and interest charged for late fee payments are not included.

Table 2-3. -- Observer fees[9] in 2019 by gear, vessel size category, and species or species group in the *Gulf of Alaska*.[10]

Vessel length category	Halibut	Sablefish	Pacific cod	Pollock	All other groundfish	Total all species
HOOK AND LINE						
<40	$164,371	$17,406	$1,318	$2	$425	$183,521
40 - 57.5	$365,707	$316,592	$9,759	$19	$8,107	$700,184
>57.5	$386,836	$397,955	$1,054		$5,767	$791,612
Gear Subtotal	$916,915	$731,953	$12,131	$20	$14,298	$1,675,318
JIG						
<40	$167		$99		$91	$357
40 - 57.5	$849		$262		$275	$1,385
>57.5			$2			$2
Gear Subtotal	$1,016		$363		$366	$1,745
POT						
<40			$147		$51	$197
40 - 57.5	$1,071	$34,800	$2,118		$8	$37,997
>57.5	$3,274	$157,874	$23,836	$1	$1,993	$186,978
Gear Subtotal	$4,344	$192,674	$26,101	$1	$2,052	$225,172
TRAWL						
40 - 57.5		$230	$10	$6,696	$253	$7,189
>57.5		$12,787	$23,960	$305,325	$60,474	$402,546
Gear Subtotal		$13,016	$23,970	$312,021	$60,727	$409,735
TOTAL ALL GEAR	**$922,275**	**$937,644**	**$62,566**	**$312,043**	**$77,443**	**$2,311,970**
PERCENT BY SPECIES	**40%**	**41%**	**3%**	**13%**	**3%**	**100%**

Rounding error sometimes results in slight differences in row and column totals.

[9] The unpaid portion of the observer fees are included. Administrative fees and interest charged for late fee payment are not included.
[10] The Gulf of Alaska includes Pacific Halibut regulatory areas 2C, 3A, and 3B; and Sablefish regulatory areas Western GOA, Central GOA, West Yakutat, and Southeast Outside.

Table 2-4. -- Observer fees[11] in 2019 by gear, vessel size category, and species or species group in the *Bering Sea/Aleutian Islands*.[12]

Vessel length category	Halibut	Sablefish	Pacific cod	Pollock	All other groundfish	Total all species
<40	$50,434	$1,150	$4,421		$38	$56,043
40 - 57.5	$71,457	$4,657	$2,203		$94	$78,410
>57.5	$119,413	$12,159	$968		$105	$132,645
Gear Subtotal	$241,303	$17,966	$7,592		$236	$267,098
JIG						
<40	$39					$39
40 - 57.5			$1,164			$1,164
>57.5			$46			$46
Gear Subtotal	$39		$1,210			$1,249
POT						
40 - 57.5		$3,853	$9,640		$299	$13,793
>57.5		$38,679	$163,724		$610	$203,013
Gear Subtotal		$42,532	$173,364		$909	$216,806
TRAWL						
>57.5			$97,081	$954	$221	$98,256
Gear Subtotal			$97,081	$954	$221	$98,256
TOTAL ALL GEAR	**$241,342**	**$60,499**	**$279,247**	**$954**	**$1,366**	**$583,408**
PERCENT BY SPECIES	**41%**	**10%**	**48%**	**<1%**	**<1%**	**100%**

Rounding error sometimes results in slight differences in row and column totals.

[11] The unpaid portion of the observer fees are included. Administrative fees and interest charged for late fee payment are not included.

[12] The Bering Sea/Aleutian Islands includes Pacific halibut regulatory areas 4A, 4B, 4C, and 4D; and Sablefish regulatory areas Bering Sea and Aleutian Islands.

Table 2-5. -- Average annual observer coverage sea day costs from 2014 to 2019.

Year	Funds expended	Number of observer sea days realized	Average sea day cost
2014	$4,937,414	4,573	$1,080
2015	$5,758,268	5,318	$1,083
2016	$4,186,303	4,677	$895
2017	$3,146,111	2,749	$1,144
2018	$4,425,144	3,207	$1,380
2019	$4,342,098	3,316	$1,309

Table 2-6. -- Annual observer full coverage sea day costs from 2014 to 2019.

	Sum totals					Averages sea day cost		
Year	Billed vessels and plants	Billed full coverage days	Base daily costs	Incidental costs	Fully- loaded costs	Base daily costs	Incidental costs	Fully- loaded costs
2014	177	39,066	$13,028,325	$1,450,220	$14,478,545	$333	$37	$371
2015	177	39,963	$13,623,614	$1,335,407	$14,980,340	$341	$33	$375
2016	179	38,536	$13,242,003	$1,518,717	$14,760,720	$344	$39	$383
2017	171	37,620	$12,972,358	$1,435,974	$14,408,332	$345	$38	$383
2018	167	36,695	$12,674,251	$1,356,088	$14,030,339	$345	$37	$382
2019	170	36,376	$12,666,376	$1,337,931	$14,004,293	$348	$37	$385

Table 2-7. -- Costs of the 2019 Fixed Gear EM Program.

Cost category	One time	Recurring	Amortized	2020 Total	Prior years amortized	Adjusted annual cost
Project Coordination	$96,281	$315,539	$0	$411,820	$0	$411,820
Data Review, Processing, and Analysis	$4,297	$96,501	$0	$100,798	$0	$100,798
EM Equipment Services	$0	$24,505	$287,419	$311,924	$409,609	$491,598
Field Technical Services	$0	$105,823	$90,194	$196,017	$75,166	$199,028
Project totals	**$100,578**	**$542,368**	**$377,613**	**$1,020,559**	**$484,775**	**$1,102,666**

Figure 2-1. -- Average number of full coverage days and average costs per day (including incidental costs), to vessels and processors for observer coverage in the full coverage category in 2019, by gear type and vessel type (CP/MS = catcher processor/mothership, CV = catcher vessel, PLANT = shoreside processor, both floating and land-based).

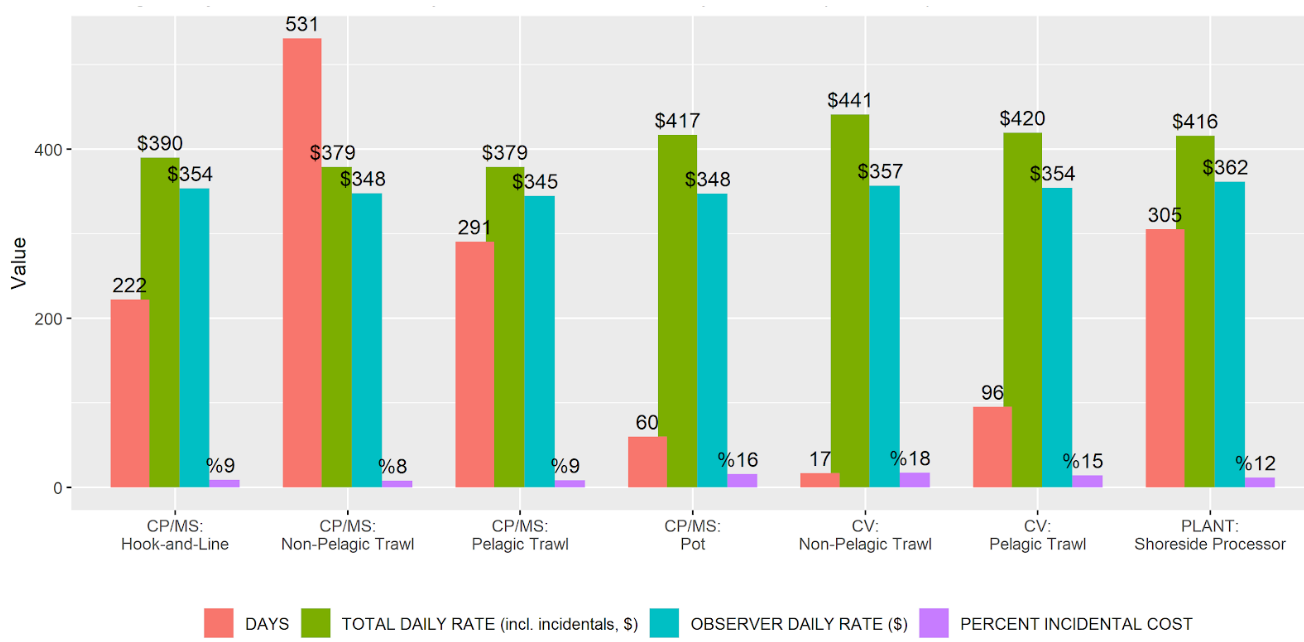


Figure 2-2. -- Full coverage average costs per year to vessels and processors for observer coverage in the full coverage category in 2019, by gear type and vessel type (CP/MS = catcher processor/mothership, CV = catcher vessel, PLANT = shoreside processor).

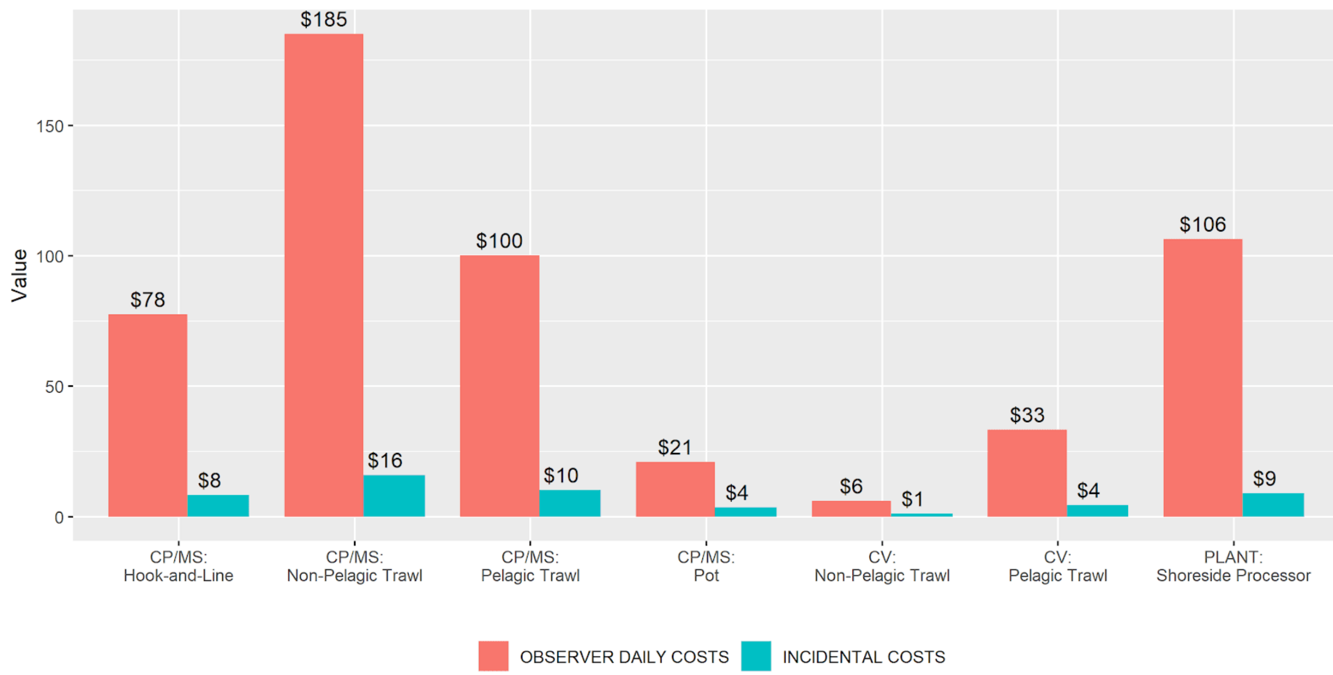
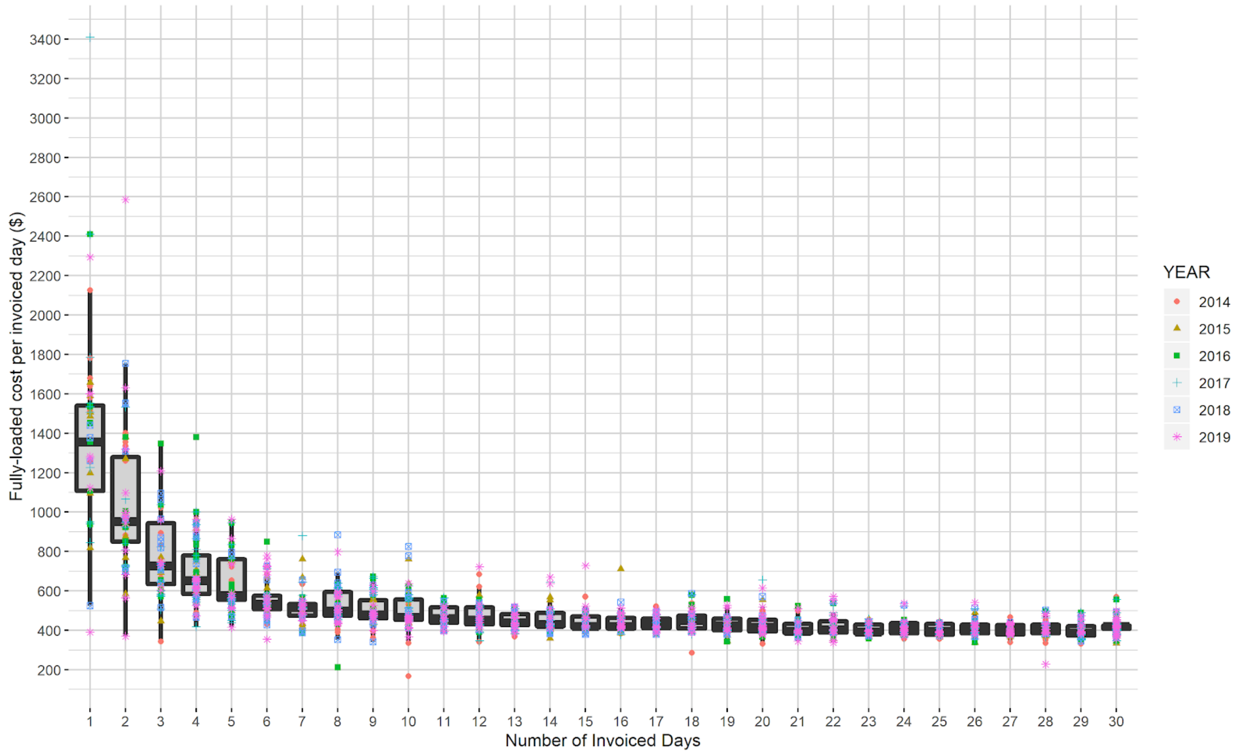


Figure 2-3. -- Relationship between the fully loaded cost per invoiced day for full observer coverage as a function of the number of days invoiced, which is a proxy for the duration of the trip. The fully-loaded cost per day is calculated as the invoice total divided by the number of days on the invoice.



3. Deployment Performance Review

3.1. Introduction

Each year the Alaska Fisheries Science Center's (AFSC) Fisheries Monitoring and Analysis (FMA) Division establishes a committee to review the scientific elements of the North Pacific Observer Program. This committee, formerly referred to as the Observer Science Committee (OSC), was renamed in 2020 as the Fishery Monitoring Science Committee (FMSC), in order to reflect the addition of electronic monitoring (EM) as a tool being used to monitor fisheries in the North Pacific. Similarly, we use the term 'monitoring' in this chapter when referencing fishing activity that has been monitored either by an observer or with EM.

The FMSC provides scientific advice in the areas of regulatory management, natural science, mathematics, and statistics as they relate to observer deployment and sampling in the groundfish and Halibut fisheries of the BSAI and the GOA. The FMSC members have analytical and scientific expertise relating to observer sampling of groundfish and halibut fisheries of the BSAI and GOA and use of the collected data. If possible, the FMSC is represented by at least one member of the AFSC/FMA (Observer Program) Division, one member of the AFSC/Stock Assessment and Multispecies Assessments Program, one member of the Alaska Regional Office (AKRO) Sustainable Fisheries Division, and one member of the International Pacific Halibut Commission (IPHC).

This chapter contains the FMSC review of the deployment of observers and EM in 2019 relative to the intended sampling plan and goals of the 2019 Annual Deployment Plan (ADP, NMFS 2018). This review identifies where possible biases exist and provides recommendations for further evaluation, including potential improvements to the observer deployment process that should be considered during the development of the 2021 ADP.

The goal of the Observer Program is to achieve a random deployment of observers and EM into fisheries to collect representative data used to estimate catch and bycatch, assess stock status, collect fishery-dependent biological information used in population and ecosystem modeling efforts, and make salmon bycatch stock-of-origin determinations, among other objectives. Therefore, this evaluation focuses on the randomization of observer and EM deployments into primary sampling units, and how departures from a random sample affect data quality.

3.2. The Sampling Design of the Observer Program

Since 2013, the Observer Program has used a stratified hierarchical sampling design with randomization at all levels. Stratification is used to increase the efficiency of sampling by observers and to address logistical issues associated with deployment. By grouping similar fishing activities into strata and sampling those strata appropriately, sampling efficiency is increased and the variance of resulting estimates may also be decreased. Sampling strata are defined in the ADP and are designed such that each unit of deployment (trip) is assigned to only one stratum.

Within a stratum, observers are deployed randomly to either vessels for a predetermined period of time (termed vessel-selection), or to individual fishing trips (termed trip-selection). In both cases, this initial deployment to the fishery is the first level of the sampling hierarchy and defines the primary sampling unit (PSU; either vessel-periods or individual trips). The list of all PSUs in a stratum defines the sampling frame and should equate to the population of interest for that sampling stratum (e.g., all trips taken by trawl vessels fishing in the Alaska EEZ). If the sampling frame does not contain all elements of the stratum, the resulting information may be biased. The magnitude and direction of the bias will depend on how different the fishing activities in the sample frame are from actual fishing activity.

Although this report evaluates whether monitoring goals were met, we include a brief summary of the full sampling hierarchy here for context. For each observed trip, if all hauls cannot be sampled for logistical reasons, hauls are randomly selected to be sampled. This is the next level in the hierarchy; the secondary sampling units are defined as hauls within a trip. Randomization of haul selection is designed to allow observers to record and transmit data, attend to other non-sampling responsibilities, and to allow observers time to sleep and eat. Randomization of haul selection also gives EM video reviewers the ability to optimize the amount of video that can be reviewed from each trip. Haul selection is determined using the random sampling tables and random break tables provided by NMFS. For each haul, fishing location and effort (e.g., number of hooks) are recorded, while marine mammal and seabird interactions are primarily recorded on randomly selected hauls. The ability of EM to capture marine mammal and seabird interactions is less than that of observers due to the fixed location in which EM equipment is placed.

For the randomly selected hauls, a random sample of the catch is collected (observers) or selected for video review (EM), and data from those samples are used to determine the species composition and amount of discarded catch. These samples of catch within each haul are the third level of the sampling hierarchy. While observers are trained to collect multiple large samples of catch, the number and size of samples taken from each haul will depend on the vessel configuration, fishing operations, and diversity of catch. The size of EM samples is largely determined by the number of video reviewers available relative to the amount of video to be reviewed.

At the fourth level of the sampling hierarchy, a predetermined number of individual fish of predetermined species is randomly selected from the species composition sample and measured. Lastly, at the fifth sampling level, a random selection of fish is used to collect otoliths, reproductive maturity assessments, stomach contents, genetic tissues, and other biological specimens. The number and species of fish selected for measurement and biological specimen collection is specified each year by the AFSC’s stock assessment scientists. Sampling rates for genetic tissue collection by observers (e.g., 1 of 10 Chinook salmon caught as bycatch) are set each year by the AFSC’s Auke Bay Laboratory. Sampling at the fourth and fifth levels of the sampling hierarchy does not occur with EM.

More information on the sampling design used by observers and the relationship between the sample design and catch estimation can be found in Cahalan and Faunce (2020) and the 2019

Observer Sampling Manual (AFSC 2018). A summary of the 2019 ADP can be found in Section 1.3. The focus of this report is related to deployment, and the evaluation is at the trip level of the sampling hierarchy.

3.3. Performance Review Objectives

The following items from the 2019 ADP have been identified as objectives for evaluation in this report:

- Deploy for the planned number of sea days. This objective will be considered to be met if the actual number of sea days expended falls within the range of values from simulated sampling provided in the 2019 ADP. The Observer Program's budget was expected to cover 3,110 days in 2019.
- Deploy at the coverage rates specified in the 2019 ADP. Following the 2019 ADP, ODDS was programmed to randomly select logged trips at a rate of 23.70% in the *TRW - No Tender* stratum, 17.71% in the *HAL* stratum, 15.43% in the *POT - No Tender* stratum, 27.12% in the *TRW - Tender* stratum, 16.11% in the *POT - Tender* stratum, and 30% in the EM strata. Under a randomized deployment scheme, these partial coverage selection rates are expected to be within a 95% confidence interval computed from the realized coverage rates (under the assumption of a binomial distribution for observed trips).
- Collect tissue samples from Chinook and chum salmon as specified in the 2019 Observer Sampling Manual to support the goal of collecting genetic samples from salmon caught as bycatch in groundfish fisheries to identify stock of origin. The sampling protocol established in the 2014 ADP (NMFS 2013) was used in 2019. Under this protocol, observers on vessels delivering to shoreside processors in the GOA trawl walleye pollock (*Gadus chalcogrammus,* hereafter referred to as simply 'pollock') fishery monitor the offload to enumerate salmon bycatch and obtain tissues for genetic analysis from the salmon bycatch. For trips that are delivered to tender vessels and trips outside of the pollock fishery, observers obtain salmon counts and tissue samples from all salmon found within at-sea samples of the total catch.
- Randomize deployment of observers into the partial coverage category of fishing activities. This randomization is used to collect observer and EM samples that are representative of the entire fishing fleet (observed and monitored trips are equivalent to unobserved and unmonitored trips within a stratum). Evaluation of this objective is focused on the randomization of observer and EM deployments into primary sampling units, and how departures from a random sample affect data quality.

3.4. Observer Deployment Performance Metrics

Performance metrics have been developed to assess whether the trip-selection process (through the implementation of the 2019 ADP) provides a representative sample of fishing trips in the

North Pacific in 2019. These metrics reflect four mechanisms that can impact the quality of the data: sample frame discrepancies, non-response, differences in trip characteristics, and sample size.

The performance metrics used in this evaluation are as follows:

1. Deployment rates for each stratum: This is the basic level of evaluation for comparing targeted and achieved sampling rates, where sampling strata are partitions of the entire population about which we want to make inferences (e.g., generate estimates of catch). Implementation challenges can be identified in this step, such as sample frame inadequacy, selection biases, and issues with sample unit definitions. Specifically, this section assesses the following:
    a. Sample rates and number of samples relative to intended values.
    b. Quantification of under- and over-coverage rates (sample frame discrepancies). Over-coverage of a population occurs when the sample frame includes elements that are not part of the target population. When these elements are included in the random sample, effort (time, cost) is expended needlessly. Under-coverage results from having a sample frame that does not include a portion of the target population which can lead to biased data if that portion of the population differs from the population included in the sample frame.
    c. Non-response rates. Non-response occurs when randomly selected elements (trips or vessels) are not actually sampled. If these trips or vessels have different fishing behavior (e.g., catch, areas fished) than the rest of the population, the data collected will not represent the entire fleet (non-response bias).
2. Representativeness of the sample: Randomized sampling is a method used to ensure that the results of sampling reflect the underlying population. Departures from randomization can lead to non-representative data and hence potential bias in estimates of the parameters of interest. A randomized sample design is expected to achieve a rate of monitored events that is similar across both space and time. Representativeness of the sample was divided into three separate components:
    a. Temporal representativeness
        i. Effort plots: plots of expected and actual monitoring effort over time. Areas where these two lines deviate from each other are indicative of periods with differential realized sample rates (and potential temporal bias).
    b. Spatial representativeness
        i. Maps: Maps provide a visual depiction of the spatial distribution of monitoring coverage relative to effort in each partial coverage stratum, as well as where low or high coverage rates occurred.
        ii. Probability of monitoring a fewer or greater number of trips within an area than would be expected given the realized sample rate for the entire stratum. These data are used to identify departures from anticipated sampling rates.
    c. Representativeness of trip characteristics
        i. Consistency of trip characteristics for monitored and unmonitored portions of the stratum. These metrics are based, in part, on the availability of data for both monitored and unmonitored fishing activities; for example, data that are

reported for all trips on landing reports. Attributes tested in this report include the following:

- Trip duration (days).
- Vessel length (feet).
- The number of NMFS Areas visited during the trip.
- The amount of landed catch (metric tons).
- The number of species in the landed catch (also known as species richness).
- The proportion of the total landed catch that was due to the most prevalent species (pMax, an inverse a measure of species diversity where an increase in pMax indicates a decline in diversity).

3. Adequacy of sample size: A well-designed sampling program will have a sample large enough to reasonably ensure that the characteristics of interest in the entire target population are represented in the data. Whether the sample size collected was adequate was determined through an examination of the probability of deploying observers at the implemented rate and having no monitoring coverage in one or more cells (e.g., defined by NMFS Reporting Area and strata).

Although these metrics can identify places where observed results differ from expectations, it is ultimately a subjective decision as to whether or not these differences are substantial enough to have management implications. This holds true even for tests that have associated *p*-values. Additionally, our focus on landed catch is due to the fact that total catch is comprised of retained and discarded portions, and since discarded catch is not available from unmonitored trips, landed catch represents the only portion of the catch that is available from all trips.

3.5. Changes to This Report from Last Year

This year we made several updates to our analyses. These include two major and several minor changes. The first major change this year is the addition of a new analysis of data gaps (Appendix B). Following the methods used in the gap analysis in Appendix C of the Draft 2020 Annual Deployment Plan (NMFS 2019a), Appendix B serves to evaluate the extent to which monitoring coverage within deployment strata was distributed proportionately to post-strata defined by FMP and trip target (predominant species) by evaluating the spatiotemporal proximity of monitored trips to unmonitored trips and assesses the likelihood of acquiring the achieved coverage in 2019 given the assumption of random deployment. It is the intent that elements of this Appendix be included in future Annual Reports. The second major change is how we calculate *p*-values in the permutation tests that assess whether or not observed or unobserved trips were different in a given metric. In recognition that these tests are not independent within a stratum, this year we adjust *p*-values to account for multiple comparisons by multiplying by the number of tests performed. In this way we inflate each *p*-value in a way that reduces the chances of making a false interpretation of differences where there are none. This is known as a Bonferroni adjustment, and is also applied to permutation test *p*-values in Appendix A. The result should be a more narrow focus on only large differences. Minor changes to the tables in this chapter include the addition of a table showing the average review times for fixed gear EM video (Table 3-7), the realized cost of the partial coverage monitoring program in dollars with the expected cost of the program (Fig. 3-1, bottom panel), and more information on when trips in ODDS were selected due to the cancellation of prior trips (Fig. 3-2).

3.6. Evaluation of Deployments in 2019

The deployment of observers into the 2019 Federal fisheries in Alaska is primarily evaluated at the level of the deployment stratum because each stratum is defined by a different sampling rate or by a different monitoring method (e.g., observers and EM). In this document, trips in the *EM HAL* and *EM POT* strata are considered successfully monitored if at least some video was reviewed from a trip. The rationale for defining monitored trips this way is that it is most similar to the way in which trips in other strata are considered observed (i.e., irrespective of whether or not haul information or usable species composition data were collected).

3.6.1. Evaluating Effort Predictions

Each year, the NMFS sets an annual budget for the Observer Program in terms of cost and observer days. Based on the analysis in the 2019 ADP, NMFS expected to spend $4,450,243 observing 3,109 days (NMFS 2018). The expected number of observer days was determined by the expected number of fishing days and the rate at which trips are selected for coverage. The number of fishing days expected to occur in 2019 was estimated using data on annual fishing effort from 2013 to 2018 (Ganz and Faunce 2019). Based on simulations using trip durations from 2017 and 2018, the NMFS then set selection rates so that the average cost from simulations was equal to the available budget (NMFS 2018).

In 2019, the FMA paid for 3,315 observer days, which was 6.6 % greater than predicted by the average simulation, but well within the range of possibilities predicted in the 2019 ADP (Fig. 3-1, top panel). This is explained by the fact that there was more effort in *HAL*, *POT – Tender*, and *TRW – Tender* than expected (Table 3-1). Despite observing more days than predicted, expenditures for partial observer coverage were under budget (Fig. 3-1, bottom panel). This resulted because the cost of a partial coverage observer day in 2019 was less than the expected cost that was estimated in the 2019 ADP.

3.6.2. Performance of the Observer Declare and Deploy System in Trip-Selection

The random selection of trips for monitoring is made by the ODDS for logged trips within the observer and EM trip selection pools. The ODDS generates a random number according to the pre-determined rates and assigns each logged trip to either “selected to be monitored” (selected) or “not selected to be monitored” (not selected) categories. For observer pool trips, the NMFS observer provider has access to all selected trip information necessary to schedule observer logistics. Up to three trips may be logged in advance of fishing to provide industry users with flexibility to accommodate their fishing operations.

Logged trips have different dispositions. When initially logged, trips are considered pending and can be either closed or cancelled. Whether changes can be made by the user (person logging the trip) or must be made by the monitoring provider (or the NMFS) depends on whether or not the trip is selected to be monitored, the stratum the trip belongs to, and the timing of the activity. Trips can be closed (marked as complete) by the ODDS user after the planned trip departure date by either entering the dates of the trip and the port processor of the landing, or by selecting from a list of pre-populated landing reports. For partial coverage strata monitored by observers, the observer provider is given 72 hours prior to the trip start to provide for an observer to board the vessel. While a trip may be entered into ODDS that is scheduled to start earlier than 72 hours from the time of entry, if selected for observer coverage, the observer provider can opt to delay the start of the trip up to, but not exceeding 72 hours from the time of trip entry. This helps protect the observer provider from the high cost of deploying an observer with short notice. The vessel operator is protected as well by guaranteeing the assigned observer to the vessel up to 48 hours past the planned start of the fishing trip. This rule helps ensure that an observer is available to the boat in case of unforeseen events such as weather. If, however, the trip start date and time has passed by more than 48 hours, then the observer provider can cancel the trip and release the observer from the vessel and trip, and the vessel would need to log a new trip with a new 72-hour notice in place prior to fishing. These 'forced cancellations' are not present in trips that are not selected for observation since the logging, closing, or cancellation of the trip is entirely under vessel control. The vessel operator may change the dates of a logged trip regardless of selection status prior to, or in lieu of cancellation. However, trips that have not been closed at the end of the calendar year are automatically cancelled by the ODDS to prevent 2019 ODDS trips from affecting the deployment rates set for the 2020 ADP.

The number of trips logged in the ODDS in 2019 and their dispositions is summarized in Table 2-2, Table 2-3, and Table 2-4. The forced cancellation rate by users and by the ODDS is summarized for selected trips in each stratum (Table 3-2). Of the 5,513 total trips logged, 1,264 were selected, and 226 were cancelled: 3 by ODDS (0.24%) and 223 by users (17.6%). The user cancellation rate for selected trips ranged from 1.9% for *EM POT* to 26.7% for *TRW - Tender*.

The flexibility offered by the ODDS means that the outcome of random selection is known to the vessel operator for up to three logged trips in advance of fishing. In the case where ODDS users disproportionately cancel selected trips, one would expect monitoring coverage to be lower than the programmed selection rates. To reduce this potential bias, the ODDS is programmed to automatically select the vessel's next logged trip if a previously selected trip was cancelled by the user. Although these "inherited" trips preserve the *number* of selected trips in the year, they cannot prevent the *delay* of selected trips during the year. Therefore, the potential for temporal bias is still present. The percentages of selected trips from either inherits or waivers are found in Table 3-3. The relative percentage of selected trips that inherited their final selected-status due to a previous cancellation ranged from 3.8% for *EM POT* to 26.7% for *POT - Tender* (Table 3-3). Within the same gear-type, cancellation rates and the proportion of inherited trips were much larger for strata that used observers for at-sea monitoring than those that used EM.

The extent to which trip-selections are changed from the time they are entered can be determined by comparing the rate of trip observation expected from 1) random selection of all logged trips (initial random selection) and 2) random selection of remaining trips after cancellations, waivers, and inherited trips. In any case, the proportion of trips selected to be observed should fall within what would be expected given the binomial distribution (since each trip is either selected or not selected). The rates obtained (%, with associated *p*-value based on the binomial distribution) in the initial selection process were within expected ranges with the following exceptions – the initial selection rate was 33.91% (*p*-value = 0.011) for the *EM HAL* stratum, and 39.47% (*p*-value = 0.020) for the *TRW - Tender* stratum (Table 3-4). This means that the *EM HAL* and *TRW - Tender* strata were being over-selected in ODDS, and that we should interpret high final coverage rates in these strata with caution.

The final selection rate after trips were closed, cancelled, or waived were within expected bounds with the exception of the *HAL* stratum 20.47% (*p*-value = 0.006), the *EM HAL* stratum, 34.80% (*p*-value = 0.002) and the *TRW - Tender* stratum 46.55% (*p*-value = 0.002; Table 3-4). Given the high initial selection rates, we can safely disregard these final selection rates with the exception of the HAL stratum.

Differences in the initial selection rates of ODDS and those that result after cancellation and trip changes can also be looked at over time (Fig. 3-2). In this plot, we are mostly concerned when the lines representing the two selection rates in this plot diverge substantially. Deviations appeared in the *HAL* stratum during January, March – April, and October – November (Fig. 3-2). This pattern can occur when cancelled trips that were originally selected for coverage are preserved through the inherit process, while cancelled trips that were not originally selected for coverage are not.

In addition to the inherit process, the lack of linkage between the ODDS and eLandings contributes to the differences between programmed selection rates in ODDS and trips that are ultimately observed. Currently, ODDS provides users with a list of Report IDs from eLandings from which to close their logged trips. However, these data are not validated, or error checked, making them unreliable in their current state. This linkage between the logged (ODDS) trip (with its selection probability) and its associated landing information is necessary to evaluate potential improvements in deployment efficiency within the partial coverage fleet.

3.6.3. Evaluation of Deployment Rates

This section compares the coverage rate achieved against the expected coverage rates. Data used in this evaluation are stored within the Catch Accounting System (CAS, managed by the AKRO), the Observer Program database (NORPAC, managed by the AFSC), and eLandings (under joint management by Alaska Department of Fish and Game - ADF&G; the International Pacific Halibut Commission - IPHC; and the NMFS). Separate rate evaluations are conducted depending on whether the unit of observer deployment was at-sea fishing trips or dockside deliveries of pollock.

At-sea Deployments

The 2019 Observer Program had 10 different deployment strata to be evaluated (Table 3-5). There was one full coverage stratum comprised of trips taken both by vessels that were required to have full coverage (e.g., AFA vessels) and those fishing in the BSAI that opted into full coverage. There were seven partial coverage strata: five observed strata defined by gear and tender designation and two EM strata defined by gear designation. There were also two zero coverage strata: one zero coverage EM research stratum and one zero coverage stratum for jig vessels and vessels under 40 ft. length overall.

Evaluations for the full coverage category and zero-selection pool are straightforward - either the coverage achieved was equal to 100% or 0%, respectively, or it was not. The program achieved 99.9% coverage in its full coverage category (Table 3-5). Five trips were not monitored in the full coverage category – four of these occurred on a single catcher vessel fishing Pacific cod with hook and line gear that was logging these trips into ODDS as partial coverage trips. The program achieved perfect compliance with the zero coverage stratum (Table 3-5). Under the assumption that the deployment was randomized, a 95% confidence interval computed from the realized coverage rates (under the assumption of a binomial distribution for observed trips) will contain the actual deployment rate 95% percent of the time. If expected coverage levels were within the 95% confidence intervals, then we conclude that realized and expected coverage rates were equal. Coverage rates were consistent with expected values in six of the seven partial coverage strata, but were higher than expected within the *POT - Tender* stratum (Table 3-5). There are two reasons why this result is of little concern. First, there is no clear evidence of trip manipulation in ODDS data from this stratum. Secondly, the achieved rate was only slightly outside of the 95% range of expected outcomes (16.1% achieved vs. a lower bound of 16.8%). Given the low number of total trips in this stratum (44), a change in a single observed trip, from 13 observed to 12 would have resulted in an expected result for this stratum since new confidence bounds would have included the expected rate.

Unlike observed trips, the coverage rate for EM is based on information provided from the Pacific States Marine Fisheries Commission (PSMFC) that is available to analysts in the NORPAC database. By the end of 2019, the PSMFC had reviewed nearly all of the EM hard drives received (Table 3-6). In 2019, the mean time between receipt and completion of review was 58 days for *EM HAL* and 79 days for *EM POT* (Table 3-7). This is compared to an average of 8.8 days during pre-implementation in 2016 (NMFS 2017a, p. 87).

In combination across all strata, coverage levels, and fishery monitoring tools, 4,497 trips (43.3%) and 510 vessels (47.0%) were successfully monitored at-sea among all fishing in Federal fisheries of Alaska in 2019 (Table 3-5).

Coverage Rates for Dockside Monitoring

Observers were assigned to monitor shoreside deliveries of pollock. The objective of this monitoring was to obtain a count of the number of salmon caught as bycatch and to obtain tissue samples for genetic analysis from these fish in each observed pollock delivery. The sampling design used for this objective in 2019 remained unchanged from that used since 2011 (Faunce 2015); all deliveries of pollock that were observed at sea were also observed dockside. While all Bering Sea pollock trips and deliveries are observed, this is not the case in the GOA (NMFS 2015), where pollock trips randomly selected for at-sea monitoring are also expected to be sampled shoreside for salmon. For this analysis, pollock deliveries are defined as any delivery where the predominant species is pollock in eLandings.

Given the design, the level of dockside observation of walleye pollock deliveries should be 100% in the full coverage category. In 2019, 100% of full coverage walleye pollock deliveries were observed (Table 3-8).

While expectations of the full coverage category are straightforward, evaluations of the partial coverage category are more complex. As a matter of policy, no tender deliveries are observed. While it may seem intuitive that the expected coverage rate for deliveries within the *TRW - No Tender* stratum should be equal to the programmed trip selection rate of 23.70%, this assumption is likely untrue because observers are not deployed into the pollock fishery but into the entire trawl fishery, and the relationship between the number of deliveries and trips is not expected to be constant, especially when measured across ports. Therefore, we present the dockside observation rates for *TRW - No Tender* pollock landings but make no comparison to deployment rates (Table 3-8).

Bycatch estimates of Chinook salmon in the GOA are estimated using methods described in Cahalan et al. (2014). In the event that a delivery cannot be monitored (e.g., the case in a tendered delivery or non-pollock delivery), then estimation of bycatch comes by applying salmon bycatch rates to landed catch. Estimates of stock of origin from salmon bycatch are produced by the AFSC's Auke Bay Laboratory (e.g., Guthrie et al. 2019).

3.7. Sample Quality

3.7.1. Temporal Patterns in Trip-Selection

The cumulative number of fishing trips in each stratum was multiplied by the stratum-specific selection rate to obtain the expected number of observed trips. Under the assumption that there is no temporal bias in observer coverage, 2.5% of values should be larger than the upper 95% confidence limit and 2.5% should be smaller than the lower limit. At the end of 2019 the number of observed trips was outside of this expected range in only one of the seven partial coverage strata: *POT - Tender* (expected rate = 0.161, realized rate = 0.295, *p*-value = 0.023; Table 3-5 and Figure 3-3). Coverage rates were outside of the expected range for 15.9%, 9.3%, 31.2%, 28.2%, and 7.9% of the year for the *EM HAL*, *EM POT*, *POT – No Tender*, *POT - Tender* and *TRW – No Tender* strata, respectively. The *EM HAL*, *POT – No Tender*, and *TRW – No Tender* strata were outside of the expected range earlier in the year but fell within the expected range by the end of April. Coverage rates were within their expected ranges for 100% of the year for the *HAL* (expected rate = 0.177, realized rate = 0.176, *p*-value = 0.925) and *TRW - Tender* (expected rate = 0.271, realized rate = 0.357, *p*-value = 0.175) strata. Overall, there appeared to be less temporal bias in 2019 than in 2018, when three of six partial coverage strata had coverage rates outside of the expected range at the end of the year (AFSC and AKRO 2019).

3.7.2. Spatial Patterns in Trip-Selection

Under a strictly random selection of trips and with a large enough sample size, the spatial distribution of monitored trips should reflect the spatial distribution of all trips. The hypergeometric distribution was used to describe the results of sampling from a population of items (fishing trips) with different characteristics (NMFS Area fished). Based on this distribution, the expected number of monitored trips in a stratum and area is the realized monitoring rate (not selection rate) for the stratum multiplied by the total number of trips from that stratum that occurred in the area of interest. Using this method, we compared the expected number of monitored trips to the realized number of monitored trips in each NMFS Area and stratum combination and found that in most cases, the realized number of monitored trips was close to the expected result (Fig. 3-4). As part of this evaluation, we calculated the probability of monitoring the realized number of monitored trips within each stratum and NMFS Area. For the purposes of the following discussion, NMFS Areas with an unexpected number of trips (probability of our result is less than 0.05) are referred to as "low-p" areas.

EM HAL stratum

Given that there were 16 NMFS Areas fished in *EM HAL*, we would expect there to be 0.05 × 16 = 1 low-p area for this stratum. There was one. The percent of trips monitored among NMFS Areas in this stratum ranged from 0% to 66.7% (median = 29.9%). The probability of these monitoring rates or rates that deviated further from expected values is depicted in Figure 3-5. These results mean that there was no clustering of monitored trips among NMFS Areas that was different from expected. No spatial bias appears to have occurred in the *EM HAL* stratum.

EM POT stratum

Given that there were 11 NMFS Areas fished in *EM POT*, we would expect there to be 0.05 × 11 = 1 low-p area for this stratum. There was one. The percent of trips monitored among NMFS Areas in this stratum ranged from 0% to 80% (median = 36.8%). The probability of these monitoring rates or rates that deviated further from expected values is depicted in Figure 3-6. These results mean that there was no clustering of monitored trips among NMFS Areas that was different from expected. No spatial bias appears to have occurred in the *EM POT* stratum.

HAL stratum

Given that there were 18 NMFS Areas fished in *HAL*, we would expect there to be 0.05 × 18 = 1 low-p area for this stratum. There were two. The percent of trips observed among NMFS Areas in this stratum ranged from 0% to 28.6% (median = 17.4%). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 3-7. These results mean that there was some clustering of observed trips among NMFS Areas that was different from expected. Some spatial bias appears to have occurred in the *HAL* stratum.

POT - No Tender stratum

Given that there were 14 NMFS Areas fished in *POT - No Tender*, we would expect there to be 0.05 × 14 = 1 low-p area for this stratum. There was one. The percent of trips observed among NMFS Areas in this stratum ranged from 0% to 37.5% (median = 12.2%). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 3-8. These results mean that there was no clustering of observed trips among NMFS Areas that was different from expected. No spatial bias appears to have occurred in the *POT - No Tender* stratum.

TRW - No Tender stratum

Given that there were nine NMFS Areas fished in *TRW - No Tender*, we would expect there to be 0.05 × 9 = 0 low-p areas for this stratum. There was one. The percent of trips observed among NMFS Areas in this stratum ranged from 14.3% to 50% (median = 22.3%). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 3-9. These results mean that there was some clustering of observed trips among NMFS Areas that was different from expected. Some spatial bias appears to have occurred in the *TRW - No Tender* stratum.

POT - Tender stratum

Given that there were 7 NMFS Areas fished in *POT - Tender*, we would expect there to be 0.05 × 7 = 0 low-p areas for this stratum. There were two. The percent of trips observed among NMFS Areas in this stratum ranged from 0% to 100% (median = 16.7%). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 3-10. These results mean that there was some clustering of observed trips among NMFS Areas that was different from expected. Some spatial bias appears to have occurred in the *POT - Tender* stratum.

TRW - Tender stratum

Given that there were five NMFS Areas fished in *TRW - Tender*, we would expect there to be 0.05 × 5 = 0 low-p areas for this stratum. There were two. The percent of trips observed among NMFS Areas in this stratum ranged from 20% to 75% (median = 36.4%). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 3-11. These results mean that there was some clustering of observed trips among NMFS Areas that was different from expected. Some spatial bias appears to have occurred in the *TRW - Tender* stratum.

3.8. Trip Metrics

This section analyses whether monitored trips are similar to unmonitored trips using a permutation test (a.k.a., randomization test). This test evaluates the question “How likely is the difference we found if these two groups have the same distribution (in the metric we are comparing)?” Permutation tests compare the actual difference found between two groups to the distribution of many differences derived by randomizing the labels defining the two groups (e.g., monitored and unmonitored). Difference values in the permutation test were calculated by subtracting the mean metric value for the “No” condition from the mean metric value for the “Yes” condition. For example, the difference between vessel lengths in a permutation test for a monitoring effect would be the mean value for unmonitored trips subtracted from the mean value for all monitored trips. By randomizing group assignments, the combined distribution of randomized differences represents the sampling distribution under the null hypothesis that the two groups are equal. In this report, 1,000 randomized trials were run for the permutation test. The *p*-value from the test is calculated as the number of randomized trials with greater absolute differences than the actual difference divided by the number of randomized trials. Similar to the other statistical tests used in this report, low *p*-values (< 0.05) indicate unlikely events under the hypothesis of equality and are therefore considered evidence against that hypothesis. As stated previously, a Bonferroni adjustment has been applied to these *p*-values by multiplying original *p*-values by the number of metrics being tested (six in this case). These adjusted *p*-values are then compared to the 0.05 significance level. In an attempt to improve clarity, although five values are calculated in the test; 1) the difference between groups, 2) the mean difference between groups from randomized trials, 3) #1 expressed as a percentage of the mean value of the metric being tested, 4) #2 expressed as a percentage of the mean value of the metric being tested, and 5) the *p*-value of the test, only values (1), (3), and (5) are presented.

Six trip metrics were examined in the permutation test. These metrics were as follows: the number of NMFS Areas visited in a trip, trip duration (days), the weight of the landed catch (t), the vessel length (ft), the number of species in the landed catch, and the proportion (0 to 1) of the total catch that is made up of the most predominant species (pMax). The metric 'vessel length' is used to help interpret the results from 'weight of landed catch' since fishing power is positively correlated to vessel length. Specifically, differences in weight *and* length are interpreted as a failure to achieve a random sample of vessels of different sizes, whereas differences in weight only lend more evidence that there was a monitoring effect. The number of species within the landed portion of the catch is a measure of species richness. Our pMax metric follows the concepts behind Hill's diversity number N1 that depicts the number of abundant species (Hill 1973) and is a measure of how "pure" catch is since a value of one would indicate that only the predominant (and presumed desirable) species was landed.

Were monitored trips similar to unmonitored trips?

The sample sizes available to the permutation test are presented in Table 3-10. Results of permutation tests are presented in Figure 3-10. A visual depiction of individual results of this permutation test for the *HAL*, *POT - No Tender*, and *TRW - No Tender* strata is given in Figure 3-12 for illustration purposes.

- Of the six metrics compared in the *EM HAL* stratum, one had a low *p*-value. Monitored trips in this stratum landed 13.4% (0.52) more species than unmonitored trips. Landed catch was 3.5% more diverse than unmonitored trips, although this difference was borderline to the traditional 0.05 significance cutoff.

- Of the six metrics compared in the *EM POT* stratum, one had a low *p*-value. Monitored trips in this stratum landed 21.2% (0.49) more species than unmonitored trips.

- Of the six metrics compared in the *HAL* stratum, two had low *p*-values. Observed trips in this stratum were 12.3% (0.66 days) shorter in duration and landed catch that weighed 13.6% (0.90 metric tons) less than unobserved trips.

- Of the six metrics compared in the *POT - No Tender* stratum, none had low *p*-values.
- Of the six metrics compared in the *POT - Tender* stratum, one had a low *p*-value. Observed trips in this stratum landed catch that weighed 100.1% (175.76 t) more than unobserved trips.
- Of the six metrics compared in the *TRW - No Tender* stratum, two had low *p*-values. Observed trips in this stratum occurred in 4.4% (0.05) fewer areas and landed 11.9% (0.73) fewer species than unobserved trips.
- Of the six metrics compared in the *TRW - Tender* stratum, there were no metrics with low *p*-values.

Based on these results, differences between monitored and unmonitored trips were found for species richness, trip duration, areas fished, and landed catch (Table 3-10). Monitored EM trips of both hook and line and pot gear types resulted in greater species numbers reported in the landings data than unmonitored trips. If monitored and unmonitored trips occur in the same fisheries, it is possible that species are lacking on unmonitored trips or are being incorrectly accounted for on monitored trips, or that there is more at-sea discard of species on unmonitored trips. The *HAL*, *POT - Tender*, and *TRW – No Tender* strata also exhibited observer effects, although the magnitude of differences for *TRW – No Tender* was small. Of these, the *POT – Tender* result is the most striking due to the large magnitude of difference, but also the easiest to explain. Landings of tendered trips can be quite large on rare occasions, and when rare large landings occur, whether they are observed or unobserved, these single trips can 'tip the scales' for permutation tests across the entire strata. In 2019, one of these very large-landing trips was observed. However, we cannot dismiss the possibility that we incorrectly accounted for the linkages between landings and trips, and some tendered trips were actually larger, or smaller, than we calculated. More on this topic is discussed in our recommendations section.

Gear, tender, and observed status combinations

One of the analyses done by the permutation test is to compare trip lengths (in days) between monitored and unmonitored trips and determine whether there were significant differences. However, these permutation tests do not visually map the data for monitored and tendered states together. To accomplish this, a plot of the trip durations for these states is included as Figure 3-13. These plots illustrate *HAL* non-tendered trips were shorter in duration when observed, which was also seen in permutation tests. In addition, tendered *POT* and *TRW* trips of more than ten days appear to have been observed at a greater frequency than unobserved trips. If these longer trips also were associated with greater landed weight, then this would explain the permutation results for these strata that showed greater landed weights on observed trips compared to unobserved trips.

3.9. Adequacy of the Sample Size

In a well-designed sampling program, the monitoring rate should be large enough to reasonably ensure that the range of fishing activities and characteristics are represented in the sample data.

The Catch Accounting System post-stratifies data into groups of fishing activities with similar trip characteristics such as gear, trip targets, and NMFS Area (Cahalan et al. 2014). At low numbers of trips and low sampling rates, the probability of no monitoring data within a particular post-stratum is increased and may result in expansions of bycatch rates from one type of fishing activity against landings for a different type of fishing activity. This will result in biased estimates of bycatch. For this reason, it is important to have a large enough sample (monitored trips and vessels) to have reasonable expectation of monitoring all types of fishing.

Over the course of an entire year, some NMFS Areas have low fishing effort and as a result have a relatively high probability of being missed by the simple random sampling represented by observer deployments and EM. The fishing effort data for each stratum and the number of monitored trips over the course of 2019 were used to illustrate their combined effect on the probability of a NMFS Area containing monitoring data using the hypergeometric distribution (Fig. 3-14). From this figure it can be seen how 1) the likelihood of at least one monitored trip is increased with fishing effort and 2) is also increased with an increase in the selection rate. Given our sampling rates in the 7 partial coverage trip-selection strata, the probability of having no monitored trips in a NMFS Reporting Areas increases quickly above 0.05 when there are fewer than 8 trips in the *EM HAL* stratum, 6 trips in the *EM POT* stratum, 15 trips in the *HAL* stratum, 19 trips in the *POT - No Tender* stratum, 7 trips in the *POT - Tender* stratum, 10 trips in the *TRW - No Tender* stratum, and 6 trips in the *TRW - Tender* stratum in a given area. Including additional factors such as week, gear, and target will decrease the number of trips with the same characteristics and hence increase the probabilities of obtaining no monitoring data of that character (post-strata of the CAS).

A new analysis presented in Appendix B – Gap Analysis examines the deployment of observers and EM systems at finer spatiotemporal scales than presented in Chapter 3. This analysis evaluates the availability of monitoring coverage within and between the partial coverage selection pools and highlights instances where sampling effort was disproportionately distributed in space and time between post-strata defined by gear, NMFS Area, and dominant species landed (trip target). For example, the spatial patterns in the *HAL* stratum appear to be due to disproportionately high monitoring rates in the GOA for trips targeting halibut and lower monitoring rates for halibut-target trips in the BSAI, especially in the Aleutian Island areas. Additionally, the low number of observed trips in area 620 in the *TRW – No Tender* stratum was due to disproportionately low monitoring rates among arrowtooth-target trips where only 2 of 42 trips were observed (Appendix B – Gap Analysis).

3.10. Responses to Council and SSC Comments

The SSC has requested that a specific section with responses to SSC comments be provided in the written report, as is done for SAFE documents. This section addresses (in italics) comments relative to this chapter made by the Council and the SSC in response to the presentation of the 2018 Annual Report made at the June 2019 Council meeting.

In the 2019 Annual Report (to be presented in June 2020), the Council recommends that NMFS:

- Continue to include an evaluation of observer effects in pelagic and non-pelagic trawl within the trawl stratum.

  This evaluation is included as Appendix A.

The SSC offered the following recommendations to NMFS:

- The analysts to initiate a comparison of the likely magnitude of bias that has been detected between monitored and unmonitored trips with the overall magnitude and precision of discard or PSC that is being monitored for compliance by management.

  While some differences were detected between monitored and unmonitored trips, the impact that these types of differences have on estimates of discard is not known at this time. We note that in 2019, the detected differences occurred primarily within the hook and line stratum where fishing activity is not limited by PSC or bycatch quotas.

- Consider [EM] coverage for the under-40'-no coverage fleet for 2019.

  This was not considered in the 2020 ADP.

- In cases where there are multiple gear types in a stratum (e.g., pelagic and non-pelagic trawls) the SSC recommends analysis of the results by gear type separately in addition to analysis aggregated to the stratum level. Such disaggregation will avoid masking of gear-specific differences in catch composition and other factors that could provide justification for possible further subdivision of strata.

  We included an evaluation of observer effect tests for different types of trawl gear in Appendix A. In response to the SSC recommendation, we note that further subdivision of strata may not be feasible as total sample size continues to decline. For example, from 2019 to 2020 the ability of observer data to adequately sample tendered and non-tendered strata was compromised to the point that the designation was no longer supported, and these trip types are now combined for a gear-based stratum.

- We look forward to seeing a full evaluation of this [EM] program as soon as is practical, as well as an evaluation of the tradeoffs between use of EM and the existing partially observed coverage category. As the Council considers continued growth of the EM program, it will be important to conduct appropriate cost comparisons, specifically including video review costs, as well as an evaluation of the ability of EM versus onboard observer data to meet program needs.

  While costs are addressed outside of this chapter, we have included deployment performance review of both fishery monitoring tools (observers and EM) used by FMA.

3.11. OSC Recommendations to Improve Data Quality

3.11.1. Recommendations from the 2018 Annual Deployment Review

The Fisheries Monitoring Science Committee (formerly the Observer Science Committee) made the following recommendations in its 2018 review of observer deployment to be considered in developing the 2020 ADP (NMFS 2019b). Following each recommendation is the italicized outcome of that recommendation.

The Fishery Monitoring Science Committee's Recommendations to improve the 2020 ADP were as follows:

- The ODDS trip logging and cancellation rules be re-evaluated and communicated to the Council and industry as soon as possible.

  No formal public action has been taken by the NMFS.

- The draft 2020 ADP stratification designs include a re-examination of tendering strata.

  The distinction between tendered and non-tendered strata was eliminated in the 2020 ADP.

- Do not stratify by type of trawl gear (i.e., NPT and PTR strata).

  These gear types were not separated in the 2020 ADP. The rationale for not creating separate NPT and PTR strata is included in Appendix A.

- Continue the baseline + optimization approach for determining coverage levels among strata.

  The 15% baseline + optimization approach for determining coverage levels among strata for observer coverage was used in the 2020 ADP.

- We recommend that EM review rates be set to ensure that the entire year is sampled and review is timely enough so that data from EM can be used for catch accounting and fisheries monitoring as envisioned by the Council.

  EM review included the entire year for 2019, which was an improvement over 2018. There was about a two-month lag between data collection and data availability in 2019. Whether this is timely enough for catch accounting and fishery monitoring is not clear to the FMSC.

3.11.2. Recommendations to Improve Data Quality and Guide the 2021 ADP

1. **We recommend that the ADP fully integrate EM and observer deployment into one fishery monitoring program**. This recommendation echoes the SSC recommendation made at their June 2019 meeting, and is based on the recognition that EM and observers are two tools at the disposal of the NMFS to monitor fisheries and each has its advantages and disadvantages. Issues due to incomplete integration of fishery monitoring tools occurred in 2019 when only EM trips were monitored in the pot gear Pacific cod Central Gulf (Area 630) fishery, introducing a

data gap for the GOA Pacific cod stock assessment. In 2020, observer coverage has been reduced further as a result of COVID-19 precautions.

2. **We continue to recommend that NMFS link the ODDS and eLandings database such that fishing trips can be uniquely identified to support the analyses presented to the Council.** The analyses contained in the Annual Report attempt to identify fishing trips, which is the unit of measurement for deployment. However, there are some instances when realized deployments do not match intended deployments. In some cases, it may be that there were no differences, but the accounting of trips between ODDS and eLandings data are incongruent. We note that the temporal bias issue identified (Fig. 3-3) in the observed tendered pot stratum and differences between the observed and unobserved landed weight (Table 3-10) in this stratum was potentially an artifact of the analysis. This artifact could have been caused by the difficulty in identifying observed and unobserved trips, especially for tendered strata.

Table 3-1. -- Comparison between predicted and actual trip days for partial coverage strata in 2019. Predicted values come from the 2019 Annual Deployment Plan (ADP).

Strata	Predicted number of trip days in ADP	Actual number of trip days	Difference from predicted	% Difference from predicted
HAL	8,561	9,426	865	**10.1**
POT - No Tender	2,468	2,421	-47	**-1.9**
POT - Tender	270	483	213	**78.9**
TRW - No Tender	4,759	4,167	-592	**-12.4**
TRW - Tender	151	332	181	**119.9**
Total	**16,209**	**17,211**	**1,002**	**6.2**

Table 3-2. -- Trip cancellation rates in the ODDS for 2019. A trip is cancelled by the system if the user did not identify whether fishing had occurred by the end of the year. “Paper” indicates that a trip was logged when the ODDS was not available.

Strata	**Random number outcomes**	**Logged (*a*)**	**Cancelled by system (*b*)**	**Trips remaining (*c* = *a*-*b*)**	**Cancelled by user (*d*)**	**Paper**	**% User cancellation (*d*/*c* * 100)**
HAL	Not Selected	1,552				0	
HAL	Selected	346	3	343	90	0	**26.2**
EM HAL	Not Selected	608				0	
EM HAL	Selected	312	0	312	14	0	**4.5**
POT - No Tender	Not Selected	499				0	
POT - No Tender	Selected	84	0	84	19	0	**22.6**
POT - Tender	Not Selected	118				0	
POT - Tender	Selected	14	0	14	3	0	**21.4**
EM POT	Not Selected	105				0	
EM POT	Selected	52	0	52	1	0	**1.9**
TRW - No Tender	Not Selected	1,321				0	
TRW - No Tender	Selected	426	0	426	88	0	**20.7**
TRW - Tender	Not Selected	46				0	
TRW - Tender	Selected	30	0	30	8	0	**26.7**
Total	**Not Selected**	**4,249**				**0**	
Total	**Selected**	**1,264**	**3**	**1,261**	**223**	**0**	**17.7**

Table 3-3. -- Number of remaining trips after cancellation in each trip-selection stratum that were selected using the initial random number generator (Random Number Selection) and those that remained after user manipulation (Total Final Selected). The relative impact of waivers in trip-selection is also shown (% Reduction of Selected Trips due to Waivers). **Not from random numbers.

Strata	**Total Trips**	**Random number selection (*r*)**	**Inherited selection** (*i*)**	**Randomly selected but waived (*w*)**	**Total final selected (*T*=*r*+*i*-*w*)**	**% Selected from inherits ((*i*/*T*)*100)**	**% Reduction of selected trips due to waivers (*w*/(*T*+*w*)*100)**
HAL	1,500	253	61	7	307	19.9	**2.2**
EM HAL	888	298	12	1	309	3.9	**0.3**
POT - No Tender	497	65	14	4	75	18.7	**5.1**
POT - Tender	103	11	4	0	15	26.7	**0.0**
EM POT	149	51	2	0	53	3.8	**0.0**
TRW - No Tender	1,528	338	50	0	388	12.9	**0.0**
TRW - Tender	58	22	6	1	27	22.2	**3.6**
Total	**4,723**	**1,038**	**149**	**13**	**1,174**	**12.7**	**1.1**

Table 3-4. -- Number of logged trips in each partial coverage stratum that were selected using the initial random number generator (Initial Random Selection) and those that remained after user manipulation (After Cancellations). The relative impact of inherits and waivers in trip-selection is also shown (With Inherits, After Waivers).

Strata	Trip disposition	Selected trips	Total trips	Actual selection (%)	Programmed selection (%)	*p*-value (H0: Actual = Programmed)
HAL	Initial Random Selection, *a*	346	1,898	18.23	17.71	0.548
	After Cancellations, *b* (*a*-*b*)	253	1,500	16.87	17.71	0.417
	With Inherits, *c* (*a*-*b*+*c*)	314	1,500	20.93	17.71	0.001
	After Waivers, *d* (*a*-*b*+*c*-*d*)	307	1,500	20.47	17.71	0.006
EM HAL	Initial Random Selection, *a*	312	920	33.91	30.00	0.011
	After Cancellations, *b* (*a*-*b*)	298	888	33.56	30.00	0.023
	With Inherits, *c* (*a*-*b*+*c*)	310	888	34.91	30.00	0.002
	After Waivers, *d* (*a*-*b*+*c*-*d*)	309	888	34.80	30.00	0.002
POT - No Tender	Initial Random Selection, *a*	84	583	14.41	15.43	0.528
	After Cancellations, *b* (*a*-*b*)	65	497	13.08	15.43	0.153
	With Inherits, *c* (*a*-*b*+*c*)	79	497	15.90	15.43	0.756
	After Waivers, *d* (*a*-*b*+*c*-*d*)	75	497	15.09	15.43	0.901
POT - Tender	Initial Random Selection, *a*	14	132	10.61	16.11	0.097
	After Cancellations, *b* (*a*-*b*)	11	103	10.68	16.11	0.178
	With Inherits, *c* (*a*-*b*+*c*)	15	103	14.56	16.11	0.789
	After Waivers, *d* (*a*-*b*+*c*-*d*)	15	103	14.56	16.11	0.789
EM POT	Initial Random Selection, *a*	52	157	33.12	30.00	0.385
	After Cancellations, *b* (*a*-*b*)	51	149	34.23	30.00	0.283
	With Inherits, *c* (*a*-*b*+*c*)	53	149	35.57	30.00	0.152
	After Waivers, *d* (*a*-*b*+*c*-*d*)	53	149	35.57	30.00	0.152
TRW - No Tender	Initial Random Selection, *a*	426	1,747	24.38	23.70	0.500
	After Cancellations, *b* (*a*-*b*)	338	1,528	22.12	23.70	0.149
	With Inherits, *c* (*a*-*b*+*c*)	388	1,528	25.39	23.70	0.125
	After Waivers, *d* (*a*-*b*+*c*-*d*)	388	1,528	25.39	23.70	0.125
TRW - Tender	Initial Random Selection, *a*	30	76	39.47	27.12	0.020
	After Cancellations, *b* (*a*-*b*)	22	58	37.93	27.12	0.076
	With Inherits, *c* (*a*-*b*+*c*)	28	58	48.28	27.12	0.001
	After Waivers, *d* (*a*-*b*+*c*-*d*)	27	58	46.55	27.12	0.002

Table 3-5. -- Number of total vessels (*V*), sampled vessels (*v*), total trips (*N*), sampled trips (*n*) for each stratum in 2019. The expected coverage and 95% confidence interval columns are expressed as percentages of the total number of trips taken within each stratum.

Coverage	Strata	*V*	*v*	*N*	*n*	Expected coverage	Realized coverage	95% confidence interval lower limit	95% confidence interval upper limit	Realized meets expected?
Full	Full	161	161	3,343	3,338	100.0	99.9			**No**
Partial	*HAL*	318	172	1,744	307	17.7	17.6	15.8	19.5	**Yes**
Partial	*EM HAL*	138	103	916	291	30.0	31.8	28.8	34.9	**Yes**
Partial	*POT - No Tender*	73	45	528	74	15.4	14.0	11.2	17.3	**Yes**
Partial	*POT - Tender*	30	12	44	13	16.1	29.5	16.8	45.2	**No**
Partial	*EM POT*	21	20	165	60	30.0	36.4	29.0	44.2	**Yes**
Partial	*TRW - No Tender*	78	70	1,568	395	23.7	25.2	23.1	27.4	**Yes**
Partial	*TRW - Tender*	26	12	56	20	27.1	35.7	23.4	49.6	**Yes**
	Gear-based Total	584	397	5,016	1,159		23.1			
Partial	Zero Coverage	393	0	2,005	0	0.0	0.0			**Yes**
Partial	Zero EM Research	4	0	29	0	0.0	0.0			**Yes**
	Total	**1085**	**510**	**10,393**	**4,497**		**43.3% Trips; 47.0% Vessels**			

Table 3-6. -- The number of EM hard drives received and reviewed by gear type and month.

Strata	Data reviewed?	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
EM HAL	Yes	14	19	28	47	39	27	23	30	39	31	9	0	**306**
EM HAL	No	0	1	0	0	2	0	0	0	1	1	0	0	**5**
EM POT	Yes	18	0	0	5	1	0	2	5	10	5	3	1	**50**
EM POT	No	1	0	0	0	0	0	0	1	0	0	0	1	**3**

Table 3-7. -- The mean number of days taken for fixed gear EM data review by gear type. Columns are not additive, and instead represent two different ways of measuring review time, starting from either the end of the trip or from the date at which the hard drive was received.

Strata	Mean number of days between end of trip and data exported to NMFS	Mean number of days between hard drive received and data exported to NMFS
EM HAL	63	58
EM POT	92	79

Table 3-8. -- The number of *TRW - No Tender* pollock deliveries by port and coverage category.

FMP	Coverage category	Port	Total deliveries (*N*)	Observed deliveries (*n*)	% Observed
Bering Sea	Full	Akutan	831	831	100.0
Bering Sea	Full	Dutch Harbor	1,170	1,170	100.0
Bering Sea	Full	King Cove	90	90	100.0
Bering Sea	Full	Sand Point	1	1	100.0
Total	**Full**		**2,092**	**2,092**	**100.0**
Gulf of Alaska	Partial	Akutan	66	15	22.7
Gulf of Alaska	Partial	Dutch Harbor.	1	1	100.0
Gulf of Alaska	Partial	King Cove	8	4	50.0
Gulf of Alaska	Partial	Kodiak	801	195	24.3
Gulf of Alaska	Partial	Sand Point	302	64	21.2
Total	**Partial**		**1,178**	**279**	**23.7**

Table 3-9. -- Number of trips by observation status in the 2019 trip-selection strata.

Strata	**Monitored**	**Unmonitored**
HAL	307	1,437
EM HAL	291	625
POT - No Tender	74	454
POT - Tender	13	31
EM POT	60	105
TRW - No Tender	395	1,173
TRW - Tender	20	36

Table 3-10. -- Results of permutation tests between monitored and unmonitored trips in the 2019 trip-selection strata. OD: Observed difference (monitored - unmonitored). A Bonferroni adjustment has been applied to *p*-values.

Strata	**Metric**	**NMFS areas**	**Days fished**	**Vessel length (ft)**	**Species landed**	**pMax species**	**Landed catch (t)**
HAL	Observed difference	0.011	-0.662	0.849	-0.019	0.000	-0.905
	OD (%)	0.996	-12.334	1.530	-0.520	-0.056	-13.636
	p-value	1.000	< 0.001	1.000	1.000	1.000	0.030
EM HAL	Observed difference	-0.003	-0.309	-1.344	0.525	-0.031	0.206
	OD (%)	-0.294	-6.224	-2.589	13.380	-3.514	2.951
	p-value	1.000	0.252	0.204	< 0.001	0.054	1.000
POT - No Tender	Observed difference	-0.011	-0.429	0.812	-0.055	0.012	4.153
	OD (%)	-1.048	-9.360	1.116	-2.849	1.188	13.241
	p-value	1.000	0.870	1.000	1.000	0.156	1.000
POT - Tender	Observed difference	-0.060	4.181	8.417	0.218	-0.001	175.762
	OD (%)	-4.679	38.089	9.203	7.279	-0.074	100.077
	p-value	1.000	0.144	1.000	1.000	1.000	< 0.001
EM POT	Observed difference	-0.019	-0.719	0.357	0.486	-0.392	-1.732
	OD (%)	-1.882	-16.757	0.490	21.202	-31.701	-6.952
	p-value	1.000	0.144	1.000	0.012	1.000	1.000
TRW - No Tender	Observed difference	-0.046	-0.033	0.859	-0.733	0.011	-3.312
	OD (%)	-4.352	-1.238	1.013	-11.856	1.235	-3.501
	p-value	< 0.001	1.000	1.000	0.024	1.000	1.000
TRW - Tender	Observed difference	0.172	0.578	5.528	-0.028	0.013	86.389
	OD (%)	15.811	9.746	8.135	-0.615	1.281	66.601
	p-value	0.312	1.000	1.000	1.000	1.000	0.330

Figure 3-1. -- Total number of observer sea days (top panel) and total cost of observing those sea days (bottom panel). Vertical bars signify the range of potential outcomes predicted by the 2019 Annual Deployment Plan. Dashed lines signify expected outcomes. Solid lines signify what actually occurred in 2019.

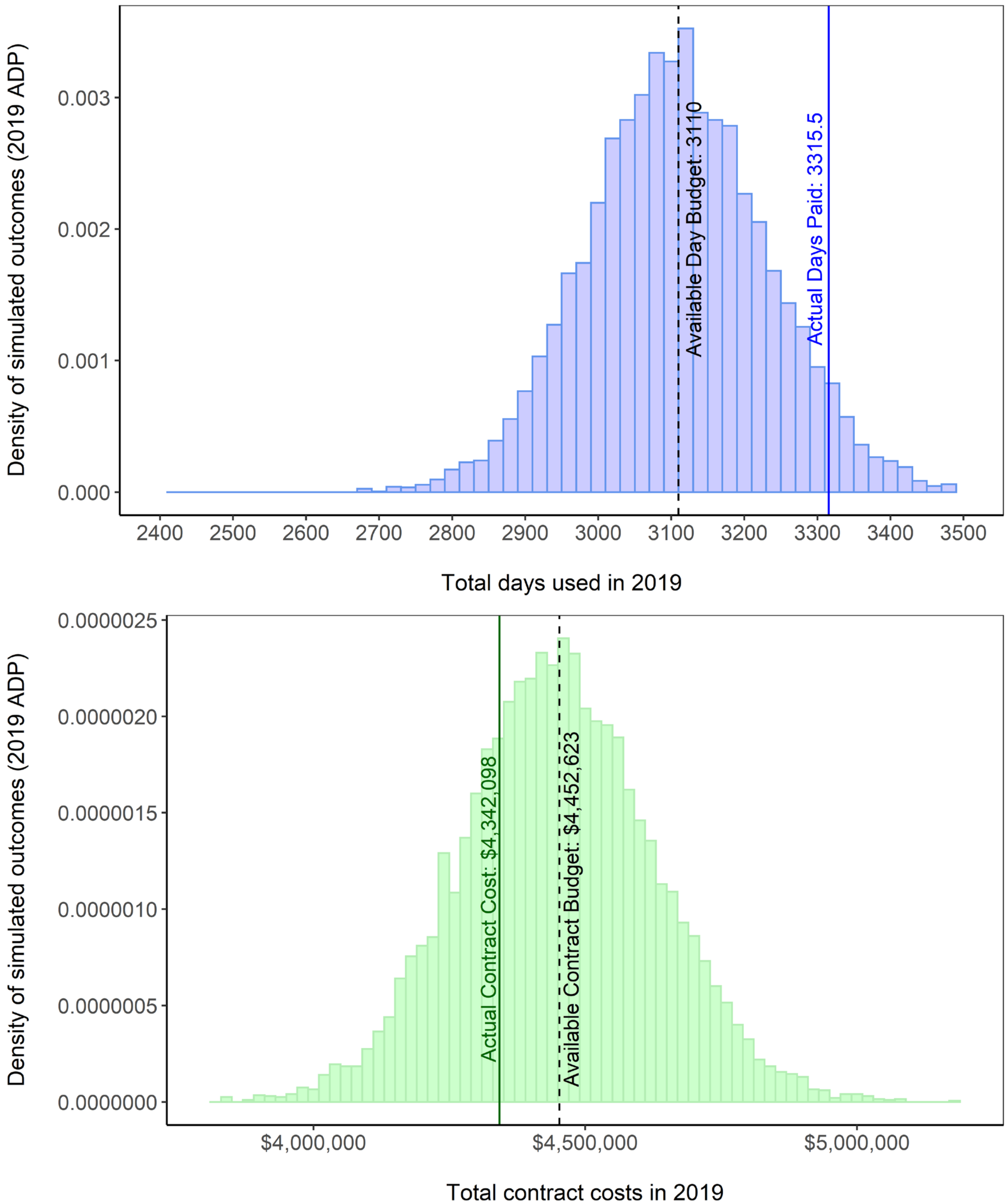


Figure 3-2. -- Rate of selected trips logged into ODDS organized by original date entered for all trips (grey line and grey text), and final date considering only non-cancelled trips (black line and black text). The programmed selection rate is depicted as the dotted line. Grey shaded areas denote the range of coverage rate corresponding to the 95% confidence intervals expected from the binomial distribution. The final coverage rates were higher than if trip dates had not been altered and/or cancelled. Vertical tick marks on the horizontal axis depict dates when an ODDS trip was selected due to a prior trip being cancelled that was selected for observer coverage (grey on the bottom for originally logged trips, and black on the top for trips after user manipulation).

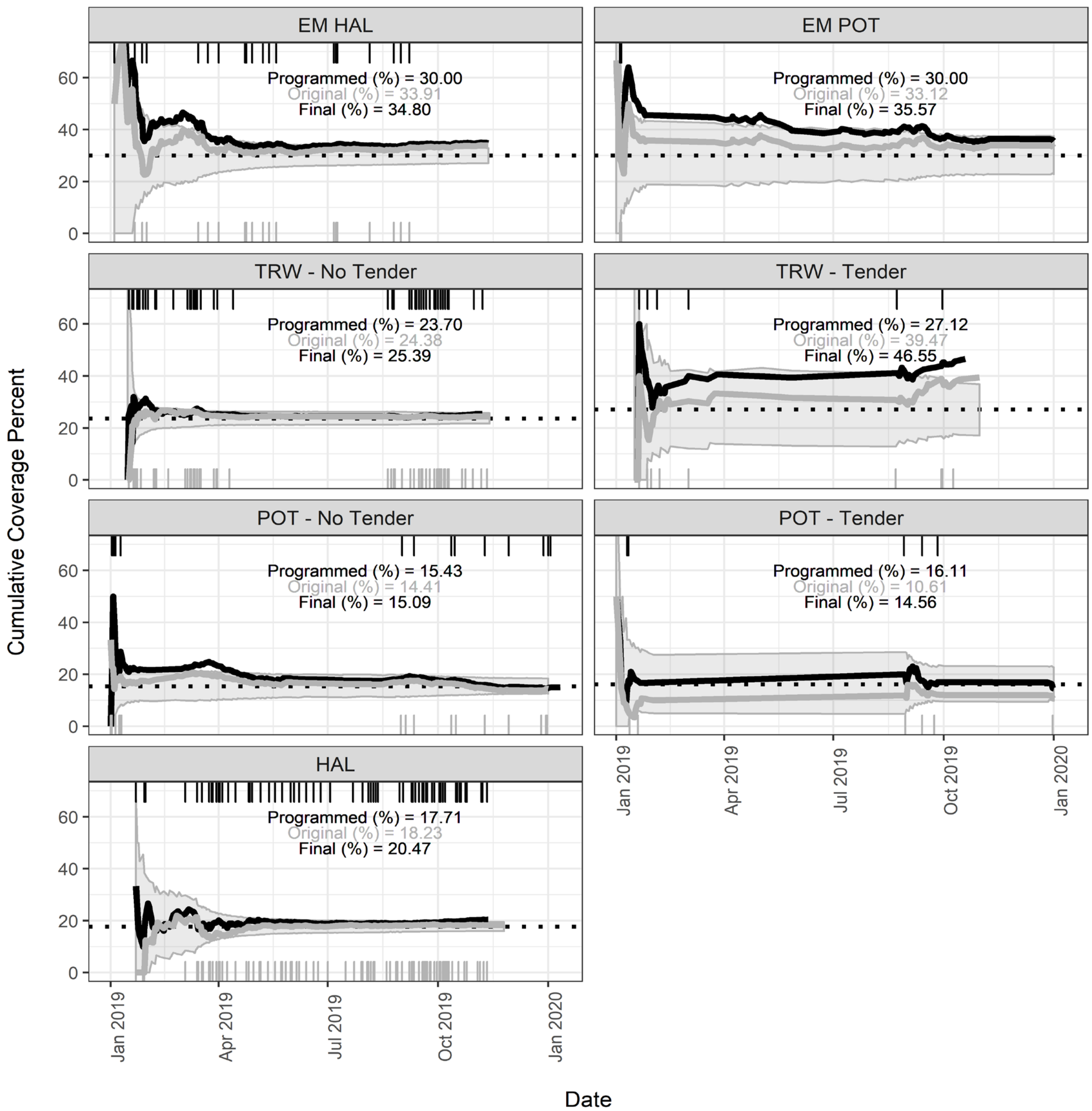


Figure 3-3. -- Cumulative number of trips monitored during 2019 (black line) compared to the expected range of observed trips (shaded area) given fishing effort and sampling rates. Dates where the monitored number of trips is outside of expected (less or more than the range) are depicted as tick marks on the horizontal x-axis. The results of tests that the observed rate derived from a binomial distribution sampled at the selection rate are denoted as *p*-values.

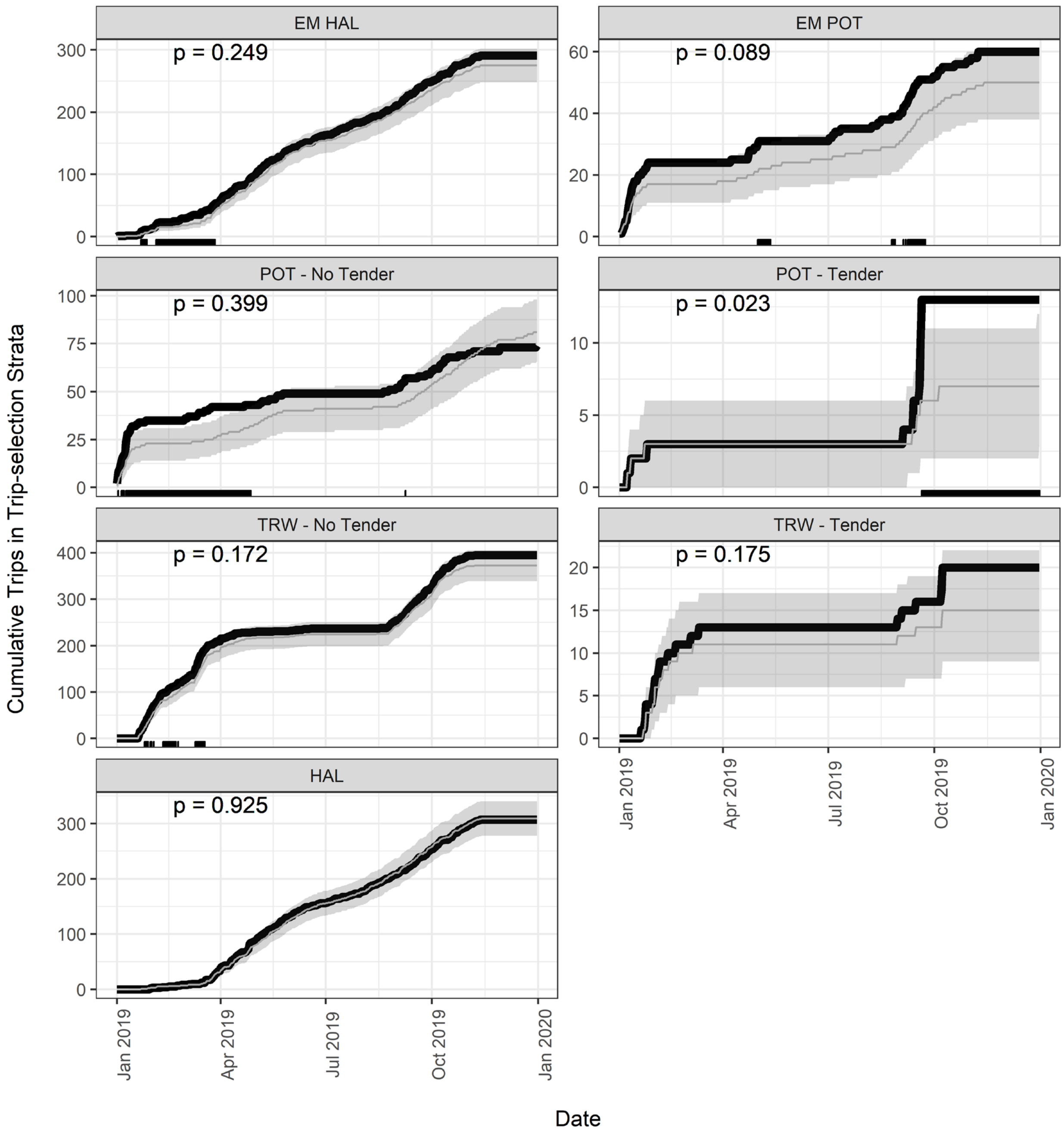


Figure 3-4. -- Comparison plots depicting the number of monitored sample units compared to the number of expected monitored sample units for each partial coverage stratum. Each point on a plot represents a NMFS Area. The darker the point, the more unusual the result.

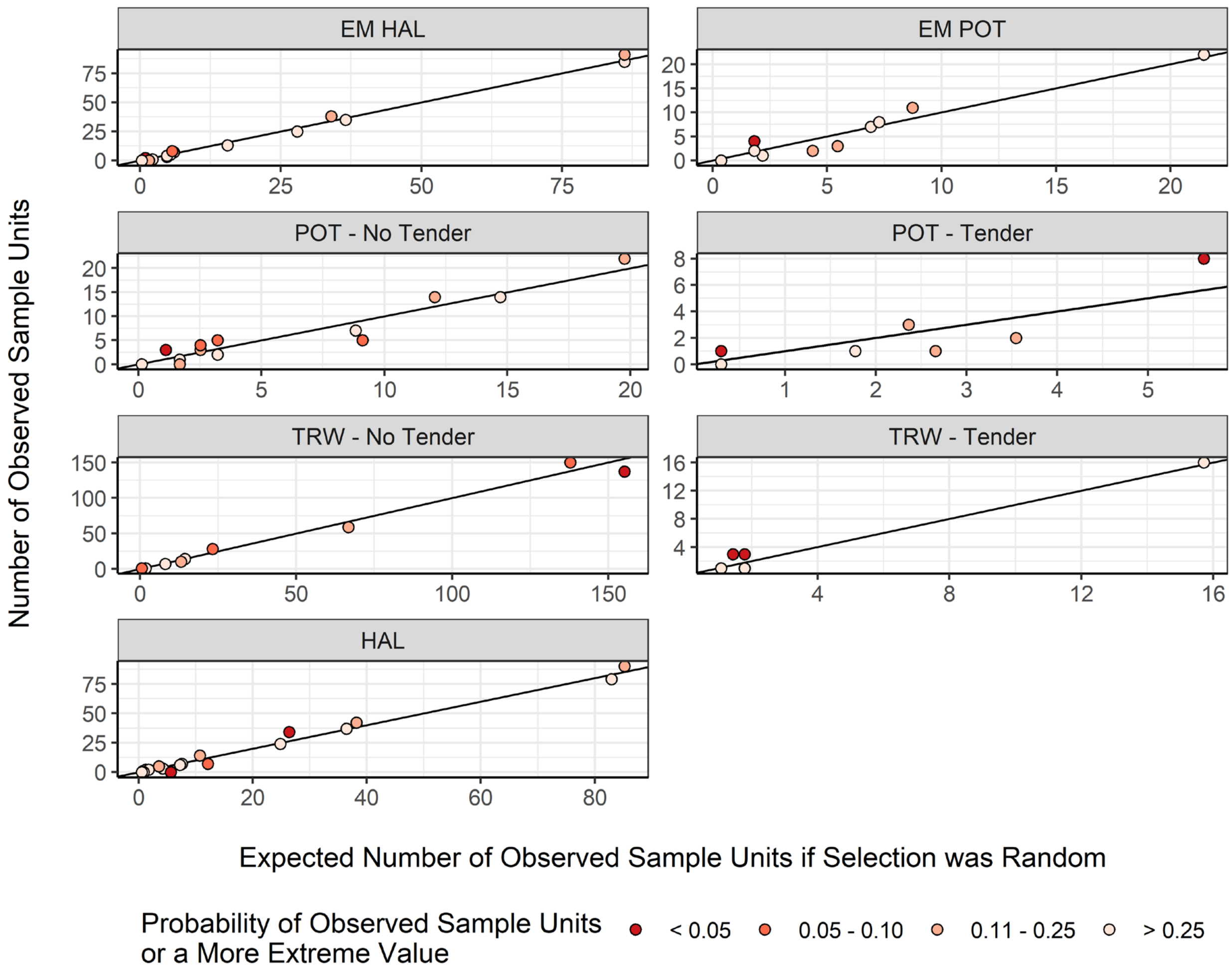


Figure 3-5. -- Probability of monitoring the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *EM HAL* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

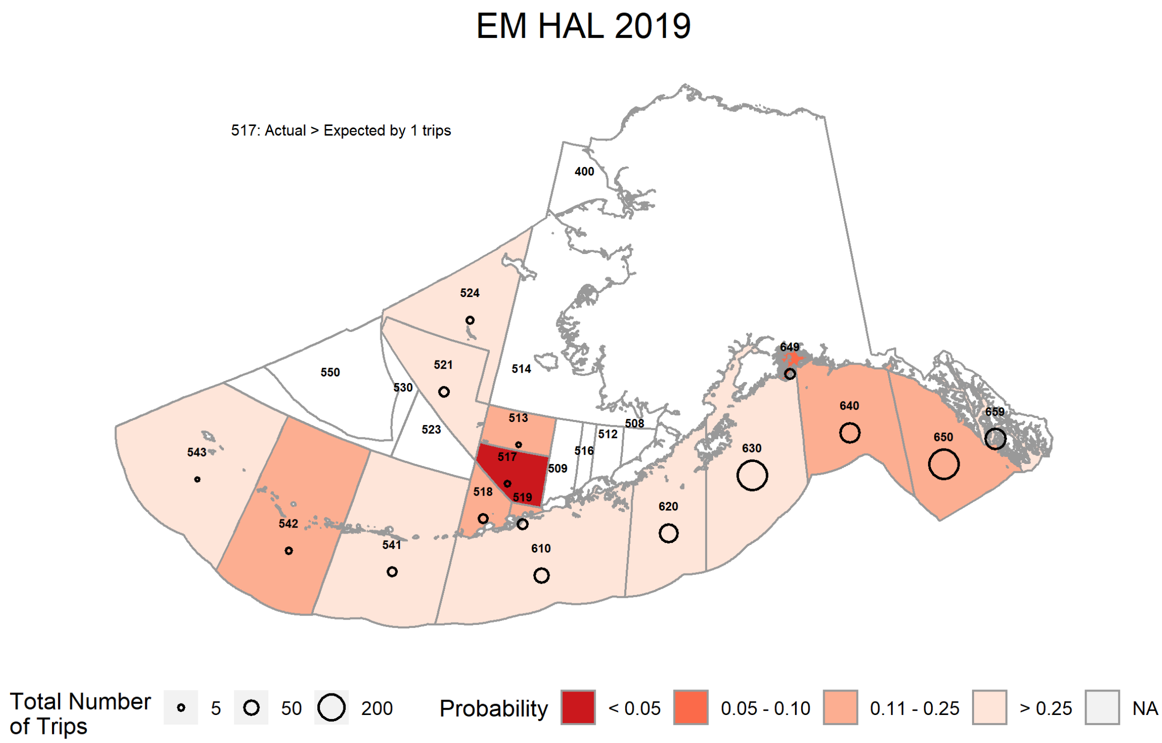


Figure 3-6. -- Probability of monitoring the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *EM POT* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

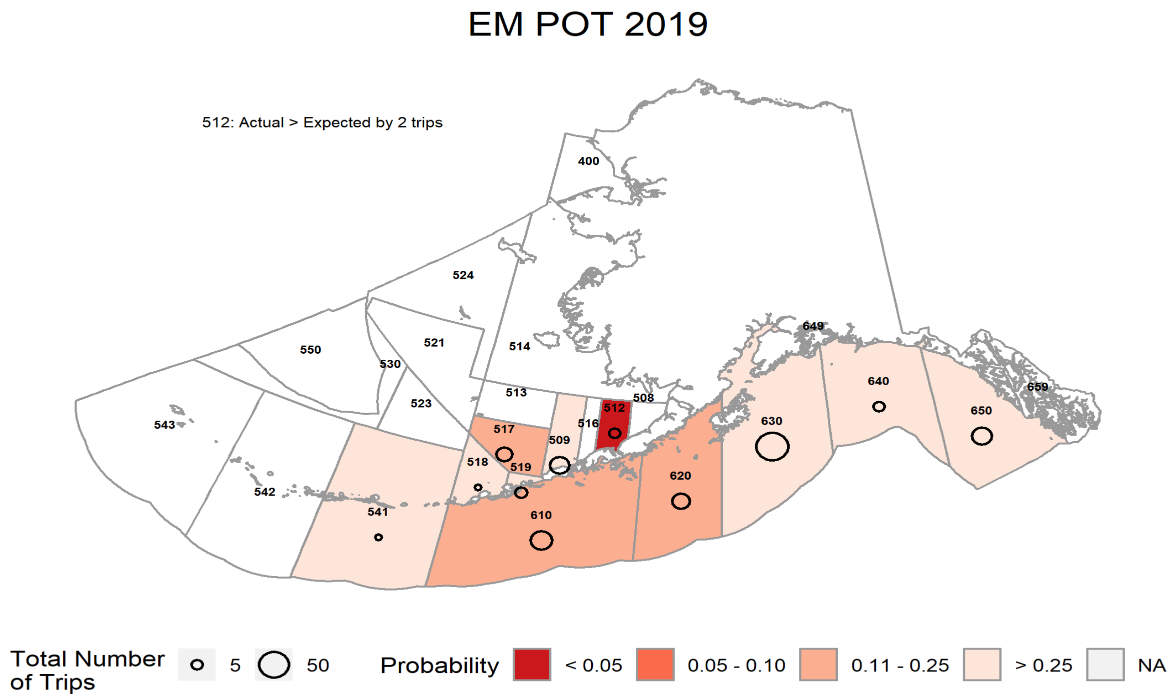


Figure 3-7. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *HAL* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

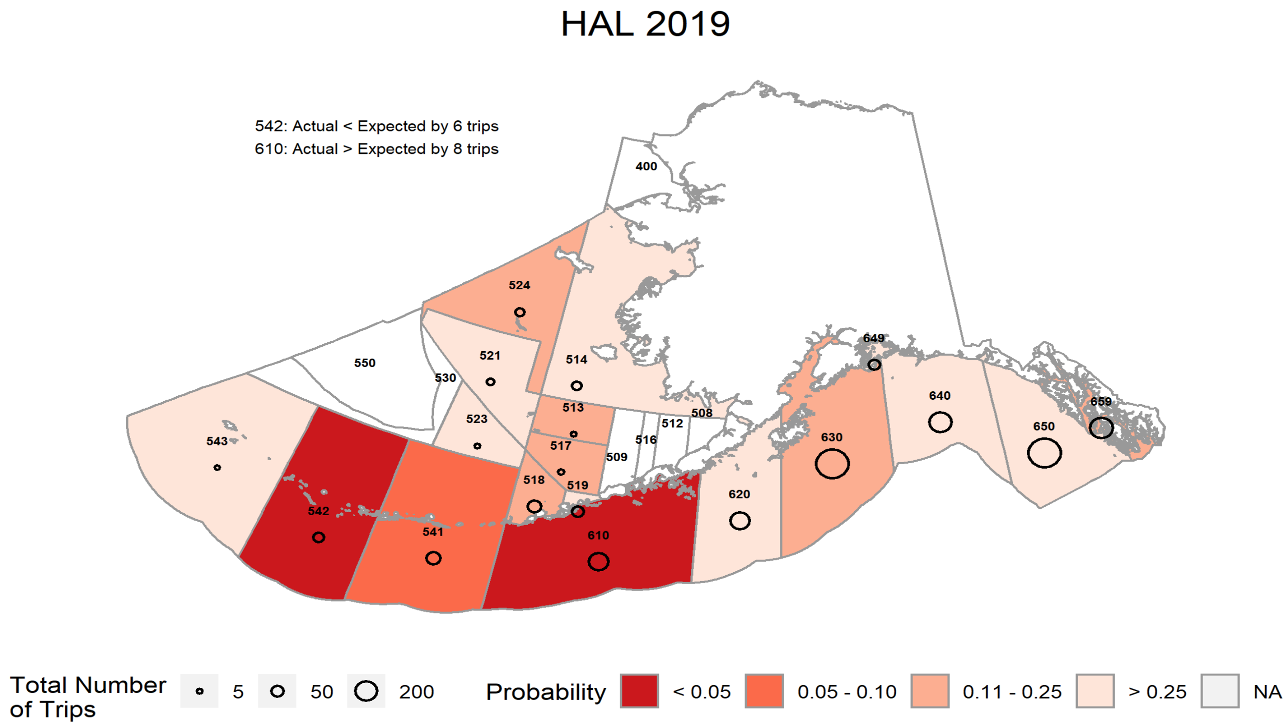


Figure 3-8. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *POT - No Tender* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

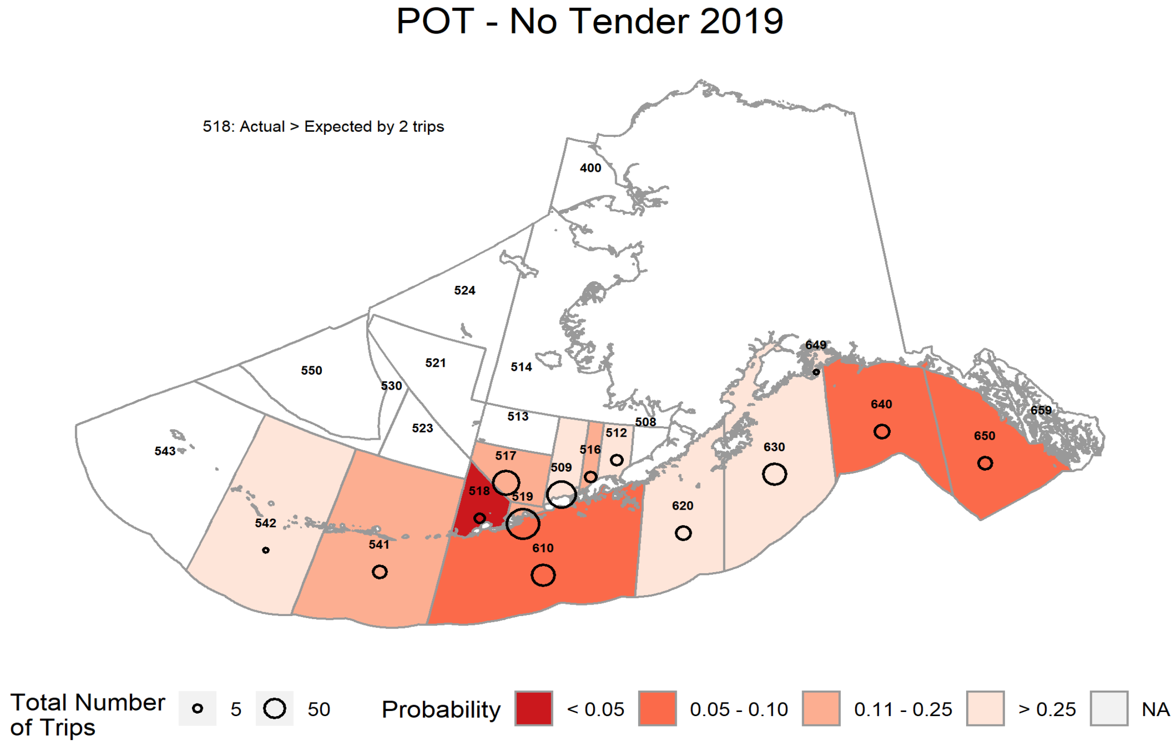


Figure 3-9. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *TRW - No Tender* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

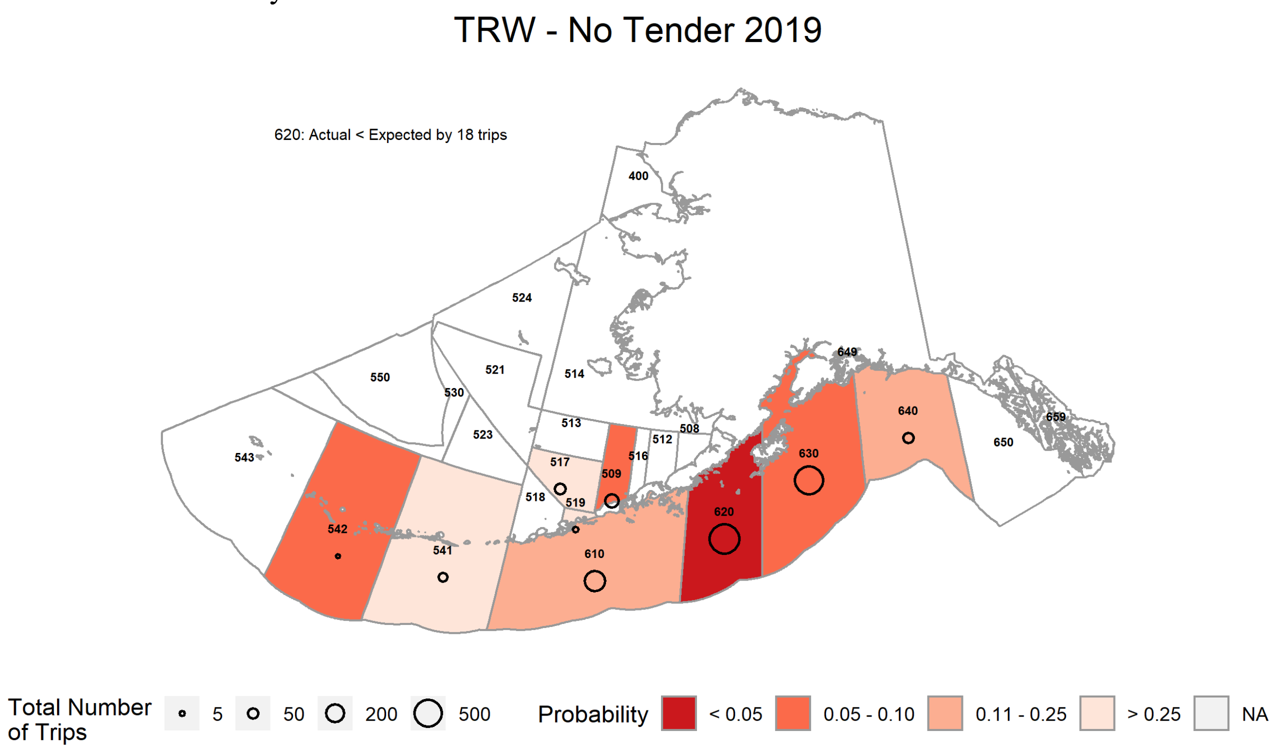


Figure 3-10. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *POT - Tender* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

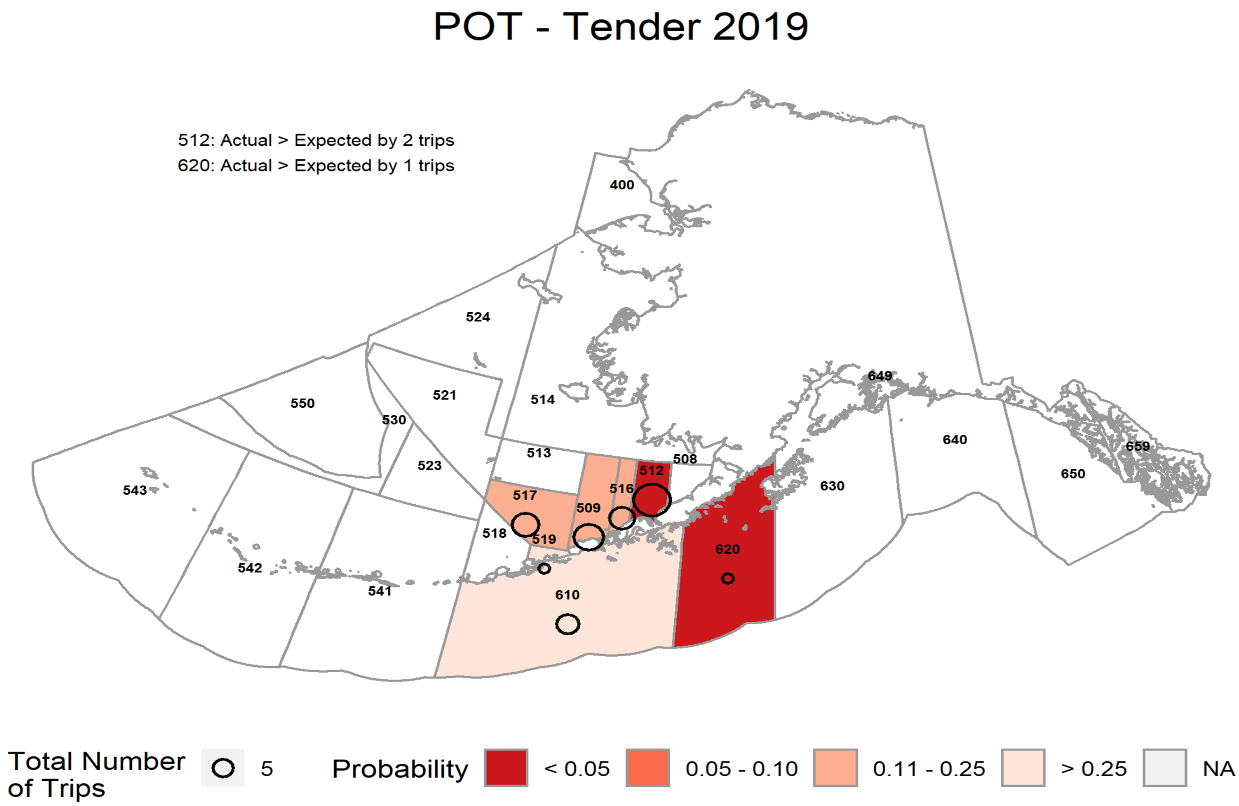


Figure 3-11. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *TRW - Tender* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

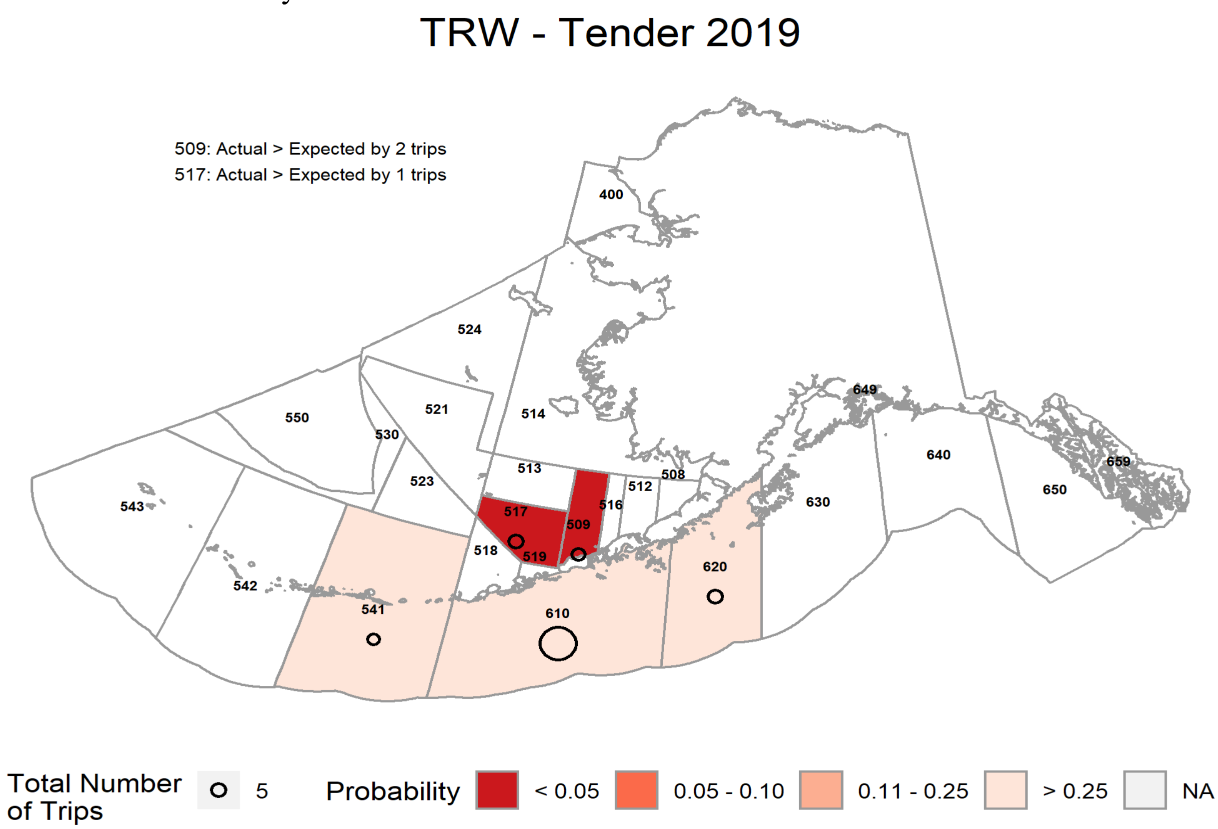


Figure 3-12. -- Example of results from permutation tests depicting percent differences between observed and unobserved trips for observer pool strata in the partial coverage category. Grey bars depict the distribution of differences between observed and unobserved trips where the assignment of observed status has been randomized (this represents the sampling distribution under the null hypothesis that observed and unobserved trips are the same). The vertical line denotes the actual difference between observed and unobserved trips. Values on the x-axis have been scaled to reflect the relative (%) differences in each metric. The *p*-value for each test is denoted in the upper left corner. Low *p*-values are reason to reject the null hypothesis and conclude that there is an observer effect. Results from all permutation tests can be found in the Tables section of this report.

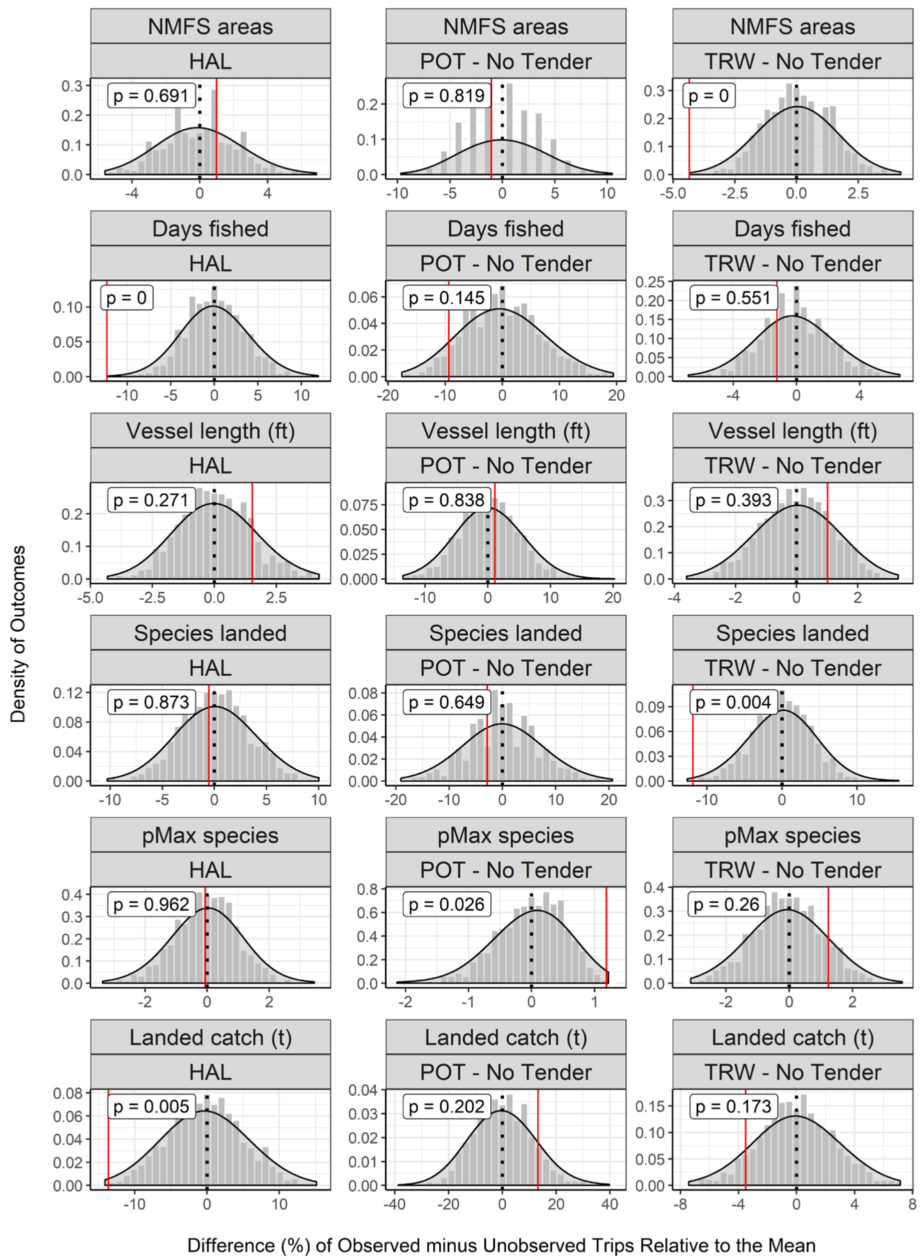


Figure 3-13. -- Distribution of trip durations for vessels in the partial coverage category by gear and observation status. Observed trips are depicted as transparent white bars overtop of solid black bars for unobserved trips. Trip durations where both observed and unobserved status exist are depicted in gray (This is not the same as a stacked bar chart, in which the height of the bar would reflect observed and unobserved on top of one another- this plot has each observation status in front of the other).

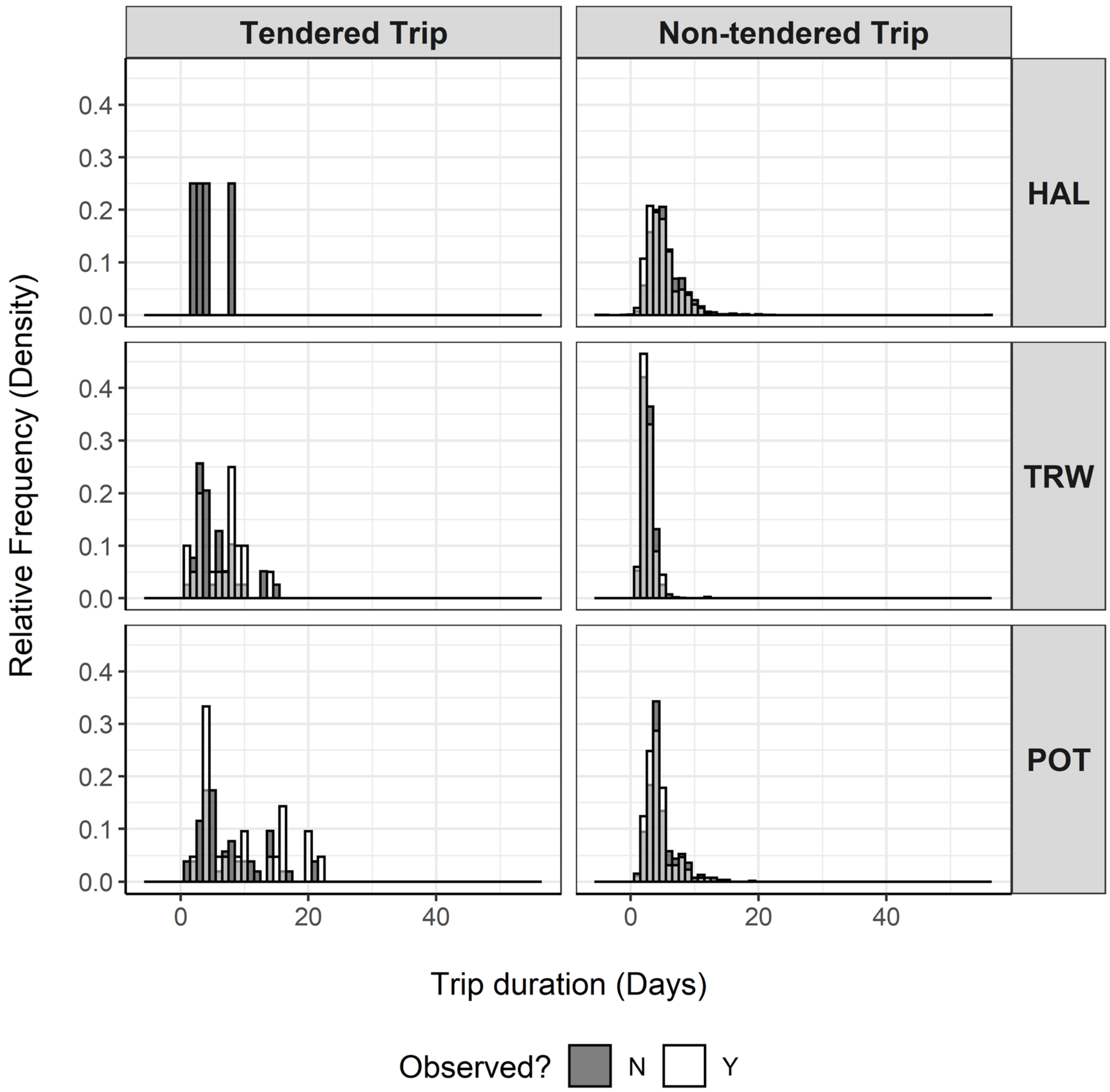
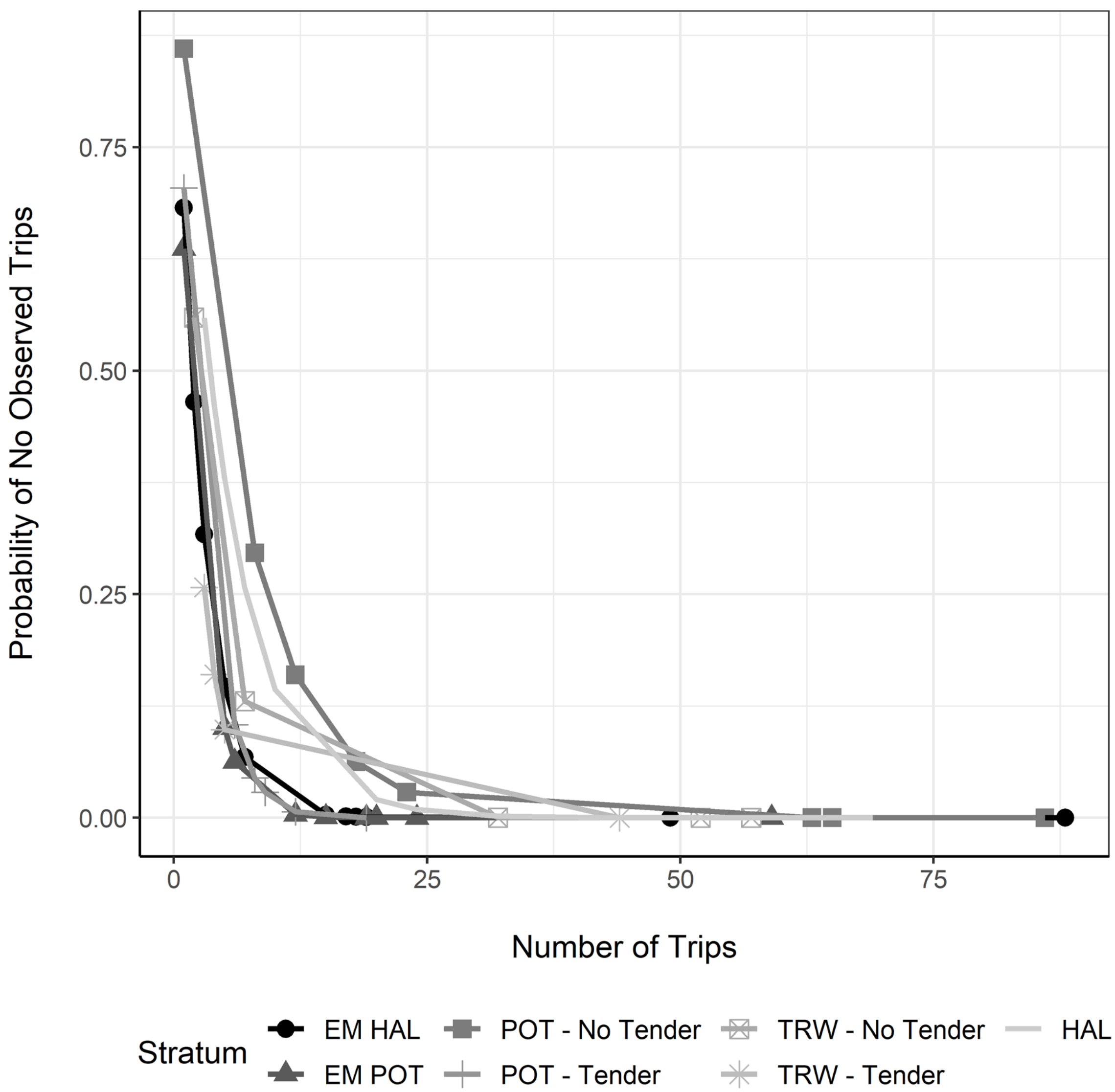


Figure 3-14. -- Probability of monitoring no trips in a NMFS Area and stratum given fishing effort and sampling rate. The x-axis has been truncated to increase resolution at low levels of fishing effort. The likelihood of having no monitoring data decreases with increasing total fishing effort and selection rate. The selection rate is 17.71% in the *HAL* stratum, 15.43% in the *POT - No Tender* stratum, 16.11% in the *POT - Tender* stratum, 23.70% in the *TRW - No Tender* stratum, 27.12% in the *TRW - Tender* stratum, 30.00% in the *EM HAL* stratum, and 30.00% in the *EM POT* stratum.



4. Descriptive Information

4.1. Number of Trips and Vessels by FMP Area, Strata, Gear and Vessel Length

In Chapter 3, Table 3-5 provides trip and vessel counts based on coverage type and strata. However, the Council has previously requested a summary of trip and vessel counts based on criteria which are not, or are no longer, considered when deploying observers on trips (e.g., FMP area and vessel length). Table 4-1 and Table 4-2 provide a summary of the number of vessels and trips by FMP area, strata, gear type, and vessel length category within the full and partial coverage categories. Trips are summarized as the number of monitored trips and the total number of trips. Monitored trips reflect either trips with an observer or EM fixed gear trips if at least some video was reviewed. The rationale for defining monitored trips this way for EM fixed gear trips is that it is most similar to the way in which trips in other strata are considered observed (i.e., irrespective of whether or not haul information or usable species composition data were collected). Table 3-6 presents detailed information about the number of hard drives received and reviewed by EM gear type.

Vessels and trips may be counted more than once in a vessel length category in Table 4-1 and Table 4-2 if a vessel is in more than one stratum, fishes in more than one FMP area, or utilizes more than one gear type on a trip or within the year. The table rows titled “BSAI Subtotal”, “GOA Subtotal”, and “Total Unique” include the number of unique vessels and unique trips in each vessel length category where each vessel or trip is counted only once, in each of the FMP areas or overall, respectively.

4.2. Total Catch and Discards and Amount of Catch Observed

The ADP does not assign observers or EM coverage by fisheries (because the fishery is not able to be defined before fishing occurs), instead observers or EM are deployed to trips and vessels across all fisheries. However, there has been interest in comparing observer and EM coverage across resulting fisheries, so this section includes summaries of monitored and total catch by area, gear type, and sector. The total catch of groundfish and halibut (retained and discarded) was summarized from the NMFS CAS in Table 4-3 and Table 4-4 for 2019. These tables allow for comparisons of the metric of catch weight derived from CAS. Catch estimation methods are described in detail in Cahalan et al. (2014).

It is important to note that the proportion of catch weight monitored for a subset of fishing activity (i.e., a fishery) should not a priori be expected to equal the deployment rates (proportion of trips selected for observer or EM coverage) specified in the ADP. In particular, if there are differences in fishing characteristics between the subsets of fishing activity, specifically differences in catch weights (or discard rates) per trip, those differences will be reflected in the relative proportions of catch monitored. For example, within the partial coverage trawl stratum, trips in the pollock fishery will have very different total catch weights and discard characteristics than trips in flatfish fisheries. In addition, there are several other factors that will contribute to the apparent inconsistencies between proportion of catch monitored, the proportion of trips monitored, and the deployment rate specified in the ADP. These include the actual number of trips selected (sample size), variability in deployment due to random chance, the ratio of number of trips in each of the fisheries, and lack of independence between the coverage rates within a sampling stratum.[13]

In Table 4-3 and Table 4-4, the table columns titled "Monitored" indicate catch that occurred on trips where an observer was present or on EM fixed gear trips for which some video was reviewed. Catch on vessels on EM pot trips are included in the monitored column in these tables for the first time. Beginning with 2019, EM data from pot gear were integrated into the catch estimation process. The columns titled "Total" represents estimates of all catch from all trips regardless of whether it was monitored. The rows titled "Retained" indicate catch that was offloaded (minus dockside discard). The rows titled "Discard" are estimated at-sea discard.

All catch and discard information, including halibut, summarized in these tables are in round weight metric tons. If species were landed in a condition other than round weight, then standard product recovery rates (PRRs) were used to obtain round weight. Halibut that were landed in ice and slime were additionally corrected for ice and slime using a standard 2% correction.

Additional retained and discard catch information, broken down by species for the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI), are available online for 2019 as well as prior years.[14] Caution should be exercised when interpreting the results for halibut in the halibut IFQ fishery in these tables, however. For longline catch, the estimated weight of each species caught is the product of the estimated number of fish, the mean weight per fish, and the proportion of the catch that is discarded. While these methods provide unbiased estimates of total catch, the estimate of at-sea discards relies on the assumption that the proportion of the number of discarded is equal to the proportion of the weight discarded. The Pacific halibut fishery is the only federally managed groundfish fishery with a regulatory minimum size limit (32 inches). Because the minimum size limit requires smaller fish to be discarded, this assumption is not valid in the directed halibut fishery.

Starting in 2016, selection sampling methods for halibut were changed so that halibut selection was randomized within sampled hauls, making these data collections consistent with methods used in other fisheries and providing data that was used to assess the magnitude of bias associated with estimates of at-sea halibut discards in the directed fishery. These data were used to develop a model in late 2019 to convert the percent numbers discarded to percent weight discarded and resolving the potential bias. These results were presented at the 2019 American Fisheries Society Meeting, and they suggest that the weight of halibut discarded on sampled hauls in the directed halibut fishery is overestimated by approximately 35%. This conversion

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[13] More trips monitored in one subpopulation (fishery) equates to fewer monitored trips in the other subpopulations since all the trips across the different subpopulations must add to the total number of trips selected.

[14] Available online at: Monitored Catch Tables.

method will be documented in a forthcoming NOAA Technical Memorandum and incorporated into the estimation process as soon as possible (expected in 2021).

4.3. Electronic Monitoring Video Review

This section provides metrics on the results of the EM video review. This information is provided as part of the Annual Report to be able to track reliability and image quality. During 2019, video that was collected from vessels participating in the EM program was sent to Pacific States Marine Fisheries Commission (PSMFC) and Saltwater for review. The EM data derived from video review were incorporated into the CAS for catch estimation to support inseason management of the fisheries.

- EM data were collected from 116 total vessels on a total of 304 hook-and-line and 53 pot trips in 2019.
- PSMFC completed video reviews of hard drives that contained 13,175 hauls total in all EM data with 4,006 of those hauls reviewed. This was a significant increase from 2018. The PSMFC report is included in Appendix Table D- 1.

4.3.1. Video Review Rates

Review rate for halibut and sablefish target fisheries ranged from 0.43 to 0.58 minutes of review per minute of video (Appendix Table D- 5). The review rate in the Pacific cod fishery was slower and close to real time (e.g., one hour of catch handling could be reviewed in just over an hour) or even longer. Pacific cod hauls tended to have a larger variety of species caught, which increases the review time. In addition, this is the only fishery where stern hauling was conducted and stern haulers were more difficult to review due to a side view of the line (as opposed to a top down view) as well as poor lighting on the line at night.

4.3.2. Data Quality

Video reviewers at PSMFC assessed aspects of data quality including video and sensor completeness, overall image quality, and image quality for every reviewed haul During an EM trip there can be times when either the sensors or video data are not captured and there are gaps in the EM information. Reviewers recorded whether sensor and video data were complete for each haul based on the quantitative data from the sensor readings. Reviewers also assessed image quality for each haul and reasons for decreases in image quality (e.g., water spots on the camera, night lighting, etc.). Data quality could be impacted by factors such as the image quality, catch handling, and camera angles, or camera operation and these can affect the ability of the reviewer to effectively quantify and accurately identify catch data. The 2019 results are presented in Appendix Table D- 3 and key finding are summarized below.

Video and Sensor Completeness

- Sensor data was complete on 94% of the trips.

- Video was complete for 86% of trips in 2019. This was an improvement from 2018 when the video was complete on 68% of the trips. As in previous years, the majority of the incomplete video in 2019 did not impact the ability of reviewers to quantify the catch because the gap in the video occurred before (or after) fishing hooks were being brought onboard. Of the 4,006 hauls reviewed 3,905 (97.5%) had complete video during the entire period when catch was brought onboard and sorted.
- 101 hauls reviewed had video gaps during fishing activity; most often these gaps resulted from video ending before catch handling ended, video starting after catch handling had begun, or from intermittent gaps in video coverage. All of these issues suggest technical problems relating to the set-up of the EM system, or ageing components of the EM system that cause technical issues. In general, video data was somewhat more likely to be incomplete on the first trip that a boat took with an EM system. PSMFC has been working with Archipelago Marine Resources (AMR) on changes to the software that will allow quantification of the lengths of these time gaps.

Image Quality

Of the 4,006 hauls reviewed, 67.7% of the video was high quality. About 27% of the hauls were assessed to have medium-quality images. This was similar, though slightly improved compared to the results in 2018. The most common reasons for medium-quality video were poor camera angles (48.8%) and water spots (30.29%); other reasons included, night lighting, dirty cameras, and glare. About 5% of the hauls were assessed as low image quality or unusable. Low-quality images were mostly a result of intermittent gaps in the video.

4.3.3. EM Video Review and Service Provider Logged Issues

If problems are discovered during video review they are logged in an EM service provider application (EMSP ODDS application) as well as in the data review program used by PSMFC on a trip and haul by haul basis. Every issue that is logged in the EMSP ODDS application results in an automated email that is sent to the associated vessel with instructions on how to fix the problem. The EM Service Provider for the equipment installed on that vessel also reaches out to vessels to resolve each issue. Unresolved issues may result in trip logging limitations (e.g., waiting period of 72 hours), additional email notifications to the vessel, additional contacts from the EM service provider, OLE contact or actions, and/or removal from the EM program.

Of the 357 EM trips that were selected for review, 177 EM trips (147 longline and 30 pot) had problems that were logged in the EMSP ODDS application during video review.

In 2019 there were 20 issue types that could be logged for an EM trip by video reviewers. The types of logged issues range from EM equipment issues to not complying with a Vessel Monitoring Plan (VMP) and the scenarios can cause data loss or data degradation due to lower quality data, or they cause bias in the data. The issues are logged at the trip-level (not at a haul level), therefore one logged issue may impact some or all of the hauls in a trip. Issues logged by video reviewers in 2019 included:

- Catch handling inconsistent with VMP occurred on 56 trips (41 on longline trips, and 51 on pot trips).
- Specific issues categories that had that had greater than 10 issues logged include:
    - Camera lens dirty – 22 issues logged
    - Hauling camera issue – 32 issues logged
    - Complete logbook not submitted – 24 issues logged
    - Camera repositioning required – 19 issues logged
    - Deck/Discard camera issue – 10 issues logged
    - Hard drive data is Incomplete – 20 issues logged
    - Streamer line camera issues – 19 issues logged
- 'Other system problems' which is a catch-all category for issues, often technical in nature (e.g. system clock not working; no EM system activation prior to leaving port), that do not fit within other issue types. 'Other System Problems' were logged on 43 EM selected trips.

EM Service Providers also have the ability to log issues in EMSP ODDS application. These issues are not associated with trips as they occur prior to a trip occurring, or on non-selected EM trips. They are always equipment issues as that is what the EM Service provider is expected to resolve.

A total of 19 issues logged by EM service providers in 2019. These issues included: problems with the Deck/discard camera, Hauling camera, or the bird streamer line camera; issues with cameras being out of focus; GPS unit malfunction; hard drive data being incomplete; and technical issues with the hydraulic sensor.

4.3.4. EM Data from Pot Vessels

In 2019 the EM data from pot vessels was used in the Catch Accounting System (CAS). Since this was the first year of full implementation of pot EM, this section provides bit more detail about the EM data from pot vessels. Species and counts of catch were recorded for a subset of hauls for single pot gear and longline gear. String pot gear, however, was reviewed in its entirety. For single pot gear, catch was reviewed for every third pot ("haul"). Catch was defined as anything seen by an EM reviewer, excluding free-moving marine birds and mammals alongside the vessel. Video reviewers were trained by a PSMFC staffer working with the North Pacific Observer Program on Alaska species reporting conventions. The reviewers were instructed to record species to the lowest identifiable taxonomic level or grouping as required by CAS for estimation and fishery management.

- More negative data quality impacts are possible in higher bycatch pot fisheries (e.g., Pacific cod) as it is harder to count high numbers of items quickly. This can result in lower ratings for data quality, image quality, and video completeness.

- Crew catch handling is impacted as crew must clear each pot, and process catch prior the next pot coming onboard. This may slow fishing efforts but must be done to comply with VMP.

- Bias might exist towards pots with lower catch if reviewers move past pots which cannot be tallied/counted to the next pot that can. Once a pot is successfully tallied, the intended sample frame is resumed. NMFS is working to support additional reviewers to decrease the review time lag, and to allow for longer review time needed by pot gear.

EM issues to address in the future:

- Low effort portion of EM fleet in regard to pot cod.
- Is it wise to tie up EM resources in vessels that do very few trips or haul small amounts of gear?
- Vessels that complete very few trips tend to have outstanding issues that do not get addressed and are perpetuated in the next year.
- Small portion of fleet/trips tie up reviewers from other hard drives.

4.4. Observer Training and Debriefing

During the 2019 fishing year, approximately 404 individual observers were trained, briefed, and equipped for deployment to vessels and processing facilities operating in the BSAI and GOA groundfish and halibut fisheries. These observers collected data on board 398 fixed gear and trawl vessels and at eight processing facilities for a total of 39,989 observer days (36,068 full coverage days on vessels and in plants; and 3,921 partial coverage days).[15]

New observer candidates are required to complete a 3-week training class with 120 hours of scheduled class time and additional training by FMA staff as necessary. The FMA Division conducted training for 165 new observers to deploy in 2019 in addition to the 239 prior observers who attended a briefing of some type (Table 4-5). Portions of FMA's 3-week observer training class were attended by observer providers, Southeast Fisheries Science Center (SEFSC) Observer Program Staff, and NOAA Fisheries Office of Law Enforcement.

During their first two deployments, observers are required to complete a mid-cruise debriefing while still in the field. This mid-cruise debriefing provides the opportunity for both the observer and FMA staff to assess the data collected up to that point, methods used, challenges encountered, and discuss future vessel assignments. After successfully completing two contracts, mid-cruise debriefings are only required on an individual basis if recommended by FMA staff. Mid-cruise debriefings can be completed in person, over the phone, electronically, or via fax. In 2019 there were 6 mid-cruise debriefings in Anchorage, 186 in Dutch Harbor, 8 in Kodiak, and 28 in Seattle.

After each deployment, observers must meet with an FMA staff member for a debriefing interview. During the debriefing process, sampling and data recording methods are reviewed and, after a thorough data quality check, the data are finalized. Twenty-seven FMA staff

[15] Note that observer days are calculated differently from invoiced days. Observer days represent any amount of time an observer is on a vessel as part of their deployment which may be inclusive of non-fishing and standby days.

members completed 121 debriefings in Anchorage, one in Kodiak, and 559 debriefings in Seattle. Many observers deploy multiple times throughout the year and debrief after each contract, followed by a briefing for re-deployment. Since observers are required to attend more than one briefing annually, the total number of briefings and debriefings for 2019 does not represent a count of individual observers.

Depending on their performance and assessment during debriefing, observers must attend a 1-day, 2-day, an annual briefing, or a fish and crab identification briefing. In rare cases when an observer has demonstrated major deficiencies in meeting program expectations, they may be required to re-take the 3-week training. Regardless of their required training as the result of debriefing, all returning observers must attend an annual briefing class prior to their first deployment each calendar year. These briefings provide observers with annual reminders on safe practices on fishing vessels and at processing plants, updates regarding their responsibilities for the current fishing season inclusive of programmatic and sampling updates, office of law enforcement training, seabird data collection, and U.S. Coast Guard (USCG) safety lectures and discussions. Additionally, observers are required to demonstrate their understanding and proficiency by passing the annual briefing exam, a seabird identification test, and successfully completing various in-class activities. In addition to all these updates, in 2019 specifically, updated curriculum focused on the halibut deck-sorting EFP updates for 2019, observer professionalism, and safety exercises and culture in observing.

Prior to being deployed on NOAA surveys and fishing vessels, North Pacific observers, AFSC staff, and visiting scientists must fulfill a requirement for cold-water safety training. All staff responsible for providing safety training to observers are required to attend a USCG approved Marine Safety Instructor course, have experience at sea, and complete regular refresher and co-trainings. In 2019, FMA provided a cross-training for staff from the SEFSC Observer Program to share information and learn from the experience of another observer program and offered the safety training to numerous AFSC seagoing staff.

Garnering expert guidance from the AFSC's Marine Mammal Laboratory scientists, FMA training team members developed curriculum and continued to train AFSC seagoing personnel on marine mammal species identification in anticipation of survey season.

The end result of 2019 for debriefings and trainings was overall another very successful and productive year for the FMA Division.

4.5. Outreach

While communication is a universal component of our operations between the AFSC, AKR, OLE, the NPFMC, and industry constituents, we wanted to highlight significant situations with elevated communications.

Throughout this year, extensive coordination and collaboration continued between the FMA, AKRO, and the Alaska Seafood Cooperative regarding the management and implementation of the 2019 Exempted Fishing Permit to conduct a feasibility study to reduce halibut mortality on designated non-pelagic trawl catcher processor vessels in the Bering Sea (Halibut EFP) and the rule making process. In addition to weekly phone and in-person discussions, FMA field staff assisted with EM camera chute data pulls and troubleshooting chute system issues, conducting deck safety plan assessments and approvals, and held several public meetings in Seattle in April and October. After several years of operating with under and EFP, the final rule to the Halibut Decksorting Monitoring Regulations was announced 15 October 2019 with an implementation date 14 November 2019. As there was minimal difference in the 2019 EFP, there was a relatively smooth transition at implementation at the end of the fishing year.

Observer providers are integral in the contribution to the management and successful deployment of observers in the Alaska fisheries. To support providers, observers, and the collaboration with the Observer Program and OLE, a day-long meeting was held in the fall with all observer providers, FMA staff, NOAA OLE, and AK General Counsel. The focus of this meeting was to address observer behavior and professionalism, the providers' responsibilities in oversight of observer behavior both on and off the boats and processors, observer confidentiality measures, and observer recruitment and shortage challenges. This meeting fortified open communications with industry, providers, FMA, and OLE, and how OLE and FMA could further support them.

Table 4-1. -- Number of vessels (V), total trips (N), monitored trips (n)[1], and percent of trips monitored (%) in 2019 in the BSAI by strata, gear type (hook-and-line (HAL), non-pelagic trawl (NPT), pelagic trawl (PTR), pot, and jig), and vessel length category (based on length overall, in feet) for the full and partial coverage categories.

		Vessel length category											
FMP area		**<40’**				**40-57.4’**				**=57.5’**			
Strata	**Gear**	**V**	**N**	**n**	**%**	**V**	**N**	**n**	**%**	**V**	**N**	**n**	**%**
BSAI													
FULL[2]	HAL					1	5	1	20.0	23	209	209	100
FULL[2]	NPT									41	554	553	99.8
FULL[2]	POT									5	31	31	100
FULL[2]	PTR									90	2,290	2,290	100
HAL	HAL					16	128	17	13.3	27	86	17	19.8
EM HAL	HAL					9	43	11	25.6	9	28	8	28.6
POT – No Tender	POT					5	50	7	14.0	49	302	46	15.2
POT – Tender	POT					1	1	0	0.0	25	38	12	31.6
EM POT[3]	POT									9	44	14	31.8
TRW – No Tender	NPT									33	143	42	29.4
TRW – Tender	NPT									7	8	4	50.0
TRW – Tender	PTR									1	1	1	100
Zero Coverage	HAL	67	740	0	0.0								
Zero Coverage	JIG	1	1	0	0.0	3	16						
BSAI Subtotal		68	741	0	0.0	30	243	36	14.8	241	3,729	3,222	86.4

[1] Monitored trips reflect either trips with an observer or EM fixed gear trips for which some video was reviewed.
[2] Full coverage in this table includes vessels in both the Regulatory and Voluntary Full Coverage strata.
[3] EM POT trips include trips that delivered to tenders and trips that delivered shoreside.

Table 4-2. -- Number of vessels (V), total trips (N), monitored trips (n)1, and percent of trips monitored (%) in 2019 in the GOA and overall, by strata, gear type (hook-and-line(HAL), non-pelagic trawl (NPT), pelagic trawl (PTR), pot, and jig), and vessel length category (based on length overall, in feet) for the full and partial coverage categories.

		Vessel length category											
FMP area		**<40'**				**40-57.4'**				**=57.5'**			
Strata	**Gear**	**V**	**N**	**n**	**%**	**V**	**N**	**n**	**%**	**V**	**N**	**n**	**%**
GOA													
FULL[2]	HAL									6	13	13	100
FULL[2]	NPT									38	189	189	100
FULL[2]	PTR									26	94	94	100
HAL[3]	HAL					195	910	151	16.6	115	658	134	20.4
HAL[3]	POT									6	16	3	18.8
EM HAL	HAL					97	630	220	34.9	38	221	52	23.5
POT – No Tender	POT					5	25	5	20.0	27	152	16	10.5
POT – Tender	POT					2	2	0	0.0	3	4	1	25.0
EM POT[4]	POT					6	41	18	43.9	9	80	28	35.0
TRW – No Tender	NPT					1	3	1	33.3	37	379	85	22.4
TRW – No Tender	PTR					1	27	6	22.2	56	1,051	268	25.5
TRW – Tender	NPT									12	27	7	25.9
TRW – Tender	PTR									11	24	9	37.5
Zero Coverage	HAL	319	1,213	0	0.0								
Zero Coverage	JIG	7	12	0	0.0	12	29	0	0.0				
Zero Coverage	POT	1	6	0	0.0								
Zero EM Research	HAL					2	19	0	0.0	2	10	0	0.0
GOA Subtotal		323	1,231	0	0.0	309	1,685	401	23.8	238	2,827	855	30.2
TOTAL UNIQUE		380	1,960	0	0.0	318	1,908	433	22.7	387	6,525	4,064	62.3

[1] Monitored trips reflect either trips with an observer or EM fixed gear trips for which some video was reviewed.
[2] Full coverage in this table includes vessels in the Regulatory Full Coverage stratum.
[3] On trips where more than one gear type is fished, the predominate gear type that will be used is selected in ODDS and determines the strata for the trip.
[4] EM POT trips include trips that delivered to tenders and trips that delivered shoreside.

Table 4-3. -- Monitored catch[1] (metric tons), total catch, and percent monitored (%) of groundfish and halibut retained and discarded in the groundfish and halibut fisheries in 2019 in the *Gulf of Alaska*. Empty cells indicate that no catch occurred.

	CATCHER/PROCESSOR			CATCHER VESSEL			CATCHER VESSEL: ROCKFISH PROGRAM			GEAR TOTAL		
	Monitored	**Total**	**%**	**Monitored**	**Total**	**%**	**Monitored**	**Total**	**%**	**Monitored**	**Total**	**%**
HOOK AND LINE												
Retained	1,725	1,837	**94%**	3,490	17,582	**20%**				5,216	19,419	**27%**
Discard	603	630	**96%**	2,556	11,978	**21%**				3,159	12,607	**25%**
JIG												
Retained	0	<1	**0%**	0	50	**0%**				0	50	**0%**
Discard												
NON-PELAGIC TRAWL												
Retained	25,919	25,91 9	**100%**	5,592	29,413	**19%**	6,704	6,704	**100%**	38,216	62,037	**62%**
Discard	5,441	5,441	**100%**	798	3,913	**20%**	250	250	**100%**	6,489	9,604	**68%**
POT												
Retained				971	5,359	**18%**				971	5,359	**18%**
Discard				90	766	**12%**				90	766	**12%**
PELAGIC TRAWL												
Retained	734	734	**100%**	30,311	112,987	**27%**	7,101	7,101	**100%**	38,147	120,822	**32%**
Discard	9	9	**100%**	214	879	**24%**	79	79	**100%**	302	966	**31%**

[1] Monitored catch is from trips with an observer or EM fixed gear trips for which some video was reviewed.

Table 4-4. -- Monitored catch[1] (metric tons), total catch, and percent monitored (%) of groundfish and halibut retained and discarded in the groundfish and halibut fisheries in 2019 in the *Bering Sea/Aleutian Islands*. Empty cells indicate that no catch occurred.

	CATCHER/PROCESSOR			MOTHERSHIP			CATCHER VESSEL			GEAR TOTAL		
	Monitored	Total	%	Monitored	Total	%	Monitored	Total	%	Monitored	Total	%
HOOK AND LINE												
Retained	101,145	101,161	**100%**				438	3,314	**13%**	101,583	104,475	**97%**
Discard	12,728	12,728	**100%**				267	2,259	**12%**	12,995	14,987	**87%**
JIG												
Retained	0	6	**0%**				0	141	**0%**	0	147	**0%**
Discard												
NON-PELAGIC TRAWL												
Retained	321,261	321,261	**100%**	40,388	40,388	**100%**	10,848	19,986	**54%**	372,497	381,636	**98%**
Discard	26,175	26,175	**100%**	2,721	2,721	**100%**	700	1,261	**55%**	29,596	30,158	**98%**
POT												
Retained	4,286	4,286	**100%**				6,949	23,172	**30%**	11,235	27,458	**41%**
Discard	129	129	**100%**				288	732	**39%**	418	862	**48%**
PELAGIC TRAWL												
Retained	639,523	639,523	**100%**	123,353	123,353	**100%**	616,674	616,674	**100%**	1,379,550	1,379,550	**100%**
Discard	2,514	2,514	**100%**	1,016	1,016	**100%**	1,712	1,712	**100%**	5,241	5,241	**100%**

[1] Monitored catch is from trips with an observer or EM fixed gear trips for which some video was reviewed.

Table 4-5. -- Number of observer training classes and number of observers trained/briefed from 28 November 2018 to 14 November 2019.

Training classes	**Number of classes**	**Number of observers trained/briefed**
3-week training	10	197
3-day annual	23	230
2-day briefing	4	4
1-day briefing	54	306
Lead Level 2	8	33
Fish and Crab ID Training	24	146
TOTAL	**123**	**923**

5. Compliance and Enforcement

This chapter provides a review of the collaborative efforts between NOAA's National Office of Law Enforcement (OLE), the Alaska Division of the OLE (AKD), the Fisheries Monitoring and Analysis Division of the Alaska Fisheries Science Center (FMA), the fishing industry, and other partners in 2019. It includes a summary of the partners involved in law enforcement, a novel analysis of potential violations from fishery observers (observers), compliance assistance and outreach efforts, and enforcement actions.

Terminology

- Complaint: A report of a potential violation. Complaints can be reported by observers, industry or anyone within the general public. When a complaint is reported by an observer, it is typically documented in a statement.
- Statement: A document where an observer will report potential violations. There are multiple statement headings used to categorize potential violations. A single statement may report multiple occurrences of the same potential violation or may report multiple potential violations falling under the same category. A statement is sometimes referred to as a "complaint" or an observer affidavit.
- Occurrence: A specific instance of a potential violation within a statement. A statement may consist of one or many occurrences.
- Incident: A tracking number generated by OLE's enforcement database. Multiple statements can be investigated under a single incident number. Not all incidents are forwarded for investigation. An incident that is forwarded for investigation is sometimes called an "investigation" or a "case".
- Investigation: An inquiry conducted by OLE agents and officers to determine if a violation has occurred.
- Case: The conclusion of an investigation that may result in enforcement action.
- Enforcement action: Holding a violator accountable through the use of a Written Warning or Summary Settlement; a case can also be forwarded to a General Counsel attorney for civil matters or an Assistant United Attorney General for criminal matters.

5.1. Enforcement and Partners in Alaska

5.1.1. NOAA Office of Law Enforcement

The NOAA OLE mission is to support resource management by enforcing the laws and regulations that protect living marine resources. Central to this mission is the OLE role in protecting observers and their ability to collect scientific data used to manage marine resources. Reports of rape, assault, sexual harassment, interference/sample bias, intimidation, coercion, hostile work environment and safety are among the highest OLE and AKD investigative priorities.[16]

AKD maintains a strong partnership with FMA. AKD Agents and Officers collaborate frequently with FMA to provide outreach, education, and compliance assistance to industry and stakeholders. Agents and officers in the field respond to industry questions about fishery monitoring requirements and participate in outreach meetings to discuss fishery management programs. AKD also assists FMA by providing training to observers, discussing compliance concerns with debriefers, and collaborating in analyzing violation trends.

AKD dedicates a full-time liaison contractor in Seattle to support the reporting of potential regulatory violations by observers trained and debriefed by FMA. The liaison receives and organizes compliance statements; compiles the compliance statements and relevant observer data for investigation; provides resources and support to observers who have been victimized; assists in developing and editing manuals, reports, and training materials; provides assistance to FMA staff and observers in identifying and documenting potential violations; serves as liaison with FMA staff; and provides observer related administrative and investigative support to agents and officers.

AKD maintains a full-time liaison Special Agent. The liaison Special Agent provides training to observers during their initial 3-week training course on compliance monitoring, observer victim crimes, and AKD's risk reduction strategy. The Special Agent also works with the liaison contractor to provide regulatory updates to FMA staff. The Special Agent also meets with industry groups and vessel companies to advise them of regulatory requirements and to discuss best practices to ensure compliance. Additionally, the Special Agent provides resources and support to observers who may have been victimized, investigates victim crimes and other complex and high priority observer related complaints, and assists other AKD agents and officers or enforcement partners in observer related cases. Other duties include collaboration with FMA staff to detect and analyze violation trends, changes to training for observers, outreach to industry and guiding enforcement operations.

5.1.2. U.S. Coast Guard

It is a high USCG priority to promote compliance with observer regulations to ensure that observers can effectively and accurately collect and report unbiased data. During at-sea boardings, the USCG seeks to detect and deter violations such as failure to carry an observer, observer harassment, observer gear tampering, and presorting of catch or otherwise biasing observer samples.

During USCG boardings where observers are present, boarding officers may discreetly invite observers to discuss concerns about their work environment or ability to perform duties. All reports of suspected offenses are passed to the AKD. Reports from observers describing harassment, intimidation, and safety issues are of particular concern.

[16] https://www.fisheries.noaa.gov/resource/document/enforcement-priorities-fiscal-years-2018-2022.

FMA reports observer statements of potential safety violations directly to the USCG for review on a case-by-case basis. NOAA Fisheries regulations establish national safety standards for commercial fishing vessels carrying observers. These regulations require that any commercial fishing vessel, not otherwise inspected, must pass a USCG dockside safety examination before carrying an observer. Observers also conduct an independent review of major safety items upon boarding a vessel.

The USCG may receive requests to assist the AKD or FMA to help evaluate safety concerns. In coordination with AKD and/or the FMA the USCG may attempt to locate the vessel and conduct a commercial fishing vessel safety boarding at-sea or dockside. A USCG commercial fishing vessel safety examiner may require actions by the vessel operator to correct safety deficiencies prior to embarking with an observer.

5.1.3. Alaska Wildlife Troopers

AKD and the Alaska Wildlife Troopers (AWT) collaborate under a Joint Enforcement Agreement which provides AWT with the authority to enforce observer and observer data protections under the Magnuson-Stevens Act. AKD and AWT work together to investigate observer complaints and to conduct patrols and at-sea or dockside boardings. In 2019, 15 observer related incidents consisting of 20 separate statements were forwarded to the AWT. During joint and independent agency patrols in 2019, efforts to contact vessel operators on vessels with ongoing observer related cases increased from previous years. One AKD officer deployed on the Patrol Vessel *Stimson* for 21 days to conduct at-sea boardings and conduct plant inspections jointly with the AWT, and two AKD officers deployed to the Patrol Vessel *Enforcer* for separate 14-day patrols targeting vessels at-sea in Southeast Alaska. An additional 22 joint patrols were conducted on smaller vessels.

5.2. Reports of Potential Violations

This is an analysis of potential violations as reported by observers in 2019. Fisheries Observer monitoring and compliance roles are identified in the Magnuson-Stevens Act and implemented in regulations. Prior to deployment, observers are trained in compliance monitoring. Observers are required to accurately record sampling data, write complete reports, and report any suspected violations relevant to the conservation of marine resources. The FMA Division forwards reports of suspected violations (termed ‘statements’) to AKD for investigation. AKD uses the data to make adjustments to training, outreach, and operations based on detected trends.

AKD works closely with the FMA Division and observer providers to address incidents that affect observer safety, sampling, and work environments. Observers record statements regarding potential resource or workplace violations. These are typically generated during the debriefing process after a cruise[17] is completed. Statements are forwarded to OLE and/or the USCG, and

[17] A cruise is actually a cruise number and is assigned to an observer upon completion of their pre-deployment briefing and becomes archived when they are debriefed. The term ‘cruise’ is thus used to define this deployment period for an observer. A cruise deployment period can last up to 90 days (not including debriefing) and may contain many individual vessel/plant assignments, but is generally limited to four assignments unless an additional-boat waiver has been requested by the provider and approved by NMFS.

some become “cases” that are pursued further by OLE. Descriptions of the statement types recorded by observers are provided in Table 5-3. Every statement received from the FMA division is evaluated and prioritized. Then, AKD Officers and Agents investigate the most egregious complaints to identify if violations have occurred and to determine the appropriate level or response.

AKD also utilizes observer compliance data to track compliance trends. Trend analysis helps AKD focus and prioritize enforcement efforts. Previous Reports summarized observer statement data as the number of statements recorded for the year in each statement category. While this method is informative as a baseline, changes in coverage rates and fishing effort were not accounted for. For example, an increase in the number of statements recorded for a particular statement category from one year to the next is likely to be interpreted as ‘bad’ because it is often assumed that the values are comparable. However, since the same vessels do not fish year to year in the same fisheries, using the same fishing effort or level of monitoring, these values are not comparable. For example, an increase in the number of statements from one year to the next may be a result of an increase in fishing effort or observer coverage in a particular fishery, which increased the number of observer deployment days in that fishery.

This section contains analyses of observer statement data that corrects for the effects of differences in fishery monitoring and fishery effort to enable comparisons and identify areas to target outreach and enforcement. The 2018 report provided a preliminary version of this method and the data were received favorably by the Council.

5.2.1. Data Preparation

A number of changes to the way observer statements have been traditionally summarized were made for this analysis.

Number of Occurrences Versus Number of Statements

Each statement is recorded in the observer database as a single record for each cruise, vessel/plant, and statement type. Within each statement, observers record the number of occurrences, which indicates how many times the particular issue happened within the statement. For example, if haul logbook data were not maintained as required by regulations on 10 separate hauls, the observer will write one record-keeping and reporting statement with 10 occurrences - one for each haul in which it occurred.

Traditionally summaries of potential violations were reported at the level of the statement. Therefore, if one statement contained 10 occurrences and one had 100, they would both be summarized as one statement. This was problematic, since one statement should have more influence than another.

Because the aim of this analysis is to report how often compliance and safety issues occur during the calendar year, the actual number of occurrences recorded by the observer within each statement is used as the unit of analysis rather than the number of statements.

First Occurrence Date Versus Statement Received Date

Previous reports summarized complaints by year based on the date they were received by OLE. The lag time between the date of occurrence-at-sea and the date the statement is written and forwarded to OLE can be weeks or months, because most statements do not get written until the observer completes the cruise and returns for debriefing. Observers do record the "first occurrence date" when they write these statements. Because this date better aligns with the observer's deployment dates and is a better match for using number of occurrences rather than number of statements, it was used to identify which statements should be included in this annual report.

Description of Factors

There are many factors that may contribute to how many occurrences are recorded in statements for an observer vessel/plant assignment. Some factors are associated with gear type or sector - for example, only the longline gear type is subject to bird streamer line regulations, so the gear type of longline is a contributing factor to the occurrence of streamer line deterrent violations. Other factors span multiple sectors (e.g., whether the observer was assigned as a lead, second, or sole observer, which may be a contributing factor in some inter-personal statement types since lead and sole observers have more fishery data responsibilities than second observers). The factors chosen for this analysis focus on things that are easily-identifiable within the observer database for each cruise/permit. Table 5-1 lists the factors and a description of each factor.

5.2.2. Rate Calculation Method

Occurrences of potential violations were used in the calculation of potential violation rates to standardize comparisons across various factors of interest (thereby eliminating the effects of differences in fishery monitoring levels or fishing effort). Two separate rates were calculated and are presented in this report: number of occurrences per 1,000 deployed days; and number of occurrences per vessel/plant assignment.

Number of Occurrences per 1,000 Deployed Days

Total days deployed was gathered from haul and delivery information recorded by all deployed observers in 2019 wherever possible, and secondarily from eLogbooks and *e*Landings. All factors – with one exception - are captured in the observer's haul, delivery, or logistics data: Vessel Type, Gear Type, Observer Role (Lead or Second), NMFS region, and Coverage Type (Full or Partial as per ADP definitions). Management Program was first obtained from the Alaska Region's eLogbook and *e*Landings data and matched to 2019 observer data using cruise, permit, dates, and landing report ID when applicable.

Each day a unique combination of factors was recorded in the observer's haul, delivery, or logistics data, that day was counted as a day for that particular factor combination. For example, for a given day, if a full-coverage observer on a vessel recorded some haul data with vessel type of "CP/MS" gear type of "NPT" and haul positions within the BSAI, and subsequently those hauls were designated by AKRO into management program code of "A80," then that particular deployment day is counted as FULL + CP/MS + NPT + A80 + BSAI. Every deployed day was assigned at least one factor combination, and in some cases more than one (e.g., it is not uncommon for a CP to fish in both CDQ and AFA fisheries on the same day, so a day would have been counted for CDQ and for AFA in this analysis). Days where the factor value could not be matched from haul or delivery data within the cruise/permit[18] (e.g., days when the observer is assigned but the vessel is steaming and there are no hauls retrieved that day) were matched from the "nearest neighbor" date within the cruise/permit - that is, the value was assigned using the value from the closest available day in time for which there were haul or delivery data within the cruise/permit.

Observer statements do not include any of the factors by which we are grouping - they are written broadly for the cruise/permit. Therefore, in order to estimate the number of occurrences within each factor combination it was necessary to "divvy up" the number of occurrences recorded for the entire cruise/permit appropriately to each factor combination. This was accomplished by weighting the number of occurrences recorded in each statement by the number of days in each factor combination in the cruise/permit. For example, following the earlier example with deployed days, if 50% of the deployment days for a cruise/permit were FULL + CP/MS + Non-Pelagic Trawl + BSAI + A80, and the observer recorded a statement for this cruise/permit with 10 occurrences, then 50% (5) of the occurrences are assigned to that factor group while the remaining 50% are assigned to the other factor groupings the observer may have been deployed into in that cruise/permit. Finally, this weighted value was summed for each factor combination, within each statement category. The final rate for each factor combination was then calculated as the sum of all occurrences divided by the sum of all deployed days for each factor combination:

$$R_1 = \left(\frac{\sum Occurrences}{\sum Deployed\ Days}\right) * 1000\ .$$

Separation of OLE Priority Statement Types

Data are presented using the number of occurrences per 1,000 deployed days, as described above, for all statement categories within each of the broader categories. In addition, we chose to separate the six OLE priority statement types into two subgroups for this report. In the first, named OLE Priority: Safety and Duties, data are only reported using the number of occurrences per 1,000 deployed days, as described above. The second group of OLE Priority is named OLE Priority: Inter-Personal. For this group, summary rates are presented as number of occurrences per 1,000 deployed days as described above and are also presented using the number of occurrences per vessel/plant assignment in the denominator. A discussion of this method follows.

[18] Synonymous with a vessel or processing plan. The term refers to each vessel or processing permit.

Number of Occurrences per Vessel/Plant Assignment

The four statement types that fall under OLE Priority: Inter-Personal are as follows:

- Intimidation, Coercion, and Hostile Work Environment.
- Harassment – Sexual.
- Harassment – Assault.
- Disruptive/Bothersome Behavior: Conflict Resolved.

The rate of occurrences per vessel/plant assignment is presented for these statement types because of the sensitive and egregious nature of these statement categories and the fact that they affect a person (thereby defining the unit of measure). Here, a single occurrence may be enough to generate enforcement action.

To calculate this rate a cruise-vessel/plant assignment was considered to be associated with a given factor combination if the observer recorded any haul or delivery data with the factor combination. Every vessel/plant assignment was assigned at least one factor combination, and in some cases more than one (see previous example re: CPs fishing both CDQ and AFA). Statements were then matched for cruise/permits where they were recorded, and the number of occurrences were weighted for each factor combination (see preceding description). Finally, the rate per vessel/plant assignment was calculated as the sum of all occurrences divided by the sum of all vessel/plant assignments for each factor combination:

$$R_2 = \left(\frac{\sum Occurrences}{\sum Assignments}\right).$$

Although it may seem that we have committed the error of 'double-counting', this is not the case since all summaries by factor combinations are independent of the summaries of other factor combinations, and because the number of incidents were weighted for the number of days in each factor combination. The total number of occurrences across all factor combinations within a cruise/permit always sums to the total number of occurrences recorded in the statement for the cruise/permit. In this way we have accounted for all of the analyzed factors simultaneously. This differs from the method that was presented in Appendix D of the 2018 annual report, in which all of the data for the year were summarized only for one factor at a time and no effort was made to account for factors simultaneously. We believe this is an improvement in the methods.

Finally, some efforts were made to protect the identity of individual observers or vessels. In cases where there were fewer than three observers deployed for a factor combination in 2019, that data was excluded from the analyses and data summary tables.

5.2.3. Results

Table 5-2 presents the results of the rate calculations for statement types grouped into their broader groups as defined by OLE, with the additional splitting of the 'OLE priority' statements into sub-groups of 'Inter-Personal' and 'Safety and Duties,' as described above. The factor group with the highest number of statements overall was full coverage non-pelagic trawl CP/MS vessels participating in Amendment 80 (A80) fisheries in the BSAI (297 total statements). The factor group with the highest total number of occurrences was full coverage pelagic trawl CP/MS vessels participating in AFA fisheries in the BSAI (1849 total occurrences). Two factor groups had 0 statements or occurrences associated with them: partial coverage longline CVs participating in Open Access (OA) fisheries in the BSAI; and pot CVs participating in CDQ fisheries in the BSAI.

Figure 5-1 through Figure 5-7 further break down each statement category group into their specific statement types and show the rate of occurrences for each specific statement category group and vessel/plant factor combination, presented as bar charts to show relative rates for each group. Further discussion of each follows.

OLE Priority: Inter-Personal Statements

This group of statement categories covers those issues that impact the observer in a personal way and are the highest priority for OLE. Nine out of the 13 partial coverage factor groups had occurrence rates of 0 for all statement categories within this category group, while 4 out of the 18 Full Coverage factor groups had overall occurrence rates of 0 (Table 5-2). Results of the rate calculations for individual statement categories within this group are shown in Table 5-1 (per vessel/plant assignment) and Table 5-2 (per 1,000 deployed days). Of the four statement categories within this group, rates tended to be highest in “Intimidation, Coercion, Hostile work environment”, and tended to be highest on non-pelagic trawl vessels, whether CP/MS or CV.

As discussed previously, statements in this category group are presented with two rates: occurrences per vessel/plant assignment, and occurrences per 1,000 deployed days. Results differ slightly between these two rates and are at least in part due to differences in deployment lengths between sectors. More time on the boat in a given sector is more deployed days. If an incident occurs on a short deployment with only a few deployment days, the rate per deployed day goes up. But as individual vessel/plant assignments get longer the more those deployed days accumulate, and the rate of occurrences per deployed day goes down, while the rate per assignment goes up. For example, observers deployed to A80 CP/MS vessels using non-pelagic trawl gear in the BSAI are typically deployed for longer durations than observers deployed to CVs using non-pelagic trawl gear in the BSAI. It is common for observer trawl CV deployments to be shortened by quota restrictions or processor availability, or the vessel may switch to a different gear type (e.g., a trawl CV targeting cod with non-pelagic gear may switch to pelagic gear to target pollock if the pollock fishing becomes more profitable).

Intimidation, Coercion, Hostile Work Environment Statements

Statements are written in this category when issues arise during the deployment that create an environment that adversely impacts the observer’s well-being. The category also includes harassment on the basis of race, color, religion, sex, national origin, or age. This may or may not cause the observer to alter their behavior and/or sampling strategies. 38 statements totaling 193 occurrences were recorded in this category and were associated with 16 factor groups in this analysis (47%), with 0 occurrences in 53% of factor groups. The highest rates of occurrences were associated with non-pelagic trawl CP/MS vessels participating in OA fisheries in the GOA (24.2 occurrences per 1,000 days, or 0.62 occurrences per vessel/plant assignment, respectively:

Table 5-1 and Table 5-2). Vessels in this factor group are typically A80 flagged vessels that participate in OA fisheries in the GOA for part of the season, and the observer is often (but not always) the same observer as the vessel carried during their BSAI A80 operations. Non-pelagic trawl CPs are regulated by halibut PSC caps and FMA has documented issues with observer intimidation/coercion/hostility when halibut bycatch is high for many years. More recently this fleet has been participating in halibut deck-sorting activities for the last several years, and in fact many of the statements from this sector describe issues related to halibut deck-sorting activities such as pressure to complete deck-sorting duties faster.

Disruptive/Bothersome Behavior - Conflict Resolved

Statements are written in this category when issues arise between observers and crew during the deployment that create a hostile work environment for the observer - but are then resolved during the deployment with minimal impact to the observer's well-being, behavior, and/or sampling strategies. This category was created in 2016 as a means of separating the highest priority issues that were not resolved, from those that required less immediate action by OLE, and it has proven to be very useful in this regard. Documenting issues that were resolved with this category ensures that there is a record of the occurrence that can inform future actions if necessary, without bogging down OLE response efforts that could be more effectively spent on issues requiring more immediate action (i.e., those that were not resolved).

Thirty-five statements with 109 occurrences were recorded in this category and were associated with 16 factor groups in this analysis (47%), with zero occurrences in 53% of factor groups. Results differ slightly when the rate of occurrence is calculated per 1,000 deployed days versus per vessel/plant assignment. Regardless of the denominator, the highest rates of occurrences were associated with full coverage non-pelagic trawl CVs participating in Open Access fisheries in the BSAI (15.4 occurrences per 1,000 days or 0.27 occurrences per assignment). Observers deployed to AFA shoreside processors and A80 non-pelagic trawl CP/MS vessels in the BSAI also experienced high rates per assignment (0.24 occurrences per assignment); however, that rate is lower when deployment days are used as the denominator. This result illustrates the utility of standardizing for deployment days. Observers deployed to both shoreside processors and Ammendment-80 trawl CP/MS vessels typically deploy for long stints up to 90 days, whereas observers deployed to Open Access non-pelagic trawl CVs in the BSAI typically deploy for much shorter stints of a few days or weeks. As deployment days accumulate on the CPs and processing plants the rate per day goes down within that assignment.

Harassment - Assault and Sexual Assault Statements

Statements in this category document issues of physical violence or threats thereof; sexual harassment/assault; that occurred during observer deployments. Rates were low in these two statement categories across all analyzed factor groups, as few statements were recorded. However, this result should be taken with a grain of salt as we know that these issues tend to be under-reported. For this analysis the issue of under-reporting was not taken into account. Instead, for consistency, these statement types were handled in the same manner as all other statement types: we calculated rates of occurrences based on what *was* reported.

There were eight Sexual Assault statements recorded in 2019 with nine total occurrences and they were associated with six factor groups (18%), all of them full coverage CP/MS sectors. An occurrence rate of zero was seen in 82% of factor groups. The highest rate was on non-pelagic trawl CP/MS vessels participating in RPP fisheries in the GOA (2.2 occurrences per 1,000 days or 0.1 occurrences per assignment).

There were only two statements recorded totaling two occurrences for other assaults and they were associated with three factor groups in this analysis (9% of factor groups): full coverage CVs using either pelagic or non-pelagic trawl gear in AFA and RPP fisheries in the BSAI and GOA. An occurrence rate of zero was seen in 91% of factor groups; the rates are low (0.1, 0.2, and 0.6 occurrences per 1,000 deployed days and < 0.01 occurrences per vessel/plant assignment).

OLE Priority: Safety and Duties Statements

Results of rate calculations per 1,000 deployed days for the statement category group "OLE Priority: Safety and Duties" are shown in Figure 5-3. Statements in the category group include "Interference/Sample Biasing" and "Safety - NMFS" categories. Observer record "Interference/Sample Biasing" when issues occur that cause the integrity of random samples to be compromised. Examples include pre-sorting by the crew before the observer has the chance to collect an unsorted sample or running fish too fast for a sample to be collected. These typically do not rise to the level of "intimidation or coercion" and so are recorded as separate types. "Safety - NMFS" statements are recorded when safety issues arise that do not fall under the specified Coast Guard statement types. An example is stacking boxes in an area that blocks the exit from the observer sample station.

Interference/Sample Biasing: Thirty-seven statements with 107 occurrences were recorded in this category and were associated with 14 factor groups in this analysis (41%), with zero occurrences in 59% of the factor groups. The highest rate was 125 occurrences per 1,000 deployed days and was associated with partial coverage CVs using pot gear participating in IFQ fisheries in the BSAI. Sample size is relevant here. There were only four assignments with 16 deployment days in this sector group, and only one statement with two occurrences that match this sector group. Thus, this one statement expands up to 125 occurrences per deployed day. The next highest rate (13.2 occurrences per 1,000 deployed days) was associated with partial coverage non-pelagic trawl CVs participating in Open Access fisheries in the GOA. The sample size in this factor group was much larger.

Safety - NMFS: Seventy-one statements with 356 occurrences were recorded in this category and were associated with 17 factor groups in this analysis (50%), with zero occurrences in 50% of factor groups. The highest rates were 39 occurrences per 1,000 deployed days in full coverage non-pelagic trawl CVs participating in RPP fisheries in the GOA and 34.4 occurrences pre 1,000 deployed days at AFA shoreside processors in the BSAI.

Limited Access Programs Statements

Results of rate calculations per 1,000 deployed days for the statement category group "Limited Access Programs" are shown in Figure 5-4. This statement category group encompasses statements that record potential violations of regulations specific to limited access privilege program (LAPP) fisheries. The applicability of these statement categories is limited to sector groups within the management program for that LAPP, or management programs that operate under the same regulations (such as CDQ on A80 vessels). For example, "AFA" statements are not applicable to an observer deployed on an Open Access hook-and-line CV in the GOA. There are five statement categories in this group that cover the various LAPPs into which the FMA Division deploys observers. A brief description (including applicability) and results for each follow.

American Fisheries Act (AFA) Statements: These statements cover issues relating to cameras, sample stations, gear, flowscales, sorting, etc. as specified in AFA-specific regulations. The applicability of this statement category is limited to full coverage CP/MS trawl vessels, full coverage CV trawl vessels, and full coverage shore-based processors participating in AFA and CDQ fisheries. Thirty-three statements with 1,181 occurrences were recorded in this category and were associated with four factor groups in this analysis (12%), with zero occurrences in 88% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of zero occurrences is expected. Where they occurred, rates were low for shoreside processors and CVs, and much higher for the highest rate was associated with full coverage pelagic trawl CP/MS vessels in AFA fisheries in the BSAI (233.8 occurrences per 1,000 deployed days). One vessel accounted for 975 of all occurrences, which drove this rate up.

Amendment 80: Statements: These statements cover issues relating to bin monitoring requirements, cameras, sample stations, flowscales, sorting etc. as specified in A80-specific regulations. Since 2017, it has also covered potential violations that occurred while non-pelagic trawl CP/MS vessels participated in the halibut deck-sorting EFP (e.g., when there are deck-sorting sample station issues). An important note is that the applicability of this statement category is limited to full coverage CP/MS trawl vessels but is not limited to vessels fishing in the A80 management program. Statements may be written under this category for vessels participating in CDQ, Open Access or RPP fisheries in the BSAI or GOA when halibut deck-sorting issues arise (e.g., AFA vessels fishing sideboard yellowfin sole); the FMA Division and OLE jointly made this decision to use this statement category to document these issues.

Eighty-three statements with 784 occurrences were recorded in this category and were associated with six factor groups in this analysis (18%), with zero occurrences in 82% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of 0 occurrences is expected. Where they occurred on CP/MS vessels, the highest rates were in CDQ, A80, and Open Access fisheries in the BSAI (65.1, 61.3, and 47.8 occurrences per 1,000 days, respectively).

Rockfish Program (RPP) Statements: These statements document potential violations that are specific to the Central GOA Rockfish Program (formerly known as the Rockfish Pilot Program).

Applicability is limited to trawl CVs and CPs that participate in those fisheries. Only two statements with two occurrences were recorded in this category and they were associated with two factor groups in this analysis (6%), with zero occurrences in 94% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of zero occurrences is expected. Where they occurred, the rates were 2.9 and 1.8 occurrences per 1,000 days on non-pelagic and pelagic trawl CVs in the GOA, respectively.

IFQ Retention Statements: These statements document potential violations of regulations pertaining to IFQ species retention such as minimum size requirements or mandatory retention. 20 statements with 86 occurrences were recorded in this category and were associated with four factor groups in this analysis (12%), with zero occurrences in 88% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of zero occurrences is expected. The highest rate was 625 occurrences per 1,000 deployed days and was associated with partial coverage pot CVs participating in IFQ fisheries in the BSAI. Overall, this was the highest rate of any factor group and statement category within the "Limited Access Programs" category group. Sample size is relevant here as it was relatively small in this factor group (four observer assignments covering 16 days), and there was only one statement with 10 occurrences associated with this group. Participation in IFQ pot fisheries is expected to grow in coming years. It is as yet unclear whether this single statement with multiple incidents is something to watch for as this fishery progresses, or an isolated, non-representative situation. Other IFQ sectors had much lower (but similar) rates between 34.8 and 65.1 occurrences per 1,000 days.

Catcher/Processor Longline Statements: Statements in this category document potential violations relating to flowscales, sample stations, gear, sorting, etc. as specified in regulations specific to CP longline vessels. As the name implies, applicability is limited to longline CPs. Eighteen statements with 27 occurrences were recorded in this category and were associated with four factor groups in this analysis (12%), with zero occurrences in 88% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of zero occurrences is expected. Rates were generally low across the four factor groups where they occurred. The highest rate was associated with CP hook-and-line vessels in CDQ fisheries in the BSAI (10.5 occurrences per 1,000 days). Interestingly, rates were calculated for pot CPs as well. This is an effect of the method used to calculate these rates that apportions occurrences in statements to factor groups by the number of days deployed in each factor group for each cruise/permit. It is common for a few of these vessels to switch back and forth between longline gear and pot gear from trip to trip. If a vessel switched gear while an observer was deployed and the observer ultimately wrote a statement in this category, then it gets assigned to the pot gear as well.

Protected Resource and Prohibited Species Statements

Results of rate calculations per 1000 deployed days for the statement category group "Protected Resource and Prohibited Species" are shown in Figure 5-5. This statement category group encompasses statements that record potential violations of regulations specific to protected species (marine mammals and seabirds) and prohibited species (salmon, crab, herring, and halibut in non-IFQ fisheries). Generally, these statement categories are applicable to all groundfish sectors with more specific applicability for some (e.g., Amendment 91 [A91] salmon statements are only applicable in A91 fisheries). A brief description (including applicability) and results for each follow.

Amendment 91 Salmon: This statement category documents potential violations of regulations specific to salmon bycatch requirements in the A91 pollock fishery in the BSAI such as mandatory retention requirements, sorting/catch handling requirements, and observer sampling issues regarding salmon. Applicability is limited to shore-based processing facilities, pelagic trawl CVs in the BSAI AFA sector, and CP/MS pelagic trawl vessels in the BSAI. Seventy-seven statements with 425 occurrences were recorded in this category and were associated with six factor groups in this analysis (18%), with zero occurrences in 82% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of zero occurrences is expected. The highest rate was on pelagic trawl CP/MS vessels participating in AFA fisheries in the BSAI at 67.3 occurrences per 1,000 deployed days.

Gulf of Alaska Salmon: This statement category documents potential violations of regulations specific to salmon bycatch requirements in trawl fisheries in the GOA such as mandatory retention requirements, sorting/catch handling requirements, and observer sampling issues regarding salmon. Applicability is limited to trawl CVs in the GOA. Twenty-three statements with 28 occurrences were recorded in this category and were associated with four factor groups in this analysis (12%), with zero occurrences in 88% of factor groups. Since this statement type does not apply to most of the factor groups in this analysis, the high rate of zero occurrences is expected. The highest rates were on partial coverage Open Access trawl CVs in the GOA (26.5 and 8.3 occurrences per 1,000 days for pelagic and non-pelagic trawl, respectively. This is not surprising as pollock is the predominant target in this sector, and salmon bycatch is common and highly regulated.

Marine Mammal - Harassment: This statement category is used when marine mammals are harassed in potential violation of Marine Mammal Protection Act regulations. One statement with one occurrence was recorded in this category, and it was associated with a factor group into which fewer than three observer-cruises were deployed and so it was removed from this analysis. In other words, there were zero occurrences in 100% of the factor groups in this analysis.

Prohibited Species - Mishandling: Sixty-nine statements with 348 occurrences were recorded in this category and were associated with 17 factor groups in this analysis (50%), with zero occurrences in 50% of factor groups. The highest rates were on partial coverage non-pelagic trawl CVs fishing Open Access in both the GOA and the BSAI at 87.8 and 48.4 occurrences per deployed day. Overall rates were low in other factor groups (less than 15 occurrences per 1,000 deployed day).

Prohibited Species - Retaining: There were seven statements totaling seven occurrences in this category. Of these, two statements were recorded in factor groups with less than three cruises deployed into them and so were removed from this analysis for confidentiality. Rates were calculated for the remaining five statements. Rates were associated with six factor groups in this analysis (18%), with zero occurrences in 82% of factor groups. Rates were low in all six factor groups where they occurred; the highest rate was 0.6 occurrences per 1,000 deployed days on partial coverage hook-and-line IFQ CVs in the GOA.

Sample Bias - Marine Mammals: Statements in this category document instances where observers were unable to complete all required data collections from marine mammals due to some biasing actions by the crew. Six statements with six occurrences were recorded in this category and were associated with two factor groups in this analysis (6%), with zero occurrences in 94% of factor groups. Given that marine mammal sampling is a rare event on observer trips, the opportunity for sampling bias to occur is limited and these low rates are therefore expected.

Sample Bias - Seabirds: Statements in this category document instances where observers were unable to complete all required data collections from marine mammals due to some biasing actions by the crew. There were only two statements with two occurrences recorded in this category and they were associated with three factor groups in this analysis (9%), with zero occurrences in 91% of factor groups. Rates were correspondingly low in the three factor groups where they occurred, with less than one occurrence per 1,000 deployed days in each.

Seabirds - Avoidance Measures: Statements in this category document potential violations of seabird avoidance gear requirements on longline sets. The category is only applicable to hook-and-line CPs and to hook-and-line CVs in certain observer deployment scenarios (requirements differ by vessel length and geographic area). Thirteen statements with 84 occurrences were recorded in this category and were associated with five factor groups in this analysis (15%), with zero occurrences in 85% of factor groups. The highest rates were associated with partial coverage hook-and-line CVs in Open Access fisheries in the GOA (432.4 occurrences per 1,000 deployed days) and partial coverage hook-and-line CVs in CDQ fisheries in the BSAI. These were also the top two highest rates of all statement types in this category group. This statement category is a good example of how the FMA division documents potential violations, but it is ultimately up to AKD to determine whether the situation constituted a violation. In some cases, observers are unsure of the specific seabird gear avoidance requirements for the vessel/area they are deployed into. Statements may be written if avoidance gear was not set, but OLE may later determine that the vessel was not in violation. However, since the full coverage longline sectors have observers onboard 100% of the time, they have had a higher level of scrutiny regarding seabird avoidance gear ever since regulations were first put in place in 2001. Most partial coverage longline sectors have only had observer coverage since 2013. These much higher occurrence rates in the partial coverage sectors may represent a historical lack of compliance that has only recently begun to be documented by observers.

Seabirds - Harassment: Two statements with five occurrences were recorded in this category and were associated with two factor groups in this analysis (6%), with zero occurrences in 94% of factor groups. The highest rate was 1.6 occurrences per 1,000 deployed days at shore-based processing facilities.

All Other Statement Types

Results of rate calculations per 1,000 deployed days for all other statement categories are shown in Figure 5-6. As this is a catch-all category group, applicability varies widely between categories, but most are applicable to all observers. A brief description (including applicability) and results for each follow.

Contractor Problems: This category is used to document potential violations by the observer provider or contractor. This category is applicable to all observers. Fifteen statements with 49 occurrences were recorded in this category and were associated with 11 factor groups in this analysis (32%), with zero occurrences in 68% of factor groups. Rate calculations by the factor groups used in this analysis are presented for consistency; however, they may be of limited utility for this category since these statements are not written against a vessel or plant, but rather against the employer. The highest rate was for pot CP/MS vessels in CDQ fisheries in the BSAI at 3.8 occurrences per 1,000 deployed days; however, rates were similar (typically between 1 and 3) in the factor groups where they occurred. The most common reason this statement was written was when cruise-deployments exceeded 90 days. Other reasons included transfer to another assignment before the collected fishery data from the previous assignment were transmitted to NMFS, deploying without an official contract, and poor bunkhouse conditions.

Failure to Notify: Used to document instances when the observer is not notified of haulback or delivery within the timeline defined by regulations. The category is applicable to all observer deployments. Forty-six statements with 166 occurrences were recorded in this category and were associated with 20 factor groups in this analysis 59%), with zero occurrences in 41% of factor groups. The highest rates were in partial coverage hook-and-line CVs in Open Access fisheries in the GOA (27 occurrences per 1,000 days) followed by full coverage pelagic trawl CVs in RPP fisheries in the GOA (25 occurrence per 1,000 days).

Inadequate Accommodations: Used to document instances where the accommodations provided to the observer may not meet the standards outlined in regulation. The category is applicable to all observer deployments. Sixteen statements with 112 occurrences were recorded in this category and were associated with 11 factor groups in this analysis 32%), with zero occurrences in 68% of factor groups. The highest rate was full coverage shore-based processors (37.3 occurrences per 1,000 deployed days).

IR/IU: Used to document potential violations of Improved Retention/Improved Utilization regulations. The category is applicable to any observer deployment where IR/IU regulations apply (typically directed Pacific cod and pollock fisheries across gear types and vessel types). Twenty-eight statements with 193 occurrences were recorded in this category and were associated with 16 factor groups in this analysis (47%), with zero occurrences in 53% of factor groups. The highest rate was on partial coverage non-pelagic trawl CVs in Open Access fisheries in the BSAI at 91.3 occurrences per 1,000 days.

Miscellaneous Violations: This is a catch-all category for statements written for potential issues that do not fit into any of the other categories. They may or may not be actual violations once OLE reviews the information. Topics include observer coverage issues and gear issues, among others. Eight statements totaling nine occurrences were recorded in this category and were associated with five factor groups (15%), with zero occurrences in 85% of factor groups. The highest rate was for full coverage non-pelagic trawl vessels in Open Access fisheries in the BSAI at four occurrences per 1,000 days.

Reasonable Assistance: This category documents instances when 'reasonable assistance' is not provided to the observer by the crew to complete their required sampling duties. Forty-three statements totaling 212 occurrences were recorded in this category and were associated with 20 factor groups (59%), with zero occurrences in 41% of factor groups. The highest rates were in full coverage hook-and-line CP/MS vessels in the BSAI ((33.7 occurrences per 1,000 deployed days).

Record Keeping and Reporting: This category documents instances of logbook or landings misreporting. One-hundred eighty-six statements totaling 1,641 occurrences were recorded in this category and they were associated with 79% of the analyzed factor groups (zero occurrences in 21% of factor groups). The highest rate was in partial coverage pot CVs in IFQ fisheries in the BSAI (250 occurrences per 1,000 days). As mentioned previously for this factor group the small sample size is relevant. Two statements totaling four occurrences were associated with this group, and there were just four assignments totaling 16 deployment days. The next highest rate was in full coverage AFA shore-based processing facilities (150.8 occurrences per 1,000 days). This rate was inflated by two statements with over 100 occurrences in each.

Record Keeping and Reporting statements are prone to high occurrences per statement, because observers typically report an occurrence for every haul or offload in which the issue occurred, and in situations where an issue was not resolved for the entire deployment, there may be hundreds of occurrences per statement (Fig. 5-6).

Restricted Access: These statements document situations where physical barriers or policy restrictions (e.g., stacked gear or 'off-limits' areas onboard) prevent the observer from accessing necessary areas to complete all required duties as prescribed in the observer sampling manual. The restricted access may or may not present a safety issue; if it does then a "Safety-NMFS" statement may also be recorded. Five statements totaling 85 occurrences were recorded in this category and they were associated with 18% of the analyzed factor groups (0 occurrences in 82% of factor groups). The highest rate was in full coverage AFA shore-based processing facilities (32 occurrences per 1,000 days).

Coast Guard Statements

These statements document marine casualties, potential MAR-POL incidents, and potential violations of USCG equipment and drill requirements. They are forwarded to the USCG upon approval by FMA debriefing staff. They are generally applicable across all observer deployments. Results of rate calculations per 1,000 deployed days for the statement category group "Coast Guard" are shown in Figure 5-7.

Safety - USCG - Marine Casualty: Statements in this category document instances of what the USCG defines as "marine casualty" and includes, but is not limited to, death, severe injury or illness of crew, man overboard, fire, vessel grounding, loss of power, and ammonia leaks. The category is applicable to all observer deployments.

Observer safety at-sea is a top priority of FMA. In addition to documenting these incidents in statements at the end of each cruise, FMA also responds to marine casualty incidents in near real-time via in-season communication with observers. When an in-season advisor[19] is notified by an observer of a potential marine casualty, FMA supervisors, the observer provider, and the USCG are notified as soon as possible. FMA also maintains a 'weekly safety spreadsheet' to track these incidents that is shared with the USCG.

There were 197 statements totaling 257 occurrences reported in this category and they spanned 76% of the analyzed factor groups (24% of factor groups had zero occurrences). Occurrence rates were similar across most factor groups where they occurred but were highest in partial coverage pot CVs in Open Access fisheries in the GOA (25.6 occurrences per 1,000 days). Pot vessels in Alaska have a reputation for being exceptionally dangerous for crewmembers, but not all marine casualties documented for this sector were crew injuries. While some were crew injuries, they also included fire, loss of power, and grounding, so this higher rate of occurrence specific to this sector may or may not be noteworthy.

There is a wealth of information recorded in this statement category. The level of detail in the statement text tends to be good, and there is strong reliability of observer reporting of these incidents. The incidents are of the highest priority for FMA (observer safety). For these reasons and because they cover a broad range of factor groups and topics/incident types, further analysis or sub-division of the category is recommended.

<u>Safety - USCG -Equipment:</u> These statements document potential safety equipment violations (required equipment missing, expired, malfunctioning, inoperable, etc.) as relating to observer deployments, including items listed on the observer pre-boarding 'safety checklist'. The category is applicable to all observer deployments. Eleven statements totaling 11 occurrences were recorded in this category and occurrence rates were associated with 29% of the analyzed factor groups (zero occurrences in 71% of factor groups). Rates tended to be low across the factor groups < 4 occurrences per 1,000 days); the highest rates were in partial coverage pot CVs in IFQ fisheries in the GOA (5.5 occurrences per 10,000 days).

<u>Safety - USCG - Fail to Conduct Drills:</u> These statements document calendar months where safety drills were not conducted. The category is technically applicable to all observer deployments that span entire calendar months; however, in practice it typically only applies to full coverage sectors because in partial coverage sectors trips tend to be short and observer deployments usually do not span an entire calendar month. One-hundred forty-two statements totaling 276 occurrences were recorded in this category and occurrence rates were associated with 59% of the analyzed factor groups (41% of factor groups had zero occurrences). Since this potential violation only applies once per calendar month, an occurrence rate per 1,000 deployed days is of limited utility for this type; however, it is presented here for consistency. Rates were associated with most of the full coverage factor groups and one partial coverage factor group.

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[19] 'Inseason Advisors' are FMA staff. Each inseason advisor is assigned a list of vessels and/or observers to communicate with inseason to monitor health, safety, and data quality.

The highest rate was for full coverage non-pelagic trawl CVs in Open Access fisheries in the BSAI (22.2 occurrences per 1,000 days).

MAR-POL/Oil Spill: These statements document instances of dumping at sea in potential violation of MAR-POL regulations, or of oil spills/leaks. The category is applicable to all observer deployments. Sixty-two statements were recorded totaling 126 occurrences were recorded for this category and occurrence rates found to be associated with 53% of the analyzed factor groups (47% of factor groups had zero occurrences). Rates were associated with most of the factor groups. The highest rate was in full coverage pot CP/MS vessels in CDQ fisheries in the BSAI (24.2 occurrences per 1,000 days), with a high rate also in partial coverage pot CVs in Open Access fisheries in the BSAI. A common theme in pot vessel MAR-POL statements was bait boxes being dumped overboard.

5.2.4. Discussion

This analysis represents an attempt to standardize observer compliance and safety incident reporting to control for the number of observers and/or time deployed. Our choice of number of occurrences (compared to number of statements) does not completely erase the effects of deployment – there is a greater chance to accumulate occurrences on longer deployments – however this is mitigated by standardizing the occurrences as a rate per deployment day. Analysis of occurrences does highlight areas of potential impact. FMA is currently working with OLE to revise the observer statement database to improve the utility of collected information. Planned improvements include: 1) improved collection of "occurrence" information to more closely match the units in the observer deployment plans; 2) streamlined statement categories that more closely match regulation texts where applicable; and 3) reducing the time needed for observers to complete statements during debriefing by automatically linking statement categories to the factors encountered on the observer's cruise deployment. This work is ongoing.

5.3. AKD Prioritized Response

Statements received by AKD are prioritized based on the potential impact of the reported complaints on observers, their data, and the resource. Some statements are sent to the field for investigation by AKD agents and officers. AKD agents and officers may contact observers to provide support when necessary and to conduct interviews to obtain additional information that may not be present in the statements and accompanying documents. The number of statements sent to AKD agents and officers for investigation and the statuses of the incidents can be found in Table 5-3.

5.3.1. OLE Priority Violations

Harassment Statements (Assault and Sexual): The highest priority violations for AKD continues to be reports involving the sexual assault, sexual harassment, intimidation or interference with an observer. There were no reports of sexual assault in 2019. This does not mean that no sexual assaults occurred; it means that if one occurred, it was not reported to FMA or AKD. There were several reports of sexual harassment that were all investigated. Several of these are ongoing investigations involving privacy violations against observers. Other investigations were resolved, which included unwanted advances by a crew member despite being told their behavior was unwanted. There were two statements in 2019 reporting assault. One was initially reported in the field and forwarded to local law enforcement. Another involved an altercation between a captain and crew on a catcher vessel; the assigned observer - who was not part of the altercation but in the vicinity - was injured.

Intimidation, Coercion, Hostile Work Environment Statements: When reviewing the statements related to hostile work environments, there were several themes that were evident. There were five statements reporting intimidation from a factory manager or foreman, or other factory crew. When these encounters were reported to the captain, the behavior was addressed. If the observer did not report the intimidation to the captain, the captain was not aware of it until talked to by an AKD agent or officer. There were 15 statements reporting intimidation from a captain or first mate. If the encounter involved the first mate and the observer reported it to the captain, the captain would address the situation. If the captain was not notified, he was often unaware there were any issues until boarded by AKD agents or officers. The reports involving the captain were often related to disagreements over the observer's halibut viabilities. There were five statements reporting intimidation from the vessel's data manager/purser. Some of the pursers were previously observers. These altercations involved the purser pressuring the observer for their data multiple times a day, tampering with the observer's data, or telling the observer how they should sample or collect data. There were also seven statements reporting observer on observer harassment, which the vessel is not liable for. This is an issue that is important to note as it may negatively impact the perception of observer professionalism and may also negatively impact the crew if they get involved in observer on observer quarrels. The remaining statements documented the work environments generally, rather than specifically, often noting the repeated use of sexist and racist language.

Disruptive/Bothersome Behavior - Conflict Resolved: There were 109 instances of resolved conflicts documented in 35 statements. This demonstrates how frequently conflict can be resolved when observers feel comfortable approaching the captain to address a situation. Over half of these conflicts were non-sexual in nature and resolved by the captain after he was notified. Five of the statements documented several instances of unwanted and unwelcome sexual advances or sexually explicit conversations that the observer felt confident addressing directly with the perpetrator or officer level person on the vessel. There was also a report of an individual complaining to an observer that AKD personnel boarded another vessel to investigate sexual harassment. When an observer reports a resolved conflict, AKD agents and officers still often follow up with the vessel or shoreside processor to discuss details or commend personnel on the successful resolution of the reported issue.

Interference and Sample biasing: Most statements received documenting interference and sample biasing were on catcher processors. However, when applying the rates, interference and sample biasing occurred more frequently in the partial coverage sectors in the Gulf of Alaska, and more detrimental to the observer's data. On one of these partial coverage vessels, the observer's sampling data was negatively impacted by the interference. A crew member on another partial coverage vessel physically prevented halibut from entering the observer's samples, even after the observer asked the crew member not to bias his samples.

On the catcher processors, the interference and sample biasing was related to crew members sorting bycatch when the observer was taking a sample, or observer's gear was tampered with just prior to their sampling period which prevented the observer from beginning sample collection as planned.

Safety: Statements involving safety continue to be high especially in the non-pelagic trawl fisheries in both the GOA and BSAI. The complaints on these vessels related to unsafe conditions on deck; observers frequently report the cable abruptly moving in their workstation without warning. Failure to have a proper lookout/wheel watch and the suspected drug or alcohol use by the captain or crew has also been reported on catcher vessels. Common reports from the catcher processor sector relate to uneven surfaces in the factory and watertight doors being latched open during inclement weather.

5.3.2. Limited Access Program Statements

American Fisheries Act (AFA) Statements: Catcher vessels fishing under AFA have fewer complaints than their at-sea processing counterparts in both the AFA and the A91 category. This is due to the nature of the complaints reported in AFA statements. AFA statements related to operational and gear requirements, such as video monitoring, sample stations, and flowscales. There have been multiple reports of required video monitoring systems failing, flowscale tests failing or not being conducted in a timely manner, MCP scales malfunctioning, and hauls being mixed. Overall, there was good communication between the observers and boat personnel when issues occurred, and efforts were made to remedy the problems reported.

Amendment 80 Statements: Similarly, to the AFA statements, A80 statements relate to operational and gear requirements. All the A80 statements document more than one complaint. Issues relating to the Halibut Deck Sorting EFP were also reported under A80 but were only mentioned in a total of 10 statements. The majority of the complaints under A80 related to either flowscale malfunctions, electronic and physical missing of hauls, and inadequacies in the sample station. Many of these complaints were brought to the attention of the factory foreman or the captain. Although some issues were resolved they reappeared on the same vessel and were reported by a different observer. The re-occurrences of the same complaint on the same vessel may result in an escalation of enforcement action in 2020.

5.3.3. Protected Resources and Prohibited Species Statements

Amendment 91 Salmon: A91 statements from AFA catcher vessels were minimal, and often upon review, were found not to document an actual violation. AFA catcher processors had a higher rate of complaints than shoreside processors. The majority of the issues on the AFA catcher processors occurred during B-season and involved vessels continuing to run fish when the salmon storage containers were full or fish were run for a new haul before the salmon from the previous haul were counted and sampled. There was good communication between observers and crew which mitigated the need for enforcement action on several of the reports. However, while the shoreside processors had fewer complaints, the issues reported were more egregious and there was most often poor or no communication between the observers and the factory personnel. Shoreside facilities were visited multiple times by AKD agents and officers, as well as by FMA and Sustainable Fisheries staff, but salmon handling violations continued. As a result, AKD will increase efforts in this area during 2020.

Gulf of Alaska Salmon: Catcher vessels targeting OA pollock in the GOA saw a rate of 26.2 occurrences per 1,000 days compared to the AFA catcher vessels rate of 4.7 occurrences per 1,000 days. Both sectors require that salmon caught during fishing operations cannot be discarded at sea and must be delivered. In the GOA, if an observer is present, the observer must be allowed to count all the salmon and collect applicable data. In review of the statements, there were several instances where an observer sampled a salmon at sea but that salmon was not found in the factory. Observers also reported crew intentionally discarding salmon at sea.

The majority of the complaints however occurred at the shoreside processors. These complaints related to salmon passing the last point of sorting, fish tickets not having the accurate number or species of salmon listed, or observers not being allowed to sample or collect data. Multiple statements document that the lines are run fast and deep, making it difficult for factory employees to sort salmon as required. AKD anticipates increased scrutiny and enforcement action in 2020.

Prohibited Species - Mishandling: There were 69 statements reporting 348 instances of prohibited species mishandling. Almost every single one of these instances involved the mishandling of halibut. Only one statement documented the mishandling of a different species. While the majority of the statements were from the full coverage catcher processor sectors, the highest rates of prohibited species mishandling occurred on partial coverage vessels in both the GOA and BSAI. Mishandling on the catcher processors was corrected when addressed by an observer, or by other crew members correcting a greenhorn's actions. On the partial coverage vessels, mishandling most often continued even after an observer attempted to bring it to a crew member or captain's attention.

5.3.4. Other Statement Types

Contractor Problems: The most frequent complaint under this category is an observer's cruise exceeding 90 days. This violation is typically self-reported by the observer's provider. However, current investigations involving observer providers are not reported through FMA, rather they may be initiated when FMA reports that a provider failed to provide required information in a timely manner. Information required to be reported to FMA includes observers failing to abide by the standard of conduct policy developed by their provider. Observers have expressed their desire to make anonymous reports against their providers citing fear of retaliation. Most notably observers want a method to anonymously report observer on observer harassment when providers are aware of an issue but may be taking no action to resolve it.

Reasonable Assistance: An observer's ability to complete their duties may rely on the assistance provided by crew. One of the most significant types of failure to provide reasonable assistance occurred in GOA shoreside processors. There were eight statements documenting that no factory personnel were sorting salmon from the lines, so the observer had to attempt to sort out the salmon themselves to complete their salmon collection duties. Other forms of failure to provide reasonable assistance included crew not providing bycatch when requested and captains not providing data when requested.

Record Keeping and Reporting: One of the observer's main responsibilities is to record haul and offload data specific to their assigned vessels and plants. During the debriefing process, the data that the observer transcribes from vessel logbooks or plant records may be inaccurate or inconsistent with the observer's own observations. In these cases, a record keeping and reporting statement may be written. It is important to note that before a record keeping and reporting statement is added to an investigation, AKD reviews it for validity as well as its effect on data quality. Twenty record keeping and reporting statements were not added to an investigation because they were found not to be violations at all - either no discrepancies were found during the vetting process or the statements recorded minor clerical errors that had no impact on observer data. Nine were closed after review by an AKD officer after no evidence of a violation was found. Eighty-seven complaints were closed as single isolated occurrences with minimal effects on observer data. Nearly a third of all record keeping and reporting statements were due to inconsistencies with ADFG Fish Tickets, which were reflective of processors not recording accurate information. Common Fish Tickets issues were: discrepancies in salmon numbers at GOA plants between what is recorded and what the observer collected during the offload, inaccurate recording of non-prohibited species weights, incorrect number of observers recorded on Fish Tickets (recorded as zero when an observer was deployed on the trip - most commonly in the partial coverage sector), and wrong offload date on the Fish Ticket. Common issues seen on vessels across both the full coverage and partial coverage sectors were: isolated errors in haul time and position information; systematic issues such as rounding of haul times (sometimes to the nearest 15 or 30 minutes); and not recording haul time and positions according to NMFS definitions.

5.4. Outreach and Compliance Assistance

AKD educates industry, stakeholders and the general public through outreach and compliance assistance. Outreach is less directed than compliance assistance, usually in the form of presentations at conferences, while compliance assistance is education directed towards specifically known violations. Observers play an important compliance assistance role onboard vessels by communicating with operators about safety concerns and potential violations. Although observers are not required to communicate potential violations to vessel operators- and they are not experts in all areas of regulation - they are encouraged to work with vessel operators if it will not impact their data quality, data collection, or work environment. Strong rapport between crew and observers can contribute to a positive compliance assistance relationship. AKD also uses compliance assistance frequently to address violations that are not severe and/or repeated.

5.4.1. Conferences and Symposiums

Observer liaison contractor Dennis Jaszka attended the End Violence Against Women International Conference in April 2019 in San Diego, CA. He attended lectures on sexual assault, gender bias, bullying, and effectively communicating with victims. He learned about law enforcement challenges regarding victim crimes and how to support victims and respond to reports of sexual harassment.

In October 2019, Special Agent Jaclyn Smith hosted a symposium titled "Collaboration to Ensure a Safe and Secure Work Environment for Observers" at the annual American Fisheries Society Conference in Reno, NV. The following presentations were part of this symposium:

- Special Agent Jaclyn Smith provided two presentations: 1) "The Frequency of Safety and Harassment Type Violations, and Factors that Impede Disclosure" and 2) "The Three Legged Stool of Risk Reduction: A Multidimensional and Collaborative Approach to Educating Suitable Targets, Involving Capable Guardians, and Deterring Likely Offenders."
- Enforcement Officer Sonya Jordan presented a talk titled "Improving Safety for Observers in the Port of Dutch Harbor, Alaska"
- Observer liaison contractor Dennis Jaszka presented "The Effect of Perceptual Biases on Fishery Observers."
- Joshua Buchan, a vessel captain with North Star Fishing presented "A Fishing Captain's Role in Ensuring a Safe and Secure Work Environment for Observers."
- Gwynne Schnaittacher presented "How to Succeed in Supporting Observers in a Complex, Remote Job: The Vital Role of an Observer Liaison."
- Pearl Rojas with the FMA Division presented "Using Safety at Sea to Improve Observer Recruitment and Retention."
- Brian McTague with the Office of General Counsel presented "Observer Harassment: Civil Enforcement Case Studies."
- Elaine Herr with Alaskan Observer, Inc. presented "An Observer Provider's Perspective: Leveraging Our Relationships with Our Observers, the Vessels We Cover, and NMFS to Prevent and Curtail Observer Harassment and Safety Concerns in Real Time."
- Stacey Hansen with Saltwater, Inc. presented "A Contract Provider's Role in a Fisheries Observer Program: Employer, Coach, Referee, Friend, Foe, and Sometimes Mom."

Additional presenters from outside of Alaska included an Enforcement Technician from Florida and an AIS observer from the Northeast Region.

5.4.2. Meetings with Industry

Special Agent Jaclyn Smith met with eight different vessel/processing companies. She spoke to company representatives about frequently reported violations and enforcement concerns for the management programs each company engaged in as well as specific issues on each company's individual vessels or shore-based processing facility. High priority topics such as sexual assault, sexual harassment, safety, and hostile work environments were reviewed. Ways to improve rapport and how to encourage observers to report issues to officer level personnel were also discussed.

5.4.3. Observer Safety and Professionalism

AKD Enforcement Officers and Special Agents received complaints regarding observer behavior that may impact safety as well as may violate an observer provider's policy on observer conduct and behavior. The most frequent complaints involved observers returning to vessels after consuming alcohol. Vessel operators were encouraged to contact the observer's provider to report incidents immediately. AKD adjusted training provided to observers to increase focus on behaviors that may impact safety and may create a negative perception of observers. AKD also collaborated with the FMA Division and the observer providers to discuss ways to address observer conduct and behavior problems.

5.5. Enforcement Operations and Actions

5.5.1. Enforcement Operations

A team consisting of three Special Agents and two Enforcement Officers conducted a pulse operation in the Port of Dutch Harbor in February 2020. The team worked together with the goal of boarding all the vessels engaged in Halibut Deck Sorting (HDS) and on any vessel with ongoing 2019 observer related cases. Out of the 53 vessels with open observer related cases, 35 vessels were boarded and the cases were furthered or resolved. Out of the 22 vessels engaged in HDS, 19 were boarded. The team inspected reports and video and discussed the new regulatory requirements. Out of a total of 269 individual complaints, 197 were closed, 33 were furthered, and 39 remain open primarily because AKD has yet to interact with the subject vessel.

5.5.2. Written Warnings, Summary Settlements, Cases Forwarded for Prosecution

Table 5-3 details the status of statements and the incidents created from the statements. There were 13 cases consisting of 35 separate statements resolved through the issuance of a Written Warning. Some of the violations include the mishandling of prohibited species, seabird harassment (the use of seal bombs to scare them), presorting of catch, catch running over the flowscale when the flowscale was not working properly, inadequate sample station, failure to notify the observer prior to bringing fish on board, and salmon passing the last point of sorting.

There were eight cases consisting of 13 statements resolved through the issuance of a summary settlement. Some of the violations that resulted in a monetary penalty include failure to place salmon into the approved salmon storage bin, mishandling of prohibited species, inadequate sample stations, and inadequate accommodation. Multiple Summary Settlements were also issued for safety complaints such as failure to conduct a proper lookout/wheel watch.

Two cases were forwarded to the General Council Enforcement Section for prosecution. One of these cases involves the intentional discard of salmon by an AFA catcher vessel. The other case involves an A80 vessel failing to conduct flowscale tests properly on multiple occasions, failure to notify the observer of haulback, and multiple instances of prohibited species mishandling.

5.5.3. NOAA General Counsel - Enforcement Decisions, Orders and Enforcement Actions

AK1803567– First Mate Thao Dihn Nguyen was charged under the Magnuson-Stevens Act with unlawfully harassing an observer, by conduct that had sexual connotations, had the purpose or effect of interfering with the observer's work performance, or otherwise created an intimidating, hostile, or offensive environment. A $30,000 NOVA was issued, and the case settled for $27,000.

AK1701779; FV *Seafisher* – The NOVA, for $60,000, alleges that crewman Iakopo Jake Vae assaulted and sexually harassed a female observer in her stateroom, in violation of the Magnuson-Stevens Act.

AK1804012; FV *Seafisher* – The NOVA, for $55,000, alleges that crewman Ioane assaulted and sexually harassed a female observer in her stateroom, in violation of the Magnuson-Stevens Act.

Table 5-1. -- Description of factors used in rate calculations. Each factor is used in unique combinations with other factors to calculate rates.

FACTOR	VALUES	DESCRIPTION
COVERAGE TYPE	FULL	Full Coverage
	PARTIAL	Partial Coverage
VESSEL TYPE	CP/MS	Catcher-Processor/Mothership vessel
	CV	Catcher Vessel
	PLANT	Shorebased Processor (floating or land)
NMFS REGION	BSAI	Bering Sea/Aleutian Islands
	GOA	Gulf of Alaska
GEAR TYPE	HAL	Hook-and-Line
	NPT	Non-Pelagic Trawl
	POT	Pot (single or strung)
	PTR	Pelagic Trawl
MANAGEMENT PROGRAM	A80	Amendment 80
	AFA	American Fisheries Act
	CDQ	Community Development Quota
	IFQ	Individual Fishing Quota
	OA	Open Access
	RPP	Rockfish Pilot Program (CGOA Rockfish Program)

Table 5-2. -- Unique factor combinations into which at least 3 observer-cruises were deployed in 2019; the number of assignments and deployed days in each factor combination; total number of statements and occurrences recorded across all statement categories in each factor combination; and the rate of occurrences per 1,000 deployed days in the broad statement category groups, for each factor combination. Rate of occurrences per assignment are also presented for OLE Priority: Inter-Personal statement categories. Bars indicate relative value compared to other values within that statement group only. The highest value in each column within each statement category group is highlighted in yellow/red for easy reference.

FACTOR COMBINATIONS					SUM TOTALS				STATEMENT CATEGORY GROUP and INCIDENT OCCURRENCE RATE						
									OLE PRIORITY: INTER-PERSONAL		OLE PRIORITY: SAFETY AND DUTIES	COAST GUARD	LIMITED ACCESS PROGRAMS	PROTECTED RESOURCE & PROHIBITED SPECIES	ALL OTHER STATEMENT TYPES
COVERAGE TYPE	VESSEL TYPE	GEAR TYPE	MANAGEMENT PROGRAM	NMFS REGION	VESSEL/PLANT ASSIGNMENTS	DEPLOYED DAYS	STATEMENTS (all categories)	OCCURRENCES (all categories)	Occurrences per Vessel/Plant Assignment	Occurrences per 1000 Deployed Days					
FULL	PLANT	(N/A)	AFA	BSAI	66	2441	52	713	0.33	9.0	35.2	1.2	1.2	20.5	224.9
	CP/MS	NPT	A80	BSAI	232	10452	297	1421	0.60	13.4	20.7	20.9	47.8	14.4	18.8
			CDQ	BSAI	102	2181	43	249	0.16	7.3	10.8	11.9	65.1	11.6	7.4
			OA	BSAI	90	2205	53	239	0.10	3.9	5.6	16.8	61.3	11.6	9.1
				GOA	31	798	17	62	0.64	25.0	1.3	15.2	6.0	0	30.5
			RPP	GOA	11	277	7	12	0.06	2.2	0	31.2	7.9	0	1.4
		PTR	AFA	BSAI	113	4842	159	1849	0.34	7.8	4.8	28.1	233.8	68.1	39.3
			CDQ	BSAI	67	1256	30	122	0.08	4.1	2.0	21.1	22.3	9.1	38.6
		HAL	CDQ	BSAI	30	517	10	30	0.02	1.1	0.2	8.3	10.5	0.9	36.1
			IFQ	GOA	4	172	5	7	0.15	3.6	0	12.0	0	3.8	22.9
			OA	BSAI	103	4301	89	696	0.10	2.3	2.3	11.3	4.5	12.8	128.7
				GOA	4	68	2	3	0	0	0	42.1	0	0	0
		POT	CDQ	BSAI	6	147	5	8	0.24	9.7	0	31.0	2.9	0	9.5
			OA	BSAI	11	152	3	3	0.01	0.9	0	7.5	6.9	0.6	6.9
	CV	NPT	OA	BSAI	22	385	12	49	0.30	16.9	0	31.5	0	21.0	58.4
			RPP	GOA	52	530	33	106	0.02	2.0	47.1	9.9	2.9	14.0	123.2
		PTR	AFA	BSAI	281	8547	204	682	0.11	3.5	2.0	9.9	2.1	7.1	55.2
			RPP	GOA	43	247	19	49	0.01	1.1	19.9	11.7	1.8	2.4	160.7
PARTIAL	CV	NPT	OA	BSAI	32	248	16	54	0.03	4.0	24.2	17.4	0	48.4	123.6
				GOA	70	303	31	61	0.08	19.5	19.8	9.9	0	96.1	55.5
		PTR	OA	GOA	192	925	70	92	0.02	4.4	11.9	5.1	0	28.2	50.2
		HAL	CDQ	BSAI	5	32	2	5	0	0	0	0	0	125.0	31.3
			IFQ	BSAI	26	196	5	31	0	0	0	1.1	65.1	6.4	87.9
				GOA	244	1590	83	249	0.004	0.6	5.7	6.6	37.3	56.3	50.3
			OA	BSAI	4	11	0	0	0	0	0	0	0	0	0
				GOA	9	37	4	19	0	0	27.0	0	0	432.4	54.1
		POT	CDQ	BSAI	3	20	0	0	0	0	0	0	0	0	0
			IFQ	BSAI	4	16	4	16	0	0	125.0	0	625.0	0	250.0
				GOA	18	121	8	10	0	0	0	10.6	33.1	0	41.2
			OA	BSAI	47	283	29	47	0	0	14.1	28.3	0	0	123.7
				GOA	7	39	1	1	0	0	0	25.6	0	0	0

Table 5-3. -- Status of Statements and Incidents - The table below records statements and incidents. 'Ongoing' typically involves complex investigations. 'No OLE Action' includes incidents forwarded to another agency, incidents determined not to be a violation after an investigation, incidents that were closed due to a lack of personnel to conduct an investigation, and incidents closed as 'info only'. Many info only incidents involved observer and operator communication resulting in voluntary compliance at sea.

Statements	Incidents	Statuses
906 statements received and reviewed in 2019 79 statements did not document an actual violation 827 statements were forwarded to agents and officers	384 new incidents created (750 statements) 77 statements were added to 14 open incidents	58 Ongoing (149 statements)
		2 Forwarded for prosecution (6 statements)
		13 Written Warnings issued (35 statements)
		8 Summary Settlements issued (13 statements)
		122 Compliance assistance provided (329 statements)
		200 Closed - No OLE Action (295 statements)
Excludes 121 Observer Coverage potential violations reported by Agency Staff.	*Multiple statements are often combined into a single incident if the same vessel, operator, or company is involved.*	

*As of 08 April 2020

Table 5-4. -- Summary of observer statements by type from 2019* “MM Harassment” statement was associated with a factor group into which < 3 cruises were deployed and so was removed from this analysis. Similarly, 2 of the 7 “Prohibited Species Retaining” statements were associated with factor groups that were removed from this analysis for confidentiality; rates were calculated for the remaining five statements.

Category group	Statement category	Total statements	Total occurrences	% of factor groups with > 0 occurrences
OLE PRIORITY: INTER-PERSONAL	Disruptive/Bothersome Behavior - Conflict Resolved	35	109	47%
	Harassment-Assault	2	2	9%
	Harassment - Sexual	8	9	18%
	Intimidation, coercion, hostile work environment	38	193	47%
OLE PRIORITY: SAFETY AND DUTIES	Interference/Sample Biasing	37	107	41%
	Safety-NMFS	71	356	50%
COAST GUARD	MARPOL/Oil Spill	62	126	53%
	Safety-USCG-Equipment	11	11	29%
	Safety-USCG-Fail to Conduct Drills	142	276	59%
	Safety-USCG-Marine Casualty	197	257	76%
LIMITED ACCESS PROGRAMS	AFA	33	1181	12%
	Amendment 80	83	784	18%
	Catcher Processer Longline	18	27	12%
	IFQ Retention	20	86	12%
	Rockfish Program	2	2	6%
PROTECTED RESOURCE & PROHIBITED SPECIES	Amendment 91 salmon	77	425	18%
	Gulf of Alaska Salmon	23	28	12%
	Marine Mammal-Harassment*	1	1	0%
	Prohibited Species - Mishandling	69	348	50%
	Prohibited Species - Retaining*	7	7	18%
	Sample Bias-Marine Mammals	6	6	6%
	Sample Bias-Seabirds	2	2	9%
	Seabird-Avoidance Measures	13	84	15%
	Seabird-Harassment	2	5	6%
ALL OTHER STATEMENT TYPES	Contractor Problems	15	49	32%
	Failure to Notify	46	166	59%
	Inadequate Accommodations	16	112	32%
	IR/IU	28	193	47%
	Miscellaneous Violations	8	9	15%
	Reasonable Assistance	43	212	59%
	Record Keeping and Reporting	186	1641	79%
	Restricted Access	5	85	18%

Figure 5-1. -- Rate of occurrences per vessel/plant assignment of statement types within the "OLE Priority: Inter-Personal" category group, by each factor combination where they occurred.

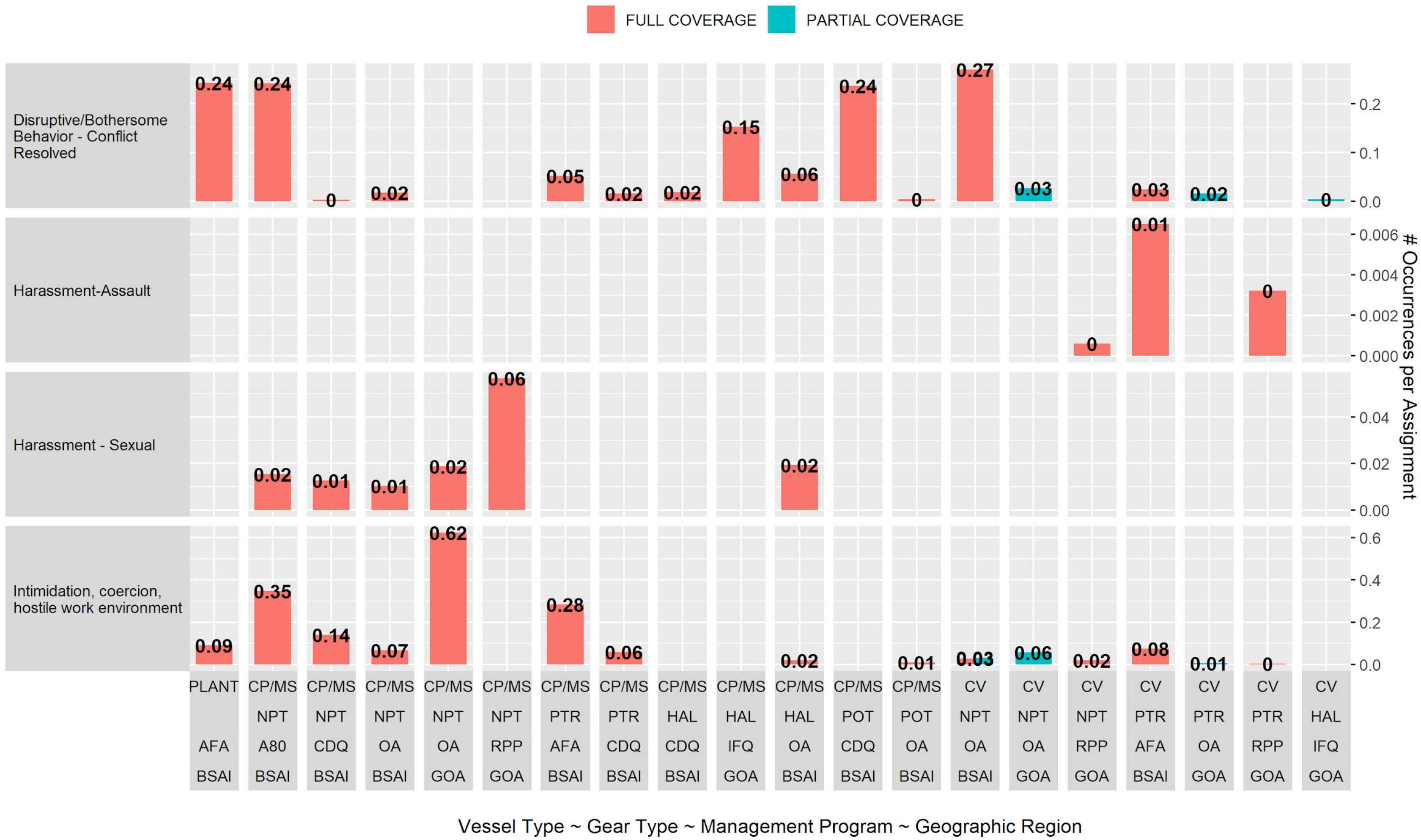


Figure 5-2. -- Rate of occurrences per 1,000 deployed days of statement types within the “OLE Priority: Inter-Personal” category group, by each factor combination where they occurred.

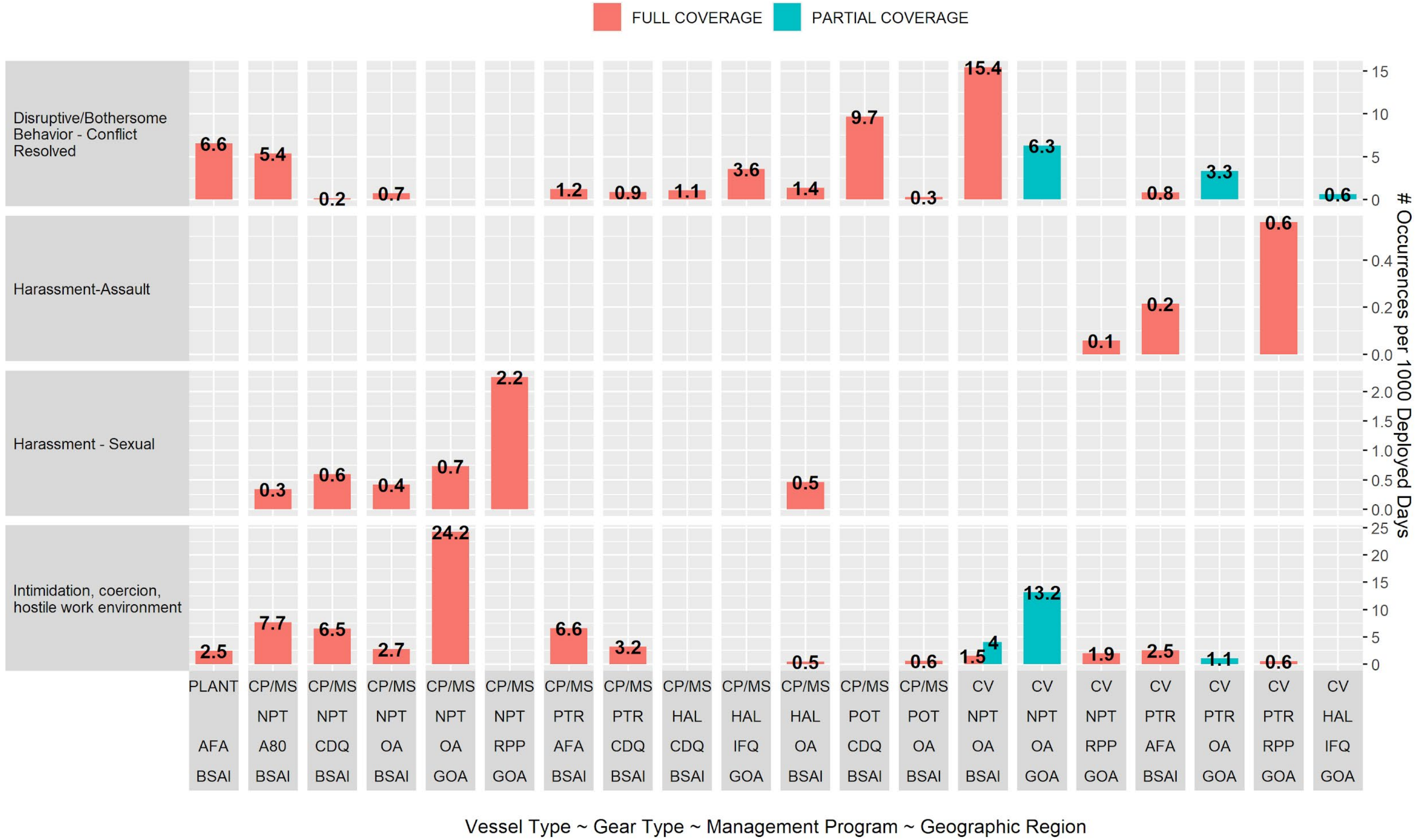


Figure 5-3. -- Rate of occurrences per 1,000 deployed days of statement types within the “OLE Priority: Safety and Duties” category group, by each factor combination where they occurred.

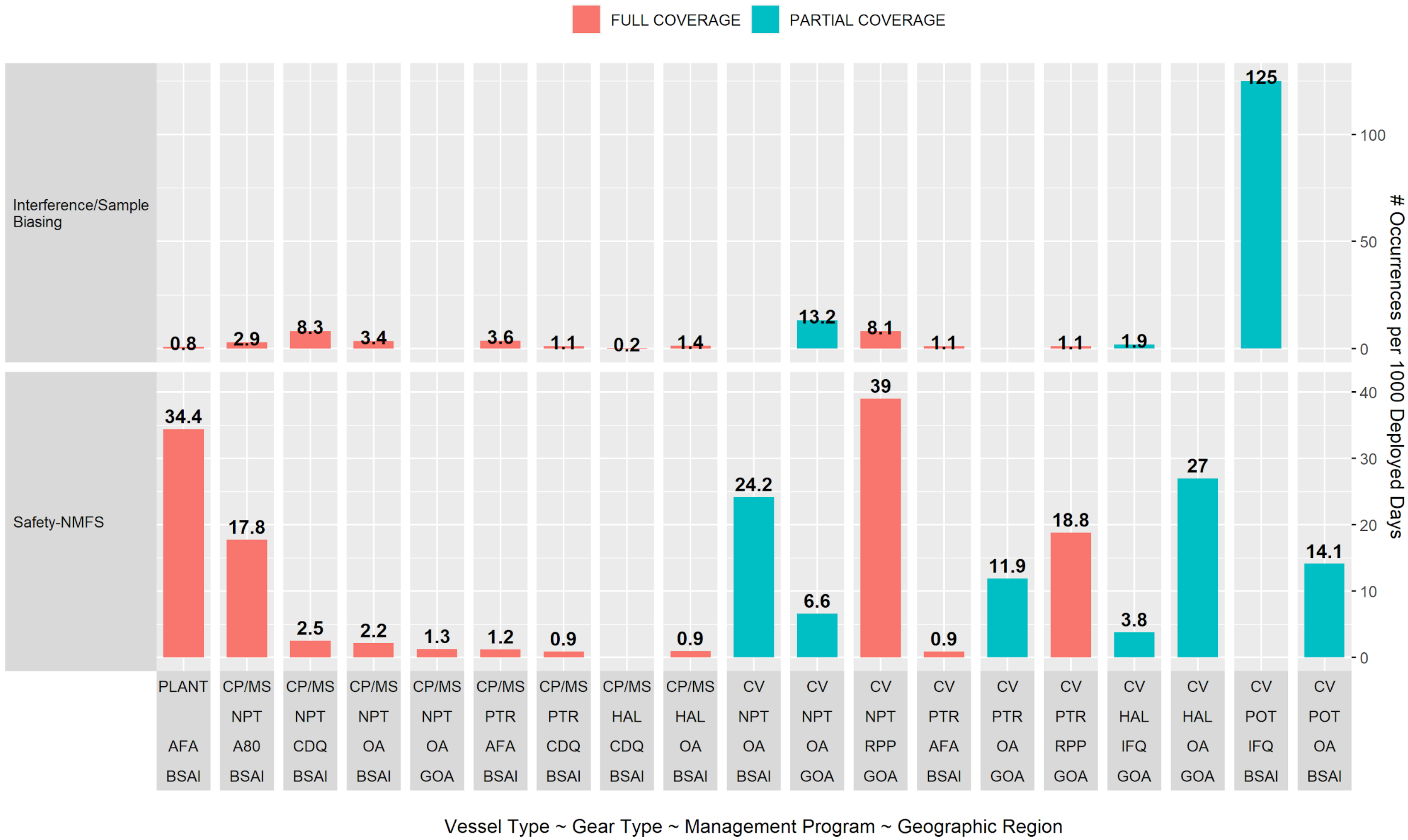


Figure 5-4. -- Rate of occurrences per 1,000 deployed days of statement types within the “Protected Resources and Prohibited Species” category group, by each factor combination where they occurred.

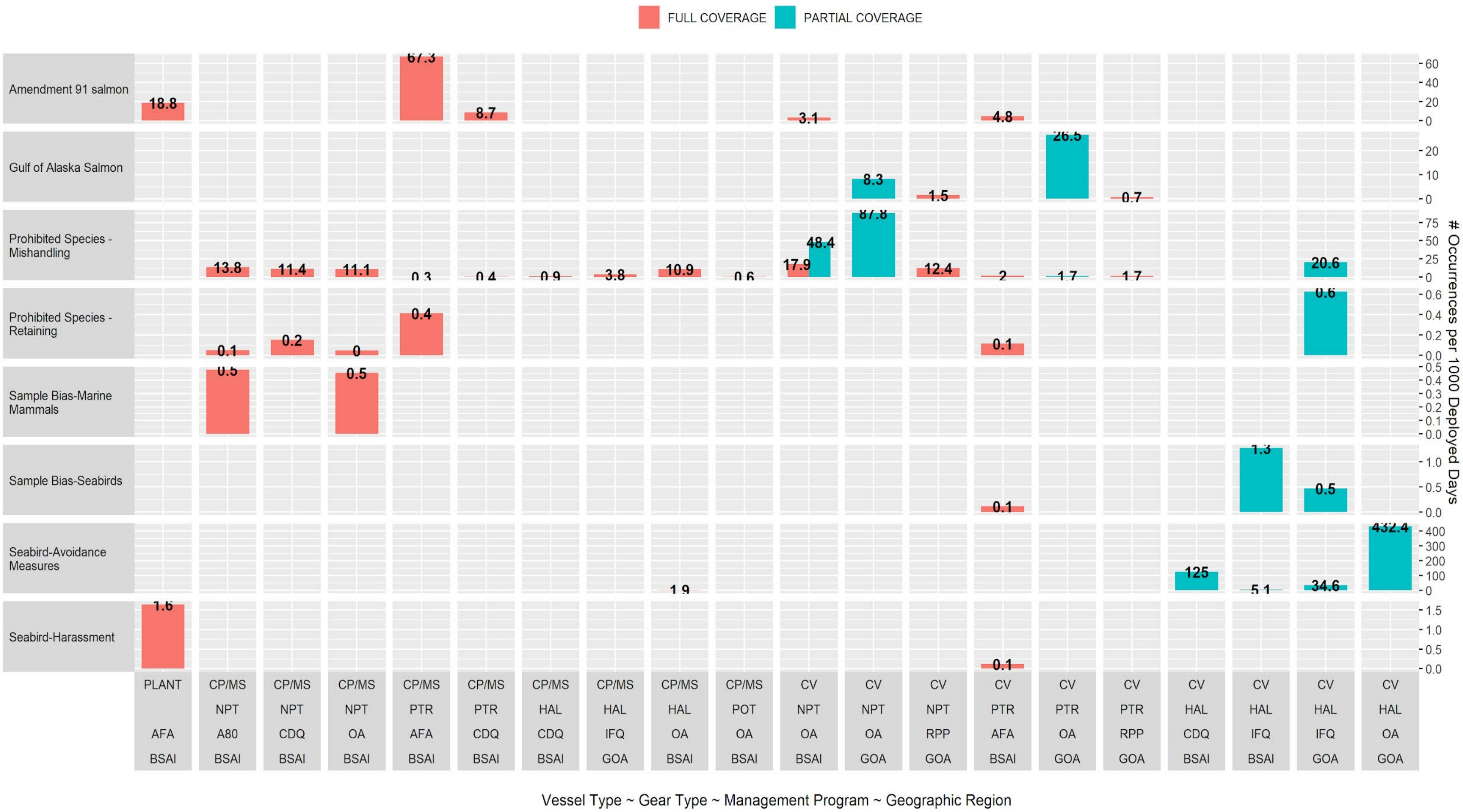


Figure 5-5. -- Rate of occurrences per 1,000 deployed days of statement types within the “Limited Access Programs” category group, by each factor combination where they occurred.

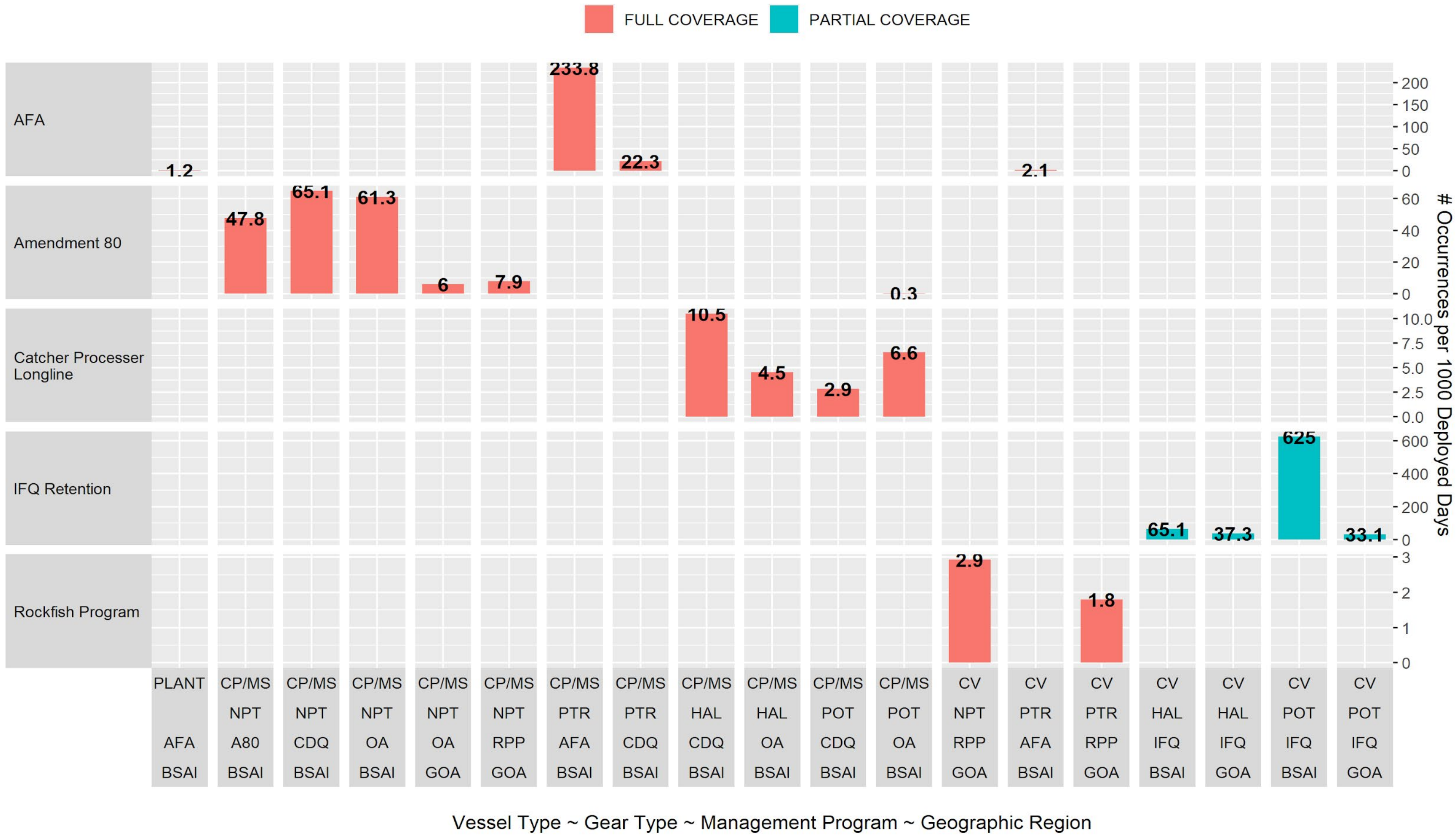


Figure 5-6. -- Rate of occurrences per 1,000 deployed days of statement types within the "All Other Statement Types" category group, by each factor combination where they occurred.

Figure 5-7. -- Rate of occurrences per 1,000 deployed days of statement types within the “Coast Guard” category group, by each factor combination where they occurred.

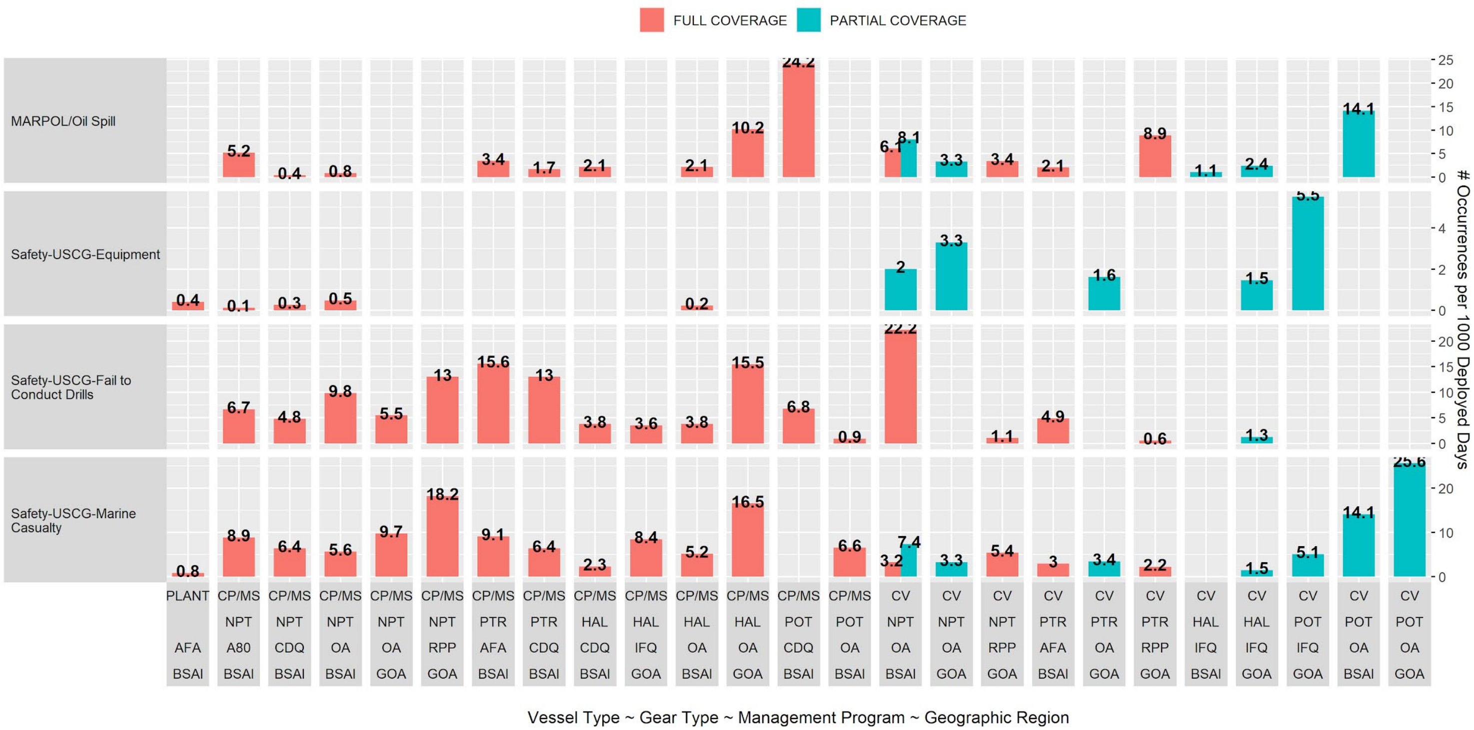
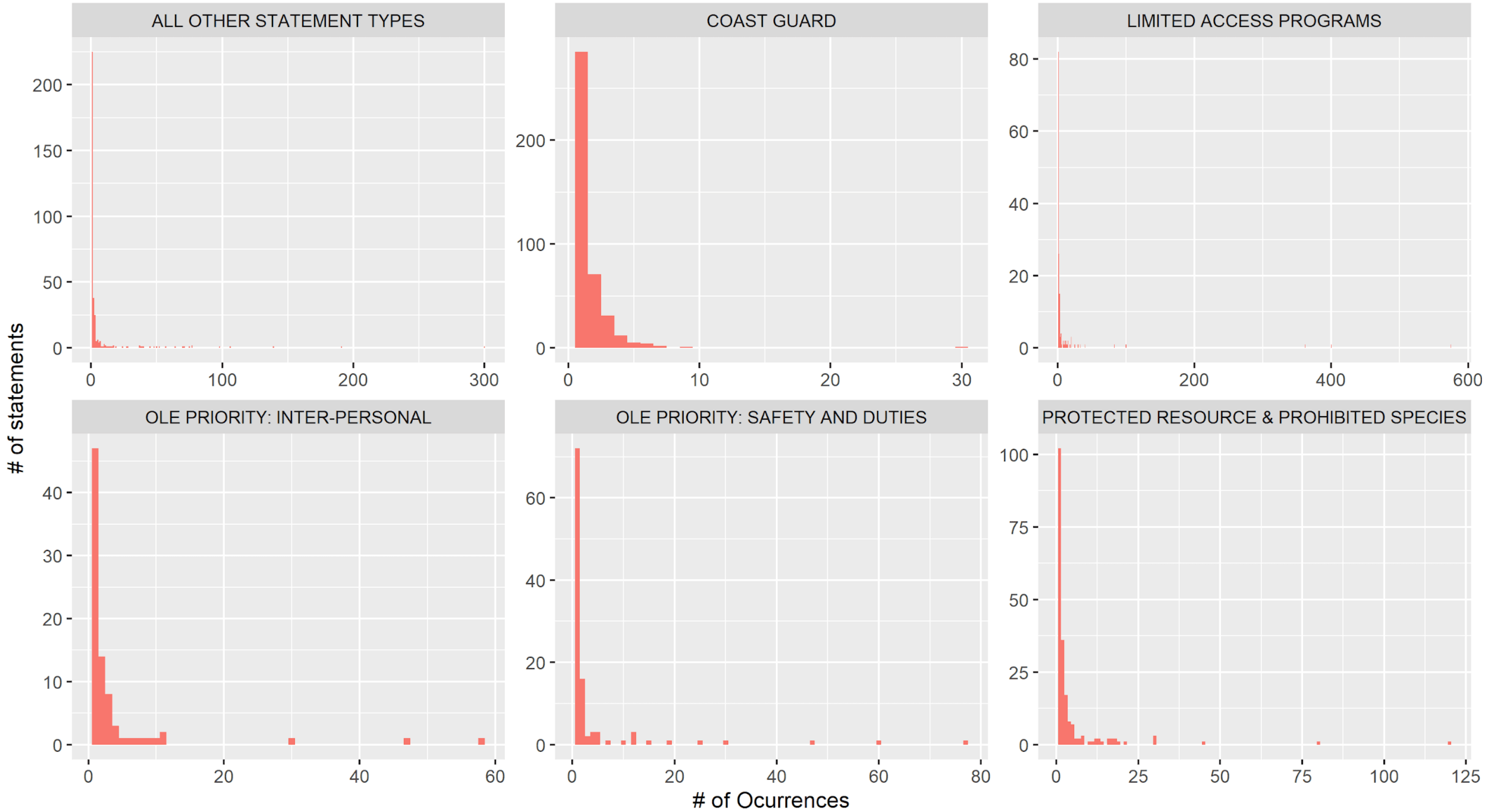


Figure 5-8. -- Number of occurrences per statement in all 6 category groups. Most statements had < 5 occurrences, with some in 'All Other Statement Types' and 'Limited Access Programs' groups containing more (up to 300).



6. NMFS Recommendations

Normally, the 2019 Annual Report would have been published in June of 2020 and the report would provide the basis of NMFS recommendations for the 2021 Annual Deployment Plan. The publication of this report was delayed and NMFS has already implemented the 2021 ADP, so instead of informing the 2021 ADP, this section documents NMFS recommendations that were made in May and June of 2020.

The Council's Fishery Monitoring Advisory Committee (FMAC) met virtually on 19 May 2020[20] with a redesigned agenda to discuss current challenges and responses to observer deployment and data collection in the full and partial coverage fleets, as well as the related implications for management and decision-making. The agency updated the FMAC on the impacts of COVID-19 on observer deployment. At that time, the agency was issuing waivers for observer coverage due to health, safety, or training issues related to COVID-19. To resume coverage in the partial coverage strata, NMFS provided the following recommendations:

- To the extent practical, emulate the "one observer, one boat" model of the full coverage and West Coast program.
- Observers follow Health Mandate 17 quarantine periods and other restrictions.
- Modify trip selection to extend observer deployments for longer periods of time, similar to previously used vessel selection.
- Observers disembark back into ports from which they embarked to limit need for further quarantine periods.
- To mitigate data loss and more closely match modified trip selection, increase fixed gear EM coverage rate from 30% to full coverage.

At their June meeting, the Council reviewed the FMAC report recommended that NMFS reintroduce partial coverage using trip selection out of a select number of key ports (e.g., in addition to Kodiak) and maintain the current coverage/selection rates for vessels carrying EM.[21]

[20] Report from FMAC meeting available at: https://meetings.npfmc.org/CommentReview/DownloadFile?p=39057a66-3b52-4b6b-b3ef-b9fc905bee7a.pdf&fileName=D1%20FMAC%20Report%20May%202020.pdf.

[21] Council motion: https://meetings.npfmc.org/CommentReview/DownloadFile?p=45cce14a-b039-4605-8ea7-79c45e909bc3.pdf&fileName=D1%20Motion.pdf.

7. Citations

AFSC (Alaska Fisheries Science Center) and AKRO (Alaska Regional Office). 2017. North Pacific Observer Program 2016 Annual Report. AFSC Processed Rep. 2017-07, 143 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. Available at https://repository.library.noaa.gov/view/noaa/14356.

AFSC and AKRO. 2018. North Pacific Observer Program 2017 Annual Report. AFSC Processed Rep. 2018-02, 136 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. Available at https://repository.library.noaa.gov/view/noaa/17728.

AFSC and AKRO. 2019. North Pacific Observer Program 2018 Annual Report. AFSC Processed Rep. 2019-04, 148 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. Available at https://repository.library.noaa.gov/view/noaa/20199.

AFSC and AKRO. 2021. North Pacific Observer Program 2020 Annual Report. AFSC Processed Rep. 2021-03, 143 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. Available at https://repository.library.noaa.gov/view/noaa/30732.

AFSC. 2018. 2019 Observer Sampling Manual. Fisheries Monitoring and Analysis Division, North Pacific Groundfish Observer Program. AFSC, 7600 Sand Point Way N.E., Seattle, Washington, 98115.

AFSC. 2019. 2020 Observer Sampling Manual. Fisheries Monitoring and Analysis Division, North Pacific Groundfish Observer Program. AFSC, 7600 Sand Point Way N.E., Seattle, Washington, 98115. Available online at https://www.afsc.noaa.gov/FMA/Manual_pages/MANUAL_pdfs/manual2020.pdf.

Cahalan, J., J. Mondragon, and J. Gasper. 2014. Catch sampling and estimation in the Federal groundfish fisheries off Alaska: 2015 Edition. NOAA Tech. Memo. NMFS-AFSC-286, 46 p.

Cahalan J., J. Gasper, and J. Mondragon. 2015. Catch estimation in the federal trawl fisheries off Alaska: a simulation approach to compare the statistical properties of three trip-specific catch estimators. Can J. Fish. Aquat. Sci. 72(7):1024:1036.

Cahalan, J., and Faunce, C., 2020. Development and implementation of a fully randomized sampling design for a fishery monitoring program. Fish. Bull., U.S. 118(1): 87-100.

Cochran, W. G. 1977. Sampling Techniques. John Wiley and Sons, Inc., New York.

Faunce, C. H. 2015. Evolution of observer methods to obtain genetic material from Chinook salmon bycatch in the Alaska pollock fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-288, 28 p.

Ganz, P., and C. Faunce. 2019. An evaluation of methods used to predict commercial fishing effort in Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-395, 19 p.

Ganz, P., S. Barbeaux, J. Cahalan, J. Gasper, S. Lowe, R. Webster, and C. Faunce. 2019. Deploy-ment performance review of the 2018 North Pacific Observer Program. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-397, 64 p.

Gasper, J., C. Tide, G. Harrington, J. Mondragon, J. Cahalan, S. Bibb, and G. Merrill. 2019. Supplement to the Environmental Assessment for Restructuring the Program for Observer Procurement and Deployment in the North Pacific. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/AKR-19, 168 p. https://doi.org/10.25923/ck9d-jy76.

Goodman, L. A. 1960. On the exact variance of products. J. Am. Stat. Assoc. 55(292):706 – 713.

Guthrie III, C. M., Hv. T. Nguyen, M. Marsh, J. T. Watson, and J. R. Guyon. 2019. Genetic stock composition analysis of the Chinook salmon bycatch samples from the 2017 Bering Sea trawl fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-391, 36 p.

Hill, M.O. 1973. Diversity and evenness: A unifying notation and its consequences. Ecology 61: 225-236.

NPFMC (North Pacific Fishery Management Council) and NMFS (National Marine Fisheries Service). 2011. Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis for Proposed Amendment 86 to the Fishery Management Plan for Groundfish of the Bering Sea/Aleutian Islands Management Area and Amendment 76 to the Fishery Management Plan for Groundfish of the Gulf of Alaska: Restructuring the Program for Observer Procurement and Deployment in the North Pacific. March 2011.

NMFS. 2019a. *Draft* 2020 Annual Deployment Plan for Observers and Electronic Monitoring in the Groundfish and Halibut Fisheries off Alaska. National Oceanic and Atmospheric Administration, 709 West 9th Street. Juneau, AK 99802.

NMFS. 2019b. 2020 Annual Deployment Plan for Observers and Electronic Monitoring in the Groundfish and Halibut Fisheries off Alaska. National Oceanic and Atmospheric Administration, 709 West 9th Street. Juneau, AK 99802.

NMFS. 2018. 2019 Annual Deployment Plan for Observers in the Groundfish and Halibut Fisheries off Alaska. National Oceanic and Atmospheric Administration, 709 West 9th Street. Juneau, AK 99802.

NMFS. 2017a. Final Environmental Assessment/ Regulatory Impact Review for Amendment 114 to the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area and Amendment 104 to the Fishery Management Plan for Groundfish of the Gulf of Alaska, and Regulatory Amendments: Analysis to Integrate Electronic Monitoring into the North Pacific Observer Program. National Oceanic and Atmospheric Administration, 709 West 9th Street. Juneau, Alaska 99802. Available online at https://www.fisheries.noaa.gov/resource/document/ea-rir-amendment-114-fmp-groundfish-bsai-and-amendment-104-fmp-groundfish-goa-and.

NMFS. 2017b. 2018 Annual Deployment Plan for Observers and Electronic Monitoring in the Groundfish and Halibut Fisheries off Alaska. National Oceanic and Atmospheric Administration, 709 West 9th Street. Juneau, AK 99802.

NMFS. 2016. Overview of Catch Estimation Project. Presentation to the Science and Statistical Committee of the North Pacific Fishery Management Council. DOI: 10.13140/RG.2.2.14387.89123.

NMFS. 2015. Draft supplement to the Environmental Assessment for restructuring the program for observer procurement and deployment in the North Pacific. NMFS, Alaska Regional Office, Juneau. May 2015. Available online at https://alaskafisheries.noaa.gov/sites/default/files/analyses/finalea_restructuring0915.pdf.

NMFS. 2013. 2014 Annual Deployment Plan for Observers in the Groundfish and Halibut Fisheries off Alaska. National Oceanic and Atmospheric Administration, 709 West 9th Street. Juneau, Alaska 99802. Available online at https://alaskafisheries.noaa.gov/sites/default/files/adp2014.pdf.

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Appendix A – Evaluation of Pelagic and Non-Pelagic Trawl Trips

Introduction

At its June 2017 meeting, the North Pacific Fishery Management Council (Council) requested that the National Marine Fisheries Service (NMFS) evaluate whether there is evidence of an observer effect in either pelagic trawl (PTR) or non-pelagic trawl (NPT) gear fished by partial coverage vessels (AFSC and AKRO 2018, p. 54). These two gear types are typically used for different styles of fishing, with NPT gear associated with bottom contact and PTR gear typically fished in the water column. The Council's request followed a Fishery Monitoring Advisory Committee (FMAC) request for the evaluation, including a discussion about the "pros and cons" of separate observer deployment strata for those two gear types. The NMFS performed the requested analyses, and the resulting recommendation was to not separate the trawl gears into two separate strata (AFSC and AKRO 2018, Appendix A; AFSC and AKRO 2019, Appendix A). Following these initial analyses, the FMAC expressed interest in continuing to see an evaluation of the NPT and PTR gear types. The analysis presented here is intended to serve as that continued evaluation.

Although the North Pacific Observer Program (Observer Program) does not currently deploy observers into separate NPT and PTR strata, the Catch Accounting System (CAS) post-stratifies observer and landings data based on whether the trip is recorded as NPT or PTR on the landing report ("fish ticket") or in the observer data. The fact that trawl trips are post-stratified by NPT and PTR gear means that estimates of bycatch for unobserved NPT trips are based solely on observed NPT trips (not PTR trips), and estimates of bycatch for unobserved PTR trips are based solely on observed PTR trips (not NPT trips). In both cases, the vessel operator reports the gear type being used to the processor. On observed trips, observers are expected to verify the reported gear type. Regulations at 50 CFR 679.2 (definitions) define NPT and PTR gear to be of certain configurations (e.g., floats, mesh configurations, line configurations).

The NPT and PTR gear types are associated with different fishery management issues, with salmon bycatch being the primary issue for the PTR pollock fisheries, and halibut PSC being of concern for some NPT fisheries. Being a relatively rare bycatch species in the PTR pollock fisheries, salmon are accounted for shoreside when an observer is on board a vessel that is targeting pollock and not delivering to a tender. In contrast, halibut discard estimates are based on samples collected by observers at sea. In both cases, data from observed trips are used to make estimates for unobserved trips, but at-sea observer samples are inherently more variable than the shoreside census conducted for salmon in pollock fisheries. Because of this sampling dynamic, and the differing incentives for different fisheries, a concern raised by some stakeholders has been that vessels selected for observer coverage are disproportionately opting to fish for pollock instead of species that are typically fished with NPT gear. Such behavior would result in higher observer coverage in PTR gear since it is used to target pollock.

Separate from differing coverage levels between gear types, the original request made by the Council was to evaluate whether or not there is evidence of an observer effect within PTR and NPT fisheries (AFSC and AKRO 2018, p. 54). We first responded to that request by providing the results of permutation tests that measured differences between observed and unobserved trips (AFSC and AKRO 2019, Appendix A). Evidence of observer effects within non-tendered trawl trips has been shown in multiple Annual Reports (AFSC and AKRO 2017, AFSC and AKRO 2018, AFSC and AKRO 2019), so one motivation for performing permutation tests within gear type is to give more granularity to those stratum-level results. All analyses in this appendix consider only non-tendered trips.

Results

Since 2016, 99.7% of the partial coverage category PTR landings targeted pollock (Appendix Table A- 1). Of these 5,425 pollock trips, 96.6% had a catch composition of at least 95% pollock, which falls into the CAS "pelagic" pollock target (suggesting midwater tows). The remaining pollock landings were in the "bottom" pollock target category, which is based on the pollock being the predominant species retained (but less than 95% of the retained catch). The predominant targets for vessels fishing NPT gear were Pacific cod (49.7% of trips) and arrowtooth flounder (34.4% of trips), followed by pollock (9.4% of trips; Appendix Table A- 1).

Observation rates for PTR gear were significantly higher than expected in one of the four years analyzed here (Appendix Table A- 2). Observation rates for NPT gear were significantly lower than expected in two of the four years analyzed (Appendix Table A- 2). Also of note is that mixed-gear trips, during which the vessel fishes both NPT and PTR gear, are not uncommon (Appendix Table A- 2). Significance tests rely on the hypergeometric distribution which, when estimating the probability of observing a given number of NPT or PTR trips, accounts for the total number of observed non-tendered trawl trips that occurred. Therefore, a significant result within a gear type means that the number of observed trips was significantly different than the number of observed trips that were expected within that gear type, given the total number of observed non-tendered trawl trips that occurred.

The majority of permutation tests conducted show no significant difference between observed and unobserved trips (Appendix Table A- 3). Of the significant differences that did occur, most occurred in only one year for any given metric and gear type combination (Appendix Table A- 3). Two differences were significant in more than one year: observed NPT trips landed fewer species (three of the four years tested) and less catch (two of the four years tested) than unobserved NPT trips (Appendix Table A- 3). In 2019, two metrics showed significant differences: NPT trips landed an average of two fewer species when observed, and PTR fished an average of 0.03 fewer NMFS areas when observed (Appendix Table A- 3). There were no significant differences in 2019 between observed and unobserved trips in the number of days fished, vessel length, proportion of catch that is made up of the predominant species (pMax), or amount of landed catch (Appendix Table A- 3). As in Chapter 3 of this report, a Bonferroni adjustment has been applied to all permutation test p-values in order to control for multiple comparisons. This adjustment was not applied to permutation test p-values presented in last year's annual report (AFSC and AKRO 2019). This adjustment corrects for the increased probability of detecting a false positive result due to conducting multiple tests on the same data. One drawback of this adjustment is the decreased ability to detect true differences if they exist.

Discussion

While it was known prior to these analyses (AFSC and AKRO 2018, Appendix A; AFSC and AKRO 2019, Appendix A) that NPT and PTR target different species, it was not known just how much observation rates and observer effects differ between the two gear types. Results presented here suggest that observation rates differed from what was expected in some years, but not others (Appendix Table A- 2). Although the significant differences occurred in the two years with the lowest observation rates of non-tendered trawl trips, we do not test for a significant relationship between non-tendered trawl observation rates and differences between observation rates within the two gear types.

Considering all years for which permutation tests have been performed within the NPT and PTR gear types, there is no clear pattern over time in terms of which metrics show an observer effect (Appendix Table A- 3). Regardless, it's important to note that creating separate NPT and PTR strata would not change the feature of fisheries monitoring that allows for observer effects in the first place: the ability of vessels to behave differently on observed trips compared to unobserved trips. Stratification does, however, have the potential to influence whether or not gear types are observed at expected rates. Although this analysis included a significance test for observation rates within the NPT and PTR gear types, the most recent Annual Deployment Plan has one trawl stratum that includes both NPT and PTR trips (NMFS 2019b). This means that, while we can analyze whether NPT and PTR were observed at expected rates given the number of observed trawl trips that occurred and the number of trips that occurred within the NPT and PTR gear types, there is currently no enforceable expectation that vessels use a particular gear type on an observed trawl trip. Despite the potential for separate strata to give NMFS more influence over whether or not the NPT and PTR gear types are observed at expected rates, the NMFS does not currently see evidence that such additional influence is warranted. In 2019, NPT, PTR, and mixed-gear trips were all observed at expected rates (Appendix Table A- 2).

Finally, in addition to a lack of evidence to support stratification, there are logistical challenges to deploying observers into separate NPT and PTR strata. These challenges were identified in previous analyses (AFSC and AKRO 2018, Appendix A; AFSC and AKRO 2019, Appendix A), and they include the potential incentive for vessel operators to log trips under one gear type to obtain the more desirable selection rate, but then fish using the other gear type. A similar issue was seen with tender strata, in which vessels would log tender trips and then deliver shoreside, or vice-versa (AFSC and AKRO 2019). The inaccurate reporting of tender status was one reason the NMFS decided not to stratify by tender status in 2020 (NMFS 2019a, Appendix B). For all the above reasons, the NMFS has not created separate strata for the NPT and PTR gear types.

Appendix Table A- 1. -- Number of trips (N) by target species for NPT and PTR gear types between 2016 and 2019. For the purpose of this table, mixed-gear trips are excluded.

Gear	Target	N
NPT	Pacific cod	1,178
	Arrowtooth flounder	816
	Pollock	223
	Flatfish (shallow water)	104
	Flathead sole	22
	Rex sole	7
	Sablefish	5
	Atka mackerel	4
	Rockfish	4
	Yellowfin sole	4
	Other	3
NPT Total		**2,370**
PTR	Pollock	5,425
	Arrowtooth flounder	6
	Flatfish (shallow water)	3
	Pacific cod	2
	Rockfish	2
	Atka mackerel	1
PTR Total		**5,439**

Appendix Table A- 2. --Number of total trips (N), sampled trips (n), and % observed for NPT and PTR gear type. Significance tests rely on the hypergeometric distribution, which accounts for the number of observed non-tendered trips that occurred when estimating the probability of observing a given number of NPT or PTR trips. For the purpose of this table, mixed-gear trips are counted separately from single-gear trips.

Year	Gear	N	n	% Observed all trawl	% Observed by gear	*p*-value	Realized meets expected?
2016	PTR	1560	421	26.2	27.0	0.10	Yes
	NPT	844	205	26.2	24.3	0.07	Yes
	NPT & PTR	62	19	26.2	30.6	0.17	Yes
2017	PTR	1544	350	20.7	22.7	0.00	No
	NPT	508	82	20.7	16.1	0.00	No
	NPT & PTR	38	1	20.7	2.6	0.00	No
2018	PTR	1292	272	20.3	21.1	0.09	Yes
	NPT	528	92	20.3	17.4	0.03	No
	NPT & PTR	44	14	20.3	31.8	0.02	No
2019	PTR	1043	267	25.2	25.6	0.28	Yes
	NPT	490	121	25.2	24.7	0.41	Yes
	NPT & PTR	35	7	25.2	20.0	0.31	Yes

Appendix Table A- 3. -- Results of permutation tests between observed and unobserved trips within the NPT and PTR gear types. For the purpose of these tests, mixed-gear trips are excluded. A Bonferroni adjustment has been applied to *p*-values.

Year	Gear	Metric	NMFS areas	Days fished	Vessel length (ft)	Species landed	pMax species	Landed catch (t)
2016	NPT	Observed difference	-0.037	-0.444	-1.044	-1.764	0.049	-23.684
	NPT	OD (%)	-2.925	-11.499	-1.188	-26.854	6.022	-39.879
	NPT	*p*-value	1.000	< 0.001	1.000	< 0.001	0.018	< 0.001
	PTR	Observed difference	-0.012	0.193	4.884	-0.185	-0.001	7.952
	PTR	OD (%)	-1.181	8.383	6.024	-3.833	-0.112	8.484
	PTR	*p*-value	1.000	0.006	< 0.001	0.678	1.000	< 0.001
2017	NPT	Observed difference	0.063	-0.143	1.504	-1.521	0.056	-16.168
	NPT	OD (%)	5.051	-3.688	1.689	-21.083	6.765	-19.774
	NPT	*p*-value	1.000	1.000	1.000	0.048	0.066	0.066
	PTR	Observed difference	-0.012	-0.032	-1.437	-0.224	-0.002	-3.072
	PTR	OD (%)	-1.178	-1.381	-1.698	-5.200	-0.169	-2.857
	PTR	*p*-value	1.000	1.000	0.948	0.636	0.036	0.960
2018	NPT	Observed difference	-0.089	-0.388	-4.309	-0.360	0.032	-18.648
	NPT	OD (%)	-7.746	-10.588	-5.059	-4.035	4.142	-26.359
	NPT	*p*-value	0.210	0.084	0.084	1.000	0.954	< 0.001
	PTR	Observed difference	-0.001	0.064	-0.644	0.195	-0.002	-2.076
	PTR	OD (%)	-0.144	2.496	-0.765	4.410	-0.158	-1.986
	PTR	*p*-value	1.000	1.000	1.000	0.930	1.000	1.000
2019	NPT	Observed difference	-0.069	-0.083	2.128	-2.024	0.023	-8.314
	NPT	OD (%)	-6.091	-2.539	2.388	-21.215	3.111	-10.357
	NPT	*p*-value	0.372	1.000	1.000	0.006	1.000	0.498
	PTR	Observed difference	-0.034	0.012	0.427	0.022	-0.001	-0.668
	PTR	OD (%)	-3.269	0.494	0.517	0.491	-0.055	-0.662
	PTR	*p*-value	0.024	1.000	1.000	1.000	1.000	1.000

Appendix B – Gap Analysis

Introduction

This analysis evaluates the deployment of observers and electronic monitoring (EM) systems within the partial coverage category in the context of catch estimation. Catch estimation relies on representative sampling of fishing activity which is achieved through random deployment of monitoring coverage. Within the observer and EM pools, fishing trips are randomly selected for monitoring via the Observer Declare and Deploy System (ODDS) at strata-specific trip selection rates. In theory, random trip selection should result in proportionate deployment of sampling effort to all post-strata within each stratum; that is, monitored trips are distributed similarly to all fishing effort spatially, temporally, and between fisheries. In reality, there are various factors that may cause sampling effort to be disproportional to fishing effort within a stratum and therefore may result in a lack of and/or non-representative samples from which to generate catch and discard estimates. Although observers and EM systems are not deployed into individual fisheries within a given stratum, by evaluating coverage within post-strata we can better understand some of the departures from expected deployment patterns found in the broader assessment presented in Chapter 3.

Although trip selection is a random process, the resulting sampling effort may not be proportionally distributed among post-strata due to random chance, cancellation policies in the ODDS, and/or observer effects. For example, monitoring coverage can be delayed by logging multiple trips, cancelling trips, and inheriting monitoring coverage from cancellation of selected trips. In addition, fishing activity may be influenced by selection status with monitored trips having different duration, location, or target species than unmonitored trips. These factors can potentially result in spatiotemporal differences between monitored trips and cause catch estimates to extrapolate from data pooled at coarser spatiotemporal scales.

In this appendix, we examine the patterns of observer and EM coverage relative to total fishing activity at a finer scale than presented in Chapter 3 of the Annual Report. Results here are intended to provide additional detail to some of the Annual Report findings, however, because these are post-hoc analyses being conducted at a finer scale than overall deployment specified in the ADP. Care should be taken when interpreting the results.

Methods

The methods used in this analysis are similar to those employed in the gap analysis in Appendix C of the 2020 Draft Annual Deployment Plan (ADP, NMFS 2019a). Partial coverage fishing effort data from 2019 was used in conjunction with a simplified version of the Catch Account System's (CAS) post-stratification process to quantify the degree to which data from monitored trips are available within specified spatiotemporal distances to unmonitored fishing trips. In general, the larger the distance, the greater the potential for problematic gaps (sparse or no data collected) within a given spatiotemporal bin (e.g., post-strata in CAS or data groupings used within stock assessments).

This analysis included four distinct types of monitoring coverage that are used within and between partial coverage selection pools: 1) Monitored observer pool trips relative to unmonitored observer pool trips (OB-OB), 2) Monitored observer pool trips relative to all zero-selection pool trips (OB-ZE), 3) Monitored EM pool trips relative to unmonitored EM pool trips (EM-EM), and 4) Monitored observer pool trips relative to all EM pool trips (OB-EM, observer data available to support EM monitoring). The OB-OB and EM-EM gap analyses were the focus of this analysis because they most closely describe whether monitored trips are representative of all trips within deployment strata. The OB-ZE and OB-EM analyses were included to assess the availability of observer pool data to other dependent pools.

Post-strata were generally defined by gear type, FMP, tender status, and the dominant species landed (trip target), with exception to the OB-EM analyses, in which tender status was excluded in the post-strata definition. This was done to mimic the post-strata CAS employs to generate discard estimates for the observer, zero-selection, and EM pools (i.e., OB-OB, OB-ZE, and EM-EM) which do not necessarily match those used in average weight estimates applied to EM monitoring (i.e., OB-EM).

Within the post-strata of a given stratum, distance categories were defined for each trip as a function of whether the trip was monitored or its proximity to a monitored trip: 1) trip is monitored (MD), 2) nearest monitored trip occurs 15 days before or after the unmonitored trip in the same NMFS area (AD), 3) nearest monitored trip occurs within 45 days before or after the unmonitored trip in the same FMP (FD), or 4) the nearest monitored trip meets none of the other categories and the nearest monitored trip occurs within the same year within either FMP (YD) (Appendix Table B- 1). After assigning distance categories to all trips within a given post-stratum, a single 'gap index' was calculated as a weighted proportion of trips within each of the four distance categories:

$$G_D = (P_{MD} \times 1) + (P_{AD} \times 0.75) + (P_{FD} \times 0.25) + (P_{YD} \times 0),$$

where G_D is the gap index for a given post-stratum D and P_{MD}, P_{AD}, P_{FD}, and P_{YD} are the proportions of trips in each distance category. The weights for the distance categories are arbitrary but were specified to provide separation between the AD distance category to the FD and YD categories that aids in interpreting whether or not a post-stratum has adequate coverage for generating area-level estimates. The gap index represents an overall measure of the spatiotemporal availability of monitoring data within a given post-stratum.

The realized strata-specific deployment rates in 2019 (Chapter 3, Table 3-5) were used to simulate trip selection 10,000 times to ensure that effects of trip cancelations and inherited monitoring coverage were included in the simulations. However, both EM HAL and EM POT trips were pooled to form a single deployment stratum with a selection rate of 32.5%. Gap indices were calculated for each iteration to produce simulated distributions to represent the range of possible outcomes under actual 2019 trip selection rates. For a given post-stratum, the simulated distributions of gap indices were compared to the gap indices resulting from trips that were actually monitored in 2019 (the realized gap indices). By calculating the proportion of simulated outcomes that were equal to or more extreme than the realized outcomes, post-strata with unlikely outcomes were identified. This provided a mean to further investigate the spatial and temporal distribution of monitoring coverage within post-strata and aided interpretations of the degree to which monitoring was proportionately distributed between post-strata.

Results

Results of the gap analyses are presented in Appendix Table B- 2 and Appendix Table B- 1 and Appendix Table B- 2. Summaries of key results are presented by deployment strata below. Graphic depictions of realized coverage are presented in Appendix Figure B- 3 through Appendix Figure B- 7 to illustrate how monitored trips were spatiotemporally distributed between post-strata in 2019 and provide context to the acquire gap indices.

OB Hook-and-line Stratum (HAL)

The OB-OB comparison gap indices for halibut-target trips in the BSAI was on the low tail of the simulated distribution (3.2% of outcomes were at least as extreme) but the gap index for halibut-target trips in the GOA was on the high tail of the simulated distribution (8.0% of outcomes were at least as extreme) (Appendix Figure B- 1). This may be due to higher realized monitoring rates in the GOA (19.6% of 152 trips) than in the BSAI (16.04% of 187 trips) and also because there was little monitoring in the Aleutian Island areas resulting in many trips being categorized in the FMP-level distance category (Appendix Figure B- 3). None of the 27 trips in area 542 were observed, and only 11.29% of the 62 trips in 541 were observed (Appendix Table B- 2). In contrast, 28.09% of the 89 trips in area 610 were observed. The elevated observer monitoring coverage in GOA halibut-target trips also resulted in unlikely (4.87% outcomes were at least as extreme) and higher OB-EM gap indices (Appendix Figure B- 1 and Appendix Figure B- 6).

Pacific cod target trips in both the BSAI and GOA had gap indices in the upper ends of the simulated distributions (11.1% and 14.9% of outcomes were as high or more extreme, respectively). FMP-specific realized coverage rates were higher than the realized rate 17.6% for the hook-and-line stratum as a whole (22.2% in the BSAI and 21.3% in the GOA), and further exploratory analyses indicate that the elevated realized rates were due to a high number of inherited trips that were monitored at the beginning of the year during the Pacific cod fishery.

None of the 10 sablefish target trips in the BSAI were monitored which resulted in a gap index of zero (Appendix Figure B- 3). However, this outcome was present in 14.2% of simulated iterations. It should be noted that these trips were generally longer in duration (mean of 13.7 days) compared to those in the GOA (mean of 4.6 days).

OB Trawl Stratum (TRW)

The realized gap index for GOA arrowtooth-target trips was below the entire simulated distribution (i.e., the realized gap index was more extreme than all 10,000 simulations), indicating a disproportional distribution of monitoring coverage within the observer trawl stratum (Appendix Figure B- 1). The realized monitoring rates for this post-stratum were only 17.2% from 233 trips, compared to the realized rate of 25.2% within the stratum. Among NMFS areas; 19.8% of the 197 trips in area 630 were monitored but only 4.8% of the 42 trips in area

620 and none of the 10 trips in area 610 were monitored (Appendix Table B- 2, Appendix Figure B- 5).

Realized gap indices for the other observer TRW post-strata were generally within simulated distributions. Of the simulated outcomes in the shallow water flatfish-target, 10.3% of simulated outcomes were at least as extreme. This coincides with the disproportionately lower monitoring rates within arrowtooth-target trips.

OB Pot Stratum (POT – No Tender)

The realized gap index for BSAI Pacific cod target trips was on the low end of the simulated distribution (5.2% of outcomes were at least as extreme) (Appendix Figure B- 2). However, the realized monitoring rate of 15.6% for this post-stratum was higher than the strata-specific realized monitoring rate of 14.0%, suggesting that monitoring coverage was not proportionately distributed in time and space. None of the 12 trips in area 516 were monitored (i.e., and therefore were assigned to the FMP-level distance category) and only 1 of 39 trips in area 509 were observed in the latter half of the year that resulted in 30 of those trips being assigned to the FMP-level distance category (Appendix Figure B- 4).

OB Trawl and Pot Tender Strata (TRW - Tender and POT – Tender)

Monitoring coverage was generally proportionately distributed across post-strata within both the TRW – Tender and POT – Tender strata (Appendix Figure B- 2 and Appendix Table B- 2) as indicated by realized gap indices well within the simulated distributions.

EM Hook-and-line Stratum (EM HAL)

Most of the post-strata within the EM HAL strata within the EM-EM comparisons had realized gap indices that were on or near the tails of the simulated distributions, indicating disproportionate monitoring coverage (Appendix Figure B- 1). Trips targeting Pacific cod had realized gap indices that were on the upper ends of the simulated distributions. Only 1.1% of simulated outcomes were at least as extreme as the realized gap index in GOA Pacific cod, and similarly, 14.26% of simulated outcomes were at least as extreme as the realized gap index in BSAI Pacific cod. The realized coverage rates in these post-strata were also higher than the strata-specific realized rate: 45.0% of 20 trips in the BSAI and 50.7% of 73 trips in the GOA compared to the stratum-wide rate of 32.5%.

Conversely, realized gap indices for trips targeting halibut were on the lower tails of their simulated distributions, especially in the BSAI where trips were monitored at 19.61% of 51 trips and only 3.5% of simulated outcomes had gap indices as or more extreme. Additionally, no halibut trips were monitored in the BSAI prior to late June, resulting in many trip assigned to the FMP-level distance category in areas 518, 541 and 542 (Appendix Figure B- 6).

EM Pot Stratum (EM POT)

Monitoring coverage was generally uniformly distributed across post-strata within the EM POT strata of the EM-EM comparisons (Appendix Figure B- 2 and Appendix Table B- 2) as indicated by realized discard gap indices well within the simulated distributions.

Discussion

This analysis indicates that the deployment of fishery monitoring tools was occasionally disproportionately distributed between post-strata. For observers this occurred within the HAL, TRW-No Tender and POT-No Tender strata. For EM this occurred within the EM HAL. In this analysis low realized monitoring rates and a low gap index in the BSAI halibut-target post-stratum and high realized monitoring rates and a high realized gap index in the GOA were found. These results are consistent with the findings in Chapter 3 for the observer pool HAL stratum that found that area 542 had fewer trips observed than expected and area 610 had more observed trips than expected (Fig. 3-7). The low gap index in the TRW GOA arrowtooth-target post-stratum may have been due low monitoring rates in area 620, which coincides with results in Chapter 3 where this stratum had 18 fewer trips observed than expected in the area (Fig. 3-9). Finally, there was a pattern within the EM HAL stratum in both the BSAI and the GOA where acquired gap indices for Pacific cod-target post-strata were high but acquired gap indices for halibut-target trips were low. This target-specific pattern was not apparent in the analyses in Chapter 3.

Despite these differences, this analysis also indicates that the deployment of monitoring within the observer pool generally resulted in expected overlap of observer coverage with fishing activity in the zero-selection pool and fishing activity in the EM pool. Only one post-stratum in the OB-EM analyses – EM HAL GOA halibut-target –had a realized gap index that was at least as extreme as 5% of simulated outcomes (Appendix Table B- 2). However, it should be noted that these conclusions only indicate that the level of coverage provided by the observer pool for the zero-selection and EM pools largely met expectations given the degree of spatiotemporal overlap between the pools and does not speak to whether or not the degree of data provided by the observer pool was or will be adequate for discard or average weight estimates. Further work is required to determine whether any findings of this analysis were present in previous years or will persist in future years. Additionally, further investigation is required to determine the specific impacts as well as the mechanisms though which any persistent patterns manifest prior to prescribing solutions.

Appendix Table B- 1. --Distance categories assigned to each trip by the gap estimation routine using nearest-neighbor methods. Within a given post-stratum defined by deployment strata, target, and FMP, trips selected for monitoring were placed in the 'Monitored' category, and unmonitored trips were assigned to the categories of finest spatiotemporal resolutions where spatial and temporal conditions were met.

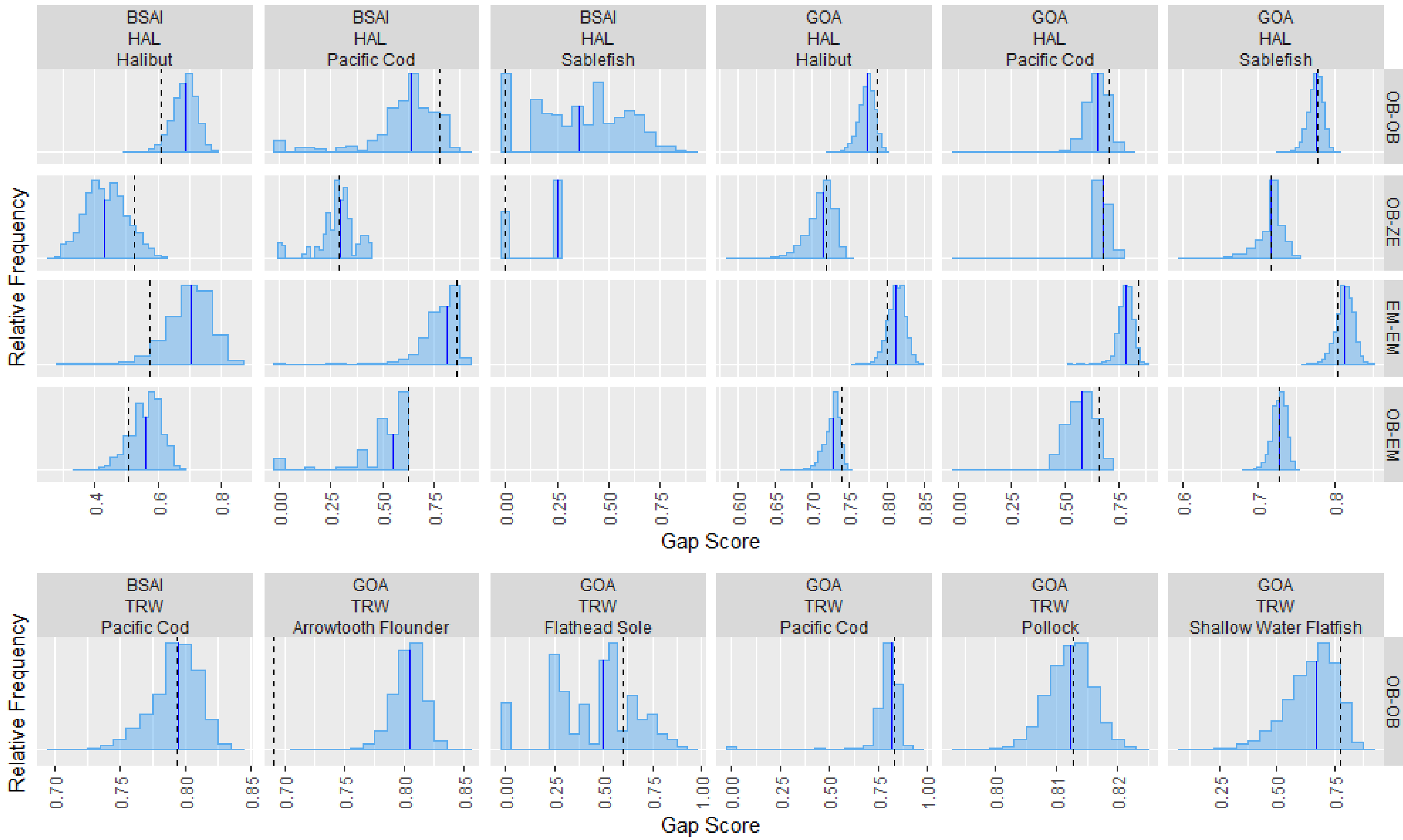
Category	Resolution	Condition	Weight
Monitored (MD)	Fine	Selected for monitoring	1.00
Area (AD)	↓	<= 15 days of monitored trip within NMFS area	0.75
FMP (FD)		<= 45 days of monitored trip within FMP	0.25
Year-to-Date (YD)	Coarse	> 45 days of monitored trip	0.00

Appendix Table B- 2. -- Summary table of gap analyses for the observer (OB), zero selection (ZE), and electronic monitoring (EM) pools. 'Type' defines the type of coverage (e.g., OB-OB is observed OB trips relative to unobserved OB trips, and OB-ZE is observed OB trips relative to all ZE trips, etc.).'Rate' is the post-strata-specific realized monitoring rate as a percentage. Gap indices represent the spatiotemporal availability of monitoring data. 'Realized' gap indices resulted from monitored trips in 2019 and 'Min', 'Med', and 'Max' represent the minimum, median, and maximum gap indices resulting from 10,000 simulations of trip selection at realized deployment rates. 'Likli.' represents the proportion of simulated outcomes that were at least as extreme as the realized result under the assumption of random deployment. Outcomes with lower likelihood are shaded darker.

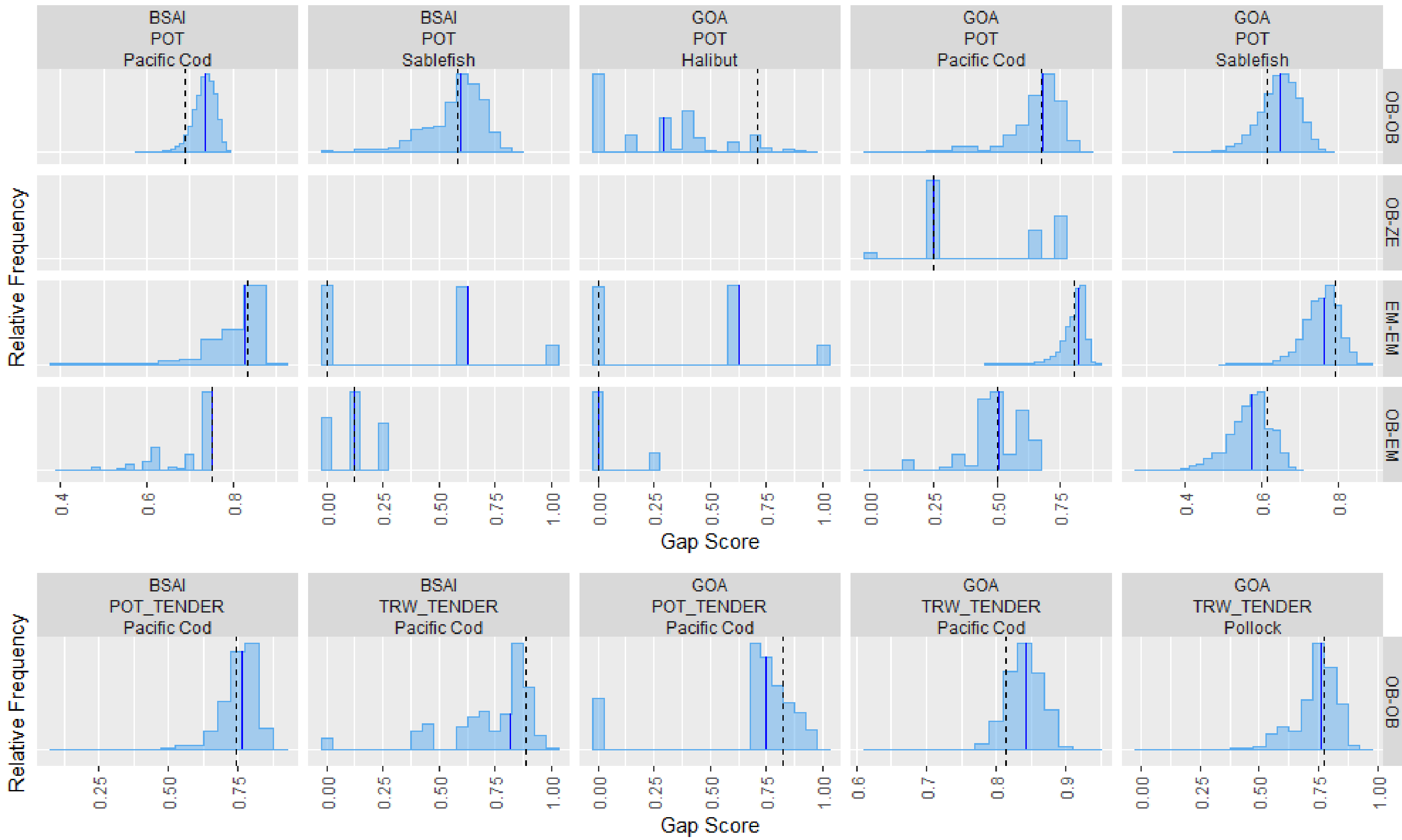
					Gap indices				
Type	**Gear/Tender**	**FMP**	**Trip target**	**Rate**	**Realized**	**Min**	**Med**	**Max**	**Likli.**
OB-OB	HAL	BSAI	Halibut	16.04	0.611	0.502	0.688	0.782	0.0320
OB-OB	HAL	BSAI	Pacific Cod	22.22	0.778	0.000	0.639	0.889	0.1117
OB-OB	HAL	BSAI	Sablefish	0.00	0.000	0.000	0.355	0.921	0.1419
OB-OB	HAL	GOA	Halibut	19.74	0.787	0.723	0.773	0.801	0.0801
OB-OB	HAL	GOA	Pacific Cod	21.28	0.704	0.000	0.653	0.806	0.1496
OB-OB	HAL	GOA	Sablefish	16.78	0.778	0.729	0.776	0.803	0.4090
OB-OB	POT	BSAI	Pacific Cod	15.56	0.689	0.588	0.736	0.795	0.0516
OB-OB	POT	BSAI	Sablefish	10.81	0.586	0.000	0.599	0.829	0.4521
OB-OB	POT	GOA	Halibut	16.67	0.708	0.000	0.292	0.958	0.1183
OB-OB	POT	GOA	Pacific Cod	11.11	0.678	0.000	0.683	0.833	0.4968
OB-OB	POT	GOA	Sablefish	10.56	0.614	0.397	0.651	0.787	0.2276
OB-OB	POT - Tender	BSAI	Pacific Cod	30.77	0.745	0.133	0.765	0.893	0.3632
OB-OB	POT - Tender	GOA	Pacific Cod	16.67	0.821	0.000	0.750	1.000	0.3141
OB-OB	TRW	BSAI	Pacific Cod	29.37	0.793	0.701	0.795	0.845	0.4808
OB-OB	TRW	GOA	Arrowtooth	17.17	0.691	0.714	0.804	0.847	0.0000
OB-OB	TRW	GOA	Flathead Sole	44.44	0.600	0.000	0.500	0.975	0.2616
OB-OB	TRW	GOA	Pacific Cod	33.33	0.833	0.000	0.817	0.933	0.3059
OB-OB	TRW	GOA	Pollock	25.68	0.813	0.794	0.812	0.825	0.4733
OB-OB	TRW	GOA	Shallow Water Flats	35.29	0.779	0.136	0.671	0.879	0.1037
OB-OB	TRW - Tender	BSAI	Pacific Cod	50.00	0.886	0.000	0.818	1.000	0.2006
OB-OB	TRW - Tender	GOA	Pacific Cod	25.93	0.815	0.620	0.843	0.935	0.1935
OB-OB	TRW - Tender	GOA	Pollock	42.86	0.773	0.000	0.761	0.943	0.4444
OB-ZE	HAL	BSAI	Halibut	16.04	0.523	0.268	0.431	0.624	0.0972
OB-ZE	HAL	BSAI	Pacific Cod	22.22	0.286	0.000	0.293	0.443	0.4930
OB-ZE	HAL	BSAI	Sablefish	0.00	0.000	0.000	0.250	0.250	0.3741
OB-ZE	HAL	GOA	Halibut	19.74	0.718	0.591	0.715	0.746	0.4128
OB-ZE	HAL	GOA	Pacific Cod	21.28	0.675	0.000	0.675	0.750	0.5000
OB-ZE	HAL	GOA	Sablefish	16.78	0.717	0.608	0.717	0.750	0.5000
OB-ZE	POT	GOA	Pacific Cod	11.11	0.250	0.000	0.250	0.750	0.5000
EM-EM	HAL	BSAI	Halibut	19.61	0.574	0.309	0.707	0.875	0.0352
EM-EM	HAL	BSAI	Pacific Cod	45.00	0.862	0.000	0.812	0.925	0.1426
EM-EM	HAL	GOA	Halibut	28.20	0.801	0.758	0.813	0.846	0.1547
EM-EM	HAL	GOA	Pacific Cod	50.68	0.844	0.523	0.786	0.877	0.0114
EM-EM	HAL	GOA	Sablefish	32.15	0.804	0.763	0.814	0.849	0.2070
EM-EM	POT	BSAI	Pacific Cod	33.33	0.833	0.423	0.827	0.899	0.4400
EM-EM	POT	BSAI	Sablefish	0.00	0.000	0.000	0.625	1.000	0.4509
EM-EM	POT	GOA	Halibut	0.00	0.000	0.000	0.625	1.000	0.4437
EM-EM	POT	GOA	Pacific Cod	42.00	0.805	0.470	0.820	0.900	0.3881
EM-EM	POT	GOA	Sablefish	36.23	0.796	0.511	0.764	0.873	0.2180

OB-EM	HAL	BSAI	Halibut	16.04	0.508	0.359	0.562	0.688	0.1607
OB-EM	HAL	BSAI	Pacific Cod	22.22	0.625	0.000	0.550	0.625	0.2519
OB-EM	HAL	GOA	Halibut	19.61	0.741	0.663	0.728	0.750	0.0487
OB-EM	HAL	GOA	Pacific Cod	21.28	0.659	0.000	0.581	0.724	0.1160
OB-EM	HAL	GOA	Sablefish	16.51	0.727	0.683	0.727	0.748	0.5000
OB-EM	POT	BSAI	Pacific Cod	17.23	0.750	0.411	0.750	0.750	0.5000
OB-EM	POT	BSAI	Sablefish	10.81	0.125	0.000	0.125	0.250	0.5000
OB-EM	POT	GOA	Halibut	33.33	0.000	0.000	0.000	0.250	0.5000
OB-EM	POT	GOA	Pacific Cod	11.76	0.500	0.000	0.510	0.640	0.4950
OB-EM	POT	GOA	Sablefish	11.97	0.616	0.292	0.574	0.694	0.2180

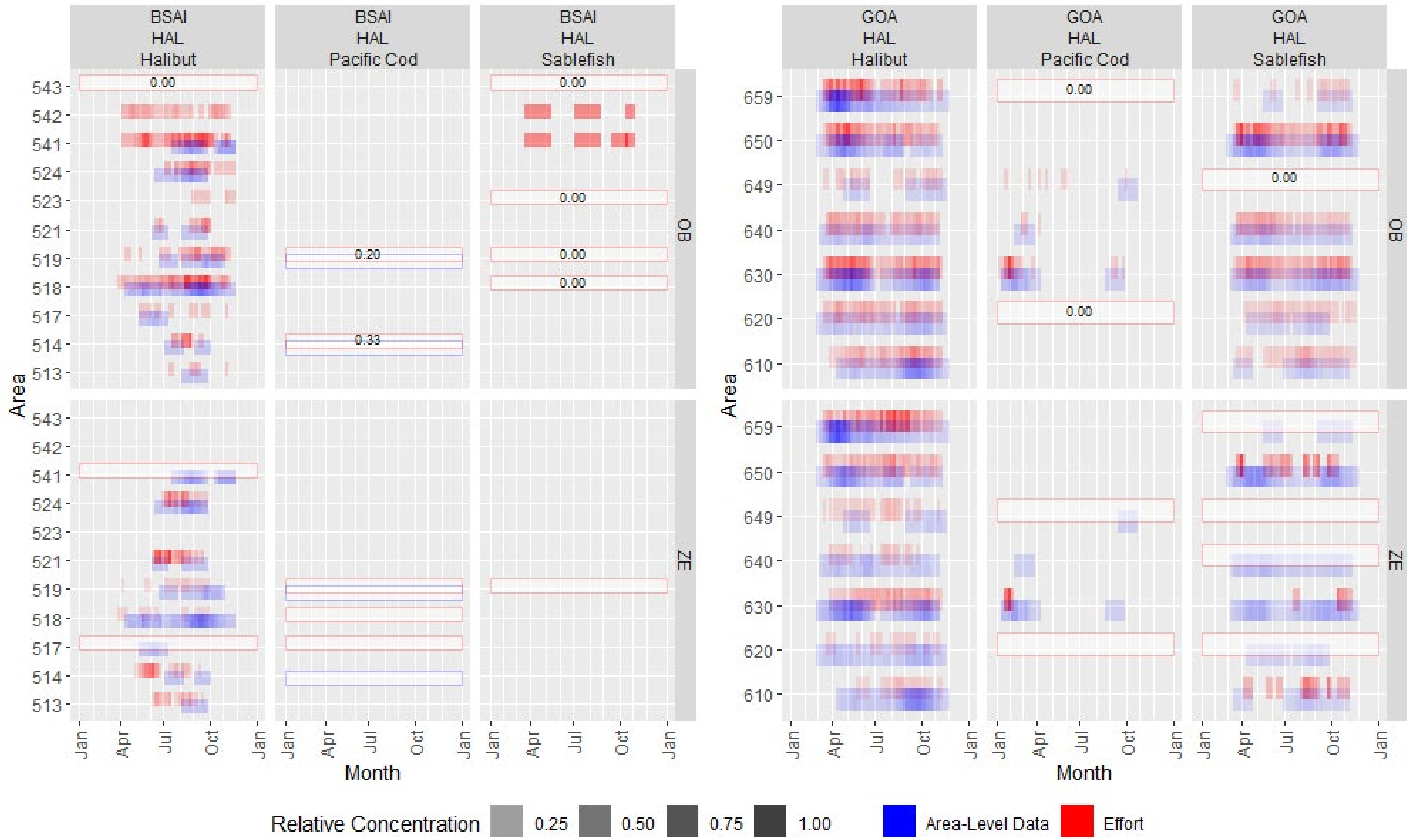
Appendix Figure B- 1. -- Acquired gap indices of hook-and-line gear (top panel) and non-tender trawl gear (bottom panel) post-strata from monitored trips in 2019 (black dashed lines) compared to gap indices resulting from 10,000 simulations of trip-selection at realized deployment rates (blue distributions, with solid blue lines representing medians). Four types of monitoring coverage are shown: OB-OB, OB-ZE, and OB-EM assessed the spatiotemporal proximity of observed trips to unobserved observer pool trips, all zero-selection pool trips, and all EM pool trips, respectively, and EM-EM assessed the spatiotemporal proximity of monitored EM pool trips to unmonitored EM pool trips.



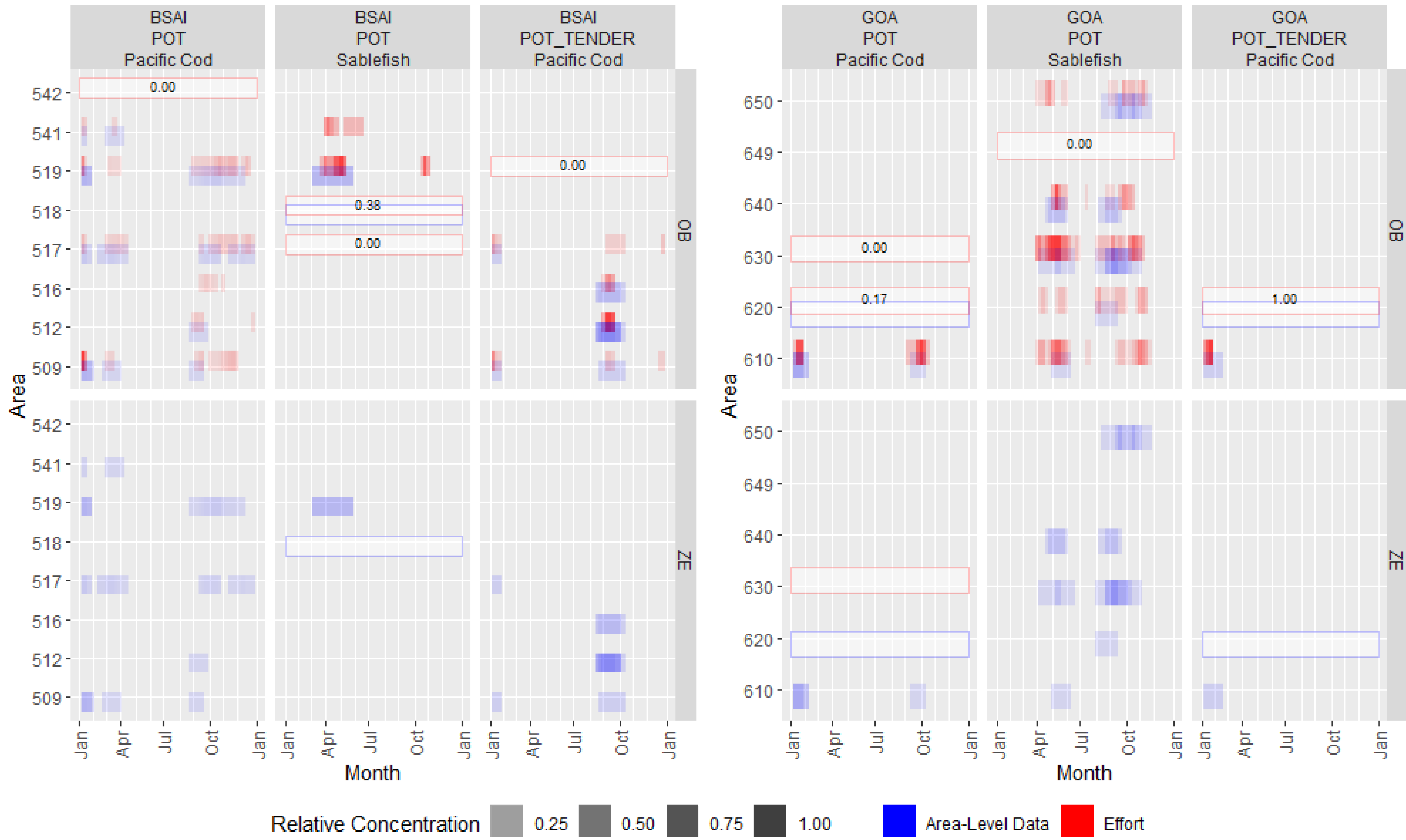
Appendix Figure B- 2. -- Acquired gap indices of pot gear (top panel) and tendered trawl and pot gear (bottom panel) post-strata from monitored trips in 2019 (black dashed lines) compared to gap indices resulting from 10,000 simulations of trip-selection at realized deployment rates (blue distributions, with solid blue lines representing medians). Four types of monitoring coverage are shown: OB-OB, OB-ZE, and OB-EM assessed the spatiotemporal proximity of observed trips to unobserved observer pool trips, all zero-selection pool trips, and all EM pool trips, respectively, and EM-EM assessed the spatiotemporal proximity of monitored EM pool trips to unmonitored EM pool trips.



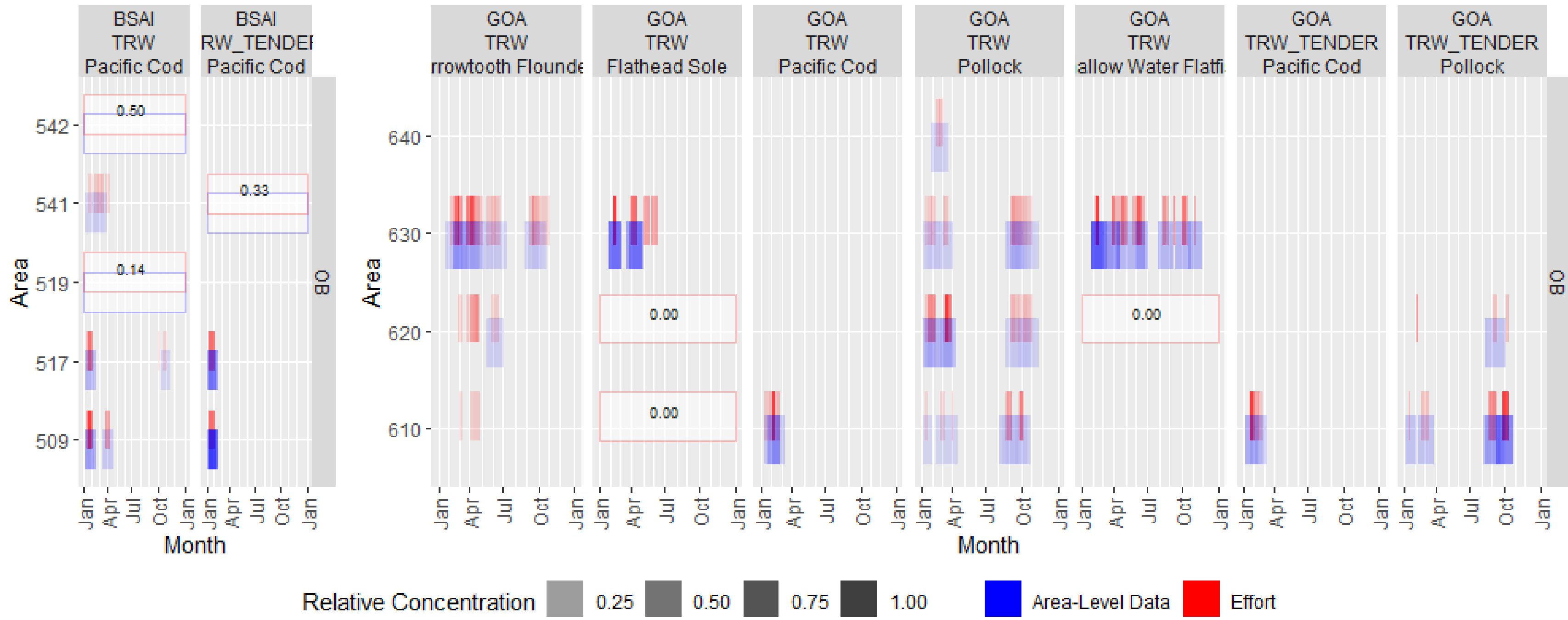
Appendix Figure B- 3. -- Relative concentrations of fishing effort (red) and monitoring coverage (blue) for observer pool (OB, top) and zero-selection pool (ZE, bottom) discard gaps for 2019 hook-and-line gear trips. Areas with fewer than three distinct fishing vessels were obscured and replaced with proportions of trips that were monitored.



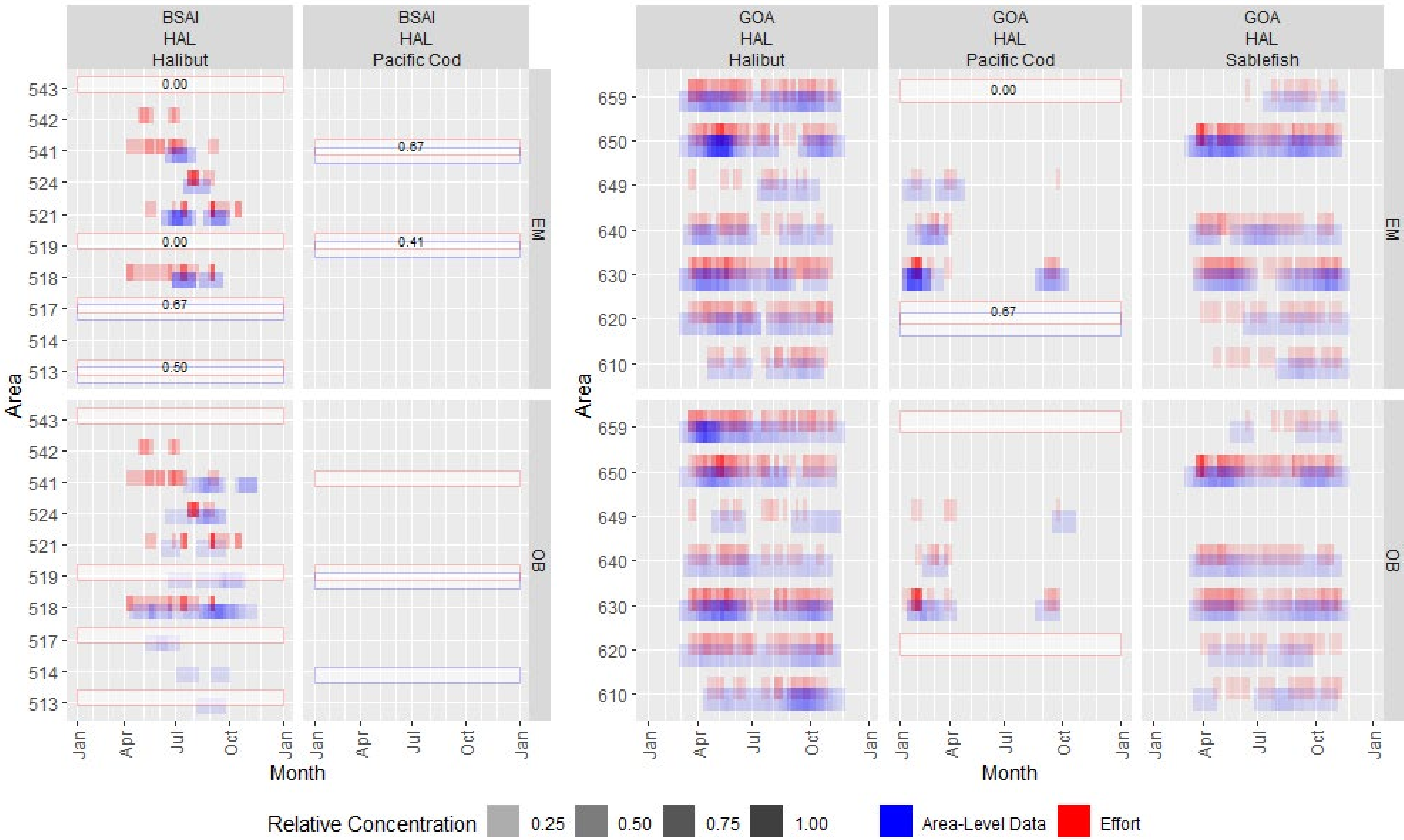
Appendix Figure B- 4. -- Relative concentrations of fishing effort (red) and monitoring coverage (blue) for observer pool (OB, top) and zero-selection pool (ZE, bottom) discard gaps for 2019 pot gear trips. Areas with fewer than three distinct fishing vessels were obscured and replaced with proportions of trips that were monitored.



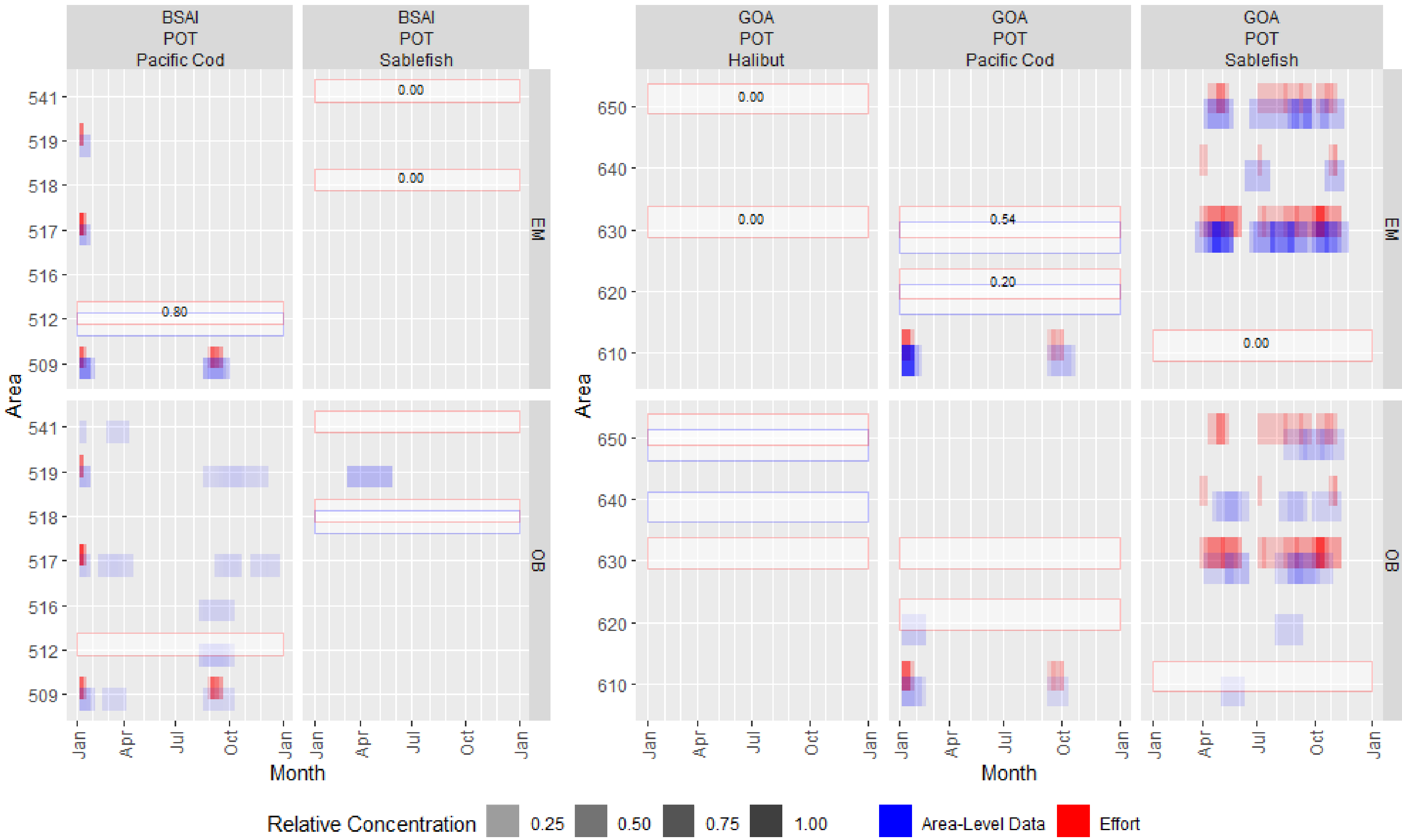
Appendix Figure B- 5. -- Relative concentrations of fishing effort (red) and monitoring coverage (blue) for observer pool discard gaps for 2019 trawl gear trips. Areas with fewer than three distinct fishing vessels were obscured and replaced with proportions of trips that were monitored.



Appendix Figure B- 6. -- Relative concentrations of fishing effort (red) and monitoring coverage (blue) from EM pool trips for discard gaps (EM, top) and from observer pool trips for average weight gaps (OB, bottom) for 2019 hook-and-line gear trips. Areas with fewer than three distinct fishing vessels were obscured and replaced with proportions of trips that were monitored.



Appendix Figure B- 7. -- Relative concentrations of fishing effort (red) and monitoring coverage (blue) from EM pool trips for discard gaps (EM, top) and from observer pool trips for average weight gaps (OB, bottom) for 2019 pot gear trips. Areas with fewer than three distinct fishing vessels were obscured and replaced with proportions of trips that were monitored.



Appendix C – Estimates of variance for groundfish and prohibited species in partial coverage

Summary

This appendix provides a broad overview of estimates of precision for catch caught by catcher vessels operating under partial coverage regulations in 2018. A design-based estimator was used to produce species-specific estimates of precision by FMP and reporting area. In general, estimates of relative precision (commonly referred to as the coefficient of variation, CV) were below 20%. Precision estimates for uncommon species or in areas with relatively low effort were generally less precise than estimates of catch in high effort areas or for species that are commonly caught. For example, Pacific sleeper and salmon sharks had low precision compared to the high precision associated commonly caught species such as trawl caught Pacific halibut, Pacific cod, or spiny dogfish. Species with high retention generally had CVs < 5%, which is expected given retained catch is reported through eLandings and is assumed to be a full accounting (without associated variance).

Introduction

Accounting for total catch is the cornerstone for the management of annual catch limits in the federal fisheries off Alaska. This information is used for assessing stock status and evaluating policies and regulations for fishery management. Total accounting of catch includes estimates of both retained (landed or processed at-sea catch) and catch discarded at-sea using information collected by onboard observers or electronic monitoring equipment. The Alaska Region Catch Accounting System (CAS) is a database that calculates the total catch estimates and makes them available for use. A detailed description of sampling and CAS estimation methods is presented in Cahalan et al. (2014).

This paper provides an overview of methods and results for estimating variance using a design-based estimation method under 2018 data collection methods. This builds on previous work presented to the SSC and the Council (NMFS 2016) and is responsive to the NMFS Analytical Task List. This work is ongoing and will be used to inform catch accounting methodology. The estimates of precision presented in this paper are intended for use as end-of year estimates for species, and specifically this report is focused on catcher vessel activity in the partial coverage fleet; full coverage vessels and partial coverage catcher processors are not included in this analysis.

Methods

Overview

The methods used to estimate variance are provided as a high-level overview in this document. We have attempted to omit equations and associated subscripts, where possible, since this document is intended to be only a summary of methods. A detailed description of equations will be forthcoming with the next update to the CAS estimation Alaska Region Technical

Memorandum.

Estimation methods are explicitly linked to the observer sampling hierarchy. The use of the sampling hierarchy provides for the analytic calculation of variance that includes variance accumulated across all selection hierarchy elements. The nested hierarchal sampling design used by the Observer Program results in random sampling being conducted at multiple stages: within a haul (haul sample), across hauls and within a trip (random selection of hauls), and across trips within a sampling strata (random selection of trips, Appendix Table C - 1). The reader is directed to the 2018 Annual Deployment Plan (ADP) for an overview of the deployment strata (sampling strata) used (NMFS 2017b).

Estimation methods in this document are described such that they start at lowest level of the estimation hierarchy and walk the reader through each hierarchical level to achieve the final estimates. There are several terms commonly used in describing methods that will help the reader understand the methods and results:

- Population: A population is the complete set of catcher vessel trips within the partial coverage category: this includes vessels in zero coverage, EM, and gear-specific strata.
- Sampling strata: Subsets of trips in the population that are grouped according to descriptive characteristics that are known before fishing occurs. Trips are selected from the population for observer coverage using stratified random sampling; within each stratum, trips are randomly selected at the same rate. Trips can only be assigned to one stratum. Strata are either established in regulations (e.g., a vessel in full coverage) or defined in the Annual Deployment Plans (ADP). Each trip can be assigned to only one sampling strata. We note that catch for unobserved trips in the zero coverage stratum was estimated based on data from trips in the observer sampling stratum with the same gear type and not with data from trips in the EM stratum (e.g., catch for unobserved trips in the zero selection stratum using hook and line gear was estimated using data from observed trips in the hook-and-line stratum). This is the same method used by CAS.
- Post-strata: Post-strata consist of trips that are categorized into groups within a sampling stratum based on descriptive characteristics known after the trip is completed. Each trip can be assigned to only one post-strata.
- Domain: Domains define the specific subpopulations for which we need estimates (e.g., Pacific cod from area 620 on hook-and-line gear). Domains differ from post-strata in that a single trip may cross multiple domains, and a domain may cross multiple post-strata and sampling strata. For example, a trip may occur in multiple areas in which case, information from that trip will contribute to multiple domain estimates. Domains are always defined by species (or groups of species) and may be defined by additional factors.

Total discard weight is estimated within and across each level of the nested hierarchy, with estimates defined by a combination of haul-level sampling (defined in the observer sampling manuals), the sampling strata, post-strata, and estimation domain. The stratification nearly always follows a nested design: Post-strata are nested within sampling strata, and sampling strata follow federal regulations defining whether the vessels is in full or partial coverage (i.e., ADPs). Details of sample selection methods and sampling results can be found in various recent studies (e.g., AFSC 2019, Cahalan and Faunce 2020, Ganz et al. 2019, Gasper et al. 2019, Cahalan et al 2014).

Haul and Set Estimates

The randomization methods and sampling protocols implemented by at-sea observers to sample hauls and sets are defined in the Observer Program sampling manual. When an at-sea observer is unable to sample all hauls, hauls are randomly selected, and samples within selected hauls are either selected systematically or randomly. The details of sampling and applicable estimators used depend on the type of gear fished (e.g., trawl, hook-and-line hooks, or pots). All estimators used for expansion assume simple random selection of samples, although, in most cases, systematic sample selection with a single random starting point is used.

Species-Specific Haul Weight: Trawl Vessels

Generally, several samples are taken from each haul to determine the species proportions of the haul. A ratio-of-means estimator is used to estimate the species proportion of the haul for each species in the sample. The estimated weight of a species in a haul is the estimated proportion of a species in a haul applied to the total weight of the haul:

$$\text{Estimated species weight} = \text{Total haul weight} \times \frac{\text{Total species weight in all samples}}{\text{Total weight of all samples}}$$

The estimator for estimated species weight (described above) uses "size-of-sample" as a weighting factor, which results in larger samples contributing more to the estimate than smaller samples. In the simple case where all the samples are the same size, then the estimated species weight (or count) is the product of the number of sample units in the population and the mean discard per unit (measured in weight or count units).

The variance of the estimated weight of a species in a haul consists of variability due to sampling (not all catch is weighed) and variability within the haul of the species diversity and size of selected samples. In addition, the finite population correction factor (fpc = 1- samples/population size) scales the estimated variance with the size of the unsampled population. The application of the fpc decreases the estimated variance as sampling rates increase. When the entire population is 'sampled' (a census), the fpc results in variance (due to sampling) becoming zero. The variance estimator has three terms that are combined before being scaled by the size of the haul (squared) and the fpc. This formulation (shown below; see Goodman, 1960) is used throughout the development of the final total variance estimator as variance arising from sampling at the additional levels of the sampling hierarchy is incorporated:

$$\text{Variance of Estimated species weight} = fpc \times \text{Squared haul weight} \times \left[\text{Squared species weight} \times \text{Variance sample weight} + \text{Squared sample weight} \times \text{Variance species weight} - \text{Variance species weight} \times \text{Variance sample weight} \right]$$

There are situations where a subsample of a predominant species must be collected to balance data collection among a predominant species and other species. These details are not provided in this methods description except to note these subsamples are expanded to the sample, then the samples are combined to generate haul-level estimates.

Species-Specific Haul Weight: Hook-and-line and Pot Vessels

Estimation methods for the hook-and-line and pot fisheries are similar to the trawl estimation methods. The major difference is that the sampling unit on hook-and-line and pot vessels is a unit of gear (skate or magazine of hooks, pots), whereas on trawl vessels the sampling units are volume or weight. Overall, estimates of species-specific weights are the product of the number of units of gear fished, the estimated number of fish per unit of gear, and the mean weight per fish:

$$\text{Estimated species weight} = \text{Number of gear segments retrieved} \times \text{Species-specific number of fish per gear segment} \times \text{Mean weight per fish for species}$$

The variance estimator for species weight include terms for both the variability in the number of fish per sample and the mean weight per sample. The form of this estimator is similar to that for species weight estimation for trawl catches, and is presented below:

$$\text{Variance of Estimated species weight} = \text{Squared number gear segments retrieved} \times fpc \times \left[\text{Squared species-specific number of fish} \times \text{Variance species mean weight per fish} + \text{Squared species mean weight per fish} \times \text{Variance species-specific number of fish} - \text{Variance species discard proportion} \times \text{Variance species-specific catch} \right]$$

The same estimation process used for hook-and-line gear is followed for pot gear, except that the number of pots set is substituted for the number of gear segments.

Observer Estimates of At-Sea Discard

The catch of groundfish that is discarded at-sea is estimated using the same general computations for all gear types (hook-and-line, pot, and trawl). The observer assesses the amount of catch that is discarded at-sea for each species encountered in the haul. This estimate is based on the observer's best professional judgment and may include observations of at-sea discard from the deck, counts of the numbers of fish that are intentionally removed or have dropped-off the hook-and-line gear as it is retrieved.

The estimated weight for a species discard at-sea is computed by applying the estimated at-sea discard rate (proportion of the catch that is discarded) to the total estimated haul weight for a species:

$$\text{Estimated at-sea discard weight} = \text{Proportion of species-specific catch discarded} \times \text{Estimated weight of species-specific catch}$$

Since the estimates of the at-sea discard rates are not based on sampling, there is no variance associated with the percent retained. The variance estimator for at-sea discarded weight is the species-specific catch estimate multiplied by the squared species-specific estimate of percent discarded.

$$\text{Variance of Estimated at-sea discard weight} = \text{Squared species discard proportion} \times \text{Variance species-specific catch}$$

EM on Hook-and-line Vessels

All catch is enumerated for all sets on hook-and-line vessels that are monitored in the EM strata for most species of concern. Since the entire set is enumerated, the within-haul variance of catch is zero. Expansion of monitored hauls to unobserved hauls is still required and this is discussed in the following section.

Expansion of observer data to trips and domains

At the trip level of the sampling hierarchy we define both post-strata and estimation domains (Appendix Table C - 1). Post-stratification is used to group similar trips together based on characteristics that become available after the trip is completed; this technique can decrease variance of the overall estimates. To be effective, post-strata should be defined by characteristics that are known for both observed and unobserved trips and should create groups that vary less within the group compared to between groups. Post-stratification can occur both within a trip (grouping similar hauls) and between trips (grouping similar trips).

Each trip in this study is classified into a post-stratum. These post-strata are defined by operation type (catcher vessel only), FMP area, and the month associated with the start of fishing on a trip (Appendix Table C - 2). A month time period was chosen since it approximates the 5-week period used in CAS for groundfish discard estimation, noting that CAS centers the fishing activity during a 5-week period rather than basing it simply on the month when fishing started.

Estimation domains define the subpopulations for which estimates are needed and are sometimes referred to as small-area estimates or subpopulation estimates. Domains correspond to quotas or other catch quantities that are of interest to fisheries managers; for example, Pacific cod catch from NMFS Reporting Area 620 during March, or the halibut PSC limit in the central GOA trawl fishery. As with stratification, estimates for each domain are generated by estimating across trips within each post-strata and sampling strata (Appendix Table C - 2). The domain estimates for the post-strata are then added together across post-strata within each sampling strata (strata-level domain estimate). Lastly, the strata-level domain estimates are summed to get the final estimate for the domain. For this study, the estimation domains investigated were Federal reporting area and species (Appendix Table C - 2) and are presented for each sampling stratum.

Trip-level Estimates

Once the haul-specific estimates of at-sea discards are calculated (as described in the previous section), estimates for each domain within a trip can be generated. Since domains refer to species-specific catch or bycatch (e.g., Pacific cod), data from one trip (or haul) can contribute to several domain estimates, and empty domains (zeros) must also be accounted for in the precision estimate (Cochran 1977).

A design-based estimator was used to calculate the estimated weight of discards for a species and domain within a trip. This estimate is based on the mean discard weight per haul for each domain, inclusive of zeros for domains that are not present, and the total number of hauls fished on a trip. The mean weight per haul of domain catch (i.e., species and reporting area) is multiplied by the number of hauls on the trip to generate the trip-level estimate.

$$\text{Estimated trip-specific domain catch} = \text{Number of hauls on trip} \times \left[\frac{\text{Sum over sampled hauls of domain catch weight}}{\text{Number sampled hauls}} \right]$$

The variance of the trip-specific domain estimate is the sum-of-squares estimate of variance, noting that haul-species combinations that are not in the domain have a value of zero. No post-stratification occurs within the trip: each trip belongs to one post-stratum (vessel, time period), hence trip-level estimates are specific to a species or species grouping, sampling strata, NMFS Reporting Area (domain), vessel type (post-strata), and time period (post-strata)[22].

The estimated variance for the domain has terms for both between hauls within a trip (first term) and within haul (second term) variance of the species-specific discard weight components. The estimator also includes the trip-level fpc (recall that the within haul fpc is included in the within haul variance).

[22] Mixed pot and hook-and-line trips were treated as gear-based sampling strata. In the future, gear should be treated as a domain to allow this mixing of gear types on a trip. In 2018, few trips had mixed gear types and thus these mixed trips would not substantially change results or inferences.

$$\text{Variance domain estimate for trip} = \text{Squared number of hauls on trip} \times \left[\left(1 - \frac{\text{Number sampled hauls}}{\text{Number hauls}}\right) \times \text{Between haul mean domain variance} + \frac{\text{Number sampled hauls}}{\text{Number hauls}} \times \frac{\text{Within haul domain variance}}{\text{Number sampled hauls}} \right]$$

Sampling Strata-level Estimates

There are four broad groupings of fishing trips that define the sampling strata (NMFS 2017b). These groups are defined as the full coverage pool (full coverage stratum); zero coverage pool (zero coverage stratum); EM-trip selection pool; and observer trip selection pool, which includes strata that are defined by gear. For the purpose of this document we are focused on the partial coverage strata, EM selection pool, and zero coverage stratum.

Zero Coverage Stratum

Vessels under 40 ft length overall are in the zero-coverage pool which means none of the fishing trips taken by these vessels require an observer to be on board. Estimation of at-sea discards for this group of vessels is based on data collected on trips occurring with the same gear type for the partial coverage non-EM strata, with the exception of jig gear (all trips with jig gear are unobserved and therefore at-sea discard is not estimated for this gear type).

Partial Coverage Strata and EM selection pool

The partial coverage pool contains sampling strata defined by the gear type fished and whether the trip is anticipated to offload catch to a tender vessel or shoreside processor, and whether a vessel has opted into EM. The EM pool in 2018 consisted of both pot and hook-and-line vessels; however, use of EM on pot vessels was in development in 2018 and not used in CAS until 2019. For the purpose of this paper, EM only includes vessels using hook-and-line gear since pot-gear EM was still in pre-implementation status.

For partial coverage and EM pool trips, estimates of catch and at-sea discards are generated by expanding data from observed trips to the unobserved trips within a post-stratum. Estimates associated with each post-stratum are combined within a sampling strata. In expanding the trip-level estimates to the unobserved trips within a post-stratum, the mean of the estimates of domain-weights per trip within the post-strata are expanded to the total number of trips that occurred in the post-strata:

$$\text{Estimated domain catch for post-stratum} = \text{Number of trips in post-stratum} \times \left[\frac{\text{Sum over sampled trips in post-strata of domain catch weight}}{\text{Number sampled trips in post-strata}} \right]$$

As with the trip-level estimates, the variance of the post-stratum-level domain estimates has two variance terms that contribute to the overall variance: 1) a between-trip variance term; and 2) a mean within-trip variance term.

$$\text{Variance domain estimate for post-strata} = \left(1 - \frac{\text{Number sampled post-stratum trips}}{\text{Total number post-stratum trips}}\right) \times \text{Between trip domain variance} + \frac{\text{Number sampled trips in post-stratum}}{\text{Total number post-stratum trips}} \times \frac{\text{Within trip domain variance}}{\text{Number sampled post-stratum trips}}$$

Lastly, to generate sampling stratum-level estimates for each domain, the post-stratum specific estimates of at-sea discards for each domain are combined across post-strata to generate the final domain estimates of at-sea discards for each sampling stratum:

$$\text{Estimated domain catch for stratum} = \text{Sum the domain catch weights over all post-strata} = \text{Sum over all post-strata}\left[\text{Number of trips in post-stratum} \times \frac{\text{Sum over sampled trips in post-strata of domain catch weight}}{\text{Number sampled trips in post-strata}}\right]$$

The stratum-level variance estimator is the sum of the variances for each post-strata (first term) and also incorporates the additional variance that is due to assigning trips to a post-strata after the selection process is complete (second term). Since trips are selected randomly and some trips occur within any given post-stratum, the number of trips within the post-stratum is a random number and that additional variance is incorporated.

$$\text{Variance domain estimate for strata} = \left(\frac{\text{Total trips} - \text{Sampled trips}}{\text{Total trips X Sampled trips}}\right) \times \text{Sum over Post-strata}\left[\frac{\text{Trips in post-strata}}{\text{Total trips}} \times \text{Squared trips in post-strata} \times \text{Variance domain estimate for post-strata}\right]$$
$$+ \frac{1}{\text{Squared sampled trips}} \times \left(\frac{\text{Total trips} - \text{Sampled trips}}{\text{Total trips} - 1}\right) \times \text{Sum over Post-strata}\left[\left(\frac{\text{Total trips} - \text{Post-strata trips}}{\text{Total trips}}\right) \times \text{Squared trips in post-strata} \times \text{Variance domain estimate for post-strata}\right]$$

Balancing properties of variance and estimation needs requires careful consideration of both domains and post-stratification, and how these interact with the sampling stratification. Post-stratification occurs after the selection of the sample and, in our situation, is thought to reduce variance within the sampling strata by grouping homogenous fishing events together. However, we note that we have not formally evaluated variance under differing post-strata scenarios. This work is forthcoming and part of this larger variance project.

Estimates of Precision

Estimates of precision were calculated at the Fishery Management Plan (FMP) and reporting area level. The list of species included in the analysis is shown in Appendix Table C - 3 and represents groundfish species that are common concerns for management, and also include several PSC species (crab, herring, and halibut). Salmon species are not included due to the complexity of shoreside versus at-sea salmon sampling and accounting, which is not incorporated into the estimation code.

Precision results use a statistic called the "coefficient of variation" of the estimate (CV, also called the Relative Standard Error (RSE)). The CV is defined here as the ratio of standard deviation of the estimate (the standard error) to the estimate itself and is a relative measure of uncertainty associated with the estimate due to sampling. A smaller CV indicates a more precise estimate and as sample size increases, the CV will decrease. We note the CV is not a measure of the bias of an estimate. While the design-based estimator used here is statistically unbiased, bias could be introduced to the estimation process by non-representative sampling (e.g., as described in Chapter 3 of this Annual Report).

Results

Estimates of precision are provided for both FMP and reporting area level estimates. Species-specific FMP estimates are broken out by FMP and gear-type estimates for 2018, with each subsection representing a gear-type. Federal reporting area estimates are broken out by sampling strata to illustrate general patterns and trends in precision as they relate to sample size, area, and catch. Due to the large number of species and area combination, detail was not provided for each species. Reporting area detail was provided for trawl caught halibut PSC, which is found in section 4. Finally, results for Pacific halibut in the hook-and-line fishery were not included due to long-standing complications related to calculating average weights of discarded halibut on IFQ vessels.

Total Catch and Discard by FMP

BSAI and GOA Trawl Gear

The CV for total catch and discard for the BSAI and GOA trawl vessels are shown in Appendix Figure C- 1 and Appendix Figure C- 2, respectively. Because sample data are combined across an entire FMP, sample sizes are large and thus CV values are generally low for estimates of most species catches, particularly those that are retained; retained catch is reported through eLandings.

The partial coverage trawl fleet in the BSAI is relatively small (28 vessels and 179 trips), with most of the fleet targeting Pacific cod (Appendix Figure C- 1) as evidenced by the high Pacific cod catch amount (Appendix Figure C- 1, top panel) with relatively low discard amounts (Appendix Figure C- 1, bottom panel). The CV for estimates of total catch of Pacific cod is much lower than those for estimated discard weight since a large portion of the estimate is comprised of landed catch which has no associated variance. Of the estimates with higher CVs (POP and octopus), catch amounts were low and the retained portion of the catch was small. Similarly, the estimated discard weight of Pacific halibut PSC had a CV of 0.13 (13%).

The estimates of catch and discard in the partial coverage GOA trawl fleet generally had CVs below 0.1 (10%, Appendix Figure C- 2). Flatfish species, Pacific cod, pollock, big skate, and POP are species commonly retained in this fleet, as evident by the catch weights shown in Appendix Figure C- 2(upper panel) compared with discard weights (Appendix Figure C- 2, lower panel). As in the BSAI, estimates for species that are commonly caught had lower CV values. Pacific halibut and sablefish were the high volume discard species, with estimates of catch for both having CVs < 0.1 (10%). Species that are less common and more variable in distribution such as Pacific sleeper sharks, octopus, and herring had estimated discard weights with higher CVs.

Fixed Gear: BSAI

This study evaluated two fixed-gear strata in the BSAI: hook-and-line and pot[23]. The primary targets in the BSAI are sablefish and Pacific cod for both gear types (Appendix Figure C- 3 and Appendix Figure C- 4), and halibut for hook-and-line gear (not shown).

In the BSAI area, the estimates for species commonly retained in pot and on hook-and-line gears had total catch CVs less than 0.10 (10%). The CVs for hook-and-line gear catch and discard estimates were generally under 0.15 (15%), with incidental amounts of pollock, grenadier, and Atka mackerel exceeding 0.2 (20%), but catch amounts were low (Appendix Figure C- 3). Of note, the CVs for estimates for the BSAI hook-and-line gear stratum are generally a little higher than those for the GOA hook-and-line stratum. Some of this difference may be due to the higher fraction of zero coverage stratum trips in the BSAI than in the GOA (69% vs. 39%, respectively), resulting in a lower fraction of the population being sampled and hence higher CVs. The small domains in the BSAI (e.g., small statistical areas and few trips) may also play a role in the greater number of estimates with higher CVs in the BSAI compared to the GOA. In addition, the inherent differences in the catch composition and variability in catch distributions between FMP regions would drive differences in precision between the FMP areas.

Fixed Gear: GOA

The sampling strata evaluated for fixed gear in the GOA include hook-and-line, pot, and EM-hook-and-line. There were very few trips in the EM-pot stratum, however the stratum was not included in this analysis because it was in pre-implementation in 2018. In general, estimates in the GOA had low CVs for all fixed-gear strata (Appendix Figure C- 5 through Appendix Figure C- 7). Precision for the EM-hook-and-line stratum and non-EM strata were comparable (Appendix Figure C- 5 and Appendix Figure C- 6), with species estimates in the EM strata having CVs that were generally higher than those in the hook-and-line stratum. Species that were infrequently encountered, such as salmon and Pacific sleeper sharks, had estimates with high overall CVs in the EM stratum. Pot gear generally has low levels of bycatch, with infrequently caught species having estimates with higher CVs (Appendix Figure C- 7).

Reporting Area Estimates

This section provides an overview of the precision of domain estimates, which are estimates for each species by sampling strata and Federal reporting area. In general, more than half of the domain estimates had CVs less than 0.20 (20%). This is illustrated in Appendix Figure C- 8. Estimates were grouped according to their CVs; the top panel in Appendix Figure C- 8 shows the proportion of estimates for each CV "bin", noting that the number indicated on the x-axis for

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[23] EM strata in the BSAI was not evaluated were not evaluated due to the small volume of catch and few participating vessels (low number of trips).

each CV bin is the upper bound of the bin (e.g., 0.1 includes estimates with CVs between 0.051 and 0.1, 5%-10%). The lower panel of Appendix Figure C- 8 shows the cumulative proportion of domain estimates grouped by their CV bin. This graph is useful for showing, across all evaluated species and reporting area estimates, the proportion of estimates relative to a specific CV bin. For example, in the trawl stratum (TRW), approximately 75% of the estimates had CVs less than 0.20 (20%). The lower panel is comparable to the histogram in the upper panel in that the cumulative sum of the histogram proportions across bins will approximate the lower panel results, noting there are some differences due to binning in the histogram. These graphs do not account for the amount of catch and thus some high-CV bins contain very small domain-specific estimates of catch. The scatter plots in Appendix Figure C- 9 through Appendix Figure C- 11 provide information on catch amounts and domain sample size.

Appendix Figure C- 9 and Appendix Figure C- 10 show the range of precisions for total catch reporting area estimates by species. An important trend apparent in these graphs is that higher precision depends on the species evaluated; estimates for rare species generally have lower precision even at higher sample sizes while estimates for common species and/or species that are retained generally have higher precision regardless of sample size. For example, in Appendix Figure C- 9 (trawl gear) and Appendix Figure C- 10 (fixed gear), nearly all species with catch in the higher two categories of catch (>100 t) had catch estimates with CVs less than 0.15 (15%) with most being below 0.10 (10%).

Sample Size and Precision Discussion

The amount of uncertainty associated with an estimate of catch or discard will depend on two main factors: how much variability there is in species catch within a stratum (between vessels, hauls, and samples) and the sample size (number of observed trips in the stratum, the number of sampled hauls on a trip, and the size of individual samples within a haul). Hence, estimates for individual species will have different levels of precision for a given number of observed trips and precision will change at different sampling rates.

Within a sampling stratum (e.g., partial coverage trawl), the sample size is the same for all species; it is the number of observed trips within the stratum. As a result, investigations of how precision varies with sample size are limited. However, we can use the number of observed trips within a domain (i.e. trips with catch of a certain species within a certain NMFS reporting area) as a proxy for sample size analysis; the same stratum-wide sample rate is applied to the trips within the domain to get the number of observed trips within the domain. Thus, larger domains are expected to have more samples, which would result in those domains generally having higher precision for non-rare species.

To illustrate the relationship of domain sample size and precision, a model was fit to the CVs for Pacific halibut domain estimates (Appendix Figure C- 11) noting that the estimate of CV can be defined as a function of the underlying variability and sample size: $CV = \sqrt{\frac{base\ variance}{sample\ size}} / estimate$. The model form was $CV = \beta \frac{standard\ deviation}{\sqrt{domain\ sample\ size}}$, where the standard deviation is the measure of underlying variability (square root of the variance), beta is the slope coefficient, and the domain sample size is the number of observed trips with domain catch (e.g., hook-and-line catch in a given NMFS Reporting Area). The shaded blue area represents the 95% confidence interval around the model fit.

The model fit illustrated how precision increases with higher sample sizes for trawl caught Pacific halibut (Appendix Figure C-11). Note that there are two domain estimates with approximately the same number of observed domain trips but different CVs: Reporting Areas 620 and 630. The differences in CVs are likely due to different levels of variation in Pacific halibut catch between those two areas. We plan to further investigate the use of this relationship along with simulations to explore precision and alternative post-stratification schemes.

Appendix Table C - 1. -- Simplified overview of the observer sampling hierarchy used for estimation.

Hierarchy level	Sampling frame	Sampling unit	Sampling type	Data/Observation
1	Set of all trips taken by CVs in the partial selection strata	Fishing trip	Bernoulli sample	Trip level data (e.g., port, date of fishing, landings, etc.).
2	All fishing events on a trip (hauls or sets)	Fishing event (haul or set)	Constrained simple random sample (SRS)	Effort data (e.g., catch, sets, hooks, location fished)
3	Set of sample units on a haul or set	Predefined sample unit (weight volume or gear segment)	SRS or systematic random sample	Species composition
4	All fish of a given sample within sampled haul or set	Individual fish	SRS from hierarchy #3	Species weight, counts, length, sex.

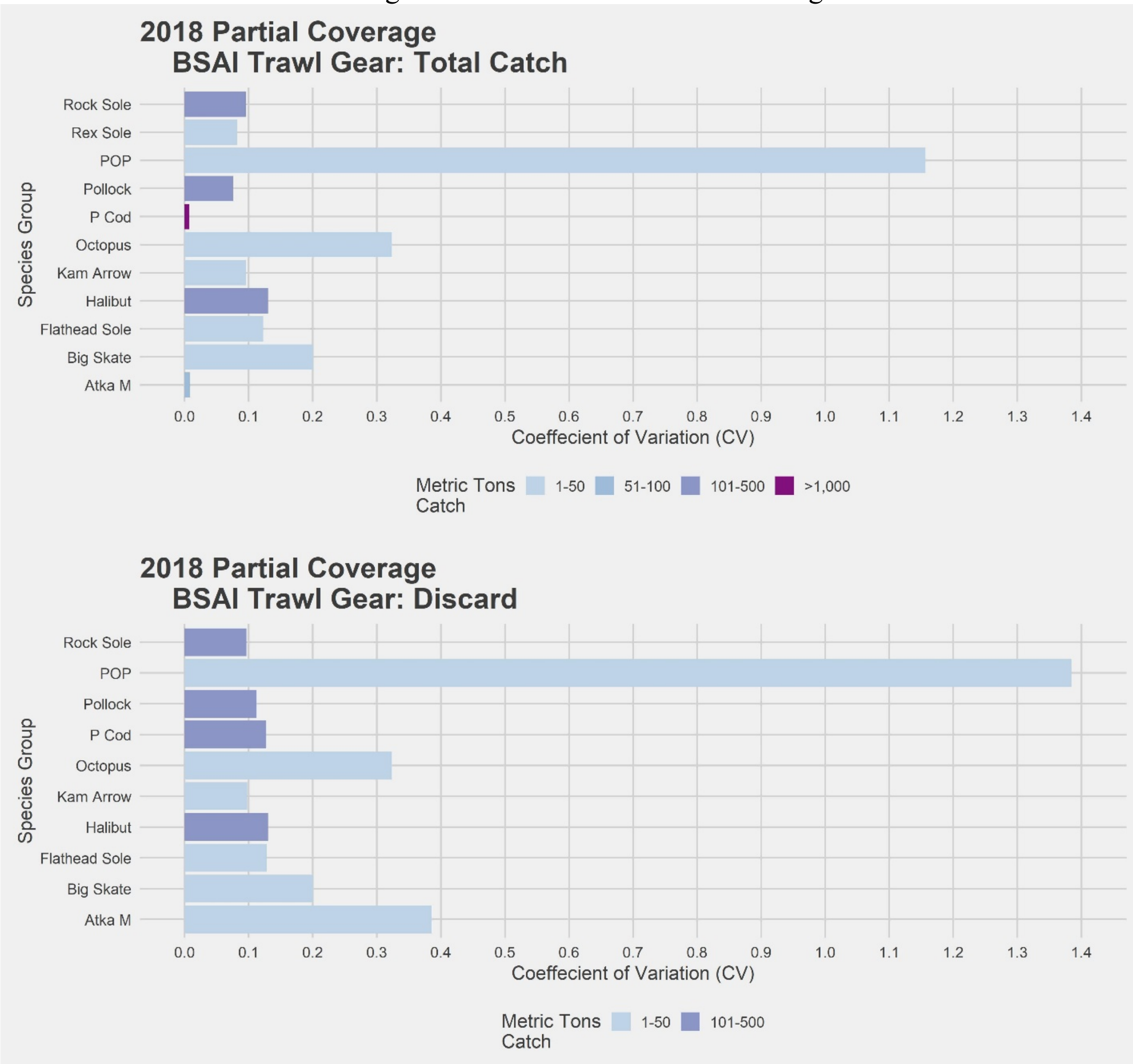
Appendix Table C - 2. -- Summary of the stratification scheme used in estimation. NA indicates not applicable.

Criteria	Sampling strata	Post-strata	Domain
Operation	Partial Coverage	Catcher Vessel	NA
Data Type	EM or non-EM	NA	NA
Gear	Pot, hook-and-line, trawl	NA	NA
Area	NA	FMP Area	Federal Reporting Area
Time	Calendar Year	Month	NA
Species	NA	NA	Species Groupings

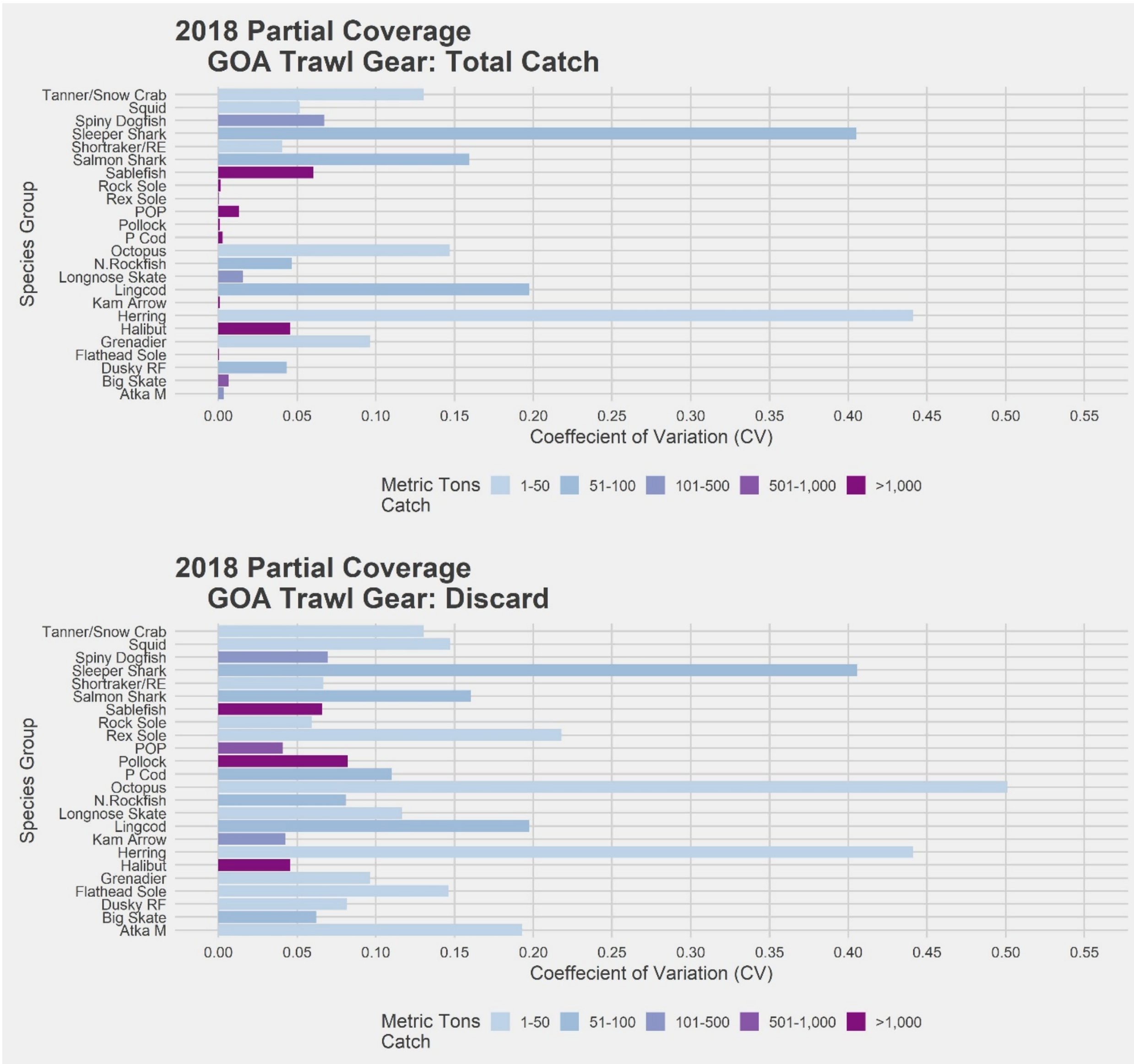
Appendix Table C - 3. -- List of species evaluated in this study.

Species group		
Pacific Cod	Pollock	Atka Mackerel
Flathead Sole	Spiny Dogfish	Dusky Rockfish
Rock Sole	Pacific Sleeper Shark	Dark Rockfish
Rex Sole	Longnose Skate	Grenadier (Giant and other)
Kamchatka/Arrowtooth	Big Skate	Octopus
Halibut	Sablefish	Squid
Yelloweye Rockfish	King Crab	Salmon Shark
Shortraker/Rougheye Rockfish	Pacific Ocean Perch (POP)	Herring
Northern Rockfish	Thornyhead	Quillback Rockfish
Tanner/Snow Crab	Lingcod	

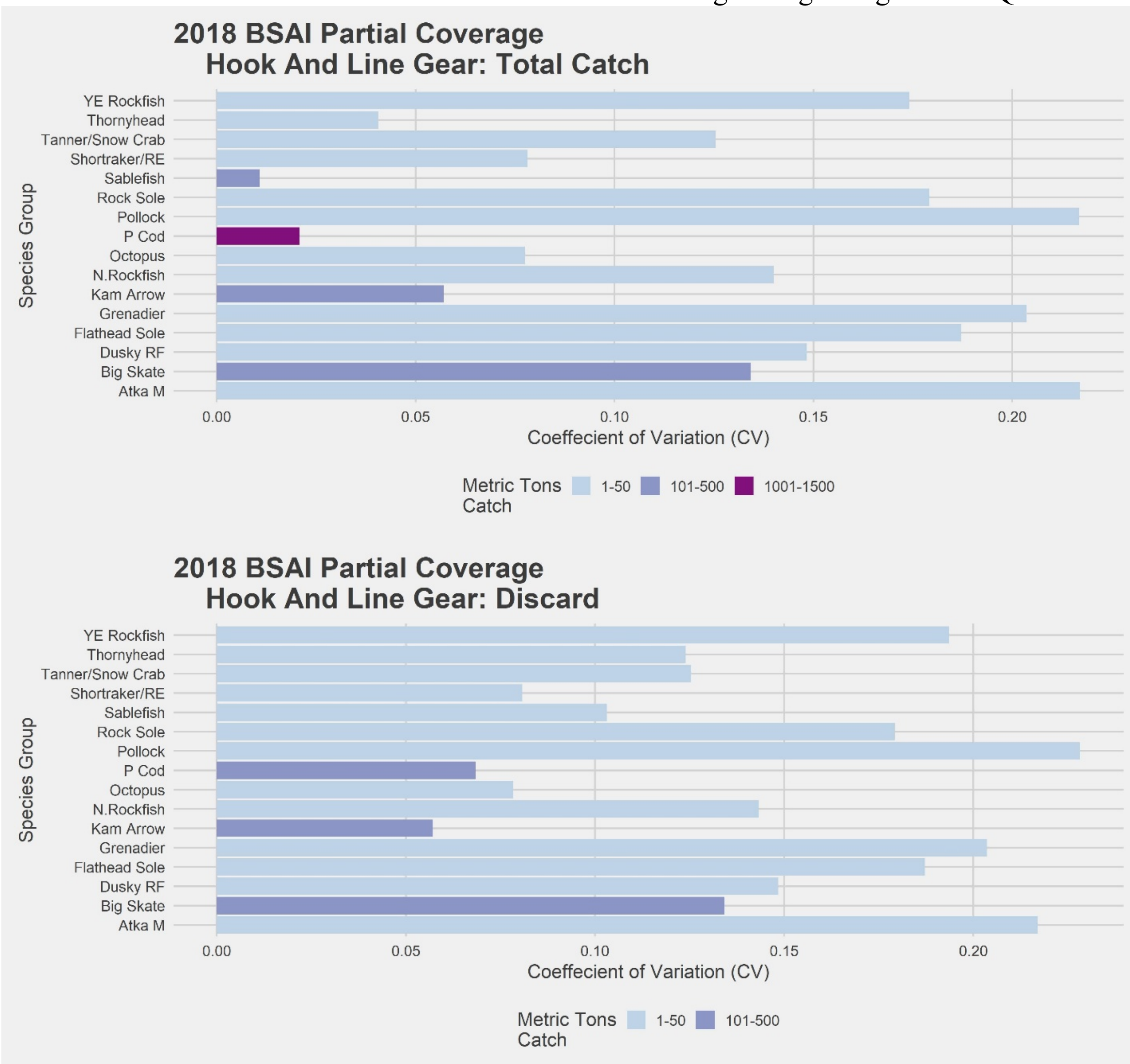
Appendix Figure C- 1. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage trawl vessels in the BSAI. The graph includes species from Appendix Table C - 2 where total catch or discard amounts ≥ 1 ton occurred, resulting in small amounts of sablefish being excluded.



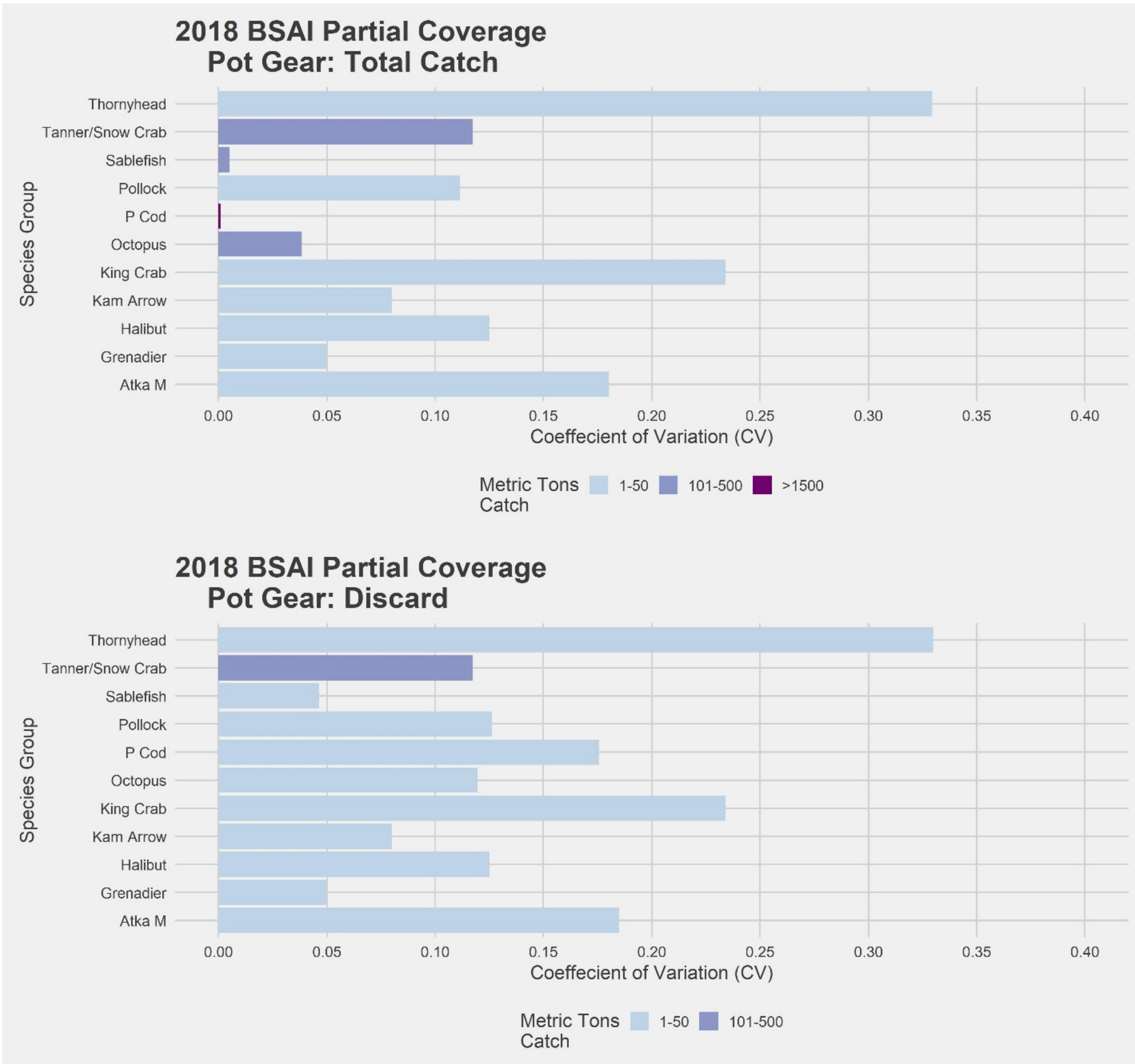
Appendix Figure C- 2. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage trawl vessels in the GOA. Only includes groundfish species where ≥ 1 ton of catch occurred, and includes halibut, herring, and snow/Tanner crab PSC.



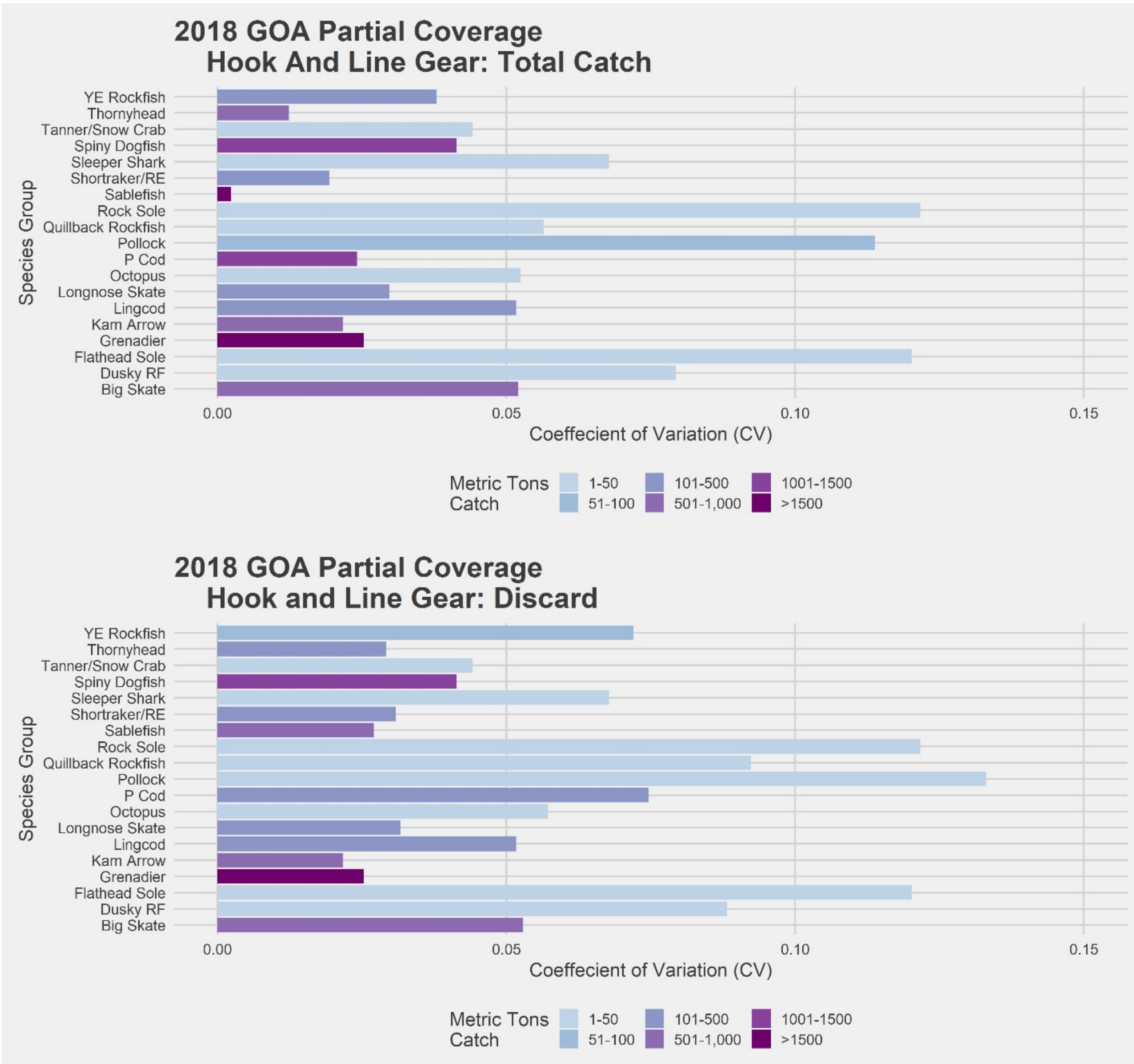
Appendix Figure C- 3. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage HAL vessels in the BSAI. Only includes species in Appendix Table C - 2 where ≥ 1 ton of catch occurred. Note that halibut is not included due to known issues with calculating average weights on IFQ vessels.



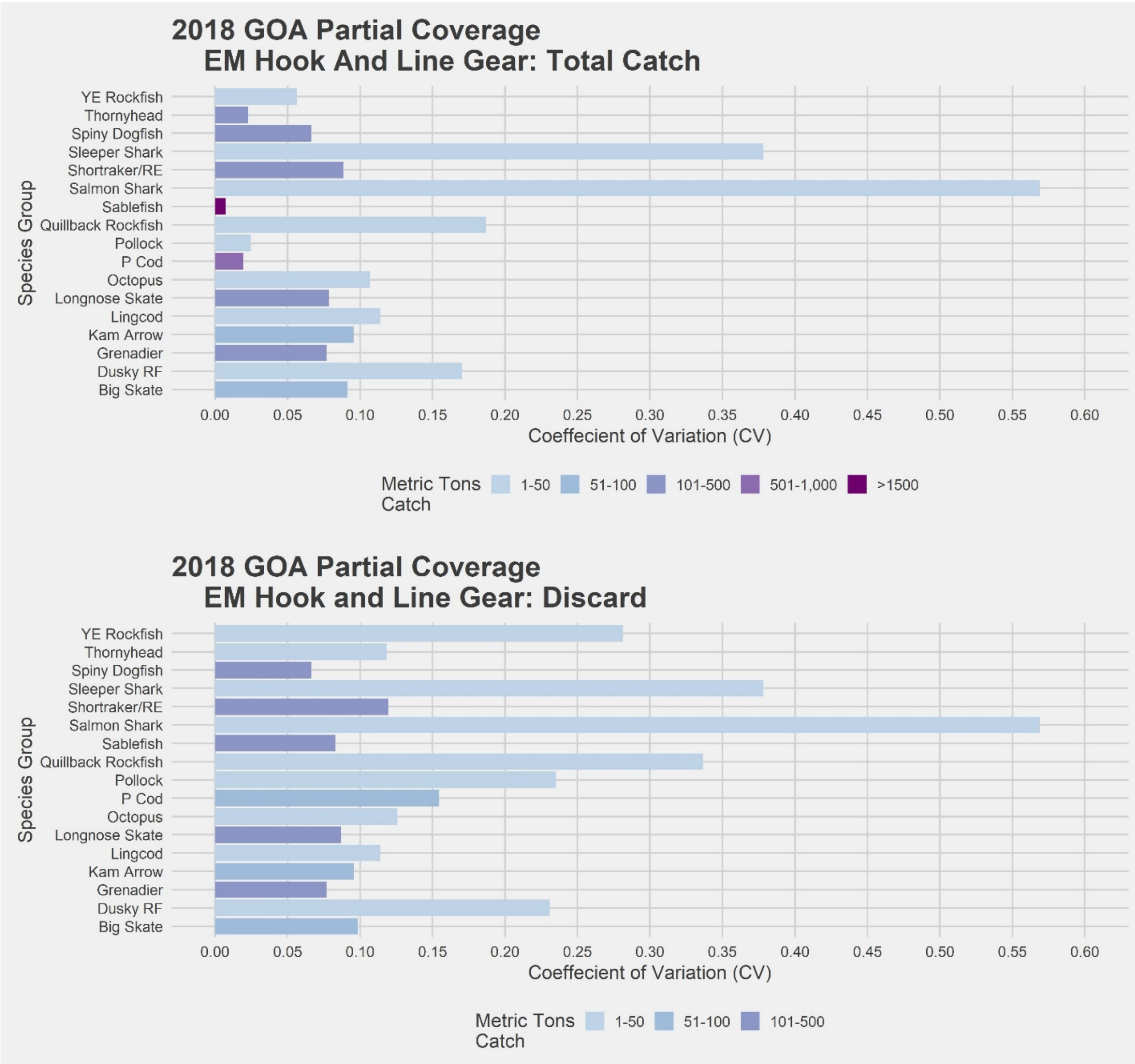
Appendix Figure C- 4. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage POT vessels in the BSAI. Only includes species in Appendix Table C - 2 where ≥ 1 ton of catch occurred.



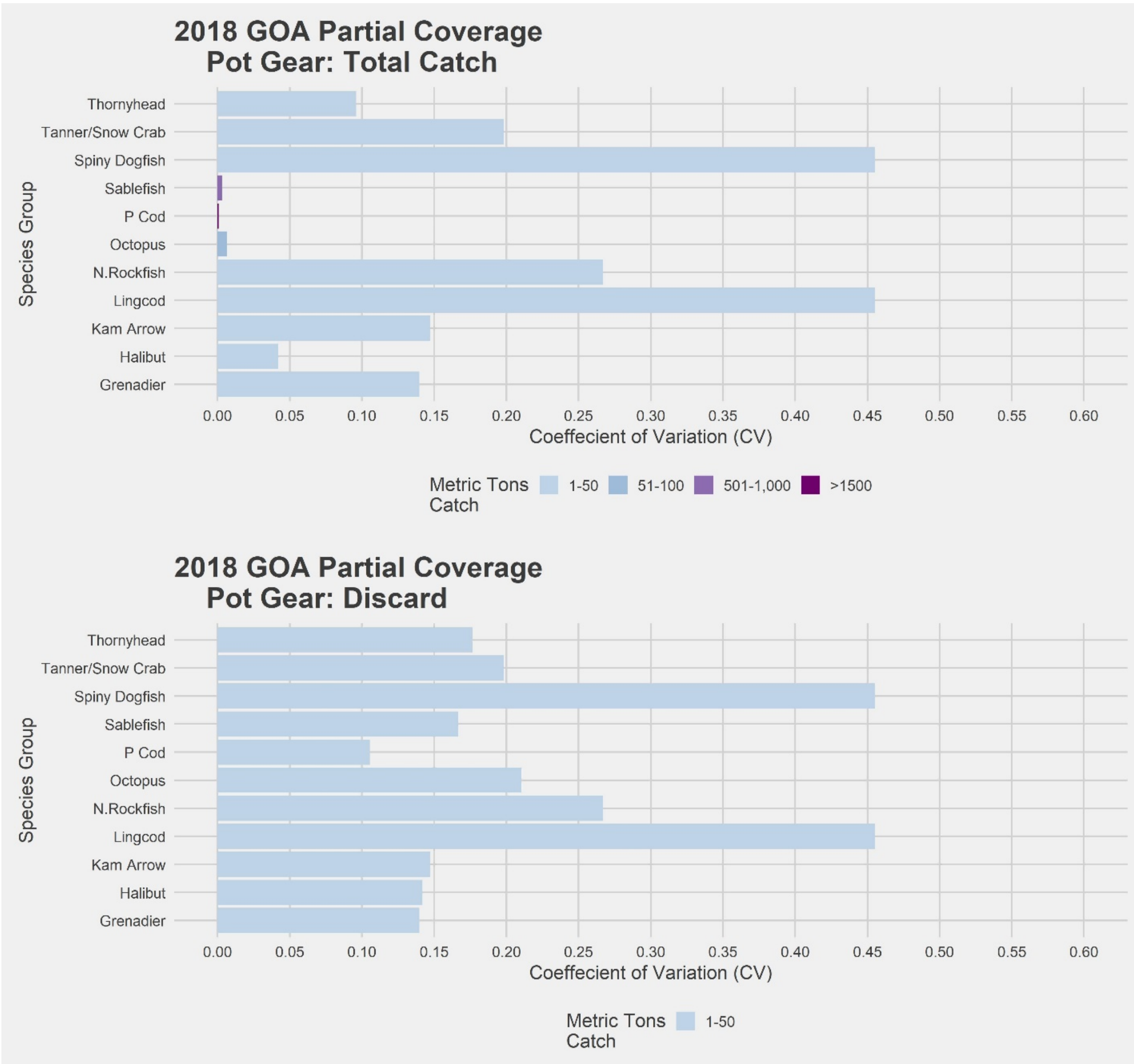
Appendix Figure C- 5. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage HAL vessels in the GOA. Only includes species in Appendix Table C - 2 where ≥ 1 ton of catch occurred and excludes halibut.



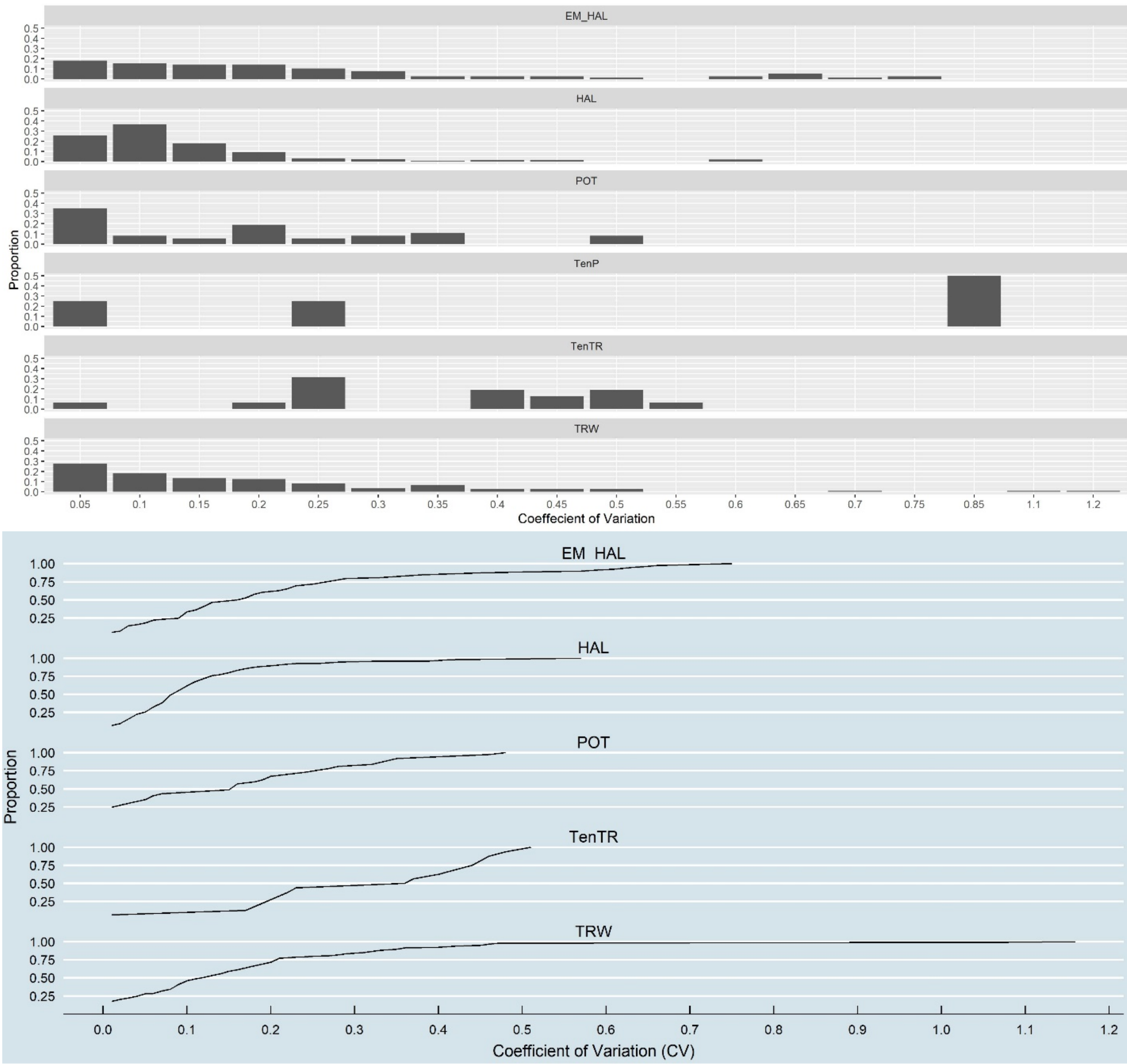
Appendix Figure C- 6. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage HAL EM vessels in the GOA. Only includes species in Appendix Table C - 2 where ≥ 1 ton of catch occurred and excludes halibut.



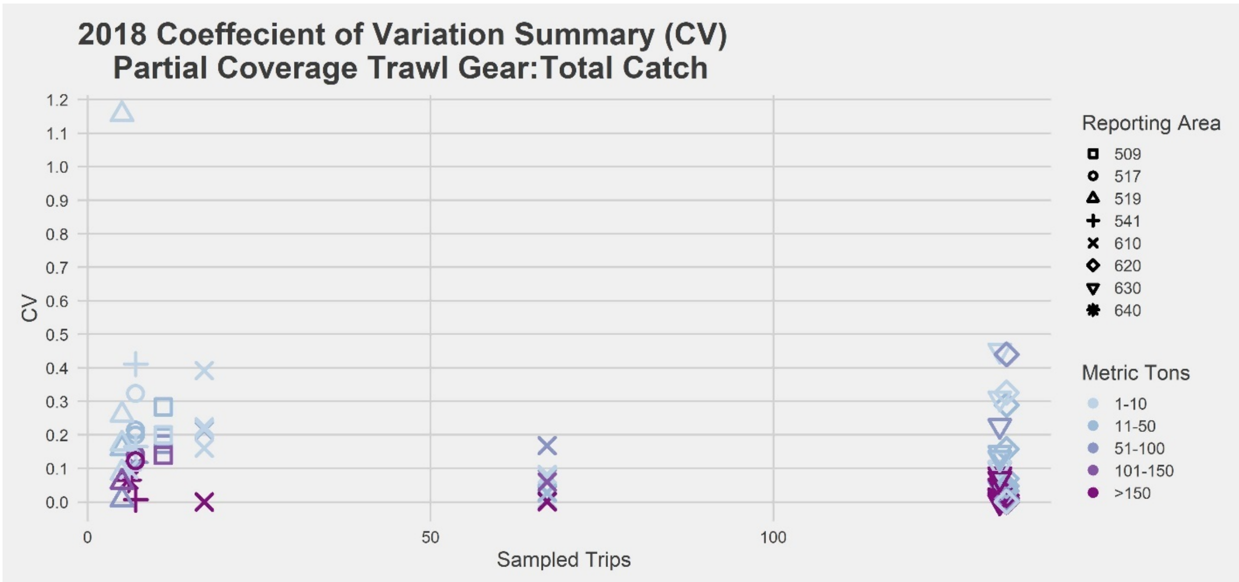
Appendix Figure C- 7. -- Coefficient of Variation (CV) by species group for total catch (retained plus discard, top panel) and discard (bottom panel) for partial coverage pot gear in the GOA. Only includes species in Appendix Table C - 2 where ≥ 1 ton of catch occurred and excludes halibut.



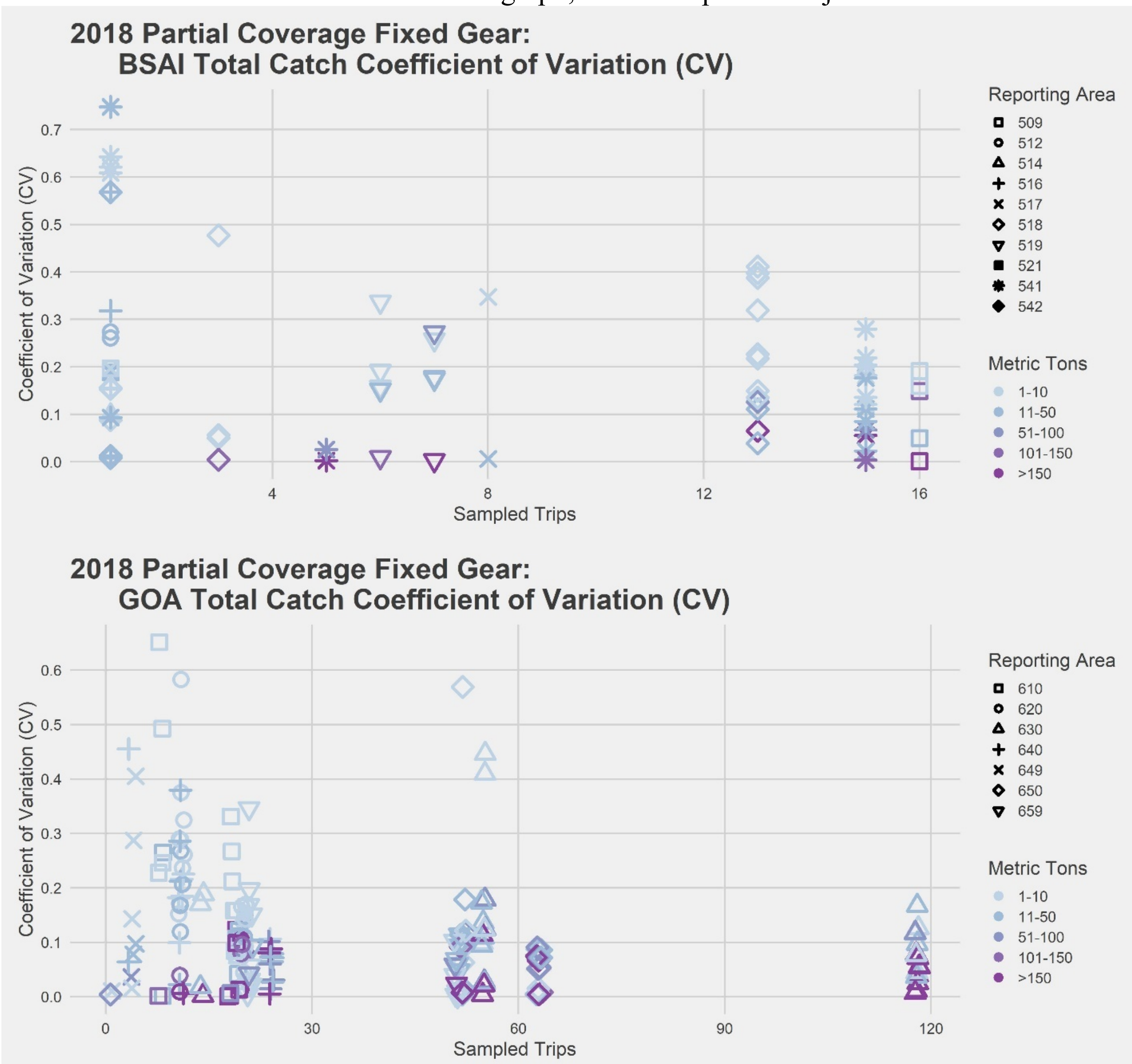
Appendix Figure C- 8. -- Summary of CVs for species and reporting-area specific estimates. The upper panel shows the proportion of estimates in a CV bin for a reporting area and species combinations, noting the x-axis indicates the upper boundary of bins (e.g., 0.05 represents CVs between 0 and 0.05). The lower panel shows the cumulative proportion of CV values for each deployment strata and domain (species, reporting area, sampling strata). The calculated proportion is unique to each sampling stratum. Sampling strata abbreviations are as follows: Electronic Monitoring Hook and-Line (EM HAL); hook-and-line (HAL), Pot (POT), Tender Trawl (TenTR), and trawl (TRW).



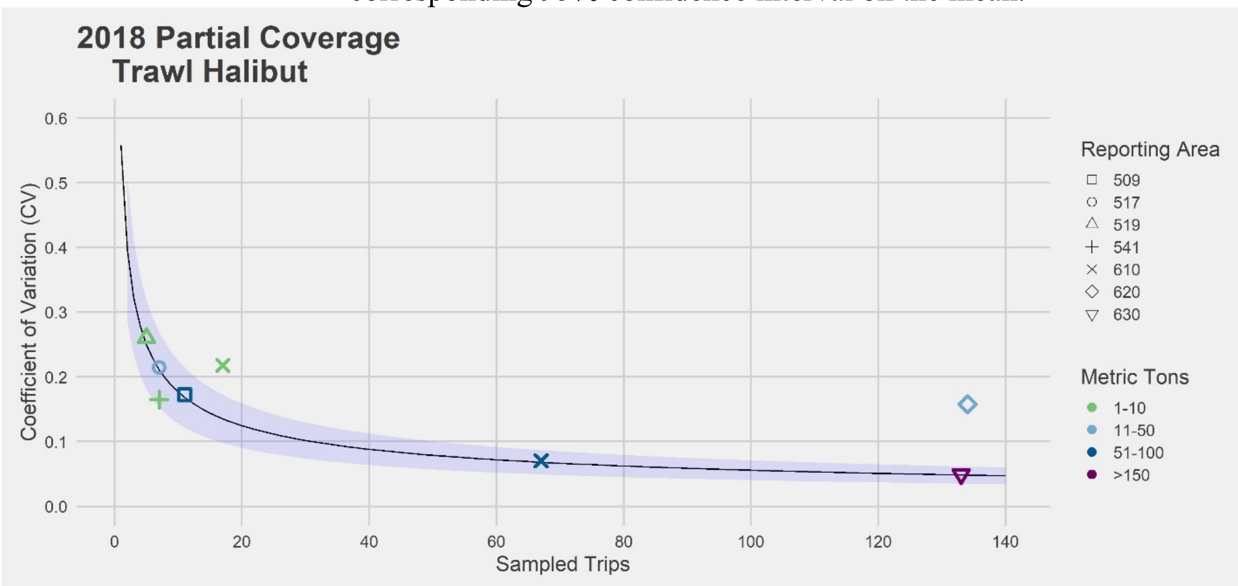
Appendix Figure C- 9. -- Coefficient of Variation (CV) for total catch by species and the number of sampled trips by Federal reporting area and catch volume for trawl gear in the BSAI and GOA. Note this figure includes both TRW and Tender Trawl strata.



Appendix Figure C- 10. -- Coefficient of Variation (CV) for estimated total catch versus the number of sampled trips by domain (Federal reporting area and species) for fixed gear (HAL, Pot, HAL EM) in the BSAI (upper panel) GOA (lower panel). Note estimates with amounts <1 t are not included in the graph, and GOA points are jittered.



Appendix Figure C- 11. -- Coefficient of Variation (CV) for total catch and the number of sampled trips by Federal reporting area for Pacific halibut discard for trawl gear. Note this includes both the trawl and tender trawl strata. The solid black line is the model fit. The blue shading is the corresponding 95% confidence interval on the mean.



Appendix D – Alaska Fixed Gear Electronic Monitoring Report for the 2019 Season

Pacific States Marine Fisheries Commission
205 SE Spokane Street, Suite 100
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Introduction

Electronic monitoring (EM) programs use video monitoring to track fishery activities. EM can be a practical alternative to carrying an on-board observer, particularly when the space or cost of an observer is prohibitive. The North Pacific Fisheries Management Council (NPFMC) established an intent to incorporate electronic monitoring (EM) as a tool of the North Pacific Observer Program for catch estimation in the fixed gear groundfish and halibut fisheries. In 2018, the NPFMC EM program fully incorporated EM in regulation as a monitoring option for fixed gear vessels in the partial coverage category of the North Pacific Observer Program.

Pacific States Marine Fisheries Commission (PSMFC) developed a program beginning in 2012 to test the use of EM for the Trawl Rationalization Program on the West Coast. This program led to a regulation recommendation for the whiting and fixed gear fleets by the Pacific Fishery Management Council; ongoing work is evaluating the possibility of using EM for other groundfish fisheries. PSMFC has participated in the NPFMC working group and has reviewed EM data for Alaska longline vessels since 2014.

The fixed gear vessels in the partial coverage category using EM include small boat longline and pot vessels targeting sablefish (*Anoplopoma fimbria*), Pacific cod (*Gadus macrocephalus*) and Pacific halibut (*Hippoglossus stenolepis*). EM systems were provided and installed by Archipelago Marine Research (AMR) and Saltwater, Inc. (SWI). Data were reviewed by PSMFC. This report details EM data collected during 2019.

Vessel Participation

Vessels in participating fisheries could elect to use EM rather than an observer. If they chose to use EM, they would log each trip in the ODDS system and then trips were randomly selected for EM coverage and review. Vessels made landings in ports including Homer, Kodiak, Sand Point, and Sitka.

Electronic Monitoring Systems

AMR and SWI were contracted to provide and install EM systems, collect data drives from the vessels, collect logbooks, and provide logistical support. The on-board systems included a sensor to capture hydraulic pressure activity; a GPS to capture locations from which the speed of the vessel was calculated; and 2-4 cameras. Additionally, on some vessels, an engine oil pressure sensor triggered the system to power down to sleep mode during periods of inactivity (e.g., at night or in port) in order to reduce power drain.

Sensor data (GPS and hydraulics) were collected at 10-second intervals when the EM system was fully powered on. Video began recording when the hydraulic pressure exceeded a trigger threshold set by the EM technician and specific to each vessel. In order to capture all catch handling, video recording continued for two hours past the last point when pressure was above the trigger threshold.

Video feed and system information were displayed on the user interface (typically installed in the wheelhouse) providing vessel operators with a live update of system performance, and continuous video feeds (even when not recording).

Effort Logs

Effort logs were distributed to all of the participating vessels. Images of effort logs were transmitted to PSMFC.

Electronic Monitoring Video Review

PSMFC reviewers used EM Interpret™ Pro (EMI) software from AMR. The software integrates the hydraulic sensor and GPS data with the synced video output. GPS data, dates and times are automatically recorded, and reviewers added annotations to identify trips, hauls, and catch data. A configuration of this software allows review of both the AMR and SWI EM data.

The start and end locations, dates, and times of all trips and hauls were annotated. Other metadata such as the vessel information, ports, and fishery were either recorded by the hardware or annotated by the reviewer.

Reviewers recorded whether a streamer line, used as a seabird deterrent, was present or absent for each longline gear trip. Reviewers would randomly check at least two setting events to determine if streamer lines were used or not and would record use as ‘partial’ if streamer lines were used on one haul, but not the other.

Reviewers recorded whether sensor and video data were complete for each haul based on the quantitative data from the sensor readings. Reviewers also assessed data quality and image quality for each haul. “Data Quality” was defined as the overall ability of the reviewer to effectively quantify and accurately identify catch data. Data quality could be impacted by a diversity of factors such as the image quality, catch handling, and camera angles or operation. Reviewers also gave specific ratings of the image quality and reasons for decreases in image quality (e.g., water spots on the camera, night lighting, etc.)

Species and counts of catch were recorded for a subset of hauls. In 2019, one of every three hauls were reviewed except for string pot gear which was reviewed at 100%.[24] Catch was defined as anything seen by an EM reviewer, excluding free-moving marine birds and mammals alongside the vessel. Video reviewers were trained by a PSMFC staffer working with the North Pacific Observer Program on Alaska species reporting conventions. The reviewers were instructed to record species to the lowest identifiable taxonomic level or grouping as required by the Alaska Region.

Catch that was kept on the vessel (excluding use as bait or food) was considered retained; otherwise, catch was recorded as discarded.[25] Discards included marine organisms that fell off or out of fishing gear before it came onboard the vessel, or that were free-floating on the surface. For cases where the video stopped recording before catch handling was completed, fish that were onboard at the time of the video ending were reported as retained.

Discards were categorized as intentional or unintentional depending on the method of discard. Any fish that dropped off the gear (i.e., without visible shaking or other interaction by a crew member, or without hitting the roller) was defined as unintentional. All other discards were categorized as intentional. If a halibut was discarded, reviewers assessed the release method and condition when longline gear was used, and the condition only when pot gear was used.

Video reviewers recorded the number of minutes it took to review each haul. On-deck sort time was calculated from the start and end times of catch handling in the video. Review rate was calculated as review minutes divided by sort minutes.

Results

There were 116 unique vessels that participated in the 2019 EM project, completing 304 longline trips and 53 pot trips. By target species, there were 119 halibut trips, 76 Pacific cod trips, and 162 sablefish trips (Appendix Table D- 1). The data spanned 597 halibut sea days, 316 Pacific cod sea days, and 904 sablefish sea days for a total of 1,817 sea days with trips averaging 5.8 days across all fisheries.

Of the 13,175 hauls on reviewed trips, the catch level data was recorded for 4,006 hauls. All catch data presented is from this subset of hauls.

Effort Log

A complete logbook (either the EM effort log, or an alternative such as the IPHC logbook) was

[24] A few exceptions were made to these rules. If there were two or fewer hauls, all were reviewed. For a few string pot trips with poor camera angles, only 1 of 3 hauls were reviewed rather than 100%.

[25] If camera views were not sufficient to see the whole deck, fish were recorded as retained or discarded based on whether they were retained or discarded at the rail. It is possible that some fish were brought onboard and later discarded out of view of the rail cameras; these fish would be recorded as retained in the EM data since the discard was not visible to the EM reviewer. In instances where fish were initially retained and later discarded in view of the rail cameras, the fish were recorded as discarded.

submitted with the video data for 222 of the 357 trips (62%; Appendix Table D- 2). The remaining 135 trips had no logbook submitted.

Data quality

Aspects of data quality including video and sensor completeness, overall data quality, and image quality were noted by reviewers for every reviewed haul (Appendix Table D- 3).

Fourteen percent of fixed gear trips and 6% of hauls had video gaps during fishing activity; most often these gaps resulted from video ending before catch handling ended, video starting after catch handling had begun, one or more cameras not working, or from intermittent gaps in video coverage. All of these issues suggest technical problems relating to the set-up of the EM system. In general, video data was somewhat more likely to be incomplete on the first trip that a boat took with an EM system (Appendix Figure D- 1). PSMFC has been working with AMR on changes to the EMI software that will allow quantification of the lengths of these time gaps. Currently this data are sufficient for investigating gaps in an individual trip, but some complications remain in summarizing the data at a fleet level.

Data quality was rated as high or medium for 96% of the 4,006 reviewed hauls. The most common reason for low data quality was dirty cameras, followed by water spots and poor camera angles.

Appendix Table D- 1. -- Summary of EM monitored fishing activity for 2019.

		Halibut target		Pacific cod target			Sablefish target			All fisheries
		Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Single Pot	Snap Longline	Fixed Hook Longline	Snap Longline	String Pot	
Reviewed EM	Vessels	43	35	2	12	13	38	18	8	**119***
	Trips	57	62	8	30	38	101	38	23	**357**
	Hauls	512	504	69	10145	553	803	373	216	**13,175**
	Reviewed Hauls	172	176	25	2865	184	276	128	180	**4,006**
	Sea Days	310	287	30	113	173	566	220	118	**1,817**
	Average Trip Length (Days)	5.4	4.6	3.8	3.8	4.6	5.6	5.8	5.1	**5.8**

*Note that there were 116 unique vessels, since some vessels fished in multiple fisheries.

Appendix Table D- 2. -- Logbook submissions.

	Halibut target		Pacific cod target			Sablefish target				
Effort Log Completed	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Single Pot	Snap Longline	Fixed Hook Longline	Snap Longline	String Pot	**Total**	**%**
Yes	28	46	8	14	38	54	31	2	**222**	**62%**
No	29	16	-	16	-	47	7	20	**135**	**38%**
Total	**57**	**62**	**8**	**30**	**38**	**101**	**38**	**23**	**357**	**100%**

Appendix Table D- 3. -- Data quality including video and sensor completeness, data quality, and image quality

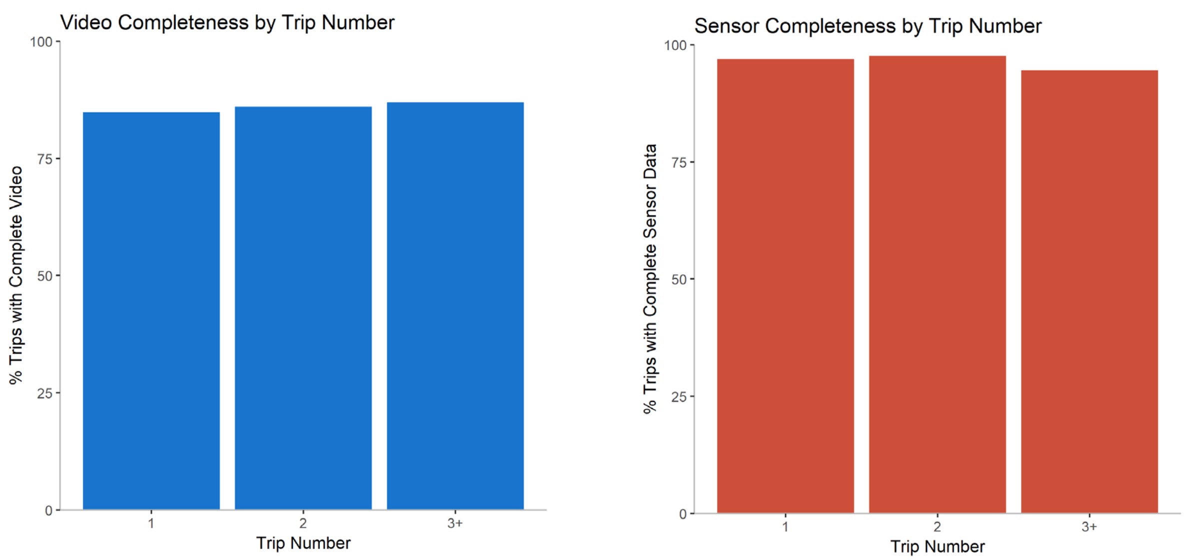
Trip Level Data Quality									
	Halibut target		**Pacific cod target**			**Sablefish target**			
Video Complete	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Single Pot	Snap Longline	Fixed Hook Longline	Snap Longline	String Pot	**Total**
Number of trips	50	56	7	23	32	90	30	18	**306**
Percent of trips	*88%*	*90%*	*88%*	*77%*	*84%*	*89%*	*79%*	*47%*	***86%***
Sensor Data Complete									
Number of trips	54	61	8	27	34	97	34	21	**336**
Percent of trips	*95%*	*98%*	*100%*	*90%*	*89%*	*96%*	*89%*	*55%*	***94%***

Appendix Table D- 4. -- Data quality.

Haul Level Data Quality	Halibut target		Pacific cod target			Sablefish target			
Haul Video Completeness (Number of Hauls)	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Single Pot	Snap Longline	Fixed Hook Longline	Snap Longline	String Pot	**Total**
Video complete - Entire haul recorded	162	166	24	2,850	172	261	118	152	**3,905**
Intermittent gaps in video	6	-	1	9	1	3	2	3	**25**
Video starts after haul start	1	2	-	2	5	4	3	-	**17**
Video ends before catch handling ends	1	1	-	-	-	1	-	11	**14**
Video ends before fish stowed (handling complete)	2	7	-	-	5	2	3	1	**20**
1+ cameras not working	-	-	-	4	1	5	2	13	**25**
Catch Video Completeness (Number of Hauls)									
Complete - All catch recorded	167	174	24	2854	180	267	124	161	**3951**
Incomplete	5	2	1	11	4	9	4	19	**55**
Data Quality from Video (Number of Hauls)									
High	145	164	22	1738	146	242	111	146	**2714**
Medium	13	9	1	1024	34	10	13	8	**1112**
Low	12	1	2	97	2	17	2	19	**152**
Unusable	2	2	-	6	2	7	2	7	**28**
No Video	-	-	-	-	-	-	-	-	**-**
Image Quality (Number of Hauls)									
High	128	147	19	1585	110	215	84	116	**2404**
Medium	26	29	4	1107	73	37	40	54	**1370**
Low	16	-	2	167	1	17	4	7	**214**
Unusable	2	-	-	6	-	7	-	3	**18**
No Video	-	-	-	-	-	-	-	-	**-**
Primary Reason for Medium Image Quality (Number of Hauls)									
Banding/Scrambling/Color	-	3	-	-	-	-	4	-	**7**
Condensation	-	-	-	-	1	-	-	1	**2**
Dirty Cameras	2	-	-	85	5	5	-	4	**101**
Glare	5	3	-	77	6	1	2	-	**94**
Night Lighting	7	7	1	3	10	13	7	1	**49**
Out of Focus	-	-	-	-	-	-	-	2	**2**

Poor Camera Angles	4	-	-	648	7	2	2	6	**669**
Video completeness	1	2	-	2	-	-	1	25	**31**
Water Spots	7	14	3	292	44	16	24	15	**415**
Primary Reason for Low Image Quality (Number of Hauls)									
Dirty Cameras	-		-	114	-	1	-	-	**115**
Glare	2		-	1	-	8	-	-	**11**
Night Lighting	2		1	-	-	-	-	-	**3**
Obstruction	-		-	-	-	-	-	6	**6**
Poor Camera Angles	8		-	21	-	1	1	-	**31**
Video Completeness	2		1	-	1	6	2	-	**12**
Water Spots	2		-	31	-	1	1	1	**36**

Appendix Figure D- 1. -- Video and sensor completeness in relation to the number of trips the electronic monitoring system had been on a specific vessel.



Review Rate

Review rate for halibut and sablefish target fisheries ranged from 0.43 to 1.13 minutes of review per minute of video (Appendix Table D- 4). The review rate in the Pacific cod snap longline fishery was slower and close to real time (e.g., one hour of catch handling could be reviewed in just over an hour).

Pacific cod hauls tended to have a larger variety of species caught, as well as being the only fishery where stern hauling was conducted. Stern haulers were more difficult to review due to a side view of the line (as opposed to a top down view), as well as poor lighting on the line at night.

Seabird Deterrents

Streamer lines are used as deterrents to seabirds on longline vessels. In 2019, 68% of trips were confirmed to have used a streamer line. No streamer line was used for 17% of trips and streamers were partially deployed for 4% of trips, while in 10% of trips the presence or absence of a streamer line could not be determined.

Pacific halibut

Reviewers recorded the method of release (longline only) and the condition of each individual halibut at the time of release. These release methods and condition ratings were identical to those used by the observer program with the addition of three new release methods after consulting with the observer program: “Hand release”, “Other careful release” and “Other non-careful release”. The majority (85%) of Pacific halibut were released carefully using the “Hook twisting and shaking” method (Appendix Table D- 6 and Appendix Table D- 9). The next largest release method (4%) was the “Hand Release” method.

Most halibut were judged to have minor damage at the time of release, of those that could be assessed (82% of those assessed; Appendix Table D- 7). Without corresponding release condition data from onboard the vessel, it is not possible to test how well a video reviewer can assess halibut release condition from EM data. A halibut was given a release condition of “unknown” if the video reviewer could not observe both sides of the fish and the injuries could not be observed clearly at point of release. A release condition was not possible to capture for 79% of the discarded halibut across all fisheries.

Appendix Table D- 5. -- Review rate by target fishery. Review of both retained and discarded catch included.

	Halibut target		Pacific cod target			Sablefish target		
	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Single Pot	Snap Longline	Fixed Hook Longline	Snap Longline	String Pot
Haul Count	172	176	25	2865	184	276	128	180
Average Sort Min/Haul	163	145	106	4	102	192	171	121
Average Review Min/Haul	84	59	113	4	95	95	73	54
Average Review Min/Sort Min	0.58	0.43	1.13	1.02	0.95	0.50	0.44	0.45

Appendix Table D- 6. -- Presence of streamer lines on EM monitored trips.

	Halibut target		**Pacific cod target**		**Sablefish target**		
Streamer Line Status	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Snap Longline	**Total**
Streamer Line Present	38	37	5	28	73	26	**207**
No Streamer Line	11	18	2	6	9	7	**53**
Partial	1	3	-	1	6	1	**12**
Unknown	6	4	1	3	11	4	**29**
NA	1	-	-	-	2	-	**3**
Percent Trips with Streamer Line	***67%***	***60%***	***63%***	***74%***	***72%***	***68%***	***68%***

Appendix Table D- 7. -- Pacific halibut counts for each release method by target fishery.

	Pacific Halibut Target				Pacific Cod Target				Sablefish Target				All Fisheries	
	Fixed hook longline		**Snap longline**		**Fixed hook longline**		**Snap longline**		**Fixed hook longline**		**Fixed hook longline**			
Release Method	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Total**	**% of total**
Crucifying	715	6%	-	> 1%	10	6%	-	> 1%	153	2%	-	> 1%	**878**	**3%**
Cut the gangion	29	> 1%	-	> 1%	-	> 1%	4	> 1%	12	> 1%	1	> 1%	**46**	**> 1%**
Gaff	116	1%	7	> 1%	-	> 1%	9	> 1%	43	1%	1	> 1%	**176**	**1%**
Hand release	50	> 1%	483	9%	-	> 1%	16	> 1%	29	> 1%	31	2%	**609**	**2%**
Hit the roller	335	3%	43	1%	7	4%	65	1%	182	3%	22	1%	**654**	**2%**
Hook straightening	226	2%	-	> 1%	-	> 1%	-	> 1%	2	> 1%	-	> 1%	**228**	**1%**
Hook twisting and shaking	9211	81%	4534	86%	132	79%	4556	92%	5509	88%	1340	80%	**25282**	**85%**
No Selection	101	1%	52	1%	1	1%	38	1%	30	> 1%	4	> 1%	**226**	**1%**
Other careful release	25	> 1%	21	> 1%	-	> 1%	6	> 1%	15	> 1%	1	> 1%	**68**	**> 1%**
Other non-careful release	70	1%	22	> 1%	-	> 1%	30	1%	56	1%	2	> 1%	**180**	**1%**
Unknown	558	5%	86	2%	17	10%	244	5%	203	3%	268	16%	**1376**	**5%**
Grand Total	**11,436**		**5,248**		**167**		**4,968**		**6,234**		**1,670**		**29,723**	

Appendix Table D- 8. -- Pacific halibut counts for each release condition by target fishery.

	Pacific Halibut Target				Pacific Cod Target						Sablefish Target						All Fisheries	
	Fixed hook longline		**Snap longline**		**Fixed hook longline**		**Single pot**		**Snap longline**		**Fixed hook longline**		**Fixed hook longline**		**String pot**			
Release Condition	**Count**	**%**	**Count**	**%**	**Count**	**%**			**Count**	**%**	**Count**	**%**			**Count**	**%**	**Total**	**% of total**
Dead/Sand Fleas/Bleeding	296	3%	216	4%	-	>1%	5	6%	94	2%	113	2%	30	2%	15	7%	769	3%
Minor	1,635		1.368	26%	33	20%	24	28%	809	16%	915	15%	275	16%	10	5%	5,069	17%
Moderate	43	> 1%	37	1%	1	1%	1	1%	23	>1%	25	>1%	1	>1%	-	>1%	131	> 1%
Severe	9	> 1%	1	>1%	-	>1%	-	>1%	4	>1%	3	>1%	-	>1%	-	>1%	17	> 1%
Unknown	9,351	82%	3,575	68%	133	80%	56	65%	3,999	80%	5,145	83%	1,360	81%	193	88%	23,812	79%
No Selection	102	1%	51	1%	-	>1%	-	>1%	39	1%	33	1%	4	>1%	1	>1%	230	1%
Grand Total	**11,436**		**5,248**		**167**		**86**		**4,968**		**6,234**		**1,670**		**219**		**30,028**	

Appendix Table D- 9. -- Pacific halibut counts for each type of discard, release method, and release condition for the three target fisheries.

			Halibut Target		Pacific Cod Target		Sablefish Target	
Discard type	**Release method**	**Release condition**	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Snap Longline	Fixed Hook Longline	Snap Longline
Discarded-Damaged	Crucifying	Dead/Sand Fleas/Bleeding	0	0	0	0	1	0
		Severe	1	0	0	0	0	0
	Gaff	Dead/Sand Fleas/Bleeding	1	0	0	0	0	0
		Severe	1	0	0	0	0	0
	Hit the roller	Unknown	2	0	0	1	0	0
	Hook twisting and shaking	Dead/Sand Fleas/Bleeding	1	2	0	1	0	0
		Minor	0	1	0	0	0	0
		Moderate	0	1	0	1	0	0
	Other non-careful release	Moderate	1	0	0	2	0	0
		Unknown	1	1	0	1	0	0
Discarded-General	Crucifying	Dead/Sand Fleas/Bleeding	32	0	0	0	4	0
		Minor	0	0	3	0	0	0
		Moderate	14	0	0	0	1	0
		Severe	3	0	0	0	2	0
		Unknown	639	0	7	0	134	0
	Cut the gangion	Minor	4	0	0	0	0	0
		Unknown	25	0	0	4	12	1
	Gaff	Dead/Sand Fleas/Bleeding	5	0	0	0	1	0
		Moderate	6	3	0	1	15	0
		Severe	2	0	0	0	0	0
		Unknown	79	3	0	8	26	1
	Hand release	Dead/Sand Fleas/Bleeding	1	6	0	0	0	0
		Minor	5	159	0	7	6	4
		Moderate	0	1	0	0	0	0
		Unknown	41	301	0	7	23	25
	Hit the roller	Dead/Sand Fleas/Bleeding	6	0	0	0	1	0
		Minor	4	2	0	0	2	0
		Moderate	4	0	0	2	1	0
		Severe	1	0	0	1	0	0
		Unknown	247	41	7	59	164	22
	Hook straightening	Minor	3	0	0	0	0	0
		Unknown	223	0	0	0	2	0
	Hook twisting and shaking	Dead/Sand Fleas/Bleeding	43	62	0	54	59	10
		Minor	1613	1201	30	797	906	271
		Moderate	13	31	0	16	8	1
		Severe	0	1	0	2	0	0
		Unknown	7457	3097	101	3654	4499	1030
		NA	1	0	0	0	3	0
	No Selection	Dead/Sand Fleas/Bleeding	0	0	0	0	0	0
		Minor	0	0	0	0	0	0
		Moderate	0	0	0	0	0	0
		Unknown	0	1	0	0	0	0

	Other careful release	Minor	1	2	0	1	1	0
		Unknown	5	5	0	2	1	0
	Other non-careful release	Dead/Sand Fleas/Bleeding	2	0	0	3	0	0
		Minor	0	1	0	3	0	0
		Moderate	4	0	0	0	0	0
		Unknown	61	16	0	20	55	2
	Unknown	Dead/Sand Fleas/Bleeding	2	0	0	6	6	0
		Minor	5	2	0	1	0	0
		Moderate	1	1	0	0	0	0
		Severe	1	0	0	1	0	0
		Unknown	542	82	17	235	196	268
		NA	0	0	0	1	0	0
Discarded-Predated	Crucifying	Dead/Sand Fleas/Bleeding	26	0	0	0	11	0
	Gaff	Dead/Sand Fleas/Bleeding	22	1	0	0	1	0
	Hand release	Dead/Sand Fleas/Bleeding	3	15	0	2	0	2
	Hit the roller	Dead/Sand Fleas/Bleeding	71	0	0	2	14	0
	Hook twisting and shaking	Dead/Sand Fleas/Bleeding	72	125	0	25	13	18
		Moderate	0	0	1	1	0	0
		Unknown	1	2	0	0	0	1
	No Selection	Dead/Sand Fleas/Bleeding	0	0	0	0	0	0
	Other non-careful release	Dead/Sand Fleas/Bleeding	1	4	0	1	0	0
		Severe	0	0	0	0	1	0
	Unknown	Dead/Sand Fleas/Bleeding	7	1	0	0	1	0
Drop Off Above Water	Hand release	Unknown	0	1	0	0	0	0
	Hook twisting and shaking	Unknown	10	11	0	3	21	8
	No Selection	Unknown	0	0	1	0	0	0
		NA	87	51	0	32	27	4
	Other careful release	Dead/Sand Fleas/Bleeding	1	0	0	0	1	0
		Unknown	16	14	0	3	12	1
Drop Off Below Water	Hook twisting and shaking	Unknown	0	0	0	2	0	1
	No Selection	NA	12	0	0	6	3	0
	Other careful release	Unknown	2	0	0	0	0	0
Utilized – On Board	No Selection	NA	2	0	0	0	0	0
TOTAL			**11,436**	**5,248**	**167**	**4,968**	**6,234**	**1,670**

Appendix E – Electronic Monitoring Innovation Project (EMIP) Summary for 2019

Introduction and Project Background

The primary focus of the EM Innovation Project (EMIP), spearheaded by the AFSC FMA Division, is to develop and integrate computer vision algorithms into cost-effective electronic monitoring systems with the aim of providing automated catch accounting data to support Council and Agency goals. This research was supported through competitive RFP processes, funded by the Fisheries Information Systems (FIS) and the National Observer Program (NOP).

In previous project research, the team focused on improving the development of EM Innovation (EMI) hardware and software applications to fully support automated fish count, size measurement and species identification across trawl (TRW) and Hook-and-Line (HAL) fishery applications. In 2019, this development was extended to processing plants. The project's effort in developing these automations are detailed in the publications listed below. This research is working toward the goals of automated image processing for catch event detection, species identification and counts, and length/weight measurements. These data elements are all needed to estimate total discarded/retained catch and length compositions necessary for stock assessments.

Research Methods and Outcomes

The machine vision algorithms used for automated data analysis relies on training imagery acquired through the deployed EMI systems on volunteer vessels and imagery collected from numerous surveys (IPHC, and NMFS Sablefish and BSAI/GOA Trawl). This imagery, in the form of image frames and video, is acquired through EMI systems built and designed by the project. Imagery is acquired, catalogued and annotated and then passed on to our partners at the Information Processing Laboratory situated in the University of Washington's Electronic and Computer Engineering Department (UWEE). Once there, our partners iteratively develops and trains the machine vision algorithms needed for the project. The project team then tests the algorithms and, where applicable, integrates them into the EMI systems for real-time automated analysis. EMI systems and research streams include:

- Camera chute systems for on deck sorting of halibut and species identifications in the trawl (TRW) fishery
- Hook-and-Line (HAL) analysis systems for automating the analysis of video to count, identify and measure fish coming over the rail during multispecies longline fisheries
- Automated monitoring system to validate compliance with accurate reporting of salmon bycatch by plants receiving trawl deliveries.

These advances also have the potential to benefit other EM programs as the technology could be transferable and the machine learning algorithms could be re-trained for any new image data stream. In 2019 the project team demonstrated this by conducting experiments to identify birds, using bird imagery, and experiments to monitor compliance, using compliance imagery data, to determine activity on deck. 2019 research outcomes for these streams are summarized below.

EM Innovation Trawl: Developing camera chute systems to automate the estimation of halibut discards, and for species identifications on trawl vessels

FMA has developed camera chute systems that are placed in the flow of discarded fish where they can detect, identify, and measure fish that are put through them. The main application of these chutes is to enable rapid discard and census accounting for deck-sorted halibut, supporting on-board observer data collection and halibut bycatch estimation. 2019 focused on the improvement of the halibut length measurement algorithm accuracy with emphasis placed on identifying the shape of the fish (bending/flapping fish) as well as improving the camera chute system used to acquire the imagery.

Chute systems were built and deployed on 6 volunteer catcher-processor (CP) vessels that deck-sorted halibut. Chutes were placed in the flow of halibut discards (after the observer on-deck sampling table), and deck-sorted halibut were put through them for image collection and processing. Imagery data collected from these deployments was used to train and test the classification and length measurement algorithms. These chute system implementations made use of machine vision cameras triggered by fish passing through a light beam to take single images with strobed lighting. Research outcomes determined that, due to environmental constraints, these sensors were consistently the first component to fail after weeks or months at sea. This was one of the main reasons for the acquisition of inconsistent imagery data and subsequent attempts to better protect the sensors or find an alternative did not resolve those durability problems. Additionally, the triggering circuitry and the machine vision cameras increased system complexity and cost of each system. Integration of the algorithms into the machine vision camera acquisition software also proved challenging due to the frequency of updates needed. In 2019 the technical design of the chute was modified to overcome these challenges, resulting in more accurate analysis while being leaner and more cost effective than previous designs.

The advancements in the detection, identification and length measurement development meant that the image quality requirements (megapixel size) of the inputted data was not as demanding as was initially conceived. This led to the design and implementation of IP cameras instead of dedicated machine vision cameras. The benefits of moving to IP cameras solved multiple problems. Firstly, they are widely available and much more cost effective compared to the machine vision cameras. Secondly, the selected IP cameras have built-in motion detection features, thus the problem of the dedicated light beam sensor was no longer an issue as this motion detection was used as the triggering mechanism for acquiring imagery. Image analysis is simplified when background and lighting are consistent and only one subject is present and well-posed at a time. The physical chute system was redesigned to incorporate a green background over the previous blue background and improvements were made to the stability and longevity of the LED lighting strips. A display screen was also incorporated into the design to provide real time feedback to the users.

With the use of IP cameras over machine vision cameras, the acquisition software needed to be changed as well. Investigations were made into redeveloping and repurposing the existing acquisition software or developing new software and integrating it with the updated algorithms. Both options proved to be too costly, both in terms of time and effort and resources and ultimately the simplest solution was implemented. Standard free, off-the-shelf IP camera acquisition software was used to capture imagery data and an automated workflow orchestration interface was developed to seamlessly communicate between the acquisition software and analysis algorithm application. This decoupled the analysis from the acquisition, allowing for either application to be updated independently, making upgrading and maintaining the algorithms much simpler. The analysis application was also updated to work on video input as opposed to single image, frame by frame, analysis. This approach produces several frames of each fish as it passes through the chute, increasing the likelihood of flapping fish having a measurable pose in at least one frame of the video. Initial lab testing found that processing time between a fish being passed through the chute and the video being analyzed is near real-time. The analysis results are written and stored with the video files and are reviewed once trips are completed. A feature was added to the system to allow for the transmission of the resulting analysis files to be communicated back to FMA via ATLAS (the observer software) for earlier review and potential maintenance troubleshooting.

Chutes using these new updated systems were deployed on two vessels doing halibut deck-sorting in early 2020. Both chutes have already exceeded the best operational durations of the previous design, with initial early review indicating length and count measurements within acceptable thresholds.

Two other chute-related investigations were conducted 2019. These endeavors focused on finding ways to relax requirements for the easiest analyses. The first experiment dealt with the feasibility of using an ‘Open Air’ chute for data collection and analysis. The Open Air chute was tested as an alternative to having one of our chute systems on deck for halibut deck sorting. The current chute system might be cumbersome for some vessels with limited space on deck, so the idea was to use a single IP camera over a designated area for halibut deck sorting and acquiring length estimates of each halibut that appears in that area. Video of an observer sampling table aboard deck-sorting vessels were collected in this proof of concept experiment and around 17,775 images were separated for annotation purposes and 2,228 rect boxes were created. This data was then passed to the UWEE team members to develop analysis algorithms. Challenges included ignoring arms and hands of personnel in the picture and highly variable lighting conditions. While standard segmentation tools (separating background from foreground) were ineffective, object (in this case, halibut) detection tools were effective in distinguishing the halibut in these images. Additional table video was acquired and will be applied to a measurement analysis in 2020.

The focus of the second experiment was to further improve a species identification algorithm developed from previous survey deployments. An IP camera chute was deployed aboard a vessel conducting the AFSC trawl survey of the Gulf of Alaska with the hopes of collecting a variety of different species for training needs. While new species data was collected, videos were also collected where many fish were poured through the chute at the same time, making it hard to automatically detect and separate specific species. These data will be used in 2020 to develop and train routines to separate, identify, and measure fish presented in this manner. Success could make these chutes viable for more rapid and varied sampling of larger volumes of fish.

EM Innovation Hook-and-Line: Developing automated video analyses to count, identify and measure fish coming over the rail during multi-species longline fisheries

In 2019 the project continued to focus on improving the stereo EM Innovation Rail system, both in the physical stereo camera system used for data collection/acquisition and in the automated analysis algorithms used to extract meaningful catch accounting data from the collections. Deployments continued on four volunteer industry longline vessels during 2019, together with four collaborations and deployments with IPHC and NMFS sablefish surveys.

Incremental Improvements were made to the collection system based on troubleshooting issues from previous deployments. Stereo camera housings were upgraded from the 2018 design and the system was designed to be more modular in approach; that is, cameras could be easily swapped out without having to do as much reconfiguration. The positioning of the parts (PC, sensor interface box, etc.) of the physical system was redesigned to make it more standard across deployments, however this is still limited by vessel space limitations. Storage for the collection of data was also improved upon with the allowance for use of a secondary hard drive, effectively doubling the capacity of available collection space. The system's up-time was also improved upon. Loss of data acquisition due to camera outages, sensor failures or software failures was not as high as 2018.

For each vessel deployment in 2019, 6 hauls worth of data were selected for training the algorithms. For each haul selected a section of 10,000 images was annotated. These annotations provide multiple backgrounds and weather and lighting conditions for the algorithm to learn from and improve upon. The algorithm needed at least 3,000 annotations (boxes are drawn around the event) for each species in order for it to have a higher confidence level. In 2019 we performed annotations on 2018 vessels to finish that year's annotation requirement as well as finding hauls with less common species that we do not have many annotations to build upon the library. Training datasets collected from 2018 and 2019 deployments provided significant improvements to the machine learning species identification algorithm and a 94+% accuracy rate for the 4 most dominant species; halibut, sablefish, dogfish shark and grenadier, was achieved.

In 2019, two of our partners at UWEE completed their Ph.D.s partially based on the work done for the project. As such the algorithm analysis application for rail was passed on to the project team and new Ph.D. students for further development and testing. Initial project analysis testing has proved positive. Running the analysis application it is possible to determine fish detection in a frame, identifying its species and determining if that fish was already previously identified from a previous frame (tracking). 2018 data were processed with initial results indicating an average processing runtime of 24 frames per second while running multiple instances. In other words, for every 60 minutes worth of haul data it was possible to analyze that data in 55 minutes. This was achievable running in optimum conditions in a lab environment utilizing GPU intensive commuting power. The results of the analysis then need to be human reviewed for quality assurance and accuracy measurement.

An example of haul analysis follows as: A haul of 3 hours and 41 minutes worth of data consisted of 265,856 image frames (left camera of stereo pair), roughly 20 frames per second. This haul was run through the analysis application taking an average 23 per second (running in concurrent sessions). The result of the analysis was that of the 265,856 frames, only 32,755 frames had some form of detection event in it. 87% of the frames in the 3 hour and 41 minute collection were non-fish images; that is, images of the sea, the empty line, etc. Of the 13% of frames with fish detected in them, 1,092 tracks were identified consisting of 16,356 frames; that is., 1,092 separate fish were identified. For human review only this subset of 16,356 frames would need to be reviewed for quality assurance and accuracy, so instead of the entire 3 hours and 41 minutes, only 13 minutes (16,356 / 20 / 60) of real fishing data needs to be reviewed. This rate of detection is dependent on the real fishing events, so if there are more fish caught in the haul, at a faster rate, then there will be more data to review. The implementation of the analysis application will dramatically increase the efficiency of human review and is one of the project's focuses for 2020 and beyond. By combining the results of analysis with data extracted from the EM Rail system haul log data from when the haul imagery was acquired (vessel information, GPS coordinates, haul start/end time etc.), a holistic view of the catch accounting data can be obtained.

Length measurement analysis continues to be a goal of the rail analysis project and in 2019, we began an investigation into developing single-camera algorithms to estimate lengths (previous length analyses have focused exclusively on stereo camera systems). The goal of this is to develop a species and count algorithm for our standard camera collections. This research is a priority for the project moving forward. Another equally important research goal is to run the analysis application in a real-time environment at sea. This has been challenging due to environmental and power restrictions, but the project team continues to research and develop possibilities to make this a reality. Sensor and triggering improvements are also a research topic in the coming months. In 2020, experiments will be conducted to test the efficacy for using image sensors alone to conduct 'Man-On-Deck' automated event detection to identify fishing events and support compliance monitoring to lower cost.

EM Innovation Plant: Developing an automated monitoring system for salmon bycatch accounting in catcher vessel offloads to processing plants

Monitoring catcher vessel deliveries at shoreside plants for bycatch, particularly salmon, is a very time-consuming and tedious task and is done in parallel with a sorting process by plant workers that is reported on fish tickets. The project identified the potential to use EM algorithms to validate the sorting process and to automate, where possible, the creation of fish tickets for bycatch reports. Starting in 2018 and continuing into 2019, imagery of salmon being inserted into the flow of rockfish predominant hauls on the belt in plants was collected. These data were collected by deploying IP cameras and making use of data from cameras already available at several offload plants in Kodiak used to monitor the plants ability to accurately detect, sort, and report salmon bycatch in deliveries from trawlers. Video was also collected from pollock deliveries in February 2019.

The collected video data were annotated for the determination of the presence of salmon. A total of 1,180,148 images for salmon in rockfish hauls with 34,666 boxes that were created and for salmon in pollock a total of 222,327 images with 33,225 boxes that were created. Due to the volume required annotated training data, the project collaborated with University of Alaska to perform a sample of the annotation. In 2019, annotation training was presented and provided to the UA students by the members of the project team.

Machine learning algorithms were developed by our UWEE partners for automated salmon detection and species identifications. Initial salmon detectors, analyzing individual frames, had large numbers of false positives. To overcome this, tracking routines to eliminate frame detections that were not part of a sequential series of detections was added, greatly reducing those false positives. Detectors with tracking found 91% of the salmon from rockfish deliveries with only 1% of false positives. Species identification routines distinguished Chinook salmon from other species at better than 90% effectiveness. Initial applications to run the detector and salmon ID algorithms on recorded video were provided late in 2019. These programs will be improved and run on previously collected videos with known salmon event times in 2020.

EM Innovation Experiments: Applying and testing developed algorithms in other environments

A number of experiments were conducted in 2019 as the project team continues to determine opportunities where existing developed algorithms can be applied outside of its current use. Highlighted below are some of these experiments and outcomes.

Man-on-Deck Activity Monitor and Sensor

In 2019, the project group collaborated with the West Coast Region to develop an algorithm that detects a man on deck for compliance purposes on a trawl vessel. The purpose of the 'Man-on-Deck Activity Monitor' is to monitor and detect compliance activity onboard commercial fishery vessels. The aim of the application is to use standard Electronic Monitoring (EM) system data to detect and report on compliance issues. These activities include: region of interest (ROI) monitoring (detecting and determining when there is human interaction within a specific area) and discard detection (detecting and interrupting the human behavior of discarding fish).

Existing imagery data was shared for the testing and training of the algorithm. These data were annotated, a total of 7,668 single frames of imagery with 3,047 boxes that were created and was used to test and train the man-on-deck algorithm. Initial results of the algorithm's ability to detect a man on deck at a 98.87% precision. Moving forward the project hopes to obtain more imagery to further improve upon the algorithm.

The promising results of the man-on-deck compliance algorithm has led to its application for use in a 'Man-on-deck Haul Station Sensor'. The development of this sensor would expand upon the compliance algorithm and use the man on deck detection as a possible alternative for a haul start sensor. This sensor was created for longliners with the idea that when the rollerman stepped into the region of interest (ROI) for "x" amount of time the sensor would trigger the start of the haul and would start the haul station cameras. When the rollerman steps out of the ROI for "x" amount of time then the cameras would turn off. Similarly, to the compliance algorithm, the sensor algorithm required annotated data for training. In 2019, sections of hauls from three different boats were annotated to train the algorithm on different backgrounds. In each haul there was a section of 10,000 images that were selected to be annotated for a total of 30,000 images and 30,000 boxes were created. The training annotation was completed using a previously collected stereo pair imagery; however, the algorithm has the capability to work on a single IP camera. In 2020, the project hopes to focus on the implementation and testing of the sensor in the field on our 2020 survey boats.

Bird Experiment

Two experiments were conducted using the algorithms previously developed for trawl use (chute) and hook-and-line use (rail). These experiments focused on using the algorithms to identify species of seabirds. The first was to identify bird species in a controlled environment (the multispectrum chute), the second investigated identifying seabirds near fishing gear or caught on the line.

The multi-spectrum chute system consists of eight machine vision cameras each equipped with a band-pass filter to limit each individual camera to a specific light frequency. This includes the standard RGB, Infrared (IR), and UV light frequencies. Images of 15 different species of seabirds were captured for this training. A total of 1,837 images were used for training the system and 213 images were set aside for testing. The results of the testing images came back with an accuracy of 93%. This includes 100% accuracy for commonly caught species including black-footed albatross, northern fulmar, and Laysan albatross. Training and testing were conducted on the standard RGB cameras and no other light frequency has been examined up to this point. The training data set is small and skewed to the species that we commonly collect in the fishery. A higher variety and quantity of specimens would generate a more robust algorithm.

After performing a proof of concept for identifying seabirds in the multispectral chute, a mock rail experiment simulating seabirds being caught on the line was conducted at the AFSC. The goal is to identify bird species using algorithms developed for stereo camera usage. Though birds are not caught in high abundance, when they are caught it is essential to identify them to species. Since few imagery data existed for instances of seabirds being caught on the line, this scenario needed to be simulated and captured using the EM Innovation stereo rail system.

For the simulation, 17 different species of birds were used to train and test the system. These included species of albatross, northern fulmars, shearwater species, and miscellaneous incidental birds that had been brought back from the field by observers. Of the total of 538,056 images recorded, 18,878 annotation boxes were created. The hook-and-line detector algorithm was trained with the dataset and a testing dataset consisting of 89 tracks and 8,868 images was used for testing.

The identification accuracy for this simulation was 93.25% overall with commonly caught species at near 100% accuracy. Moving forward, collecting more specimens will further improve the accuracy of this system and the bird species identification will be integrated into the standard stereo systems for identifying birds seen on the water near the gear.

Cod Volumetric Experiment

A proof of concept experiment on Pacific cod volumetrics was conducted. This test was performed to determine if stereo camera algorithms could accurately calculate the volume of fish on sorting tables in the pot cod industry. While imagery was collected and fish volumes were recorded, the results of the experiment are ongoing.

Rockfish Uncontrolled Environment Imagery Collection

Previously, images and genetic samples were collected from shortraker, rougheye, and blackspotted rockfish in a controlled environment through the chute. EMIP used this collection to build upon the image library and develop algorithms to identify the difference between the three rockfish with a 92% accuracy. For continued development, more imagery and genetics are needed to improve upon the accuracy of our previous results. Rockfish imagery collected in an uncontrolled environment would benefit the training due the variety of backgrounds. As such, at the start of “B” season 2019, EMIP collaborated with the observer program on a survey project to collect images and genetics on shortraker, rougheye, and blackspotted rockfish while out in the field. The genetics that are collected will be used to verify the species since it is difficult to be able to separate rougheye and blackspotted rockfish from visual observations. This project was introduced on a volunteer basis with the plan on continuing this project in 2020.

Machine Learning Publications Funded through FIS/NOP

Wang, G., J-N. Hwang, K. Williams, F. Wallace, and C. S. Rose. 2016. Shrinking encoding with two-level codebook learning for fine-grained fish recognition, p. 31-36. *In* Proceedings of the 2016 ICPR 2nd Workshop on Computer Vision for Analysis of Underwater Imagery CVAUI; Dec. 4, 2016, Cancun, Mexico.

Wang, G., J-N. Hwang, K. Williams, and G. Cutter. 2016. Closed-loop tracking-by-detection for ROV-based multiple fish tracking, p. 7-12. *In* Proceedings of the 2016 ICPR 2nd Workshop on Computer Vision for Analysis of Underwater Imagery CVAUI; Dec. 4, 2016, Cancun, Mexico.

Wang, G., J-N. Hwang, Y. Xu, F. Wallace, and C. S. Rose. 2018. Coarse-to-fine segmentation refinement and missing shape recovery for halibut fish, p. 370-374. *In* Proceedings of the 2018 IEEE Global Conference on Signal and Information Processing (GlobalSIP); Nov. 26-29, 2018, Anaheim, California.

Wang, G., J-N. Hwang, C. Rose, and F. Wallace. 2019. Uncertainty based active learning via sparse modeling for image classification. IEEE Trans. Image Process. 28(1):316-329, Jan. 2019.

Wang, G., J-N. Hwang, F. Wallace, and C. S. Rose. 2019. Multi-scale fish segmentation refinement and missing shape recovery. IEEE Access 7: 52836 - 52845, April 2019.

Huang, T.W., J-N. Hwang, and C. S. Rose. 2016. Chute based automated fish length measurement and water drop detection. Presentation at IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 20-25 March 2016.

Huang, T.W., J-N. Hwang, S. Romain, and F. Wallace. 2016. Live tracking of rail-based fish catching on wild sea surface. Presentation at ICPR 2nd Workshop on Computer Vision for Analysis of Underwater Imagery (CVAUI), 4 Dec. 2016.

Huang, T.W., J-N. Hwang, S. Romain, and F. Wallace. 2017. Tracking and measurement of catch events in stereo video for longline fisheries. Presentation at American Fisheries Society 141th Annual Meeting, Aug. 2017.

Huang, T.W., J-N. Hwang, S. Romain, and F. Wallace. 2018. Fish tracking and segmentation from stereo videos on the wild sea surface for electronic monitoring of rail fishing. IEEE Trans. CSVT 29(10): 3146-3158. doi: 10.1109/TCSVT.2018.2872575.

Huang, T.W., J-N. Hwang, S. Romain, and F. Wallace. 2019. Recognizing fish species captured live on wild sea surface in videos by deep metric learning with a temporal constraint. IEEE International Conference on Image Processing (ICIP), Taipei, Taiwan, Sept. 22-25, 2019.

Fitzgerald, S., F. Wallace, S. Romain, K. Magrane, R. Kazmerzak, B. Moore, and M.A. Kim. 2019. Improving seabird species identification in electronic monitoring applications using machine learning systems. Working Group Information Paper for the Ninth Meeting of the Seabird Bycatch Working Group of ACAP: Florianópolis, Brazil, May 2019. SBWG9 Inf 21. Online at https://www.acap.aq/en/working-groups/seabird-bycatch-working-group/seabird-bycatch-wg-meeting-9/sbwg9-information-papers/3383-sbwg9-inf-21-improving-seabird-species-identification-in-electronic-monitoring-applications-using-machine-learning/file.

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