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U.S. DEPARTMENT OF COMMERCE
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Deployment Performance Review of the 2016 North Pacific Groundfish and Halibut Observer Program

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ABSTRACT

This report contains the analyses and findings of the Alaska Fisheries Science Center's Fisheries Monitoring and Analysis Division's Observer Science Committee on the efficiency and effectiveness of observer deployment following the 2016 Annual Deployment Plan (ADP). Responses to comments by the North Pacific Fishery Management Council's Science and Statistical Committee from the 2015 version of this report, and recommendations to improve data quality and guide the 2018 Annual Deployment Plan are also included. In 2016, there were 15 strata to evaluate: two full coverage strata, three gear-based partial coverage strata for observers, partial and full coverage electronic monitoring (EM) strata among four time periods, and two zero-coverage strata. Observers were deployed under trip-selection on 172 full coverage vessels that fished for 4,716 trips and 365 partial coverage vessels that fished 6,654 trips total. Pre-implementation EM systems were successfully deployed onto 24 vessels that fished for 227 trips using vessel-selection. A total of 421 vessels fished 2,079 trips with no chance of being observed or monitored (zero selection strata). Coverage rates in partial coverage trip- and vessel-selection met expectations for the year. Although the pre-notification system employed for EM boats in vessel-selection eliminated unnecessary deployments, there remained vessels that failed to comply with the voluntary rules of the EM strata and had no chance of being selected for monitoring. It is unknown if this resulted in biased data from the EM strata. There was no evidence of temporal bias in observer deployments. However, some spatial bias was evident in all three gear types and observer effects (different trip characteristics between observed and unobserved trips) were found in hook and line and trawl gear types. Differences between trips that delivered to a tender and those that did not were also evident in trawl and pot gear types. Tendering in the trawl pollock fishery occurred in Akutan, Sand Point and King Cove - the latter port had none of the 322 deliveries observed. This year marked the third consecutive year the observer program has not been able to deploy onto a random subset of pollock trawl deliveries due to tendering activity. We recommend that the linkages between the planned and realized trip databases be strengthened, that NMFS provide adequate funding for at least 15% trip coverage to guard against data gaps, that future ADPs set coverage rates proportional to effort among strata (and only optimize for sea-days in excess of those required for 15% coverage), and that the NMFS change its monitoring strategy for salmon bycatch in the pollock trawl fishery.

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INTRODUCTION

Background of the North Pacific Groundfish and Halibut Observer Program

Fisheries observers collect independent information that is used to determine the effects of fishing on natural resources. The National Marine Fisheries Service (NMFS) uses its observer program in Alaska to enable the use of tools such as catch quotas to manage against the over- or under-harvest of fishes. The data collection by observers is currently the only reliable and verifiable method for fishery discard information that facilitates estimation of total catch, as well as seabird and marine mammal interactions with fisheries. In addition, observers also collect biological information such as length, sex, weight, ageing structures (e.g., otoliths, spines, scales, and vertebrae), and stomachs to support ecosystem studies and stock assessments.

The observer program in the North Pacific has a long history. Observers were first deployed onto fishing vessels in the Bering Sea in 1973 and into the remainder of the North Pacific in 1975 (Nelson et al. 1981, Wall et al. 1981). Fisheries in the North Pacific were initially prosecuted exclusively by foreign and later by "joint venture" operations where a developing domestic fleet of catcher vessels delivered to foreign-owned processing vessels. During the foreign and joint venture operations, foreign vessels carried fisheries observers at their expense, while domestic vessels were exempted from this observer coverage. As foreign vessels' rights to fish in the U.S. Exclusive Economic Zone (EEZ) were reduced over time and the domestic fishery grew, it became obvious that observer coverage would be necessary for the emerging domestic fleet. At the onset of fully domestic fishery operations in 1990, the North Pacific Groundfish Observer Program was established as an interim observer program with rules governing observer coverage codified in regulations. This interim program would be extended four times over the next 20 years by the North Pacific Fishery Management Council (Council) - the last without a sunset date.

The regulations established in 1990 required vessels 60-125 feet in length (overall) and all vessels fishing pot gear to carry observers at their own cost for 30% of their fishing days in a calendar quarter plus at least one trip in each fishery they participate in (termed the "30% fleet"), and vessels greater than 125 feet in length to carry an observer for 100% of their fishing days at their expense. Some vessels were not required to carry observers. These included vessels less than 60 feet, vessels fishing jig gear or vessels fishing with trawl gear that deliver unsorted codends to processing vessels (termed "catcher processors" or CPs if the vessel also has catching ability and "mothership" or M if the vessel does not) and catcher vessels that fished for Pacific halibut (*Hippoglossus stenolepis*). For shoreside processors, the rules governing observer coverage were based on the estimated tonnage processed in a calendar month: plants that processed less than 500 metric tons (t) a month were exempted from coverage, those that processed between 500 t and 1,000 t a month were required to be observed for 30% of the calendar days, and those that processed more than 1,000 t a month were required to be observed for each day in the month.

Soon after the establishment of the domestic observer program, concerns over the ability and incentive for fishers to bias observer data through the ability to manipulate observer coverage prompted efforts by NMFS and the Council to provide a mechanism for NMFS to gain control over where and when observers were deployed (Faunce and Barbeaux 2011). From 1992 to 2008, several attempts to "restructure" the program were made. In 2010, the Council unanimously decided to move forward with the restructured observer program. In 2012, the Final Rule 77 FR 70062 was published to implement Amendment 86 to the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands (BSAI) Management Area and Amendment 76 to the Fishery Management Plan for Groundfish of the Gulf of Alaska (GOA). Amendments 86/76 added a funding and deployment system for observer coverage to the existing North Pacific Groundfish Observer Program and amended existing observer coverage requirements for vessels and processing plants. The 'restructured' North Pacific Groundfish and Halibut Observer Program (hereafter termed 'Observer Program') began in 2013 with the randomization of deployments among trips and vessels. Since 2013, the Observer Program has employed a hierarchical sampling design with randomization at all levels (trips > haul > species composition > length, age, sex, maturity and tissues for genetic analysis).

THE ANNUAL DEPLOYMENT PLAN AND REVIEW

Analysis and evaluation of the data collected by observers is an ongoing process. NMFS considers Council input in making decisions as to the amount of coverage (i.e., selection probabilities that are assigned to each partial-coverage category). These decisions are based on available funding, the cost of observer coverage, and anticipated effort. The restructure of the Observer Program established new annual reporting processes. Each June, NMFS provides the Council with a comprehensive evaluation of past years' observer deployments, costs, sampling levels, and implementation issues as well as recommended changes for the coming year. The June deployment performance review aims to identify areas where improvements are needed to 1) collect the data necessary to manage the groundfish and halibut fisheries; 2) maintain the scientific goals of unbiased data collection; and 3) accomplish the most effective and efficient use of the funds collected through the observer fee. It is intended that this deployment performance review will inform the Council and the public of how well various aspects of the program are working, and consequently lead to recommendations for improvement. The NMFS also releases a draft and final Annual Deployment Plan (ADP). The ADP defines deployment strata and establishes selection rates given available budgets and anticipated fishing effort. A draft ADP is released by September 1 of each year to allow review by the Council's Groundfish Plan Teams, as well as the Council and its Scientific and Statistical Committee (SSC). Based on input from its advisory bodies and the public, the Council may choose to clarify objectives and provide recommendations to NMFS for the ADP. Upon analysis of the Council recommendations, NMFS will make any necessary adjustments to finalize the ADP and release it to the public. The ADP is released to the public prior to the December Council meeting.

Observer Science Committee

Each year the Alaska Fisheries Science Center's (AFSC) Fisheries Monitoring and Analysis (FMA) Division establishes an *ad hoc* Observer Science Committee (OSC) for the North Pacific Observer Program. The OSC 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 Bering Sea and Aleutian Islands (BSAI) and the Gulf of Alaska (GOA). OSC members have practical, analytical, and scientific expertise relating to the observer sampling of groundfish and halibut fisheries of the BSAI and GOA and/or the use of the resulting data. If possible, the OSC 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/ Sustainable Fisheries Division (SF), and one member of the International Pacific Halibut Commission (IPHC).

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. By grouping similar fishing activities into strata and sampling appropriately to those groupings, logistics of sampling is increased and variance of resulting estimates is decreased. Sampling strata are defined in the ADP, and all fishing activities must be contained in one, and only one, stratum.

Within each of the strata, observers are deployed randomly to either vessels for a predetermined time period (termed vessel-selection), or to individual 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 strata (for example all trips taken by trawl vessels fishing in the Alaska Exclusive Economic Zone). In cases where the sampling frame (list of PSUs) for a stratum does not include all the elements of the stratum (i.e., where some fishing occurs in the stratum but is not captured by the sample frame), the resulting sampling may be biased. The magnitude and direction of the bias will depend on how different the sample frame is from actual fishing activity.

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. 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.

For the randomly selected hauls for each trip, a random sample of the catch is collected 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 tertiary sampling units, 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.

At the fourth level of the sampling hierarchy, a predetermined number of individual fish of predetermined species are randomly selected from the species composition sample and measured. Lastly, at the fifth sampling level, a random selection of fish are 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 Resource Ecology and Fisheries Management Division (REFM). Sampling rates for genetic tissue collection by observers (e.g., 1 of 10 Chinook salmon caught as bycatch) are set each year by the Auke Bay Laboratories of the AFSC.

In summary, the overall sample design used by the Observer Program is a stratified design where within each stratum, NMFS randomly selects primary units (vessels or trips) to be monitored. Within each selected trip (in vessel-selection, all trips are monitored), hauls are randomly selected to be further sampled, and marine mammal and seabird interaction data are collected. From each selected haul, a random sample of the catch is collected to obtain species composition and disposition data. From within each species composition sample, individual fish are randomly selected and measured. Finally, from these measured fish, additional fish are randomly selected for the collection of biological specimens. More information on the sampling design used by observers and the relationship between the sample design and catch estimation can be found in Cahalan et al. (2014) and the 2016 Observer Sampling Manual (AFSC 2016).

DEPLOYMENT PERFORMANCE REVIEW

The following sections contain the OSC review of the deployment of observers in 2016 relative to the intended sampling plan and goals of the 2016 ADP (NMFS 2015a). This report 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 2018 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. 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. Although this report includes evaluations of EM deployment, current evaluation of this tool is limited in scope due to its pre-implementation status.

Observer Deployment Performance Metrics

Performance metrics have been developed to assess whether the trip- and/or vessel-selection process (through the implementation of the 2016 ADP) provides a representative sample of the catch in the North Pacific in 2016. These metrics reflect four mechanisms that can impact the quality of the data: sample frame discrepancies, non-response, trip differences, and sample size. The sampling frame consists of the portion of the population available for sampling. In cases where the vessel is the sampling unit, sample frame discrepancies (i.e., under- and over-coverage of the sample frame) were used to quantify the differences between the sampled population (i.e., observed vessels) and the population for which estimates (inferences) are made (e.g., all vessels that fished), as well as to identify possible mechanisms of bias. Non-response assessments are made to quantify the differences between the selected sample (selected trips or vessels expected to be observed) and the actual observed sample that may lead to bias in the resulting data.

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 strata are subgroups or partitions of the entire population from which estimation and inference is desired. Implementation challenges can be identified in this step, such as sample frame inadequacy (vessel-selection only), selection biases, and issues with sample unit definitions (e.g., tender trips). Specifically, this section assesses the following:
    a. Sample rates and number of samples relative to intended values.
    b. (Vessel-selection strata only) Quantification of under- and over-coverage rates (sample frame discrepancies). Over-coverage of a population occurs when the sample frame includes elements (trips or vessels) 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. (Vessel-selection strata only) 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 estimators of parameters of interest. A randomized sample design is expected to achieve a rate of observed events that is similar across both space and time. The hypergeometric distribution is used to construct several of these metrics. Based on a sample taken from a population with known characteristics (e.g., trips that occurred in a NMFS Reporting Area), this distribution describes the probability of selecting sample units (e.g., trips) with specific characteristics (e.g., NMFS Reporting Area). Representativeness of the sample was divided into three separate components:

    a. Temporal representativeness

        i. Effort plots: plots of expected and actual observed 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 observer coverage relative to effort in each partial coverage stratum, as well as where low or high coverage rates occurred.

        ii. Probability of selecting a sample and observing a fewer or greater number of trips within an area than would be expected given the implemented sample rates. These data are used to identify departures from anticipated sampling rates.

c. Representativeness of trip characteristics

   i. Consistency of trip characteristics for observed and unobserved portions of the stratum. Attributes include:

      - 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. This determination was made through an examination of the probability of deploying observers at the implemented rate and having no observer coverage in certain cells (e.g., defined by NMFS Reporting Area and strata).

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 unobserved trips, landed catch represents the only portion of the catch that is available from all trips.

CHANGES TO THIS REPORT FROM LAST YEAR

Strata Definitions and Deployment Methods

Observers in 2015 and 2016 were deployed into fishing events through trip-selection, the random selection of fishing trips as they were entered into an online application (also available by phone) known as ODDS. In 2015 there were two principal deployment strata based on vessel size: hook-and-line and pot gear catcher vessels 40-57.5 ft in length overall (LOA) were termed the *t* stratum, and larger fixed gear catcher vessels in addition to trawl gear vessels and three catcher-processors were termed the *T* stratum. The *t* stratum had selection rates of 12% while the *T* stratum had a selection rate of 24% (Faunce et al. 2016, NMFS 2016a). In 2016, observers were deployed into three gear-based strata with separate selection rates: trawl gear (*TRW*; 28.31%), hook-and-line gear (*HAL*; 15.41%), and pot gear (*POT*; 15.24%; NMFS 2015a). Since 2013, nearly all catcher-processor vessels have been subject to full coverage at the PSU.

The year 2016 was the second year of the NMFS 'Pre-Implementation' of Electronic Monitoring (EM) Cooperative Research (NPFMC 2016a). The Final 2016 Electronic Monitoring Pre-Implementation Plan developed by the EM Working Group (EMWG) (hereafter EMWG Plan) is similar to the EMWG Plan for 2015 in that it defines the desired number and type of vessels, selection process, and sample-size for EM. Therefore the EMWG Plan defines the sampling design for EM vessels. Similar to 2015, the NMFS incorporated the EMWG sample design into its ADP for 2016. This was accomplished by predicting the number and type of vessels that would be included in the EMWG Plan and subsequently developing coverage rates and strata for human observer coverage based on the remaining vessels and fishing activity (NMFS 2015a). In this way the inclusion of vessels into the EMWG Plan superseded their inclusion in the sampling design of the NMFS through the ADP. This is expected to change as EM in 2018 will be under a regulated program and part of the ADP.

The EMWG Plan for 2016 was to expand the number of vessels that participate in EM from 15 in 2015 to 58, and limit participation to volunteer longline vessels 40 to 57.5 ft in length. EM systems (defined as packages that contain multiple cameras, GPS, hydraulic line sensors and a control box) were deployed onto vessels according to a vessel-selection design consisting of four time periods: Jan.-Feb., Mar.-Jun., Jul.-Oct., and Nov.-Dec. Vessel-selection was last used for deploying observers in the 2014 ADP (NMFS 2013). This method involves selecting for observation a subset of vessels that are anticipated to fish during each time period. The ability to achieve a target number of observed vessels in vessel-selection within each time period is hindered by the difficulty identifying a complete sampling frame, which should include all the elements of the population of interest. A complete sampling frame for vessel-selection would consist of a list of vessels that actually fish in each time period. In trip-selection, only vessels that intend to fish log trips into ODDS. Consequently, the trip-selection sampling frame for the observer program is equal to the target population. However in vessel-selection, without a similar notification system informing NMFS of their intent to fish, a method was needed to generate the sampling frame.

EM-eligible vessels were determined in the following manner according to the Final 2016 Electronic Monitoring Pre-Implementation Plan (NPFMC 2016a). NMFS sent a letter to what it believed were all hook-and-line vessels 40-57.5 ft LOA (the equivalent of the *t* stratum in the 2015 ADP), and requested that vessels indicate their interest in being in the EM pool by 27 July 2015. The subset of vessels that expressed interest in EM participation by the first deadline in July was sent a second letter. This second letter informed recipients that unless NMFS received their notification to "opt-out" of EM participation by 20 November 2015, they would be included in the group of EM vessels with no probability of carrying an observer on any trips for the calendar year. In addition, the letter specified that vessels participating in EM must notify NMFS of their intent to fish at least 30 days in advance of each of the selection periods for 2016. Hence, a list of vessels anticipated to fish was available to NMFS prior to each selection period (i.e., a sampling frame was created), and a random sample was made from this list to select vessels for observation. Random selections were made by assigning each vessel in the list a random number, placing those vessels in ascending order by their random number, and selecting the first *v* vessels where *v* is the number of vessels in the list multiplied 0.30 (the selection rate) rounded to the nearest whole number. In this way, vessels that followed the instructions set out by the pre-implementation plan were subject to a 30% chance of selection.

For vessels that did not notify NMFS 30 days in advance of a time period, NMFS underwent a different selection process. A vessel was subject to either 100% or 0% selection by either notifying NMFS after 30 days prior to each selection period or failing to notify NMFS prior to fishing (NPFMC

2016a). In the former case, the vessel was automatically selected to carry EM if a camera system was available (100% selection). If a camera system was not available, then the vessel would not be selected to carry EM (0% selection). If a vessel simply failed to notify NMFS prior to fishing, that vessel had no chance of being selected (0% selection).

The deployment performance of the 2016 EM sampling design was difficult to evaluate for several reasons. First, the selection process used for EM in 2016 effectively created two EM selection strata with additional time periods to evaluate that were not specified in the 2016 ADP. While the 2016 ADP simply specified three gear-based stratum in partial coverage, the selection process set up by the EMWG and employed by NMFS created eight new strata to evaluate (two selection rates × four time periods). Since the EM participation was voluntary in 2016, vessel owners could contact NMFS at any time throughout the year to be removed from participation and were returned to the human observer pool. In this way a vessel could be in multiple selection strata during an EM time period. In addition, the selection process involved both random and non-random elements, the latter of which is nearly impossible to evaluate without making certain assumptions that will now be described. The number of vessels anticipated to fish in the EM Voluntary category was derived from the Final 2016 Electronic Monitoring Pre-Implementation Plan (NPFMC 2016a). Vessels that followed the notification rules were considered "within the sampling frame" for that time period, were selected for EM coverage at a 30% rate, and were considered the Voluntary 30% EM stratum. Vessels that missed the 30-day cutoff prior to the start of the time period but still wanted to volunteer for EM were selected at a 100% rate if equipment was available. Correspondence with the observer program indicates that EM systems were installed on all late-notifying vessels. Therefore we categorized all late notifying vessels as belonging to the EM Voluntary 100% stratum. Vessels that requested EM, but failed to notify NMFS of their fishing plans had no chance of being selected and monitored. In a regulatory program, these vessels would have been referred to OLE. Here we assume that these vessels represent a special case of late-notification vessels that would have been given a camera if one was available had they complied with the voluntary agreement. For this reason, we considered 'failure to notify' vessels as part of the EM Voluntary 100%

stratum. Finally, we considered any vessel successfully monitored if some EM video data had been received and reviewed within a time period by the Pacific States Marine Fisheries Commission. Although it is nearly impossible to truly gauge what would constitute the expected number of EM deployments given the sampling design, for the purposes of evaluation we have made the assumption that the desired number of vessels observed was equal to the number of vessels that fished multiplied by 30% following the EMWG Pre-Implementation Plan for 2016.

Methodological Changes

The results of the current year and the prior year versions of the Annual Deployment Review are now compared. Spatial coverage maps have been improved. Summaries of vessel-selection strata were generated in tables following the 2014 Annual Report (vessel-selection was not used in the 2015 ADP). However, in an attempt to improve clarity these data are now depicted visually and one table has been moved to an appendix for reference.

EVALUATION OF DEPLOYMENT IN 2016

The deployment of observers into the 2016 Federal fisheries in Alaska is evaluated at the level of the deployment stratum because each stratum is defined by a different sampling rate or by a different monitoring tool (e.g., observers and EM). Since a mix of selection methods was used in EM deployments, the results of each are evaluated separately. This is necessary because time periods within each EM selection period have expected outcomes in accordance with the selection rate. In this document, EM strata are considered successfully monitored if at least some video was reviewed from a trip. In summary tables these vessels are considered 'observed'. However, to avoid confusion, the term 'monitored' is used hereafter to refer to EM trips with video data, and 'observed' refers to trips containing some data from human observation.

Evaluating Effort Predictions

Each year the NMFS sets an annual budget in terms of observer days. Therefore how close anticipated observed effort is to actual invoiced effort in each ADP is a function of how well the NMFS predicts effort and how well the NMFS achieves its sampling rate. The observer day budget for 2016 was set at 5,107 days in the 2016 ADP (NMFS 2015a). Based on simulations using 2015 fishing data conducted a year in advance of deployment for the 2016 ADP, the FMA predicted it would observe 4,900 fishing days at the end of 2016. In 2016, the FMA paid for 4,677 observer days, which was 8.4% lower than predicted (Fig. 1). This can partially be explained by an overestimation of trip days in the *TRW* stratum by 581 days (7.5% fewer than predicted) in the 2016 ADP (Table 1; NMFS 2015a). For comparison, in 2015 the expended budget was 3.6% less than predicted in the 2015 ADP (NMFS 2014a).

PERFORMANCE OF THE OBSERVER DECLARE AND DEPLOY SYSTEM IN TRIP-SELECTION

Random selection of trips in the trip-selection stratum is facilitated by the ODDS. The ODDS generates a random number according to pre-determined rates and assigns each logged trip to either "selected to be observed" (selected) or "not selected to be observed" (not selected) categories. 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 logged they are considered pending and can be either closed or cancelled. Permissions depend on whether or not the trip is selected to be observed, the strata 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 in one of two methods: by entering the dates of the trip and the port processor of the landing, or by selecting from a list of pre-populated landing reports. Trips can also be cancelled (marked as incomplete) in two ways. First, in 2016, some vessels were granted by NMFS to voluntarily be 100% observed while trawl fishing in the BSAI FMP. These 100% voluntary observed trips were automatically selected and closed upon entry by the ODDS, so no cancellations are possible by the users. Second, for most partial coverage strata, the observer provider is given 72 hours for an observer to board the vessel prior to the trip start. 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 little 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 + 48 hours has passed, 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 2016 ODDS trips from affecting the deployment rates set for the 2017 ADP.

The number of trips logged in the ODDS in 2016 and their dispositions is summarized in Tables 2-4. Due to the nature of trip cancellations, the cancellation rate by users and by the ODDS is summarized only for selected trips in each stratum (Table 2). Of the 7,143 trips logged, a total of 286 trips were cancelled, including 3 by ODDS (0.04%) and 283 by users (4.0%). However, the user cancellation rate for selected trips was much higher (19.6%) and ranged from 15.8% for trawl gear to 25.3% for pot gear (Table 2).

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, observer coverage is expected to be less than the programmed selection rates. To reduce this potential bias, 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. The relative percentage of total valid trips that were selected from the inherit process ranged from 9.3% for Declared Gear - Trawl to 18.6% for Declared Gear - Pot gear (Table 3). In contrast only between 0.0% and 3.5% of the total trips after cancellations were waived (i.e., given a "pass" on their required observer coverage by NMFS) among gear selection strata (Table 3).

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 (Table 4). 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 rate obtained in the initial selection process was 15.88% for the *HAL* stratum, 14.27% for the *POT* stratum, and 28.39% for the *TRW* stratum (Table 4). These values were well within the range of values expected from a binomial distribution (exact binomial test p-values = 0.483, 0.341, and 0.933 for *HAL*, *POT*, and *TRW*, respectively; Table 4). This means that the ODDS was selecting trips according to the programmed rate. The final selection rate after trips were closed, cancelled, or waived was 17.72% for the *HAL* stratum, 14.42% for the *POT* stratum, and 29.55% for the *TRW* stratum (exact binomial test p-values = 0.003, 0.462, and 0.170 for *HAL*, *POT*, and *TRW*, respectively; Table 4). The fact that the final selection rates were greater than the initial selection rates (especially for *HAL* and to a lesser extent *TRW*) results from the fact that 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.

Differences in the initial and final selection rates were present among gear based strata during 2016. Deviations were most evident in the longline gear stratum during May, in the pot gear stratum during February, and in the trawl fishery during February and again in September and December (Fig. 2). In the longline and trawl strata, the final selection rate eclipsed that of the initial selection rate and remained the higher rate through the remainder of the year. These patterns are consistent with the hypothesis that trips selected for coverage are being delayed, and cancellation of selected trips results in a greater number of selected trips later in the year as the result of the inherit process. It is important to remember that ODDS only provides the *expectation* as to what levels of observer coverage levels should be resulting from actual fishing events. The 2016 ODDS provided users with a list of Report IDs from *e*Landings from which to close their logged trips, and *e*Landings has been updated to facilitate ODDS trip numbers. While these improvements help bridge the gap between intended and realized trip data sets, these data are not currently validated or error checked, making them unusable in their current state. This linkage between the trip stratum (with its selection probability) and the landing information is necessary to evaluate potential improvements in deployment efficiency within the partial coverage fleet.

Evaluation of Deployment Rates

This section compares the coverage rate achieved against the expected coverage rates. Data used in this evaluation are stored in a special database generated specifically for this purpose that utilizes information within the Catch Accounting System (CAS, managed by the AKRO), the Observer Program database NORPAC (managed by the AFSC), and *e*Landings (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, vessels participating in the voluntary EM program, or dockside deliveries of pollock.

At-Sea Deployments

The 2016 Observer Program had 15 different deployment strata to be evaluated. There are two deployment strata to evaluate in full coverage; trips belonging to vessels defined in regulation (e.g., AFA, termed regulatory full coverage), and those made by vessels that volunteered to carry full observer coverage when fishing in the BSAI (termed voluntary full coverage). Deployment strata in the partial coverage category include: the *TRW*, *HAL*, and *POT* strata in the trip-selection pool, *EM Voluntary 30%* and *EM Voluntary 100%* (2 strata × all time periods) in the vessel-selection pool, and the zero-selection pool which also included three vessels participating in EM innovation research (hereafter simply EM research; Chilton et al. 2016).

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. Evaluations of the partial coverage category are slightly more complicated. Following the 2016 ADP, the ODDS was programmed to randomly select logged trips at a rate of 28.31% in the *TRW* stratum, 15.41% in the *HAL* stratum, and 15.24% in the *POT* stratum. These rates were the expected rates of observer coverage in these strata. Following the EMWG Plan, EM was anticipated to be installed on 30% of vessels in each of four time periods, but were always or never installed on vessels under certain conditions. Partial coverage rates were expected to fall between upper and lower bounds of the expected value from the 0.025 and 0.975 quantiles of a binomial distribution (aka a 95% "confidence bound") since deployment in strata under trip- or vessel-selection were randomized. Coverage levels were considered to have met expected goals if the actual value was equal to one of the upper or lower confidence bounds, or fell within them.

The program met expected rates of coverage for all of the full coverage and trip-selection strata (Table 5). These results are similar to those found in 2014 and 2015 (Faunce et al. 2015, NMFS 2015b, Faunce et al. 2016, NMFS 2016a). The trip-selection processes for observing full coverage and partial coverage trips have consistently been shown to achieve the desired rates of coverage when measured over the entire year. Vessel-selection strata were evaluated based on the number of vessels monitored rather than coverage rates as was done for trip-selection strata. Given the total number of vessels that fished and the selection rate, the number of vessels observed in each time period within the EM Voluntary 30% stratum was within the expected bounds while the number of vessels observed within the EM Voluntary 100% stratum were not (Table 5). These results are discussed in more detail in the next section of this Review. Evaluation of the entire program is complicated somewhat by whether monitored EM vessels are considered equivalent of observed vessels. When EM vessels with at least some video reviewed are considered equivalent to observed vessels, 6,142 trips (44.8%) and 514 vessels (43.9%) were observed among all fishing in Federal fisheries of Alaska (Table 5). However, in 2016, EM data were not used in catch accounting. Therefore, a more accurate depiction of data collection from the North Pacific Observer Program would be to consider EM vessels equivalent to zero-coverage vessels. Under this evaluation, 6,066 trips (44.3%) and 490 vessels (41.8%) were observed among all fishing in Federal fisheries of Alaska (Table 5).

Coverage Rates in Vessel-Selection (Voluntary EM)

Vessel selection data were visually depicted by two themes that included 1) evaluations of the sampling frame (i.e., how many vessels were anticipated to fish, how many volunteered to fish, and how many actually fished), and 2) evaluations of the realized sample (i.e., how many vessels were expected to be monitored, how many vessels were expected to be selected to be monitored, and how many vessels were actually monitored). The results of the anticipated number of vessels that would notify NMFS prior to fishing, the actual number of vessels that notified NMFS prior to fishing, and the actual number of vessels that notified NMFS prior to fishing and actually fished are depicted in Figure 3. The number of vessels anticipated to fish in the Final 2016 Electronic Monitoring Pre-Implementation Plan was always greater than the number of vessels that actually fished within a given time period, but these two metrics shared similar trends among time periods with the greatest values were during March-June and lowest values during November-December.

The data in Figure 3 (raw values in Table 1 in the Appendix) were also used to quantify under- and over-coverage rates (sample frame discrepancies). Over-coverage of a population occurs when the sample frame includes elements (trips or vessels) 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. Over- and under-coverage rates in the vessel-selection sampling frame are not additive since the former is a percentage of the sampling frame, and the latter is a percent difference from the true frame (i.e., the list of vessels that actually fished). Over-coverage rates were 0 for all time periods (Table 6, Row 1). If being selected for coverage has no effect on the likelihood that a vessel fishes in Federal waters, we would expect that the percentage of vessels that were in the selection frames and did not fish to be approximately equal to the percentage of vessels that were in the selection frame and were selected for coverage and did not fish. A comparison of Rows 1 and 3 of Table 6 shows that this was the case for the voluntary EM strata in 2016. These results are a significant improvement over the vessel-selection process in 2014, when over-coverage rates were between 39.6% and 65.2% (Faunce et al. 2015, NMFS 2015b). The element of the EM vessel-selection design that asked participants to identify their intent to fish prior to each time period, and use this as a selection frame, ensured that the NMFS did not deploy EM systems on vessels that did not fish. However, similar to 2014, there were vessels that belonged to vessel-selection strata, fished, but did not have any chance of being observed. Under-coverage rates in 2016 ranged between 0% and 100% (Table 6, Row 2). This larger value occurred because there was only one vessel that fished the November-December time period (Table 6, Rows 1 and 2). Under coverage in 2014 ranged from 29.6% to 63% among time periods and was also largest during the November-December time period (Faunce et al. 2015, NMFS 2015b). Participation by fishers in vessel-selection appears less successful during the November-December time period. While only one EM vessel in 2016 fished during this time, it represented the entire stratum, had no chance of being selected, and no data were obtained.

The dual selection process for EM in 2016 resulted in more vessels selected for coverage than planned by the EMWG. Figure 4 shows how the number of vessels selected for coverage was increased by the EM Voluntary 100% vessels, and that all of these were successfully monitored. One vessel that had been selected to be monitored during the March-June time period had EM data reviewed two weeks into the next time period. It is assumed that the EM equipment was not removed prior to the start of fishing by this vessel in the July-October time period. This resulted in one extra vessel having EM data reviewed than was selected for coverage during July-October (Fig. 4). In a regulated EM program, it is questionable whether this data would be reviewed (or paid for) since it would likely not be used in catch accounting.

Coverage Rates for Dockside Monitoring

Observers were assigned to monitor deliveries of walleye pollock (*Gadus chalcogrammus*). The objective of this monitoring was to obtain a count of the number of salmon caught as bycatch and to obtain genetic samples from these fish in each observed pollock delivery. There have been many iterations of the sampling design used to obtain genetic samples from salmon bycatch for the purposes of stock of origin (Faunce 2015). The sampling design used for this objective in 2016 remained unchanged from that used since 2011; all deliveries of walleye pollock that are 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 2015c). For this analysis, pollock deliveries are defined as any delivery where the predominant species is pollock in *e*Landings (i.e., CAS assigned trip target = B or P = pollock). However, because trip target cannot be easily assigned for tender trips, our evaluation of this deployment objective is conducted at the level of the each delivery.

Given the design, the level of dockside observation of walleye pollock deliveries should be 100% in the full coverage category, and within acceptable tolerance of the deployment rate of 28.31% in the partial coverage category (since all trawl catcher vessels in partial coverage participating in this fishery are within the *TRW* stratum). Unbiased estimates of salmon stock of origin should arise from samples of individual fish obtained from samples of pollock deliveries given randomization protocols. However, a random sample of pollock deliveries is not always possible from the partial coverage fleet because of tendering activity (NPFMC 2016b). This activity occurs when a vessel delivers caught fish to a tender and that tender vessel then delivers the fish to a shoreside processing plant. Since tender vessels can provide fuel and food, it is possible that a catcher vessel can remain at sea on a single trip for the entire season. If that trip were logged into ODDS and not selected, the vessels' entire season activity would not be observed (it is also possible the vessels' entire season activity is observed).

The relative impact of tendering activity can be illustrated by comparing the observer coverage rates by port for all pollock deliveries to those without tender deliveries. As expected, all pollock deliveries were observed in full coverage. In contrast, the chance that the coverage rate achieved in partial coverage resulted from a random deployment at the expected rate (28%) was extremely small (Percent observed = 19.6%; exact binomial test p-value < 0.001; Table 7). When tendered deliveries of pollock were removed, this probability did not increase despite an increase in the percent observed (Percent observed = 24.5%; p-value < 0.001; Table 7). All of the pollock deliveries in the port of King Cove from the partial coverage category were tender deliveries and none of these were observed (Table 7).

The results of dockside monitoring from 2016 represent the third year in which the observer program failed to obtain a random sample of partial-coverage trawl deliveries due to tendering activity. Over the past 3 years, tendering activity in this class of deliveries has changed from predominantly to exclusively within the port of King Cove (Faunce et al. 2015, NMFS 2015b, Faunce et al. 2016, NMFS 2016a, this report). However, while a random sample under expected rates was achieved for non-tender partial coverage pollock deliveries from King Cove in 2015, in 2016 zero deliveries out of 322 were observed from King Cove (Table 7). These results have impacts for both in-season management of bycatch caps and the collection of genetic samples. 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), 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 Auke Bay Laboratories of the AFSC (e.g., Guthrie et al. 2017).

It is clear after 3 years of consistent results that the observer methods to monitor salmon bycatch are not achieving their goal of achieving a representative sample from all pollock trawl deliveries in the fleet. This is especially problematic since Chinook salmon bycatch in the trawl fishery are fully utilized and error tolerance is low.

SAMPLE QUALITY

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; acceptable bounds on the number of observed trips were defined as the 0.025 and 0.975 quantiles from the normal approximation of the binomial distribution (the 95% "confidence bounds"). Under the assumption that there is no temporal bias in observer coverage, 2.5% of values should be larger than upper bound and 2.5% should be smaller than the lower expected bounds. The number of observed trips achieved was outside of their expected values on 46 days and all of these occurred in the *TRW* stratum with selection rates higher than expected (0.06%; Fig. 5). For comparison, in 2015 this occurred for 0.60% of the year (Faunce et al. 2016, NMFS 2016a). Results from the exact binomial test suggest that observed rates at the end of the year were within the expectation for all strata (*HAL* stratum expected rate = 0.15, realized rate = 0.15, p-value = 0.57; *POT* stratum expected rate = 0.15, realized rate = 0.15, p-value = 0.61; *TRW* stratum expected rate = 0.28, realized rate = 0.28, p-value = 0.75; Fig. 5). Based on these combined results, there is no evidence of temporal bias in 2016.

Spatial Patterns in Trip-Selection

Under a strictly random selection of trips and with a large enough sample size, the spatial distribution of selected trips should reflect the spatial distribution of all trips. The hypergeometric distribution was used to calculate the probability of observing a minimal number of trips within a stratum and NMFS area given the sampling rate and the distribution of trips across NMFS Reporting Areas based on landings data. The expected number of trips based on this distribution is the number of trips selected divided by the total number of trips (= sample rate) multiplied by the number of trips that fished in an area (observed and unobserved). This evaluation does not test whether the resulting coverage rate in a NMFS Area for a stratum is equal to the stratum selection rate, but instead tests whether the resulting coverage rate in a NMFS Area for a stratum is unexpected compared to the stratum-wide realized observation rate.

Using this method, we compared the expected number of trips and the observed number of trips in each NMFS Reporting Area and stratum combination (Fig. 6). The shade of the data points in Figure 6 indicates whether the point is unusual (higher or lower than expected). Darker data points indicate an observed number of trips or vessels that is increasingly unlikely given randomized observer deployment. For the purposes of discussion, areas with probabilities less than 0.05 are considered "low-p" areas.

The HAL Stratum

Given that there were 18 NMFS Areas fished in *HAL*, we would expect there to be $0.05 \times 18 = 1$ low-p area for this stratum. There were two. The percent of trips observed among NMFS Areas in this stratum ranged from 0% to 20.4% (median = 14.7%, Fig. 7). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 8. 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.

The POT Stratum

Given that there were nine NMFS Areas fished in *POT*, we would expect there to be $0.05 \times 9 = 0$ low-p areas for this stratum. There was one. The percent of trips observed among NMFS Areas in this stratum ranged from 0% to 100% (median = 15.1%, Fig. 9). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 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* stratum.

The TRW Stratum

Given that there were six NMFS Areas fished in *TRW*, we would expect there to be 0.05 × 6 = 0 low-p areas for this stratum. There was one. The percent of trips observed among NMFS Areas in this stratum ranged from 22.8% to 29.8% (median = 25.8%, Fig. 11). The probability of these coverage rates or rates that deviated further from expected values is depicted in Figure 12. 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* stratum.

Trip Metrics

This section is focused on answering four questions related to the deployment of observers: 1) Are observed trips identical to unobserved trips?, 2) Are tendered trips identical to non-tendered trips?, 3) Are observed tendered trips identical to unobserved tendered trips?, 4) Are observed non-tender trips identical to unobserved non-tender trips?

Permutation tests (a.k.a., randomization tests) were used to answer each question. Each test evaluates the question "How likely is the difference we found given 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., observed and unobserved). Difference values in all permutation tests 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 tendering effect would be the mean value for non-tendered trips subtracted from the mean value for tendered 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 are run for each 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 rare events and provide evidence to reject the null hypothesis of equality. In an attempt to improve clarity, although five values are calculated in each test; 1) the difference between groups, 2) the mean difference between groups from randomized trials, 3) number 1 expressed as a percentage of the mean value of the metric being tested, 4) number 2 expressed as a percentage of the mean value of the metric being tests, and 5) the p-value of the test, only numbers 1, 3 and 5 are presented in relevant tables.

Six trip metrics were examined in each permutation test. These metrics include: 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 landed catch that was due to the most predominant species (pMax). The metric vessel length is used to help interpret the results from landed weight of 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 is an observer 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 1 would indicate that only the predominant (and presumed desirable) species was landed.

Since there are six metrics within each permutation test, and each is evaluated to be unusual if the p-value is < 0.05, we would expect by random chance to have $0.05 \times 6 = 0.3$ tests to have low p-values.

Are Observed Trips Identical to Unobserved Trips?

This comparison is the basis for examining if there is an observer effect (i.e., differential behavior when observed compared to when not observed) within all partial coverage trips. Sample sizes for this test are presented in Table 8.

Of the six metrics compared in the *HAL* stratum, four had low p-values. Observed trips in this stratum were 6.1% (0.3 days) shorter in duration, occurred on vessels 2.5% (1.4 feet) longer in length, landed 7.6% (0.3) more species, and landed catch that weighed 9.6% (0.7 tons) less than unobserved trips (Table 9).

Of the six metrics compared in the *POT* stratum, one had low p-values. Observed trips in this stratum landed 8.2% (0.2) fewer species than unobserved trips (Table 9).

Of the six metrics compared in the *TRW* stratum, three had low p-values. Observed trips in this stratum were 12.8% (0.3 days) shorter in duration, landed 15.5% (0.8) fewer species, and landed catch that weighed 10.1% (8.4 tons) less than unobserved trips (Table 9).

A visual depiction of individual results of this permutation test is given in Figure 13 for illustration purposes. Based on these results, we conclude that observer effects were present in the *HAL* and *TRW* strata at the sampling rates achieved in 2016.

Are Tender Trips Identical to Non-Tender Trips?

This comparison is the basis for examining if there is a tendering effect (i.e., differential trip characteristics when vessels use tenders compared to when they do not) under the null hypothesis tendered and non-tendered trips are the same. Sample sizes for this test are presented in Table 10. Permutation tests were not evaluated for this question in *HAL* since there were only three tendered trips in this stratum.

Of the six metrics compared in the *POT* stratum, four had low p-values. Trips in this stratum that delivered to a tender were 38.4% (1.4 days) longer in duration, occurred on vessels 16.7% (11.7 ft) shorter in length, landed 39.2% (0.8) more species, and landed catch that weighed 42.6% (13.6 t) more than trips that did not deliver to a tender (Table 11).

Of the six metrics compared in the *TRW* stratum, five had low p-values. Trips in this stratum that delivered to a tender occurred in 8.2% (0.1) fewer areas, were 27.9% (0.7 days) longer in duration, occurred on vessels 30.3% (24.7 ft) shorter in length, landed 17% (0.9) fewer species, and landed catch that was 7.1% less diverse than trips that did not deliver to a tender (Table 11).

A tendering effect was evident in 2016 in *POT* and *TRW*; trips that delivered to a tender were not the same as trips that did not deliver to a tender.

Are Observed Tendered Trips Identical to Unobserved Tendered Trips?

The finding that tendered trips are different from non-tendered trips necessitates separate examination of an observer effect within tendered and non-tendered trips. This comparison is the basis for examining if there is an observer effect (i.e., differential behavior when observed compared to when not observed) within tendered trips. Sample sizes for this test are presented in Table 12. Permutation tests were not evaluated for this question in *HAL* since there were only 3 unobserved and 0 observed tendered trips in this stratum.

Of the six metrics compared in the *POT* stratum, one had low p-values. Observed trips in this stratum that delivered to a tender occurred in 16.2% (0.2) more areas than unobserved trips that delivered to a tender (Table 13).

Of the six metrics compared in the *TRW* stratum, three had low p-values. Observed trips in this stratum that delivered to a tender were 87.9% (2.9 days) shorter in duration, landed 15.9% (0.7) fewer species, and landed catch that weighed 69.5% (59.0 tons) less than unobserved trips that delivered to a tender (Table 13).

From the above results, we conclude that there is evidence of an observer effect within trips that delivered to tenders in the *TRW* stratum in 2016.

Are Observed Non-Tendered Trips Identical to Unobserved Non-Tendered Trips?

This comparison is the basis for examining if there is an observer effect (i.e., differential behavior when observed compared to when not observed) within non-tendered trips. Sample sizes for this test are presented in Table 14.

Of the six metrics compared in the *HAL* stratum, three had low p-values. Observed non-tendered trips in this stratum were 6% (0.3 days) shorter in duration, occurred on vessels 2.5% (1.4 ft) longer in length, and landed 7.5% (0.3) more species than unobserved non-tendered trips (Table 15).

Of the six metrics compared in the *POT* stratum, there were no metrics with low p-values (Table 15).

Of the six metrics compared in the *TRW* stratum, two had low p-values. Observed non-tendered trips in this stratum occurred on vessels 3.2% (2.7 ft) longer in length and landed 14.2% (0.8) fewer species than unobserved non-tendered trips (Table 15).

For comparison, this analysis was performed by gear type in 2014 but not in 2015. In those tests, *HAL* landed 14.4% less catch and 9.1% more species when observed than when unobserved (Faunce et al. 2015, NMFS 2015b). Landing reports from hook-and-line gear trips may be under-reporting species, or observed trips are occurring differentially in some fisheries with greater diversity, since under-reporting of species has been repeatedly found. Consistent differences between observed and unobserved trips from trawl vessels in 2014 and 2016 were also evident. Trawl trips in 2014 fished in 4.2% fewer areas and had trips that were 8.4% shorter in duration than unobserved trips (Faunce et al. 2015, NMFS 2015b). It appears that trawl vessels fish in fewer areas when observed than when unobserved; however, the nature of this potential bias has yet to be explored. Taken together, it appears that while an observer effect was present within the *HAL* and *TRW* strata in 2016, the magnitude of such biases is small. Nonetheless, the consistent differences in species landed in *HAL* and areas fished in *TRW* warrants further examination. The fact that both strata fished for shorter durations but had similar catches is evidence of an observer effect within non-tendered *HAL* and *TRW* trips in 2016.

Gear, Tender, and Observed Status Combinations

One of the first analyses presented in the 2013 Annual Report was a comparison of trip durations for combinations of observed and tendered status by stratum (Faunce et al. 2014, NMFS 2014b). The rationale for this plot and focus on this metric was because of the concern that tendered trips were longer than non-tendered trips and therefore were being avoided for observer coverage. Frequency distributions showed that tendered trips had a long right tail compared to non-tendered trips, and that there were few observed trips in that long right tail (Faunce et al. 2014; Fig. 14). The OSC concluded that there were no major differences between observed and unobserved tendered trips based on the fact that there were observed trips (however few) in those long duration tendered trips. Since 2013, permutation tests have replaced these frequency plots. However, these permutation tests do not visually map the data for observed and tendered states together. To accomplish this, a plot of the trip durations for these states is included as Figure 14. While tendered trips can be as long as a month, there appears to be a lack of observed tendered trips within trawl gear. Whether this is due to an observer effect through intentional manipulation of trips (facilitated by the flexibility in ODDS and the current trip definitions, or by vessel behavior in the *TRW* pollock partial coverage fleet), the structure of the data (observed trips and trips with VMS are shortened since all unobserved non-VMS deliveries to a tender are lumped into the same trip), or simply low sample size is unknown.

ADEQUACY OF THE 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 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 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.

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. The fishing effort data for each stratum and the number of observed trips over the course of 2016 was used to illustrate their combined effect on the probability of a NMFS Area containing observer data using the hypergeometric distribution (Fig. 15). From this figure it can be seen how 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 three partial coverage trip-selection strata, the probability of having no observed trips in a NMFS Reporting Areas increases quickly above 0.05 when there are fewer than 18 trips in the *HAL* stratum, 19 trips in the *POT* stratum, and 9 trips in the *TRW* 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 observer data of that character (post-strata of the CAS).

Response to 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 address comments made by the SSC (in italics) in response to the presentation of the 2015 Annual Report made at the June 2016 Council meeting.

The SSC offered the following comments and recommendations to the Council:

The SSC agrees with all of the recommendations of the Observer Science Committee (OCS) and NMFS, some of which are mentioned and expanded on below.

The analysts were very responsive to SSC comments made on the 2014 Annual Report and provided a section in the 2015 report to specifically address each SSC comment made. The SSC appreciates this attention to our recommendations and logging of responses by the analysts.

Thank you.

The SSC agrees with the analysts' choice of permutation tests for assessing differences between attributes of observed and unobserved trips. This method of statistical testing is appropriate for assessing potential bias in realized observer deployments. However, we note that the outcomes of the permutation tests depend on the assumption that data arise from a random sample, which in some instances may not be the case.

We appreciate the input of the SSC on these tests. The permutation tests used in this Review are a special application that does not depend on the assumption that data arise from a random sample. The permutation tests used in this Review contain the entire population of trips where the observed group is the sample. The goal of the permutation test is to assess whether or not the sample is representative of the total population.

As stated previously by the SSC concerning the 2017 Annual Deployment Plan, we agree with the analysts' decision to change stratification to three gears (trawl, pot, hook-and-line) instead of two vessel lengths. Trip selection will continue as the sole basis for random assignment of observers to vessels in 2016.

Six trip-selection strata (3 gears by tendering activity) were incorporated into the 2017 ADP.

The SSC continues to recommend that sampling issues and bias that arise with tendered trips be addressed. We realize that regulatory action may not be practical to implement and agree with the analysts' decision to place tendered trips in a separate stratum for estimation. We look forward to seeing how this approach to stratification will address the potential for bias in the draft Annual Deployment Plan for 2017.

The OSC recommended that tendering activity be incorporated into stratum definitions to be declared by fishers before a trip began for the 2017 ADP. Based on this input and support from the SSC, NMFS and the Council adopted a deployment design with six strata (3 gears × tendering activity) for the 2017 ADP. In a preliminary assessment of deployment, from 1 January to 8 March 2017, there were 128 potential trip logging errors reported by FMA to OLE. Of these trip logging errors, 106 indicated that the type of tender trip was entered incorrectly. For context, the highest number of reported trip logging errors since trip-selection began has been 136 for the entire year (2015). There were no changes to the way trips are entered between years. In 2016, tendering activity within the trawl pollock fleet was almost exclusively within the port of King Cove and none of these trips were observed. Results and an evaluation of trip logging and observation rates from 2017 will be included in the 2017 Annual Deployment Review that is scheduled to be presented to the Council in June of 2018.

The report detailed continuing problems associated with trip cancellation in the Observer Declare and Deploy System (ODDS). We agree with the recommendation of the OSC to allow the date of a logged trip to be changed rather than cancelling the trip as way to perhaps reduce temporal bias due to delay in observed trips.

We agree with the SSC on this issue and continue to recommend this be addressed.

The SSC continues to recommend that methods to link data from the ODDS to the e-Landings system be developed.

We agree with the SSC on this issue and continue to recommend this be addressed. There has been a slow (but steady) effort by the NMFS to nudge industry towards greater participation in providing these data. Data entry fields to facilitate greater linkage now exist in both ODDS and *e*Landings, but their completion in *e*Landings remains voluntary, and in ODDS is not rigorously enforced (manual entry is allowed). Due to discrepancies in ODDS number and Report ID data in both systems, analyses that require matching landings data with trips selected for observing will continue to rely on using fuzzy matching or other algorithms that make similar assumptions or bypass the linking fields entirely.

Continuing work to improve the sampling design and to provide estimates of variance needs to consider the linkage between the sampling design (i.e., level of stratification and sampling rate) and the needs of management (e.g., precision and accuracy needed for estimation of PSC or discards in particular areas and/or fisheries).

OSC members are participating in this ongoing work. However, this issue is beyond the scope of the Annual Deployment Performance Review.

The SSC expressed concern about continuing delays in the release of collected observer fees by the Treasury and the Office of Management and Budget (OMB). These delays have the potential to negatively impact observer provider contracting and thereby adversely impact data collection and strata coverage. We join the OSC in recommending that the Council re-emphasize to NMFS leadership that the timeliness of OMB's release of fees collected from harvesters and processors is important to the success of the partial coverage program.

While we agree with the SSC in their concern, this issue was not recommended by the OSC since it is beyond the scope of the Annual Deployment Performance Review.

The SSC offered the following recommendations to the Observer Program:

Evaluate performance relative to the success of observer deployments. Specifically, improve the system for logging complaints by observers so that differences in trip metrics associated with trips where there were observer complaints versus those without complaints can be evaluated.

While some progress has been made on redesigning the infrastructure pertaining to potential violations reported by observers and the OLE, this project remains largely stalled due to a lack of resources; currently there are more than 13 projects listed as analytical priorities for the observer program by the Council. Staff are fully tasked to other projects that include electronic monitoring, maintenance of observer program data architecture, calculating variance, etc.

As a potential deterrent to issues with compliance, consider publishing a list of vessels that are repeat offenders of specific complaints as logged by observers.

This is beyond the scope of the Observer Science Committee. We understand that this has been forwarded to the observer program and to the Office of Law Enforcement.

The SSC requested that the following analyses be added to the list of analytical tasks:

Many of these recommendations are beyond the scope of this review by the Observer Science Committee. Below we have limited our comments to those which are relevant to observer and EM deployment.

Address issues with estimation of discards in the directed halibut fishery as detailed in issue #1 of public comment from the IPHC.

Use data from the 100% observer coverage fleets to conduct simulations with various levels of sampling rate to assess practical constraints to precision and accuracy of partially observed fisheries, with particular attention paid to estimation of rare events and PSC.

While this is beyond the scope of this document, some of this work has already been completed and can be found in Cahalan et al. (2015a).

Once estimates of variance are available, discuss and evaluate the potential for development of accuracy and precision objectives for key estimated quantities with stock assessment authors.

While this is beyond the scope of this document, draft variance estimates were presented to the SSC in June 2015 and have been published elsewhere (Cahalan et al. 2015b). Work is ongoing to program variance calculations into the catch accounting system to make them available for assessment authors on an annual basis.

Non-representativeness of the observed trips relative to all fishing (as evidenced by the permutation test results) is a problem for simple interpretation of the variance estimates being developed. The potential for bias in the expectations and/or variance estimates will remain as long as there are nonrandom differences in the properties of the observed and unobserved trips and this should be evaluated.

We agree. This report evaluates whether there are nonrandom differences in the properties of the observed and unobserved trips (see section on Trip Metrics in this report).

Report on the full workflow from strata-level observer data collection to information support for fishery stock assessments.

While this is beyond the scope of this Annual Deployment Performance Review, the workflow of catch estimation can be found in Cahalan et al. (2014). The workflow for biological data collection is found in Annual North Pacific Fishery Observer Manuals (e.g., AFSC 2016).

OSC Recommendations to Improve Data Quality

The Observer Science Committee made the following recommendations in its 2015 review of observer deployment to be considered in developing the 2017 ADP (NMFS 2016b). Following each italicized recommendation is the outcome of that recommendation.

Recommendations from the 2016 Annual Deployment Review

The Observer Science Committees recommendations to improve the 2017 ADP are as follows:

The OSC recommends that tendered vessels be addressed differently in future ADPs. In any proposed solution to this issue, particular attention must be paid to ensure the safety of observers.

- *Tendered trips should be evaluated as separate strata in future ADPs.*
- *There is not a way to identify the duration of fishing trips made by catcher boats delivering to tenders without an observer or VMS on-board. The OSC recommends that NMFS and Council address this data gap. The OSC supports the continued expansion and implementation of tLandings.*

The OSC reiterates our 2014 recommendation that the expansion of the pool of partial coverage catcher processors warrants their treatment as separate strata in future ADPs.

The Draft 2017 ADP analyzed the performance of alternative sampling designs defined by gear and tender or non-tender deliveries, and partial coverage catcher-processor strata (Faunce 2016, NMFS 2016b). The designs were evaluated using gap analysis (i.e., exploring situations where no observer data would be available). The gap analysis was used to determine which sampling designs would have a 50% probability of having at least one and three observed trips. The gaps associated with each design were compared to provide a relative ranking of sampling designs. The gap analysis found that gear and tender/non-tender stratification scheme more often outperformed the gear and partial coverage catcher-processor stratification scheme for inclusion in the 2017 ADP (Faunce 2016, NMFS 2016b).

Three observed trips are needed to calculate variance. The OSC recommends that sampling rates in future ADPs be high enough in each stratum to maximize the probability of achieving three observed trips in each NMFS Area. In simulated sampling evaluations of 2014 data, most observer data gaps disappeared or were severely minimized at deployment rates greater than or equal to 15% (relative to a 50% probability of a post-strata being empty; NMFS 2015c, p. 98). In 2015, selection rates in the t *stratum were 12%, and an actual observation rate of 11.2% was achieved. At this level of coverage numerous NMFS Areas without any observer coverage resulted. The temporal bias present in the T stratum in 2014 when selection rate was 15% was no longer present in 2015 when selection rates were set at 24%.*

The selection rate that can be afforded in the coming year depends on the amount of fishing that is expected to occur and the available budget. The budget for 2017 was set so that the ADP was economically solvent without Federal Funds through June 16, 2020, given stable fee collection funding each year and a fixed travel budget. The ADP deployment budget set for 2017-2019, while promoted as stable, represents a 33.2% decline from the number of days observed in 2016 (4,677) due to a halt of Federal funding for observer deployment. Sample allocations among strata were set following optimization routines based on discarded catch, retained catch, and a blend, or compromise of discard and retained optimal designs (Faunce 2016). The NMFS selected the design defined by gear by tender stratification and optimal allocation based on discarded catch. Resulting selection rates were programmed into ODDS for 2017 (anticipated number of observed trips provided for context): Hook-and-line Non-Tender trips - 11.1% (288), Hook-and-line Tender trips - 25% (2), Pot trips - 3.9% (32), Pot Tender trips 3.9% (6), Trawl trips 17.6% (433), Trawl Tender trips 14.3% (24) (NMFS 2016b).

The OSC recommends that NMFS should work with its partial coverage contractor and the OAC to explore the possibility of eliminating the ability to cancel a trip in ODDS, since the ability to change dates is already facilitated.

This recommendation was not pursued by the NMFS.

Recommendations to Improve Data Quality and Guide the 2018 ADP

1. **The OSC reiterates its 3-year recommendation that the NMFS improve the linkages between ODDS and *e*Landings** (OSC recommendation for 2013, 2014, 2015 version of this Review).

2. **The OSC reiterates its 2-year recommendation that the NMFS explore ways to reduce the impact of cancellations on the number of trips selected for observer coverage in the ODDS.** This may be accomplished in a variety of ways that include, but are not limited to the following: reducing the number of trips that can be logged in advance (OSC recommendation from the 2014 and 2015 version of this Review), and/or reducing the incentive or ability to cancel trips selected for observer coverage or electronic monitoring.
3. **The OSC recommends an alternative model of monitoring salmon bycatch be explored in the partial coverage fleet.** Salmon bycatch in some fisheries constrains the catch of target species. Salmon are relatively rare in catches and are difficult to detect by observers or cameras. These factors can lead to imprecise catch estimates. For 3 years of deployment performance review, the observer program has been unsuccessful in achieving its goal of obtaining an unbiased sample from the pollock trawl fleet for enumerating salmon bycatch and determining stock of origin (see section on Coverage Rates for Dockside Monitoring in this report). A solution is to require full retention of salmon and full monitoring at the point of delivery. This solution could be achieved by prohibiting vessels that deliver to tenders from discarding salmon at sea, monitoring those vessels and associated tenders for compliance with electronic monitoring, and observing or monitoring all tender deliveries at the plant.
4. The OSC has three recommendations concerning future at-sea coverage rates for observers (and potentially monitoring):
    a. **We reiterate our recommendation from last year that sampling rates in future ADPs be high enough in each stratum to maximize the probability of achieving three observed trips in each of the NMFS Areas (under funding constraints).** Based on the results of the draft 2017 ADP, the best design for achieving this goal would have been a strict three gear stratification. The results of this Review reinforce the results of simulated sampling evaluations of 2014 data that showed that most observer data gaps disappeared or were severely minimized at deployment rates greater than or equal to 15% (relative to a

50% probability of a post-strata being empty; NMFS 2015c, p. 98). It must be noted that the total number of observer days afforded by the Agency for the 2017 ADP has resulted in ODDS selection rates in most strata that are below those shown to result in spatial and temporal bias in past versions of this report regardless of the optimized allocation used. The comparatively low coverage rates in 2017 compared to 2013-2016 will affect our ability to interpret the results of the analyses in this Review with much certainty since power of test is a function of sample size.

b. **The OSC recommends that future ADPs include in each proposed sampling design sample allocation that is proportional to fishing effort (equal rates among strata).** This should be accomplished by adopting a 'hurdle model' approach to sample allocation in future ADPs, whereby if the total sample size (observer days) is insufficient to observe all strata at a 15% coverage rate of trips, then allocation of observer days among strata defaults to proportional to effort (all strata get equal coverage rates).

c. The OSC recommends that the SSC and Council request NMFS reinstate its funding for observer deployment in the North Pacific at levels necessary to ensure a minimum of 15% coverage among all strata in upcoming ADPs. If the critical 15% coverage rate is surpassed among all strata combined, then sampling days afforded in excess of this amount may be allocated among strata according to an optimization algorithm.

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TABLES

Table 1. -- Comparison between predicted and actual trip days for partial coverage strata in 2016. Predicted values come from the 2016 Annual Deployment Plan (ADP).

Strata	Predicted number of trip days in ADP	Actual number of trip days	% Difference from predicted
POT	4,403	4,622	4.97
HAL	13,144	13,493	2.66
TRW	7,773	7,192	-7.47
Total	25,320	25,307	-0.05

Table 2. -- Trip cancellation rates in the ODDS for 2016. 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)
BSAI Cod 100% Voluntary Coverage	Selected	141				0	
Declared Gear - Longline	Not Selected	2,394				0	
	Selected	452	1	451	108	0	23.9
Declared Gear - Pot gear	Not Selected	1,141				0	
	Selected	190	0	190	48	0	25.3
Declared Gear - Trawl	Not Selected	2,023				0	
	Selected	802	0	802	127	0	15.8
Total		7,143	3	7,140	283	0	4.0

Table 3. -- Number of remaining trips after cancellation in each trip-selection strata (*TRW*, *HAL*, and *POT*) 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)
Declared Gear - Longline	2,274	343	73	13	403	18.1	3.1
Declared Gear - Pot	1,158	142	31	6	167	18.6	3.5
Declared Gear - Trawl	2,518	675	69	0	744	9.3	0.0

Table 4. -- Number of logged trips in each trip-selection strata (*TRW*, *HAL*, and *POT*) that were selected using the initial random number generator (Random Selection Only) and those that remained after user manipulation (Final Expected). The relative impact of waivers in trip-selection is also shown (No Waivers).

Strata	Trip Disposition	Selected trips	Total trips	Actual selection (%)	Programmed selection (%)	p-value (H0: actual = programmed)
Declared Gear - Longline	Initial Random Selection, *a*	452	2,846	15.88	15.41	0.483
	After Cancellations, *b* (*a-b*)	343	2,274	15.08	15.41	0.684
	With Inherits, *c* (*a-b+c*)	416	2,274	18.29	15.41	0.000
	After Cancellations, with Inherits and Waivers, *d* (*a-b+c-d*)	403	2,274	17.72	15.41	0.003
Declared Gear - Pot gear	Initial Random Selection, *a*	190	1,331	14.27	15.24	0.341
	After Cancellations, *b* (*a-b*)	142	1,158	12.26	15.24	0.004
	With Inherits, *c* (*a-b+c*)	173	1,158	14.94	15.24	0.806
	After Cancellations, with Inherits and Waivers, *d* (*a-b+c-d*)	167	1,158	14.42	15.24	0.462
Declared Gear - Trawl	Initial Random Selection, *a*	802	2,825	28.39	28.31	0.933
	After Cancellations, *b* (*a-b*)	675	2,518	26.81	28.31	0.097
	With Inherits, *c* (*a-b+c*)	744	2,518	29.55	28.31	0.170
	After Cancellations, with Inherits and Waivers, *d* (*a-b+c-d*)	744	2,518	29.55	28.31	0.170

Table 5. -- Number of total vessels (V), sampled vessels (v), total trips (N), sampled trips (n) for each stratum and observer deployment method (vessel and trip-selection) in 2016. When trip-selection is used as the Deployment Method, the Expected, Minimum Expected, and Maximum Expected Coverage columns are expressed as percentages. When vessel-selection is used as the Deployment Method, the Expected, Minimum Expected, and Maximum Expected Coverage columns are numbers of vessels. Fleet totals are reported with and without Electronic Monitoring (EM) since EM data were not used for catch estimation in 2016.

Coverage	Strata	Deployment method	Time period	V	v	N	n	% Observed by deployment method	Expected coverage	Minimum expected coverage	Maximum expected coverage	Meets expectations?
Full	Regulatory	Trip	Year	170	170	4,579	4,579	100.0	100.0			Yes
Full	Voluntary	Trip	Year	23	23	137	137	100.0	100.0			Yes
Full Coverage Total		Trip	Year	172	172	4,716	4,716	100.0				
Partial	HAL	Trip	Year	466	244	2,655	398	15.0	15.4	13.7	16.4	Yes
Partial	POT	Trip	Year	113	73	1,261	185	14.7	15.2	12.8	16.7	Yes
Partial	TRW	Trip	Year	85	82	2,738	767	28.0	28.3	26.3	29.7	Yes
Gear-based Total		Trip	Year	595	365	6,654	1,350	20.3				
Partial	Zero Coverage	Trip	Year	418	0	2,079	0	0.0	0.0			Yes
Partial	Zero Coverage EM Research	Trip	Year	3	0	30	0	0.0	0.0			Yes
Zero Coverage Total		Trip	Year	421	0	2,109	0	0.0				
Partial	EM Voluntary 100%	Vessel	Mar-Jun	7	4	26	16	57.1	7			No
Partial	EM Voluntary 100%	Vessel	Jul-Oct	9	5	25	6	55.6	9			No
Partial	EM Voluntary 100%	Vessel	Nov-Dec	1	0	10	0	0.0	1			No
Partial	EM Voluntary 30%	Vessel	Jan-Feb	4	2	22	11	50.0	1	0	3	Yes
Partial	EM Voluntary 30%	Vessel	Mar-Jun	28	10	93	33	35.7	8	4	13	Yes
Partial	EM Voluntary 30%	Vessel	Jul-Oct	16	6	51	10	37.5	5	1	9	Yes
EM Voluntary Total		Vessel	Year	42	24	227	76	57.1				
Total Fleet (with EM coverage)	Total			1,172	514	13,706	6,142	44.8% Trips; 43.9% Vessels				
Total Fleet (without EM coverage)	Total			1,172	490	13,706	6,066	44.3% Trips; 41.8% Vessels				

Table 6. -- Vessel-selection rates in EM Voluntary strata expressed as percentages (all rate formulations multiplied by 100). Abbreviations follow Table 1 in the Appendix.

Row	Metric	Jan-Feb	Mar-Jun	Jul-Oct	Nov-Dec
1	Error in 30% selection frame due to over-coverage (% of sample frame); fN/F	0.0	0.0	0.0	0.0
2	Error in 30% selection frame due to under-coverage (% of true frame); f0/f*	0.0	20.0	38.5	100.0
3	Error due to non-response: selected and did not fish; vN/vS	0.0	0.0	0.0	0.0
4	Error due to non-response: Selected, fished, and not observed; (vF-v)/vF	0.0	0.0	-10.0	0.0
5	Percent chance of random selection if in 30% selection frame and fished; vS_30/fY	50.0	35.7	37.5	0.0
6	Percent chance of selection if not in 30% selection frame and fished; vS_100/f0	0.0	57.1	40.0	0.0
7	Percent coverage planned; vT/f*	50.0	31.4	30.8	100.0
8	Percent coverage achieved; v/f*	50.0	40.0	42.3	0.0

Table 7. -- The number of pollock deliveries by observation and tendering status. The '% Observed' column is the percent of all deliveries observed (including tendered deliveries), while the '% Observed Non-tendered' is the percent of non-tendered deliveries observed. For partial coverage, the p-values for 'Deliveries Observed' and 'Deliveries Observed Non-tendered' show the probability that the achieved rates came from random deployment at the expected rate (28%). IFP: Inshore Floating Processor, Hbr: Harbor.

FMP	Coverage category	Port	Total deliveries (*N*)	Observed deliveries (*n*)	% Observed	p-value deliveries observed	% Tender deliveries	% Observed non-tendered	p-value deliveries observed non-tendered
Bering Sea	Full	Akutan	751	751	100.0		0.0	100.0	
	Full	Dutch Hbr.	806	806	100.0		0.0	100.0	
	Full	IFP	339	339	100.0		0.0	100.0	
	Full	King Cove	79	79	100.0		0.0	100.0	
	Full	Sand Point	5	5	100.0		0.0	100.0	
Total	Full		1,980	1,980	100.0		0.0	100.0	
Gulf of Alaska	Partial	Akutan	158	47	29.7		1.9	30.3	
	Partial	Dutch Hbr.	7	4	57.1		0.0	57.1	
	Partial	IFP	29	2	6.9		0.0	6.9	
	Partial	King Cove	322	0	0.0		97.5	0.0	
	Partial	Kodiak	1,097	315	28.7		0.0	28.7	
	Partial	Sand Point	560	58	10.4		21.2	12.9	
Total	Partial		2,173	426	19.6	< 0.001	20.1	24.5	< 0.001

Table 8. -- Number of trips by observation status in the 2016 trip-selection strata.

Strata	Observed	Unobserved
HAL	398	2,257
POT	185	1,076
TRW	767	1,971

Table 9. -- Results of permutation tests between observed and unobserved trips in the 2016 trip-selection strata. OD: Observed Difference (Observed - Unobserved).

Strata	Metric	NMFS areas	Days fished	Vessel length (ft)	Species landed	pMax species	Landed catch (t)
HAL	Observed difference	0.0	-0.3	1.4	0.3	0.0	-0.7
	OD (%)	1.3	-6.1	2.5	7.6	-0.5	-9.6
	p-value	0.522	0.027	0.030	0.013	0.521	0.037
POT	Observed difference	0.0	-0.1	0.5	-0.2	0.0	-2.0
	OD (%)	2.1	-1.5	0.6	-8.2	0.2	-6.3
	p-value	0.234	0.706	0.809	0.033	0.243	0.428
TRW	Observed difference	0.0	-0.3	0.3	-0.8	0.0	-8.4
	OD (%)	-2.9	-12.8	0.4	-15.5	2.6	-10.1
	p-value	0.019	< 0.001	0.691	< 0.001	< 0.001	< 0.001

Table 10. -- Number of trips by tendered status in the 2016 trip-selection strata.

Strata	Tendered	Non-tendered
HAL	3	2,652
POT	132	1,129
TRW	272	2,466

Table 11. -- Results of permutation tests between tendered and non-tendered trips in the 2016 trip-selection strata. Results for *HAL* have been omitted due to low sample sizes. OD: Observed Difference (Tendered - Non-tendered).

Strata	Metric	NMFS areas	Days fished	Vessel length (ft)	Species landed	pMax species	Landed catch (t)
POT	Observed difference	0.0	1.4	-11.7	0.8	0.0	13.6
	OD (%)	0.5	38.4	-16.7	39.2	-0.2	42.6
	p-value	0.856	< 0.001	< 0.001	< 0.001	0.400	< 0.001
TRW	Observed difference	-0.1	0.7	-24.7	-0.9	0.1	2.3
	OD (%)	-8.2	27.9	-30.3	-17.0	7.1	2.8
	p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.477

Table 12. -- Number of tendered trips by observation status in the 2016 trip-selection strata.

Strata	Observed	Unobserved
HAL	0	3
POT	14	118
TRW	122	150

Table 13. -- Results of permutation tests between observed and unobserved tendered trips in the 2016 trip-selection strata. Results for *HAL* have been omitted due to low sample sizes. OD: Observed Difference (Observed tendered - Unobserved tendered).

Strata	Metric	NMFS areas	Days fished	Vessel length (ft)	Species landed	pMax species	Landed catch (t)
POT	Observed difference	0.2	-0.3	-4.6	-0.5	0.0	-21.8
	OD (%)	16.2	-5.1	-7.7	-19.6	0.7	-49.7
	p-value	0.034	0.820	0.279	0.161	0.229	0.155
TRW	Observed difference	0.0	-2.9	0.5	-0.7	0.0	-59.0
	OD (%)	0.3	-87.9	0.8	-15.9	0.0	-69.5
	p-value	1.000	< 0.001	0.516	0.001	0.868	< 0.001

Table 14. -- Number of non-tendered trips by observation status in the 2016 trip-selection strata.

Strata	Observed	Unobserved
HAL	398	2,254
POT	171	958
TRW	645	1,821

Table 15. -- Results of permutation tests between observed and unobserved non-tendered trips in the 2016 trip-selection strata. OD: Observed Difference (Observed non-tendered - Unobserved non-tendered).

Strata	Metric	NMFS areas	Days fished	Vessel length (ft)	Species landed	pMax species	Landed catch (t)
HAL	Observed difference	0.0	-0.3	1.4	0.3	0.0	-0.6
	OD (%)	1.3	-6.0	2.5	7.5	-0.5	-9.2
	p-value	0.506	0.029	0.029	0.017	0.557	0.056
POT	Observed difference	0.0	0.0	0.5	-0.1	0.0	0.2
	OD (%)	1.0	0.4	0.6	-5.4	0.2	0.7
	p-value	0.731	0.917	0.828	0.201	0.408	0.928
TRW	Observed difference	0.0	-0.1	2.7	-0.8	0.0	-1.6
	OD (%)	-2.6	-2.1	3.2	-14.2	2.3	-1.9
	p-value	0.052	0.437	0.002	< 0.001	0.003	0.456

FIGURES

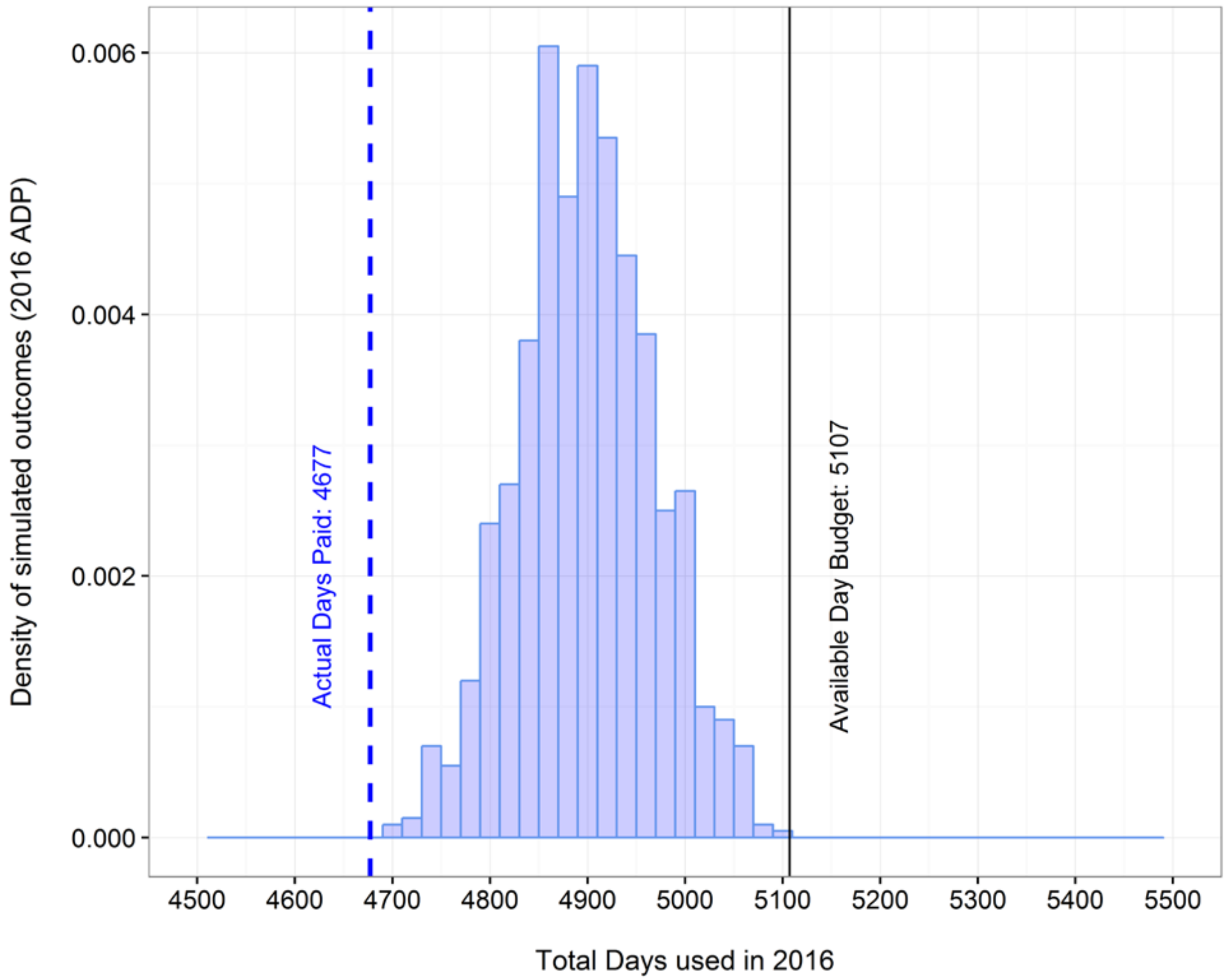

Figure 1. -- Actual paid sea-days in 2016 (dotted line) in relation to the range of potential budgetary outcomes estimated in December 2015 for the Final 2016 Annual Deployment Plan (vertical bars).

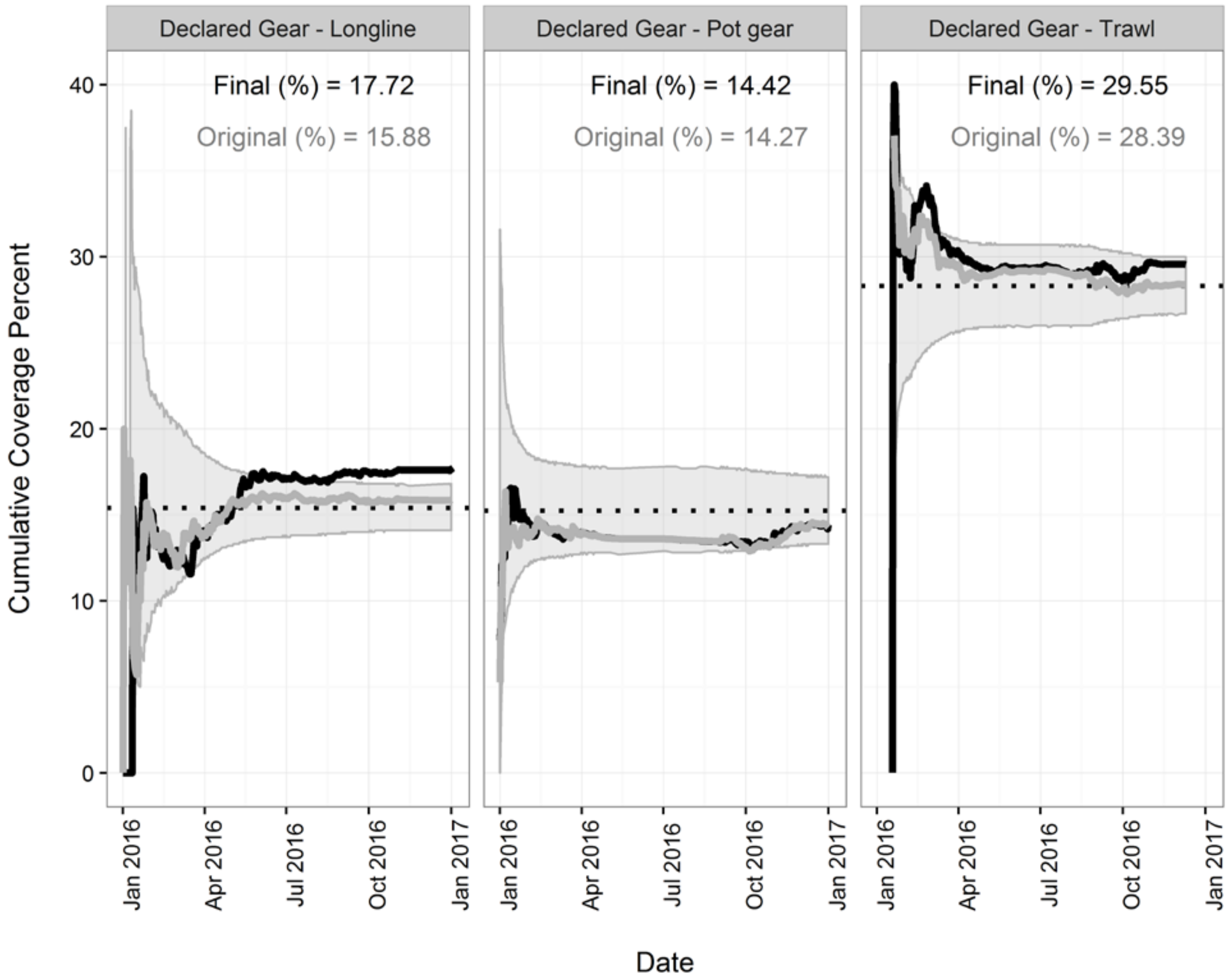

Figure 2. -- Rate of selected trips logged into ODDS organized by original date entered for all trips (grey line and grey text), and final date considering only non-cancelled trips (black line and black text). The programmed selection rate is depicted as the dotted line. Grey shaded areas denote the 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.

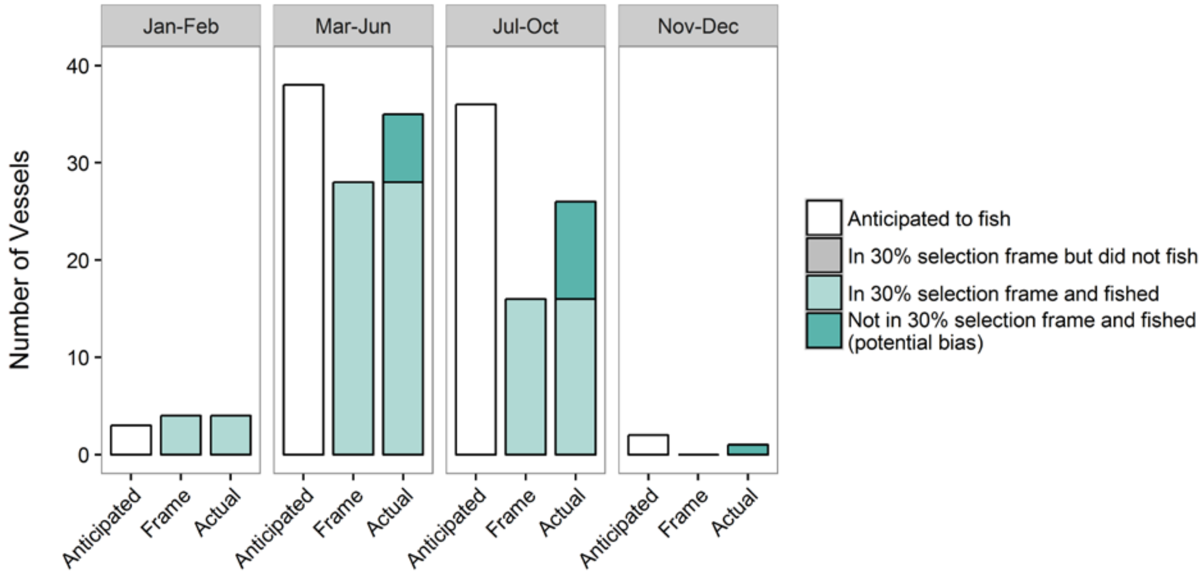

Figure 3. -- For each EM Voluntary vessel-selection time period, we compare the number of vessels anticipated to fish in the 2016 Annual Deployment Plan (white bars), the number of vessels in the 30% selection frame that fished or not (light teal and grey bars, respectively), and the number of vessels that fished but were not in the 30% selection frame (dark teal bars), which represents a source of potential bias. The data used to generate this figure is found in Table 1 of the Appendix.

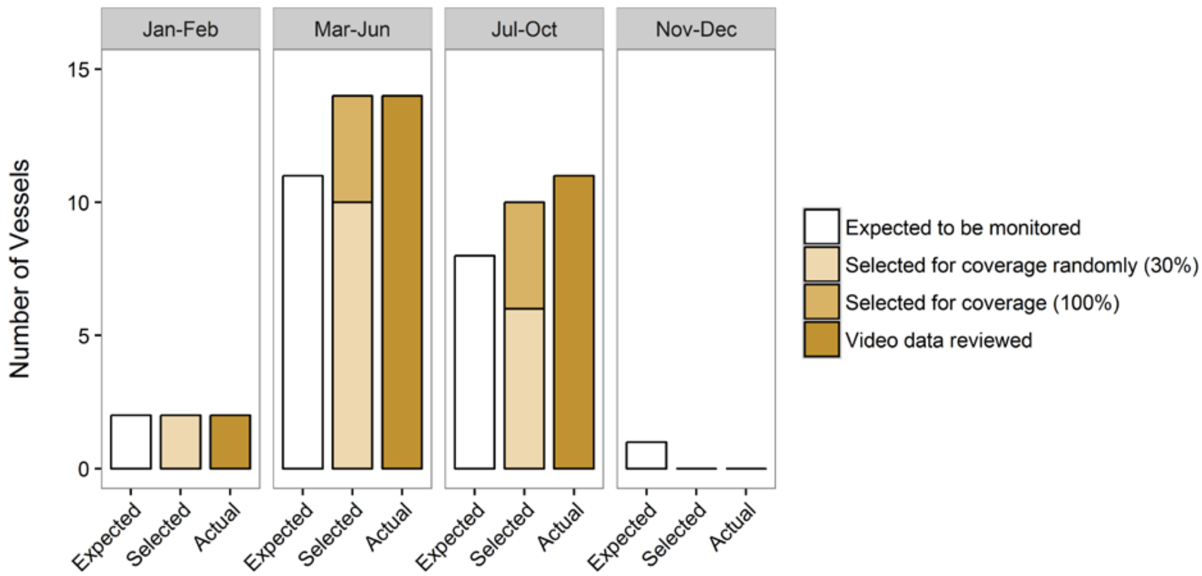

Figure 4. -- For each EM Voluntary vessel-selection time period, we compare the expected number of vessels to be monitored (30% of the vessels in the 30% selection frame, white bars), the number of vessels selected for coverage randomly at a 30% rate (light gold bars) or at a 100% rate because they notified NMFS after the 30-day cutoff (medium gold bars), and the number of vessels for which video data was reviewed (dark gold bars). The data used to generate this figure is found in Table 1 of the Appendix.

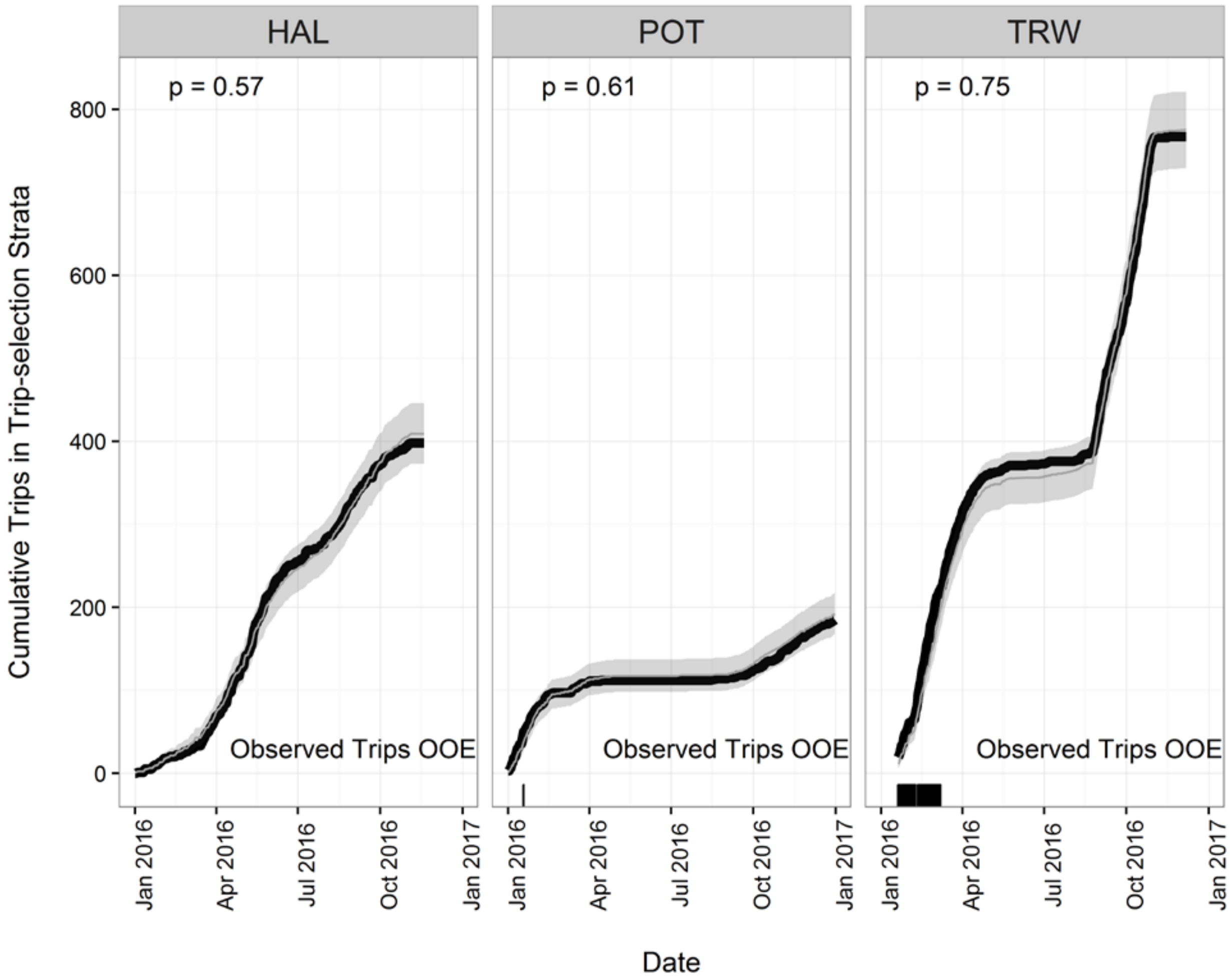

Figure 5. -- Cumulative number of trips observed during 2016 (black line) compared to the expected range of observed trips (shaded area) given fishing effort and sampling rates. Dates where the observed number of trips is outside of expected (less or more than the range; OOE) are depicted as tick marks 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.

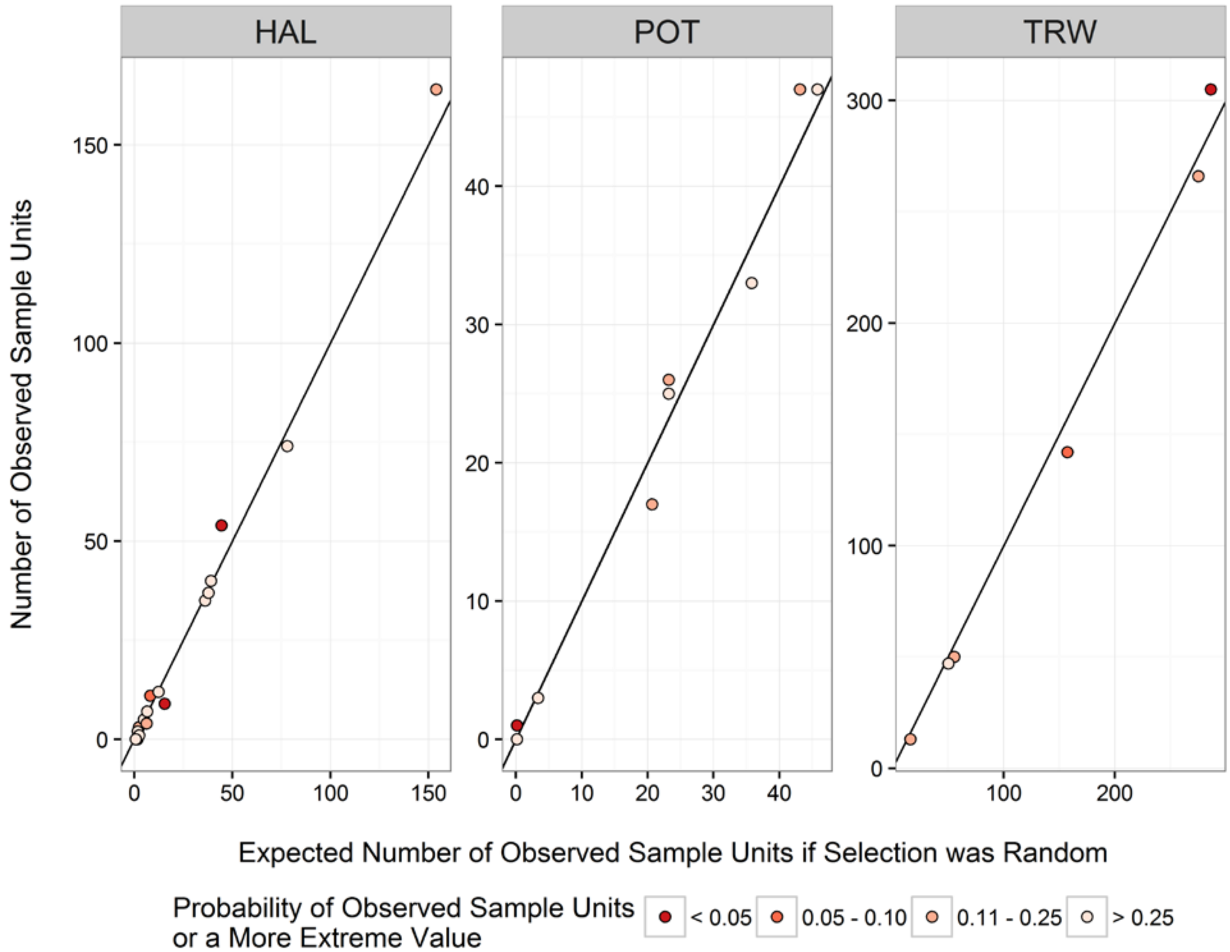

Figure 6. -- Comparison plots depicting the number of observed sample units compared to the number of expected observed sample units for each partial coverage stratum. Each point on a plot represents a NMFS Area. The darker the point, the more unusual the result.

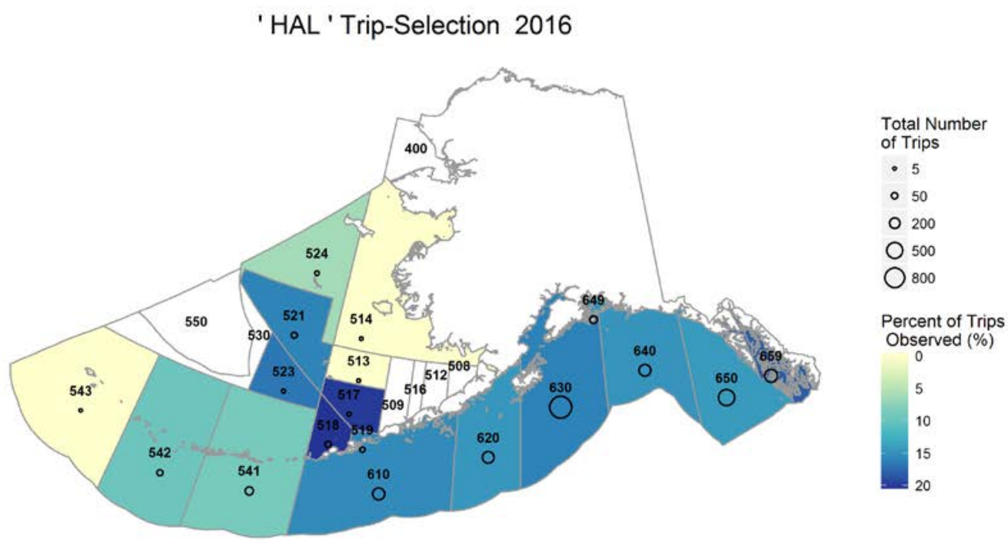

Figure 7. -- Percent of trips observed by NMFS Reporting Area in the *HAL* stratum. For reference, the programmed rate in the *HAL* stratum was 15.41%.

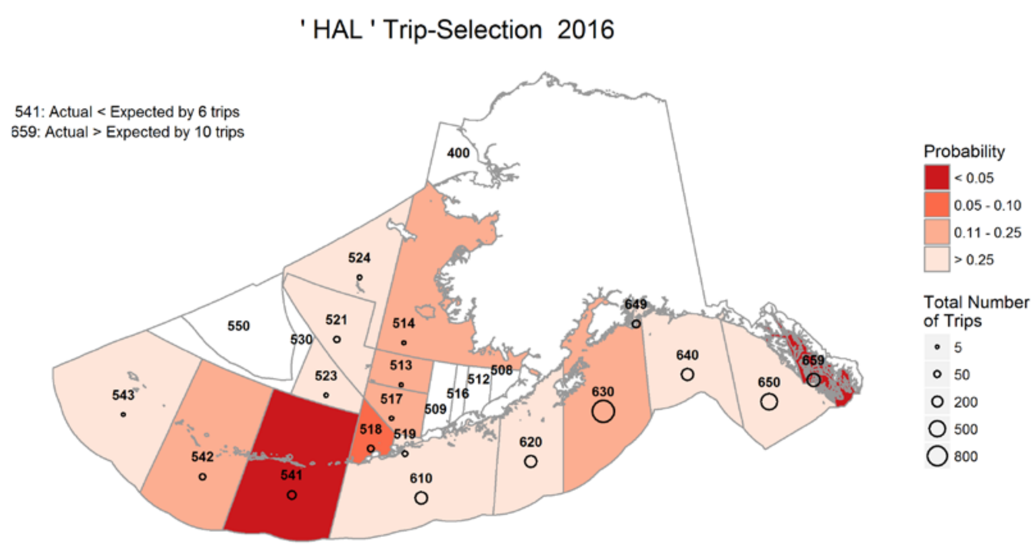

Figure 8. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *HAL* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

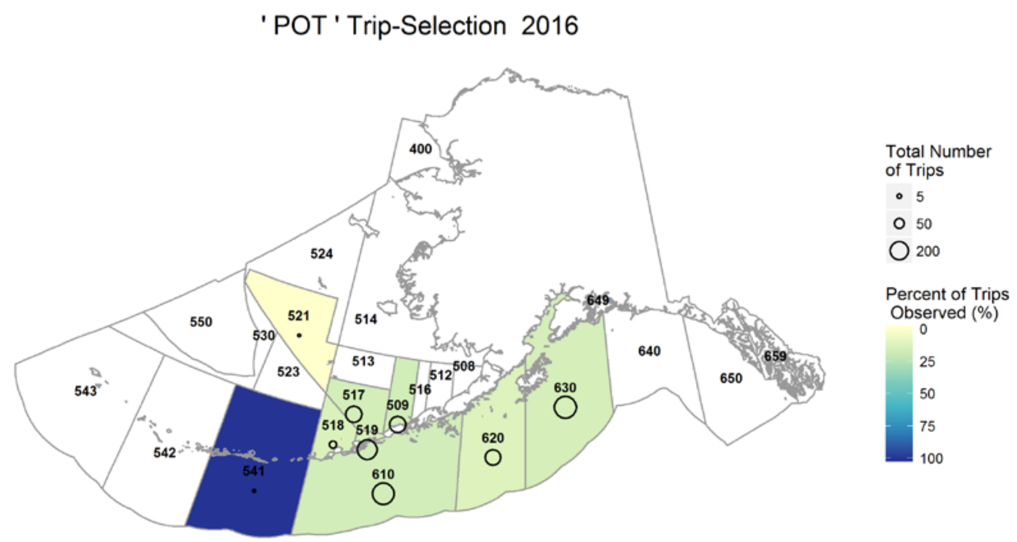

Figure 9. -- Percent of trips observed by NMFS Reporting Area in the *POT* stratum. For reference, the programmed rate in the *POT* stratum was 15.24%.

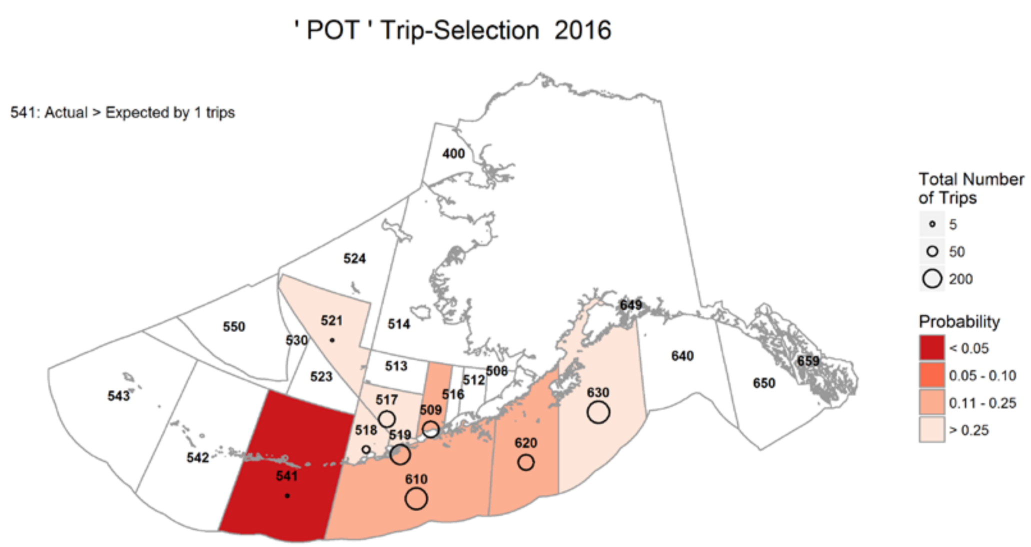

Figure 10. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *POT* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

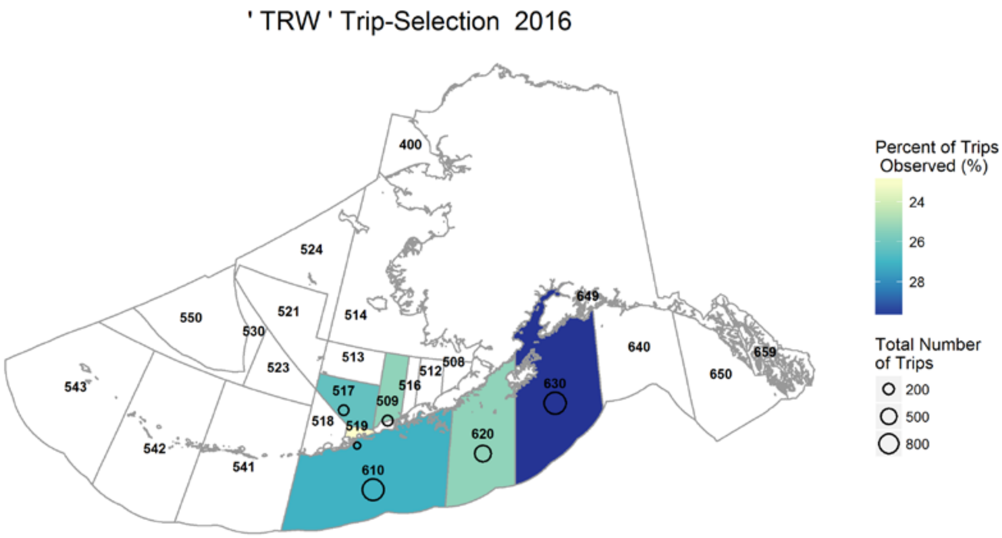

Figure 11. -- Percent of trips observed by NMFS Reporting Area in the *TRW* stratum. For reference, the programmed rate in the *TRW* stratum was 28.31%.

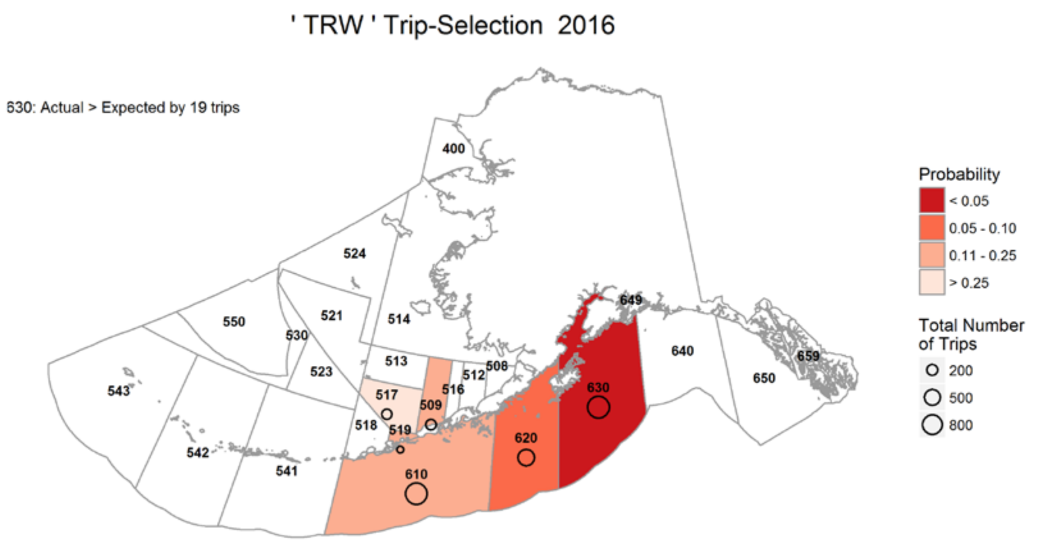

Figure 12. -- Probability of observing the realized or more extreme outcome (coverage rate) in a NMFS Reporting Area in the *TRW* stratum. Reporting Areas where unlikely outcomes occurred are shaded in darker colors.

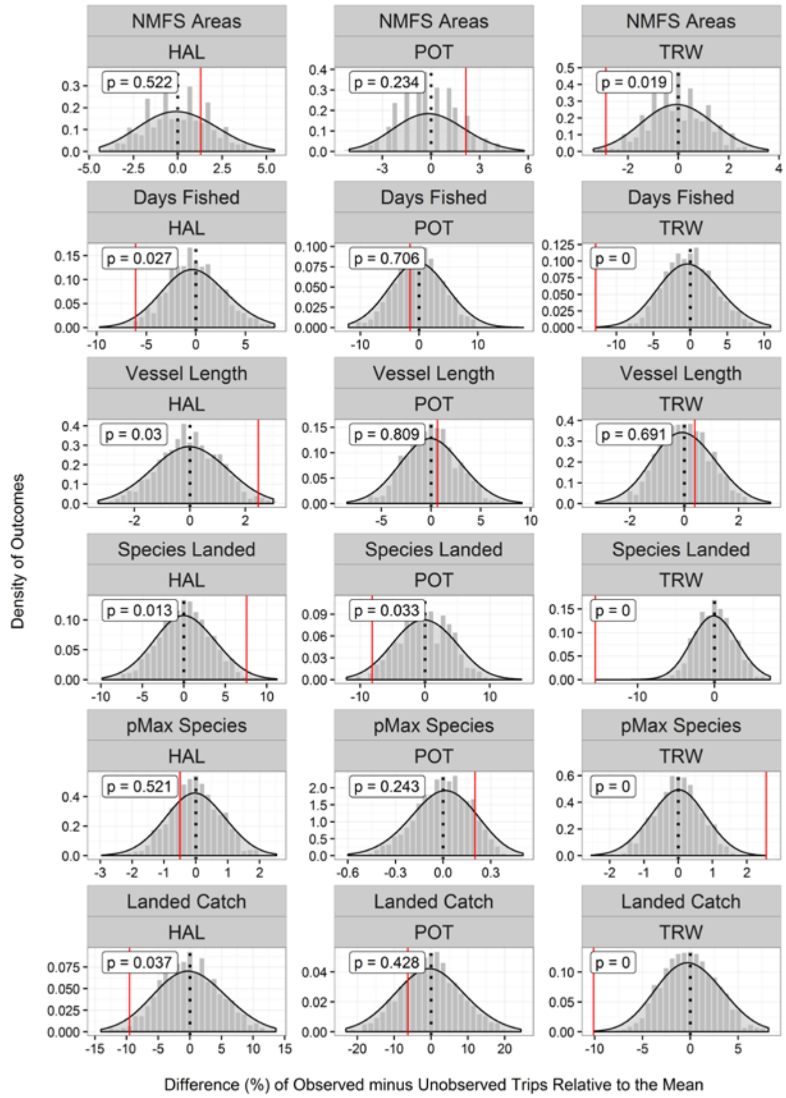

Figure 13. -- Example of results from permutation tests depicting percent differences between observed and unobserved trips for each stratum in the partial coverage category of the 2016 ADP. In each panel, the grey bars depict the distribution of differences between observed and unobserved trips where 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 corresponding 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.

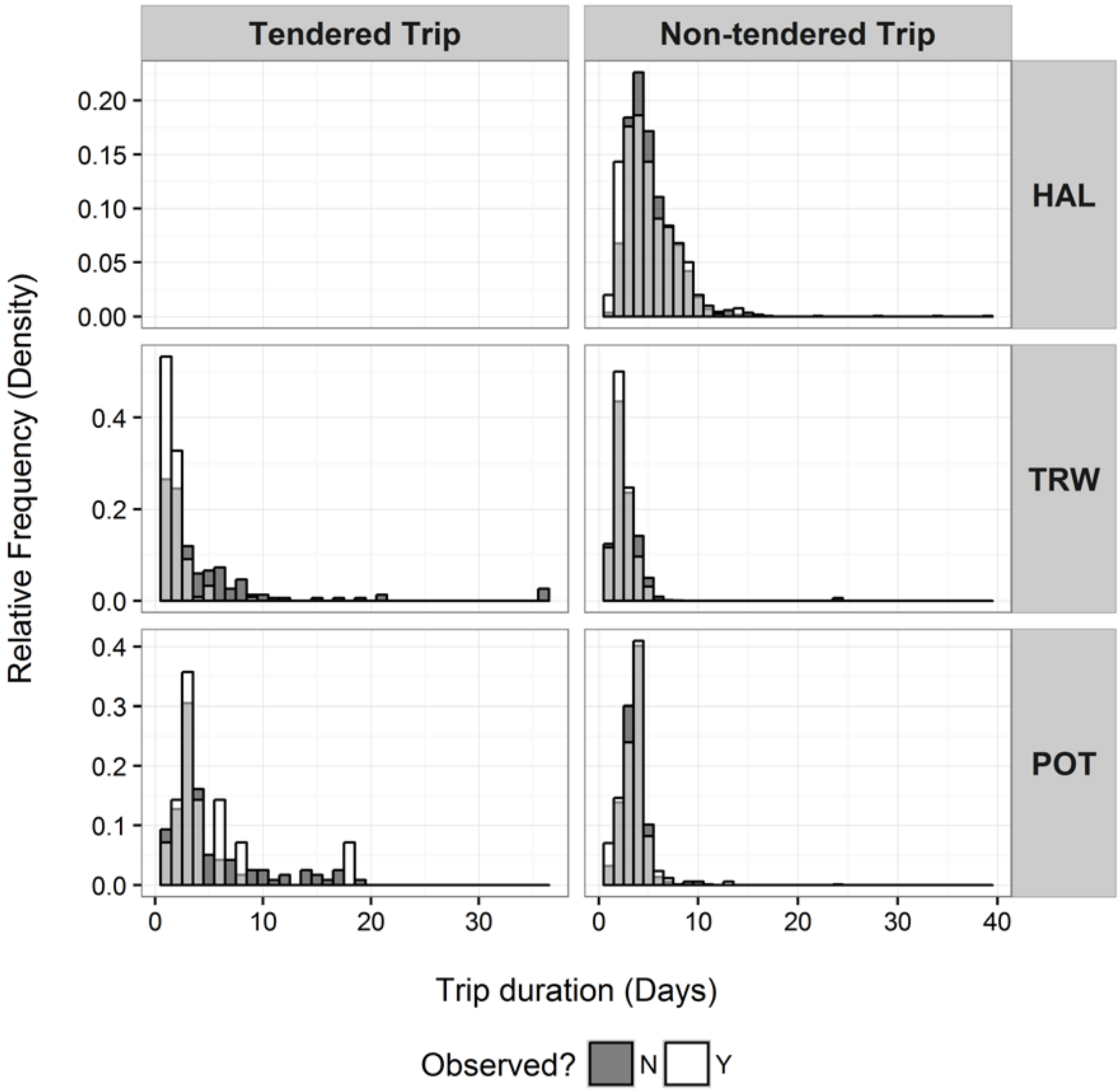

Figure 14. -- Distribution of trip durations for vessels in the partial coverage category by gear and observation status. Observed trips are depicted as transparent white bars overtop of solid black bars for unobserved trips. Trip durations where both observed and unobserved status exist are depicted 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).

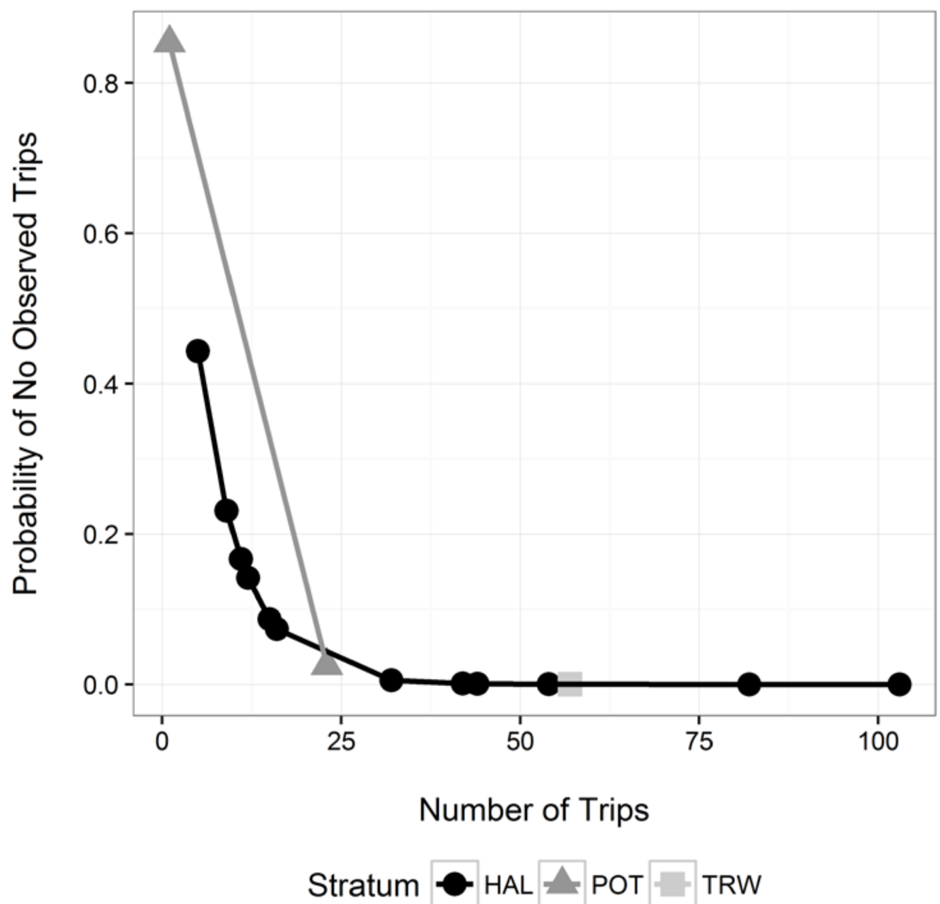

Figure 15. -- Probability of observing no trips in a NMFS Area and stratum given fishing effort and sampling rate. The x-axis has been truncated to increase resolution at low levels of fishing effort (note there are only 2 POT and 1 TRW data points on this scale). The likelihood of having no observer data decreases with increasing total fishing effort and selection rate. The selection rate is 28.31% in the *TRW* stratum, 15.41% in the *HAL* stratum, and 15.24% in the *POT* stratum.

APPENDIX

Table 1. -- The number of vessels that fall under specific criteria within the EM Voluntary vessel-selection strata.

Row	Metric	Jan-Feb	Mar-Jun	Jul-Oct	Nov-Dec
1	Anticipated to fish (Final 2016 EM Pre-Implementation Plan)	3	38	36	2
2	In 30% selection frame (Notified will fish); F	4	28	16	0
3	In 30% selection frame and fished; fY	4	28	16	0
4	In 30% selection frame and did not fish; fN	0	0	0	0
5	Not in 30% selection frame and fished (potential bias); f0	0	7	10	1
6	Active (fished = true frame); f* = f0 + fY	4	35	26	1
7	Expected to be monitored; vT = 0.30 x f*	2	11	8	1
8	Selected for coverage randomly (30%); vS_30	2	10	6	0
9	Selected for coverage (100%); vS_100	0	4	4	0
10	Selected for coverage (Total); vS = vS_30 + vS_100	2	14	10	0
11	Selected but did not fish; vN	0	0	0	0
12	Selected and fished; vF = vS - vN	2	14	10	0
13	Video data reviewed; v	2	14	11	0

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