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ABSTRACT

As part of a new annual review process implemented by the North Pacific Fishery Management Council for the North Pacific Groundfish and Halibut Observer Program, the Observer Science Committee used a set of performance metrics to assess the efficiency and effectiveness of observer deployment into the trip- and vessel-selection categories of the partially observed fleet. These included deployment rate metrics that evaluated whether achieved sample rates were consistent with intended sample rates, sample frame metrics that quantify differences between the population for which estimates are being made and the sample from which those estimates are derived, and sample size analysis to determine whether sample rates were high enough to ensure adequate spatial and temporal coverage. Evaluation of the deployment performance was conducted at the stratum level. Each stratum is defined by the sampling unit (i.e., vessels or trips) and/or the rate of sampling.

There was a marked difference in the relative performance of the two deployment methods in 2013. In trip-selection, sample rates were adjusted from 0.15 to 0.11 during a part of the year to avoid cost overages and then returned to the original rate. This created three temporal strata within the trip-selection stratum. Realized rates of coverage for 2013 met the anticipated coverage goals for all trip-selection strata, the Observer Declare and Deploy System performed as expected throughout the year and was unaffected by the government shutdown in October. Excepting small deviations at the start and end of the year, there was no evidence of bias present in the temporal or spatial analyses conducted in trip-selection, and observed and unobserved trips had similar characteristics.

In the vessel-selection stratum, coverage levels were less than expected during the first five selection periods (January - October). The random selection of vessels for observer coverage was abandoned during the last selection period (November-December). During this selection period coverage levels achieved the anticipated number of vessels specified in the 2013 Annual Deployment Plan. Coverage shortages in vessel-selection were due to a lack of a proper sampling frame and a substantial non-response (17-71% among selection periods). The small number of observed trips in each selection period made distinguishing differences in trip attributes between observed and unobserved portions of the fleet difficult. With this caveat in mind, large differences in trip duration or landed catch weight were not evident. Observed trips did tend to have landings with higher diversity in landed catch than unobserved trips.

Some expected patterns were found in both deployment methods; Reporting Areas and gear types that had more fishing effort had higher probabilities of having observer data in that gear/area/stratum combination. There were differences in the probability of an observed trip between gear types, with trawl generally having a higher probability of observation due to concentrated fishing in fewer areas (e.g., more trips in any given area) whereas hook-and-line was more disperse (e.g., fewer trips in an area) and more areas/stratum combinations had a higher probability of zero observer coverage.

An examination of observed and unobserved tender and non-tender trips did not yield meaningful differences, but the number of observed tender trips was too low to examine on a fine temporal or spatial scale.

Coverage rates for dockside sampling did not meet the objective of deploying observers to complete salmon sampling during all pollock offloads in the Gulf of Alaska for the purpose of obtaining genetic tissues used to identify stock of origin (91% were observed).

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INTRODUCTION

Background of the North Pacific Groundfish and Halibut Observer Program

Fisheries observers are people who collect independent information on the total impact of fishing operations on natural resources. The National Marine Fisheries Service (NMFS) uses a robust observer program in Alaska to facilitate the use of output controls 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 NPGOP 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, those fishing jig gear or those 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 self-selection prompted efforts by NMFS and the Council to provide a mechanism for NMFS to gain control over where and when observers were deployed (in the most recent analysis, two of five fisheries examined exhibited such biases, see 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

BSAI Management Area and Amendment 76 to the Fishery Management Plan for Groundfish of the 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 New Observer Deployment Method

The restructured observer program places all vessels and processors in the groundfish and halibut fisheries off Alaska into either full- or partial-coverage categories. Vessels and processors in the full-coverage category still obtain observers by contracting directly with observer providers. Vessels and processors in the partial coverage category obtain observers through a NMFS-contracted provider(s), and pay a 1.25% fee on all groundfish and halibut landings. Funding for the 2013 observer deployment was provided by NMFS.

Decisions as to the type of vessel operation that would be contained within the full- and partial- coverage category were made as part of the supporting analysis in the Public Review Draft of Observer Amendments 86/76 (NPFMC 2011).

The full-coverage category in 2013 included the following:

- catcher/processors (CPs) [1]
- motherships

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[1] An exception to this rule from the Council's October 2010 motion reads: "*catcher processors less than 60 ft. LOA with a history of catcher/processor and catcher vessel activity in a single year from January 1, 2003, through January 1, 2010 or any catcher/processor with an average daily groundfish production of less than 5,000 pounds round weight equivalent in the most recent full calendar year of operation from January 1, 2003, to January 1, 2010*". Two vessels with catcher processor endorsements are exempted from full coverage during 2013 under this rule.

- catcher-vessels while participating in American Fisheries Act (AFA) or Community Development Quota (CDQ) pollock fisheries
- catcher-vessels while participating in CDQ groundfish fisheries (except: when fishing longline sablefish and halibut, or when fishing pot gear)
- catcher-vessels while participating in the Central Gulf of Alaska Rockfish Program (RP)
- inshore processors when receiving or processing Bering Sea pollock.

Vessels and processors in the partial coverage category included the following:

- catcher vessels designated on a Federal Fisheries Permit (FFP) when directed fishing for groundfish in Federally managed or parallel fisheries, except those in the full coverage category
- catcher-vessels when fishing for halibut IFQ or CDQ
- catcher-vessels when fishing for sablefish IFQ or fixed gear sablefish CDQ
- shoreside or stationary floating processors, except those in the full coverage category.

In the partial coverage category, three deployment strata were implemented. In the first, termed trip-selection, vessel owners and/or operators are provided with a username and initial password to the Observer Declare and Deploy System (ODDS) -- a web-based application used to log intended trips (odds.afsc.noaa.gov). Each trip is assigned a random number, and if the number is below a pre-determined threshold, the trip is selected for observer coverage. Users close their unselected trips by either selecting one or more landing reports made by their vessel that are provided to them within the logged date range for the trip, or can manually enter the port, processor, and date of landing. Catcher vessels ≥ 57.5 feet in length were placed in the trip-selection stratum.

Catcher-vessels 40-57.5 feet were placed in the vessel-selection stratum. In this stratum, the observer program uses past activity in the year prior to create a list of vessels eligible to carry observers, and a sample of vessels from this list are selected for observer coverage. Selected vessels are subject to observation on all of their fishing trips during a 2-month period. Vessels less than 40 feet in length and those fishing jig or troll gear were not subject to observer coverage in 2013 and constitute the "zero-selection" stratum.

The Annual Deployment Plan and Review

Analysis and evaluation of the data collected by observers is an on-going process. Decisions as to the amount of coverage (i.e., selection probabilities that are assigned to each partial-coverage category) are based on available funding, the cost of observer coverage, anticipated effort, and the inclusive, cooperative decision-making process of the Council. Each June, NMFS provides the Council with a comprehensive evaluation of past years' observer activities, costs, sampling levels, and implementation issues as well as potential changes for the coming year. The June report 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 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. This June report is termed the Annual Report. The NMFS releases a draft Annual Deployment Plan (ADP) by 1 September of each year to allow review by the Groundfish and Crab Plan Teams, as well as the Science and Scientific and Statistical Committee

(SSC) and the Council. Based on input from its advisory bodies and the public, the Council may choose to clarify objectives and provide recommendations. Upon analysis of the Council recommendations, NMFS will make any necessary adjustments to finalize the ADP and release it to the public; ideally the ADP is released to the public prior to the December Council meeting. The Final ADP contains the deployment rates that will be programmed into ODDS and used in the following year. The initial and final ADP for 2013 can be found online at (http://alaskafisheries.noaa.gov/sustainablefisheries/observers/default.htm).

The Observer Science Committee

To provide 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), 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 Groundfish and Halibut Observer Program (Observer Program). OSC members must 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).

Deployment Performance Review

Hereafter the Observer Science Committee (OSC) presents its review of the deployment of observers in 2013 relative to the intended sampling plan and goals of restructured observer program, and is a formalization of Chapter 3 of the 2013 Annual Report (NMFS 2014). This work 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 2015 Annual Deployment Plan (ADP).

The goal of sampling under the restructured program is to randomize the deployment of observers into fisheries to collect representative data used to estimate catch and bycatch, assess stock status, and determine biological parameters used in ecosystem modeling efforts and salmon stock-of-origin analyses (NMFS 2013). Therefore, this evaluation focuses on the randomization of observer deployments (primary sampling units) under the restructured Observer Program, and how departures from a random sample affect data quality. It does not evaluate the catch estimation process that is currently being assessed separately.

Observer Deployment Performance Metrics

Performance metrics have been developed to assess the efficiency and effectiveness of observer deployment into the partial coverage strata. These metrics reflect three mechanisms that can impact the quality of the data: sample frame discrepancies, non-response, and sample size.

Sample frame metrics (under- and over-coverage of the sample frame) are used to quantify the differences between the sampled population and the population for which estimates (inferences) are made, as well as to identify possible mechanisms of bias arising from sample frame discrepancies. Similarly, non-response measures are used to assess differences between the selected sample (selected trips or vessels) and the observed sample (observed trips or vessels) that may lead to bias in the resulting data. Other measures that address potential observer deployment effects (*sensu* the “observer effects” of Benoit and Allard [2009]) are focused on the representativeness of the sample; whether observed trips have similar characteristics to unobserved trips such as areas fished, numbers of species landed, and trip duration.

Adequacy of sample size is evaluated by assessing whether sample sizes were large enough to ensure data were captured for all types of fisheries. Specifically, the probability of selecting a sample and observing no trips in a specified area is used to evaluate the adequacy of the sample rates used in 2013.

It is important to recognize that the annual Observer Program review is an evaluation of whether the deployment of observers into the fisheries (randomization of the primary sample units) is representative of the fisheries themselves. The Observer Program collects data for a broad range of purposes ranging from quota management (where timely and accurate catch information is critical), to stock assessment (where length and age distributions are critical), to monitoring of endangered species impacts due to fishing (where detection is critical). The metrics that are used to evaluate those estimates and analyses, such as catch variance, variance of catch- or length-at-age, or effective sample size are specific to the analysis. For example, because of the complex nature of the estimation routines, and the numerous points where variance is introduced into the estimates, final variance estimates are neither the only metric nor necessarily the best metric for evaluating stratification and randomization of sampling of primary sample units (trips, vessels). An analytical focus on variance does not evaluate the overall quality of the underlying data collection process. The performance measures listed below are meant to assess the representativeness of the data collected by the observer program through the implementation of the 2013 Annual Deployment Plan.

Description of Performance Metrics Used in this Evaluation

1. Deployment rates for each stratum: This is the basic level of evaluation comparing sampling

rates targeted and achieved. Implementation challenges can be identified in this step, such as:

sample frame inadequacy, selection biases, and issues with sample unit definitions (e.g., tender trips). Specifically, this section assesses the following:

a. Sample rates (partial selection strata) and number of samples (vessel selection strata) relative to intended values.

b. Quantification of under- and over-coverage rates (sample frame discrepancies). Over-coverage of a population occurs when the sample frame includes elements (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. 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. We expect a randomized sample design to result in an achieved rate of observed events (relative to the trip or vessel strata) that is similar across both space (NMFS Reporting Areas) and time (e.g., months).

The hypergeometric distribution is used to construct several of these metrics. This distribution describes the probability of selecting sample units (e.g., trips) with specific characteristics (e.g., NMFS Reporting Area) based on a sample taken from a population with known characteristics (e.g., trips that occurred in a NMFS Reporting Area).

Representativeness of the sample was divided into three separate components:

a. Temporal representativeness
    i. Effort plots: plots of effort (cumulative) over time (x-axis) for unobserved and observed trips. 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 total effort, 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. This probability of observing as many or a more extreme number of trips for each NMFS Area and deployment stratum is determined using the hypergeometric distribution.
c. Representativeness of trip characteristics
    i. Consistency of trip characteristics for observed and unobserved portions of the

stratum. Attributes such as trip length, total catch, number of species caught for observed versus unobserved can be used as an indicator of representativeness of the sample relative to the population.

3. Adequacy of sample size: A well-designed sampling program will have a sample large enough to reasonably ensure that the entire target population is sampled (represented in the data). This determination was made through an examination of the probability of selecting a sample and having cells (e.g., defined by NMFS Reporting Area) with no observer coverage as determined using the hypergeometric distribution.

Overview of Catch Estimation

The estimation routines used by the Catch Accounting System (CAS) rely on the expansion of available observer data and on catch reports provided by industry. These are combined to obtain estimates of retained catch, at-sea discards of groundfish species, and at-sea discards of non-target and prohibited species. A schematic of the methodology is provided in Fig. 1 and additional details are provided in Cahalan et al. (2010). An update is expected to be available in 2014 (Cahalan et al. 2014a).

The analytic methods used to estimate catch assume that the sample process is randomized and therefore sampling bias is minimized. If this assumption is not valid, the estimates of (by)catch and associated variance may be biased; although, since the true values are not known, it is often not possible to estimate the magnitude and the direction of this bias. Thus, this review of the 2013 sampling effort is focused on the first two steps of the CAS process (Fig. 1, nos. 1 and 2).

A separate evaluation of the estimation process is currently underway (Cahalan et al., 2014b). In the first phase of this evaluation, the imputation process (Fig. 1 at number 5) was evaluated against two alternative estimators (Cahalan, et al. 2014a). In this evaluation, the design-based and ratio (model-based) estimators exhibited better overall statistical performance than the currently used imputation estimator. In the next phase of the evaluation, variance estimates at the trip level for all fisheries will be generated and tested using simulation (Fig. 1 nos. 3 through 5). This is an analytic process building on the imputation simulations and incorporating the variance from at-sea sampling through to the trip-level: a three-level sampling hierarchy (samples, hauls, trips). Algorithms for estimating variance will be developed and is expected to be complete in 2015.

Expansion of the trip-level data to the final fishery (quota) level will be dependent on the previous work and the definition of post-strata. The performance of design-based or ratio estimators will be compared to assess the most appropriate method for this portion of the estimation process. Based on, and incorporating, results from the previous phase, the expansion of catch from the trip to the fishery will be assessed (Fig. 1 nos. 6, 7, and 9) and estimation algorithms for (by)catch and its associated variance will be developed. In addition, the suite of variables used to define the current post-strata will be assessed to determine whether these are the most appropriate post-strata given the underlying fisheries and sampling programs. Incorporation of these algorithms into the CAS is expected to begin in mid-2016 or early 2017.

EVALUATION OF 2013 IMPLEMENTATION OF OBSERVER DEPLOYMENT

The deployment of observers into the 2013 Federal fisheries in Alaska needs to be evaluated against stated goals. NMFS has stated in the 2013 ADP that its goal for 2013 was to "*address the data quality concern expressed within the Council's 2010 problem statement, i.e., to achieve a representative sample of fishing events, and to do this without exceeding available funds*" (NMFS 2013, p. 11). Evaluations need to be conducted at the level of the deployment stratum, because each stratum is defined by a different sampling unit and sampling rate (i.e., time period).

Tracking Costs and Creating Temporal Strata in Trip Selection

One of the principal objectives set out in the 2013 ADP was that NMFS not exceed budgets. To do this, a sampling rate was derived using 2011 fishing effort information and anticipated budgets that would likely meet this objective. Following a Council request to NMFS that coverage rates in trip selection be higher than those in vessel selection, we performed an analysis that was adopted in the ADP whereby trip selection coverage rates would be 15% of trips and vessel selection coverage rates would be approximately 11% of vessels (NMFS 2013). Whether these sampling rates actually result in cost overages will be a function of how much fishing effort was observed in 2013 relative to anticipated observed effort from simulated sampling of 2011 effort data.

To inform the Observer Program of costs throughout the year, three sources of information were used. The first was the range of observer days expected to be observed from the 2013 ADP simulations. The second was the number of days invoiced to NMFS from the observer provider; however, this information was delayed by up to 2 months. The third source of information was the amount of observer days for which the program had data for, updated daily. Because these values were expressed as an accumulated value throughout the year, they are referred to as cost-trajectories, and are presented in units of days. From simulations of 2011 fishing data, the FMA expected fishing effort to have a surge during the first 20 weeks, a slow-down during the summer months, and a second surge starting around week 36 (Fig. 2). The number of observed days in trip selection exceeded our expected values for the first 20 weeks of 2013. At this point NMFS faced a difficult decision; with the anticipated surge in effort to come after the summer, there was a risk of ending up over budget at the end of the year. The only option available to the program was to reduce the selection rate, which would slow down the cost trajectories; however a reduction in coverage during the second surge in effort was to be avoided. The decision was made on 22 June to reduce the selection probability in the Observer Declare and Deploy System (ODDS) from 0.1478 to 0.1115. This date effectively meant that two temporal strata were created: the first period from 1 January to 21 June (where the expected coverage rate was 0.1478), and another after 21 June (where the expected coverage rate would be 0.1115). As desired, the cost trajectory during weeks 24-32 went from above the upper range of expected values to the lower bound of expected values. On 17 August the decision was made to return the selection rate of ODDS back to the original 0.1478. This then created a third temporal stratum that lasted until the end of the year. While the amount of observed days did indeed surge after this date and was close to expected values at week 36, it never again reached expected values and ended the year below the lower bound of the expected value from the 2013 ADP simulations (Fig. 2).

Performance of the Observer Declare and Deploy System in Trip Selection

ODDS is a web application and database that enables fishermen to declare their intent to fish, capturing anticipated dates and ports of departure, dates and ports of return, and the anticipated processor for delivered catch. ODDS generates a random number and assigns each logged trip to either the “selected to be observed” (selected) or “not selected to be observed” (not selected) categories. NMFS observer provider has access to all selected trip information necessary to schedule observer logistics. If a vessel operator (ODDS user) cancels a selected trip, the user’s next logged trip is automatically selected for coverage. This is termed an “inherited trip” since the trip inherits the cancelled trip’s selection.

The rate of trip selection is broken down into its component rates: the rate from the random number generator, the rate from the random number generator inclusive of the inherited trips, and these two processes combined with trip cancellations (Table 1). Because each trip is assigned observer coverage randomly, the proportion of trips selected to be observed will not be equal to the programmed rate (the number of selected trips is a random variable that is binomially distributed with probability of selection equal to the programmed rate). Hence, it is of interest to assess whether the actual proportion of trips selected falls within what would be expected given the binomial distribution (is the outcome of the initial random assignment within expectations). The rate obtained in the initial selection process was within the 0.025 and 0.975 percentiles expected from a binomial distribution, and two-sided tests of proportions failed to reject the null hypothesis that the selection results were the result of a selection rate that was equal to the programmed rate (Table 1). As expected, the rates of selection were greater when inherited trips were included. These are trips that when logged by the user bypass the random selection algorithm and are automatically selected. This routine is executed when a user cancels a “to be observed” trip. The term comes from the fact that the original selection was “inherited” on the vessels’ next logged trip. Final selection rates were less than the rates that included inherited trip assignments (Table 1). These data would result if not-selected trips were disproportionately fished by vessel operators compared to selected trips. The performance of the selection process in terms of the daily expected rate is presented, with 0.025 and 0.975 percentiles, for the three trip selection periods in Figure 3.

There is no mechanism to link the trips logged in ODDS with the landings data stored in eLandings. This disconnect represents a potential source of error in tracking deployment performance. This problem is constrained in the case of observed trips because the observers track landing report identifiers that are stored in the observer database and can be used to link with ODDS. In addition, for trips that are not selected, there is the potential that those trips were taken but were not "closed" by the vessel operator (user indicating that they fished this trip). To prevent 2013 ODDS trips from bleeding into 2014, trips that were not closed by the end of the year were automatically closed (cancelled) by ODDS. The number of trips that were cancelled by ODDS highlights the scale of this problem; a total of 239 trips were auto closed at the end of 2013 by the NMFS. The percent difference between the number of trips expected based on ODDS and number of trips based on observer and landings data (enumerated in this chapter) was between 4.5 and 16.7 among time periods with a weighted difference of just over 7 (Table 1).

There were two other events that occurred during 2013 in trip selection that are noteworthy. The first is the impact of the Federal Government Shutdown that lasted between 1 October and 17 October. During this time ODDS functioned properly with no interruptions to vessel operators or the NMFS observer provider. This period coincided with a rapid increase in the number of logged trips in ODDS (Fig. 4).

The second was the discovery of an error (bug) in the trip selection system resulting from simultaneously allowing trips to be logged at two different rates (one for the end of 2013 and one for 2014). For 7 days in December, logged trips had no probability of being selected for observer coverage. Since prior to this period and after this period there were no observed trips realized during 2013 (Fig. 4) there was no impact to realized coverage rates as a result of this programming error.

Evaluation of Deployment Rates

There are three deployment strata described in the 2013 ADP; trip selection, vessel selection, and dockside coverage. These are the only strata described in the ADP because these are the strata that are under NMFS deployment control and were to have observer coverage greater than zero. However, there are additional groups evaluated here: the partial coverage's no selection pool, and the full coverage category. There are two groups of full coverage vessels: those covered in Federal regulations and a group of vessels that voluntarily agreed to full coverage when fishing in the BSAI. In addition observers were deployed dockside to monitor deliveries of walleye pollock (formerly *Theragra chalcogramma* now *Gadus chalcogrammus*).

In each selection category, additional strata are defined by sample rate. Within trip selection, three time periods defined by changes in the selection rate programmed into ODDS defined three strata that set the expected level of observer coverage. Because the sample rate differs between these time periods, each defines a separate stratum. Furthermore, within each trip selection time period, vessels are divided into those that are catcher vessels (CVs), and catcher/processors (CPs) that qualified for an exemption from the full coverage requirement. Similarly, the vessel selection stratum has six selection periods to evaluate, each corresponding to a 2-month period of the calendar year. All remaining coverage categories are pertinent for the entire year, and do not have temporal or vessel-type demarcations.

Evaluations for the full coverage category and the partial coverage no selection category are straightforward—either the coverage achieved was equal to 100% or 0%, respectively, or it was not. For each vessel-type category in each time period within the trip-selection stratum the coverage rate achieved was compared against the coverage rate expected from ODDS programmed selection probabilities. Achieved rates were expected to fall between upper and lower bounds on the expected value that were generated from the 0.025 and 0.975 quantiles of a binomial distribution (aka a 95% "confidence bound") for each time period for trip selection deployment. Coverage levels were considered to have met expectation goals if the actual value was equal to one of the upper or lower confidence bounds, or fell within them.

The process for evaluating coverage rates in the vessel selection strata is based on the number of vessels observed relative to the target number of vessels. For the 2013 ADP, simulated sampling of 2011 data at an 11% rate of selection of vessels in the vessel selection strata yielded the number of vessels to be targeted for 2013 (v_t). The expected coverage rate for 2013 is the target number of vessels, v_t , divided by the number of vessels that actually fished in 2013 (f^*), as opposed to those that fished in 2011. Hence, the anticipated rate of coverage for vessel-selection is v_t / f^*. The expected rate of coverage for 2013 will not equal 11% in each vessel selection time period unless effort in 2011 and 2013 is exactly equal. Coverage levels for vessel selection were considered to have met expectation goals if the actual coverage rate (number of observed vessels divided by f^*) met or exceeded the expected rate.

The 2013 Observer Program had 16 different deployment strata to be evaluated (Table 2). The program met expected rates of coverage for the full-coverage regulatory and full-coverage voluntary strata, all vessel-type and time periods within trip selection deployment, one of six time-periods within vessel selection, and the partial coverage no selection (Table 2).

Coverage Rates in Vessel Selection

Coverage levels did not meet expectations for the first five vessel selection time periods, potentially due to a variety of factors. Two of particular interest are 1) the lack of a complete sampling frame, and 2) policies that grant releases from observer coverage based on certain conditions. A sampling frame should include all the elements of the population of interest. Hence, a sampling frame for vessel selection would consist of a list of vessels that actually fish in each 2-month deployment period. This list is not available for the vessel selection strata. In trip selection strata, vessels that intend to fish log trips into ODDS, hence the sampling frame is equal to the target population. However in vessel selection, without a similar notification system informing NMFS of their intent to fish, the sample frame is based on past fishing behavior, specifically whether the vessel landed catch in the same 2-month period the year prior.

The lack of a complete sampling frame means that NMFS uses past fishing activities to build the sample frame (list of vessel that will fish) for the current year. As briefly described earlier, NMFS used 2011 data to plan for coverage given anticipated budgets for the 2013 ADP. However, for each selection period in 2013, the list of vessels expected to be in the vessel selection strata were based on 2012 landings data, noting that a list of vessels that fished 2 years ago may not be the same as the list of vessels that fish in the current year.

This introduces two potential sources of error. The first is the inclusion of vessels that fished prior to 2013 but did not fish during 2013. This is called "over-coverage" and results in sampling inefficiency (this term over-coverage derives from survey research methods and should not be confused with having too much observer coverage). To meet the target sample size (number of vessels), additional vessels are selected to carry observers. The amount of this "over-draw" was based on the expected proportion of vessels in the selection frame that will not fish in 2013 *plus* the proportion of vessels that are selected and will fish, but are granted a release from observer coverage. The greater this combined proportion, the greater the inefficiency of the sampling process. The relative amount of over-draw for each selection period was based on the differences in the numbers of vessels that fished in each time period of prior years, and the information from previous time periods in the current year. To allow for a 60-day advance notice of selection to vessel operators, results were from two time periods earlier were used in the current year (e.g., the first time-period results could not inform future draws until the third time period, the fourth time period over-draw was informed by the first and second time period over-sampling results).

The second source of error introduced by an incomplete sampling frame is that a portion of the population has no chance of being selected for observer coverage (no way to select “new” vessels). A new vessel in this case is one that did *not* fish during a time period in 2012 but *will* fish in the same time period in 2013; these are not included in the selection frame. These “new” vessels then have no chance to be selected for observer coverage. This is called “under-coverage” and is of particular concern because it represents a potential bias (the term under-coverage derives from survey research methods and should not be confused with having too little observer coverage). Bias would result if these new vessels fish differently than vessels that fished in 2012 and were in the selection frame.

Vessels in the vessel-selection stratum can be classified in numerous ways depending on their fishing, selection, and observation status. Table 3 presents these values for each time period. Among time periods, the number of vessels that fished in 2013 was equal to, or lower than, the number of vessels anticipated to fish based on 2011 and 2012 data (row 6 vs. row 1 in Table 3). Values of the relative amount of overdraw, (expressed as the number of selected vessels divided by the target number of vessels to be observed) were 1.28, 1.71, 1.56, 2.37, 3.10, and 6.71 for the six time periods, respectively. Between 4 and 27 vessels were selected and actually fished in 2013 among time periods (Table 3, line 10). Between 3 and 13 vessels were selected, fished, and actually observed among time periods (Table 3, line 15).

The number of vessels that would be expected to carry observers after considering conditional release policies is difficult to determine because a conditional release may be granted that is only for a part of the coverage period, or for only some activities. For example, if a vessel is granted a conditional release based on a life raft with insufficient capacity, then we would expect all fishing to be released from coverage. However if a release was granted for only those trips during which an IFQ holder is on board, the vessel would carry an observer when fishing without an IFQ holder, that is, outside of IFQ fisheries. In this example the vessel has received a conditional release based on certain criteria; in some situations there is an observer on board, whereas on other trips there is not. The data summaries pertaining to the expected number of observed vessels are presented in a generalized level in Table 3 on lines 12-19.

To measure the performance of the vessel selection process, data in Table 3 were expressed as relative percentages (Table 4). 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). Values in these metrics ranged from 17 to 68% among time periods, with the highest values in the last selection period (Table 4, rows 1 and 2). The percentage of vessels that were in the selection frames and did not fish should be approximately equal to the percentage of vessels that were in the selection frame and were selected for coverage and did not fish. However, comparing the first and third lines of Table 4 shows that the percentage of selected vessels that did not to fish was consistently higher than the percentage of vessels that did not fish and were not selected. This may be evidence of an “observer effect” where the act of observation, or in this case selection of a vessel to carry an observer, alters fishermen’s behavior.

The presence of an observer effect and an over-draw may imply that the burden of observation falls disproportionately on those vessels in the sampling frame (i.e., fished in 2012) that are selected for coverage, and choose to fish. Yet the actual likelihood of these events happening after conditional releases from coverage are factored in are actually quite low--less than 23% in all but the last time period, when it suddenly jumped to 100% (Table 4, line 5). This is because the percentage of vessels that were selected for observer coverage and given a conditional release from coverage increased from 0 in the first time period, to 27 in the second time period, to over 55 in the remaining time periods. Over two-thirds of the vessels selected in the fourth and sixth time periods were granted releases from coverage (Table 4, line 7).

The probability of being selected in the last time period of vessel selection jumped to 100%, which can be explained by the difference between the target coverage rate and the achieved coverage rate for this selection type. By dividing the number of desired vessels to be observed from the 2013 ADP by the number of vessels that actually fished in 2013, the expected proportion of vessels to be observed is obtained (Table 4, line 8). Dividing the number of observed vessels by the number of vessels that actually fished in 2013 gives the actual proportion of vessels observed (Table 4, line 9). In each vessel selection period of 2013, the achieved coverage rate was less than the target rate. In the first five selection periods, a respective over-draw of nearly 30, 71, 156, 237, and 310% failed to result in target rates of coverage. The Observer Program abandoned the random selection of vessels from the selection frame in the last selection period and every vessel in the selection frame was selected for coverage. NMFS achieved its target coverage rate when every vessel that fished during the last 2 months of 2012 was selected for observer coverage in 2013.

Since the manner in which selections for observer coverage were made differed between the last and the five prior selection periods, there is opportunity to compare their performance. Selection of every vessel in the sampling frame during the last time period coincided with more new vessels fishing; the percentage of new vessels that fished spiked from between 17 and 32 for the prior five periods to 68 during the last period (Table 4, line 2). In the absence of an observer effect, caused here by the selection of every vessel, we would have expected the percentage of new vessels that fished during the last period to be between 17 and 32 (since that is what resulted from the first five periods).

Our final evaluation of the vessel selection sampling rates involves the loss of information on trips that should be observed. This type of non-response is represented by the number of vessels that were selected, fished, but were not observed divided by the number of vessels that fished. It can be caused by conditional release, loss of observer data due to poor quality or failure to follow protocols, or non-compliance. The percent non-response for "expected to be observed" vessels ranged between 13 and 71 with peak values during the third and fourth selection periods (Table 4, line 4).

Spatial Patterns of Non-response in Vessel Selection

The effect of non-response (expected to be observed but were not) on the spatial distribution of observer coverage was evaluated (Table 5). In total, 52% of the vessels, and 50% of the trips resulting from these vessels, were in the non-response category (expected to be observed but were not). All vessels that were released from coverage used hook and line gear. The percentage of non-response vessels (and resulting trips) was not equally distributed among NMFS Areas. Non-response percentages must be interpreted with caution when only a few vessels are present within each category (consider the extreme case where only one vessel fishes- the only possible percentages are either zero or 100%). The percentages of non-response vessels among NMFS Areas are similar, with the exception of higher percentages in Area 650 (Fishery Management Plan for Groundfish of the Gulf of Alaska [GOA FMP], Southeast outside State Waters [SE]). There was more variation in the resulting percentages of non-response trips in vessel selection. There were greater percentages of trip non-response in Area 541 and (Fishery

Management Plan for Groundfish of the Bering Sea and Aleutian Islands [BSAI FMP]) and Area 650, and lower percentages of trip non-response in Areas 620 and 630 (GOA FMP, Central), and Areas 649 and 659 (GOA FMP, inside State Waters).

Coverage Rates in Dockside Deployments

Coverage rates in dockside observer deployments did not meet stated objectives and warrant further investigation. Observer dockside deployments were made to comply with the sampling requirements for obtaining genetics tissues from the bycatch of salmon within the pollock fishery according to Pella and Geiger (2009). Dockside, this sampling design requires a census of the primary sampling units (pollock landings) and a systematic random sample of individual salmon in the bycatch. Rates of sampling individual fish are set from anticipated bycatch amounts and desired numbers of samples from the AFSC's Auke Bay Laboratories. In the Bering Sea, Amendment 91 to the BSAI FMP facilitates the interception of pollock deliveries at dockside processing plants by observers by requiring 100% coverage and modifications to the way fish are offloaded increase the likelihood of detection of salmon bycatch in the offload. In the Gulf of Alaska, a voluntary agreement between fishermen, processors, and NMFS was in place in 2012 that was codified into regulation as Amendment 93 of the GOA FMP. Amendment 93 does not carry full-coverage requirements for observers nor does it require modifications to the offload process to improve salmon bycatch detection. Amendment 93 in the Gulf of Alaska requires that the processing plant notify NMFS that a pollock delivery has occurred and set aside any salmon bycatch it obtains in the offload until an observer has had a chance to quantify it. This system offers multiple challenges for obtaining a census of deliveries: notifications may not be always made, observers may not always be available when and where a pollock delivery is made, and salmon held by the processing plant may not represent a census of all bycatch salmon from which the observer obtains his or her systematic sample. In addition, the definition of a pollock delivery is dependent on the captain at sea, the processor for dockside notification, and the percentage of pollock in the landed catch in the resulting data. For a combination of these reasons, the Observer Program sampled from 91% of the pollock deliveries defined by landed data and regulations as greater than or equal to 20% pollock in the landed catch.

Spatial Patterns in Dockside Deployments

The amount and percentage of pollock deliveries observed in various ports during 2013 are presented in Table 6. In full-coverage operations, which include those under Amendment 91 in the BSAI, the Observer Program obtained near census of all pollock deliveries; only 3 of 1,956 pollock deliveries were not observed (0.2%). In the partial-coverage operations, the Observer Program was able to sample from 73% of operations where pollock landings occurred. Most of these 739 deliveries occurred in Kodiak, where the Observer Program was stationing observers for this purpose; 92% of pollock offloads were observed in this port. The potential errors in properly identifying a pollock offload are illustrated by the number of non-pollock offloads observed. Such errors in the sampling frame for dockside observers appear to be minor (0.3%).

REPRESENTATIVENESS OF THE SAMPLE

Temporal Patterns in Trip Selection

There were two types of non-response in trip-selection. The first was the phone-in request by vessels in this coverage category to be released from coverage based on the conditional release policy granted to vessels. The second resulted from the observer provider being unable to get an observer to a vessel in time for its anticipated departure, which may be due to reasons such as the lack of availability of an observer, failure to secure a flight due to weather, or observer illness; exploring those reasons is beyond the scope of this chapter. There were 16 trips that were granted a conditional release from coverage; 14 of these occurred during the first trip selection period. There were 28 provider-releases granted, and all of these occurred during the first trip selection period. The impact of those releases can be measured by comparing the coverage rate achieved and the coverage rate that would have been achieved without non-response. The results are presented in Table 7. Coverage percentages during the first and second period would have risen from 16.2 to 17.9 in the first period and from 9.2 to 10.4 in the second period. Since achieved coverage rates in the first period were already higher than our programmed rate in ODDS this loss due to non-response is less concerning than the loss due to non-response in the second period. That is, the loss of an observer trip has much greater impact when coverage rates are low than when they are high.

We evaluated the effect of these sources of non-response on the temporal coverage of fishing trips. Observed trips should occur throughout the year at the same relative pace as unobserved trips. To evaluate this, cumulative plots of the number of unobserved and observed trips were generated for the year. The expected 95% bounds of observed trips and unobserved trips was generated in three steps: 1) by calculating the variance (s^2) for each day of the year from $Nr(1\text{-}r)$ where r is the rate programmed into ODDS and N is the total number of observed or unobserved trips; 2) generating the expected number of unobserved and observed trips from Nr; and 3) subtracting and adding $1.96s$ to the expected trips (i.e., by using a normal approximation to the binomial distribution). The same was done on the cumulative number of observed and unobserved trips throughout the year, and these cumulative trips were divided by their maximum to put them on the same scale (0-1).

The number of observed and unobserved trips achieved was outside of their expected values during part of the year. Focusing on the observed trips, the achieved values were below the lower range of expected during three periods: 2–8 January, 2–16 February, and 21 February–6 March (36 days total). We would expect that 5% of our observed values would fall outside of our upper and lower expected bounds, and the value was only slightly higher (6.8%). If the deployment of observers was occurring as anticipated, a random selection of trips to be observed in ODDS should result in the accumulation of observed trips and unobserved trips at the same pace. Excepting the periods at the start of the year, this is what occurred (Fig. 4, lower panel). However, it is worth noting that there were no observed trips after 25 November, whereas unobserved trips continued throughout the year.

There are multiple factors that could explain the results shown in Figure 4. As was demonstrated in Table 1, a number of releases from observer coverage were granted to the vessel and to the observer provider during 2013, and the majority of these happened in the first trip-selection period. However, the realized observed rate was 16.2%, which was above the anticipated 14.78% programmed into ODDS. A review of the expected selection probability in ODDS during the first selection period was also 16.4. The apparent paradoxical situation is due to a nuance in the trip selection system. The ODDS allows users to log up to three trips prior to making a landing. At the start of the year, users were able to declare these trips as completed and "closed" in any order. If one or more of those trips were selected for coverage, the user could delay fishing with an observer by fishing the unselected trips first. The same mechanism could also explain the dearth of observed trips at the end of the year.[2]

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[2]Changes to the trip logging logic changed on 15 January 2014 in an attempt to limit this behavior. Trips must be closed in the order they are entered.

Spatial Representativeness

In the trip selection category, there were three selection periods with different selection rates. Each of these time periods became a separate sampling stratum. 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 the overall population. Therefore the proportion of observed trips in each area should be similar to the selection rate used to select individual trips. The proportion of trips actually observed in each NMFS Reporting Area varied (0% to 100%). The NMFS reporting Areas where the proportion of trips observed was very different from the expected proportion (14.87% or 11.15%) generally occurred in areas with less fishing activity (Fig. 5).

The same analysis was conducted for the vessel selection strata. There are six 2-month time periods during which vessels were selected for coverage, each having a different sample rate (see Table 1). The target proportion of trips observed is between 11% and 15%. The proportion of trips actually observed varied with NMFS Reporting Area (Fig. 6). In those areas where fewer fishing trips occurred (e.g., trip-selection category, time period 1, NMFS Area 523), there is a larger probability of observing zero trips due to the randomization process than there is in other areas where more fishing occurred. In other words, the probability of drawing a sample from *all* trips and having that sample include no trips from an area with little fishing is relatively high. For example, in the first time period, 2,375 fishing trips occurred (Table 1), and of those only 4 occurred in Area 523, which was less than 0.2% of all trips in the first period. In an observed sample of 386 trips, we would expect less than 1 of the 386 selected trips to occur in Area 523; hence, observing no trips in Area 523 (Fig. 5) is not unlikely.

To properly address the confounding effect of population size on expected rates of coverage, we computed the number of trips that are expected to be observed given the stratum-specific sample rate, the underlying fishing patterns, and randomization of deployment using the hypergeometric distribution. The hypergeometric distribution describes the probability of having a given number of items with a certain characteristics (e.g., trips in NMFS Area 610) in a sample taken from a population (all trips in a stratum) where the number of items with that same characteristic is known (the number of trips in a NMFS Reporting Area based on landings data). [3] 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. Using this method, we compared the expected number of trips with the observed number for any NMFS Reporting Area and stratum (Fig. 7). In both selection strata, the actual number of observed trips generally followed the expected; note the difference in scale (number of trips) between the two graphs. The size of the data points represent the probability of observing that number of trips or a number of trips farther from the expected number (more extreme), also based on the hypergeometric distribution. Small data points indicate an observed number of trips that is unlikely given randomization of deployments. Note that unlikely events do occur by chance: an outcome with probability of 0.05 is expected to occur once out of 20 times, for example. This analysis of the vessel selection strata (Fig. 7, right panel) should be viewed with caution since trips are not independent but rather clustered within a vessel. Not accounting for this clustering of trips will result in an underestimation the probability of observing that number

[3] The hypergeometric distribution is similar to the binomial distribution which describes the number of successes in a sample drawn with replacement. Since fishing trips cannot be sampled with replacement, the hypergeometric distribution (sampling without replacement) is more the appropriate distribution to use in this analysis.

of trips or a more extreme value; more cells will be identified as extreme outcomes than actually exist.

We also computed the number of expected trips in both NMFS Area and gear type (Fig. 8). Each cell is defined by gear in addition to NMFS Area and the hypergeometric distribution is used as before so that the size of the data point represents the probability of observing that number of trips or a number of trips farther from the expected for that cell.

The probability of observing a number of trips as far or farther than the expected number are mapped for trip and vessel selection (Fig. 9 and Fig. 10, respectively). While values less than 5% are often considered to be statistically significant (evidence that the hypothesis being tested is false), in this case we are not testing a hypothesis, but rather assessing patterns of unlikely outcomes (the tails of the distribution).

In each trip selection time period stratum, there were 1 or 2 NMFS Areas where the probability of the observed number of trips or a more extreme outcome was less than 5% (Fig. 9). These occurances do not necessarily indicate a departure from what is expected under random deployment. On three of the five NMFS Areas where the probability was less than 5%, the observed number of trips was higher than expected: first period Area 521 (expected 3.4, observed 11); and NMFS Area 519 (expected 0.3, observed 1) and NMFS Area 610 (expected 7.1, observed 12) during the second period. On two occasions the observed number of trips was lower than expected: first period NMFS Area 519 (expected 20.1, observed 10); and third period NMFS Area 509 (expected 4.8, observed 1).

There were more NMFS Areas where the probability of the observed number of trips (or a number farther from expected) was less than 5% in the six vessel selection strata compared to the results of trip selection. In four of the five time periods that had fishing effort, the probabilities of observing a number of trips in NMFS Area 650 that was as far or farther from the expected number was less than 5% (Fig. 10).

However, the direction of this outcome was not always the same among time periods. The observed number of trips in this area was less than expected in the July-August period (0 observed, 3.2 expected) and the September-October period (0 observed, 3.9 expected). The observed number of trips was larger than expected on all other occasions where the probability the observed number of trips being as far or farther from expectation was less than 5%. Clustering of trips within each vessel may result in data that do not follow the hypergeometric distribution, and therefor the probability of observing a more extreme number of trips may not be correct.

Taken together, there are no apparent departures in the spatial distribution of observed trips in either strata from what would be expected under a random sample of trips and the distribution of observed trips appears to be consistent with the distribution of unobserved trips. There are a greater number of unusual results in the vessel selection strata than might be expected due to random chance. However, the clustering of trips within vessels combined with the sparseness of data in vessel selection may cause overdispersion (i.e., the variance is larger than expected under the hypergeometric distribution), resulting in the map-depicted probability values being overestimated and complicating interpretation of probability values. This issue needs further evaluation; but comparing the relative spatial patterns of extreme values is important especially in light of certain federal Reporting Areas consistently exhibiting extreme values.

Trip Metrics

The consistency of trip characteristics between the observed and unobserved trips in trip- and vessel-selection was evaluated to assess whether observed trips had characteristics that were different from the portion of the fleet that was not observed. Specifically, the distributions of trip duration, number of NMFS Areas visited during a single trip, landed weight of catch, and the species diversity of catch were visually compared for each strata.

Trip Duration

In the trip selection stratum, the duration of trips varied between 1 and 47 days (first time period) and between 1 and 15 days in the third time period (Fig. 11). The distributions of trip length were consistent between the observed and not observed categories.

In the vessel selection stratum, the distributions of trip length were consistent between the observed and not observed categories for most time periods (Fig. 12.). The distribution of trip length was less consistent between the observed and not observed trips in Period 4 (July - August) and Period 5 (September - October).

For the vessel selection strata, the distribution of trip duration was also evaluated for several subsets of trips without observers. These included: trips made by vessels that were not in the sample frame (zero chance of carrying an observer), vessels that were released from observer coverage, and trips made by vessels that were not selected to carry an observer (and are not in the other categories). Allowing for the lack of data in the observed category, the distributions of trip length are consistent between categories (Fig. 13).

Lastly, the duration of trips for observed and unobserved trips that delivered their catches at-sea to tenders was inspected for trips in the trip selection strata (Fig. 14). In terms of observer deployment, trips are defined as the length of time from when a vessel leaves port with an empty hold to the time it returns to a port with a shoreside processor with a valid Federal Fisheries Permit. While trips delivering to tenders had a few trips of longer duration than those that deliver catch to shoreside processors, the differences in trip length between the observed and unobserved trips was less pronounced than earlier comparisons from the first 16 weeks of 2013 (NMFS 2013). There were insufficient trips in vessel selection for this same comparison to be made.

Taken together, there were no patterns in trip duration that provide evidence of systematic differences in trip length between trips that are observed and those that are not. However, the lack of data in the observed trip categories resulted in distributions that tended to be less dense, and hence may have been insufficient to clearly capture any discrepancies.

Number of NMFS Areas Visited per Trip

The proportion of trips that visited one, two, three, or more NMFS Areas was computed for the observed and not observed trip categories within trip and vessel selection strata (Fig. 15 and Fig. 16, respectively). In the absence of an observer effect, the proportion of trips that visited a one, two, or more NMFS Areas should be the same between observed and unobserved trips. While this was the case in the first time period of the trip selection strata, in the second and third time periods the proportion of observed trips visiting a single NMFS Area was higher than for the unobserved group while the opposite condition was true for trips visiting more than one NMFS Area (Fig. 15). In these same time periods there were no observed trips that visited more than two NMFS Areas.

Differences were more pronounced in the vessel selection strata. In every time period but the second, the proportion of trips visiting only one NMFS Area was lower for observed trips than unobserved trips while the opposite condition was true for trips visiting more than one NMFS Area (Fig. 16).

Landed Catch Weight

Distributions of landed catch did not show any obvious differences between observed and unobserved trips in any of the deployment strata (Figs. 17, 18). As expected, vessels in trip selection strata tended to have larger deliveries than those in vessel selection. Landings early in the year (time periods 1 in both trip and vessel selection strata) tended to be larger than in later time periods. Of particular note are a few deliveries of over 200 t in the vessel selection strata (time period 1).

Species Diversity

The number of species within the landed portion of the catch should be dependent in some degree to the size of that catch. For this reason, a suite of possible metrics have been devised in ecology to standardize comparisons. However these techniques all rely on the relationship between the number of species and the number of individuals, not weight (e.g., rarefaction). Relative species diversity curves have been shown to convey large amounts of information about the structure of the population or sample, but can be difficult to understand (Magurran 1988). For this reason, we adopted a simplified version of the species diversity curve, and compared the percentage of the total retained catch that was accounted for by the most abundant species. This metric follows the concepts behind Hill's diversity numbers N1 and N2 that depict the number of abundant and very abundant species (Hill 1973). High percentages in our metric should indicate lower diversity catches. We did not find large differences between observed and other classes of trips in trip selection (Fig. 19) or vessel selection (Fig. 20).

However, the relative proportion of trips that had no diversity (a value of 1 in Figs. 19, 20) was higher for vessels in the frame and out of the frame than for observed trips in five of six time periods in vessel selection, and differences were more pronounced and could not be explained by releases from coverage in period 5. In vessel selection, catches are less “pure” during observed trips than during unobserved trips.

Summary

Overall, there were no consistent patterns of discrepancy between the observed trips and the unobserved trips for any metrics except possibly the number of NMFS Areas visited on a trip and the purity of the catch. Although in some comparisons the lack of data for the observed group may have masked inconsistencies, we found no evidence of systemic bias for those characteristics for which data are available for both observed and unobserved groups.

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 coming into the system to group data from fishing activities of similar character (gear, NMFS Area, trip targets) within weekly periods. At low sample sizes, the probability of the observer sample data containing no observations for 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. For this reason it is important to have a large enough sample to have reasonable expectation of observing all types of fishing.

There are many fishing trips in each of the gear types, hence regardless of sample size, all gear types can be expected to be represented in the sample. However, over the course of an entire year, some NMFS Areas have low fishing effort and as a result relatively high probability of collecting a sample across all NMFS Areas that contains no data for that area with low effort.

The fishing effort data for each stratum (trip and vessel selection for each time period) and the sample size (number of observed trips) over the course of 2013 was used to evaluate the probability of drawing a sample of trips and observing no trips in a NMFS Area, based on the hypergeometric distribution (Fig. 21). The smaller the population being evaluated, in this case defined only by NMFS Area, the larger the probability of failing to capture observer data from that cell. Including additional factors, such as week, will decrease cell size and increase the probabilities of obtaining no observer data in the random sample. Because trips in the vessel selection strata are not independent, but rather are grouped within vessels, these results should be interpreted with caution.

In addition to assessing the probability of the sample of trips containing no data for a NMFS Area (cell), the probability of a sample containing no trips was computed for cells defined by gear type, NMFS Area, and stratum (selection category and time period) (Fig. 22).

Similar to the probability of not observing any trips in an area, given the same fishing trips and same sample size, we can compute the probability of drawing a sample and observing three or more trips (Fig. 23). In this scenario, the probability of observing three or more trips increases as the number of trips that occurs in an area increases (note that the x-axis is truncated in these plots). For example, looking at trawl gear, the same areas (NMFS Areas 640 and 620) and strata combinations having few trips have a low probability of 3 or more trips (Fig. 23) and a large probability of no observed trips.

In both Figure 21 and Figure 22, the cells are defined as all trips in each selection group, time period, NMFS Area (Fig. 21) and gear type (Fig. 22). If the data are divided into smaller cells, with fewer trips occurring in each cell (e.g., by including week), the probability of observing no data in a cell will increase. Conversely, the probability of observing no data in a cell will decrease with increasing sample rate (in addition to increasing numbers of trips in a cell). Sample size requirements to ensure data are present in all cells of interest will be evaluated during the planning process for 2015.

RECOMMENDATIONS TO IMPROVE DATA QUALITY

Three sources of error were found that disrupted the integrity of the observer deployment sampling design: the lack of a proper sampling frame in vessel selection, conditional release policies, and the manipulation of trip order in trip selection.

- The sampling frame in vessel selection would be improved through a check-in system whereby vessels would notify the Observer Program of their intent to fish and would in return be notified of whether the vessel would require an observer and the duration of the observation period. This type of check-in system is identical to the procedure currently used in trip selection. Use of such a system would greatly reduce errors due to oversampling and improve the efficiency of the selection process.

- The conditional release policy imparts bias into the observer data. If such releases are continued, then they should apply to all fishing activities within the sampling unit (all trips made by a vessel during the time period, and not only during certain fishing activities).

- The selection rate in ODDS should remain constant throughout the year. Changing the selection rate creates temporal strata. Rather than reduce the selection rate in ODDS to reduce the risk of cost overages, we recommend that NMFS use budget buffers if possible to mitigate for the rare event of overage.

- Data analyses continue to be hampered by the lack of a trip identifier. We recommend that the linkage between ODDS and eLandings be strengthened.

ACKNOWLEDGMENTS

In support of the review, revise, and repeat process now integral to the observer program, we would like to acknowledge those who worked so hard to set up the infrastructure that facilitated this review in the Council process: Sally Bibb, Brandee Gerkee, Martin Loefflad, Glenn Merrrill, Jennifer Mondragon; as well as those who built and supported the observer trip- and vessel- logging systems: Julie Blair, Glenn Campbell, Paul Packer, Martin Park, and Gary Zhou.

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TABLES AND FIGURES

Table 1. -- Summary of trip selection metrics (CV and CP combined) measured in the Observer Declare and Deploy System (ODDS). The Binomial test p-value refers to the value returned by a two-sided exact binomial test with a probability of success equal to the programmed rate and an actual probability of success given the random number generator. Values were not sufficient to reject the null hypothesis that the random number generator was selecting at the programmed rate. Inherited selection percentage is the percentage of logged trips selected to carry an observer given the random selection process and a 100% selection probability if the user's last cancelled trip was to be observed. These are termed "inherited trips". The expected trips is the number of logged trips expected to be realized considering random selection, inherited trip probabilities, trip releases, and cancelled trips. Expected selection percentage is the percentage of expected trips selected to be observed. Trip amounts reported here between logged and actual may not match because the logged dates will be different from the dates a trip is realized. In addition, there were 239 trips that were cancelled by the system. We would expect the totals for the year in ODDS to be similar to the totals in this analysis identified using the eLandings and Catch Accounting System databases. The mismatch in the totals column highlights some potential problems with defining trips between various databases.

Selection Period	**1**	**2**	**3**	**Totals**
Selection period duration	Jan. 1 – June 21	June 22 – Aug. 16	Aug. 17 – Dec. 31	
		Selection Percentages		
Programmed	14.8	11.2	14.8	
Random number generator	15.5	10.2	13.9	
95% interquartile range	(13.7 – 17.5)	(6.5 – 14.9)	(12.1 – 16.0)	
Binomial test p-value	0.39	0.75	0.43	
Inherited	17.9	11.1	15.6	
Expected	16.4	11.4	15.7	
Actual	16.3	9.1	13.4	
		Trips		
Logged into ODDS	2,551	225	1,257	4,033
Expected after user cancellations	2,206	201	1,043	3,450
Cancelled by ODDS (CS)	78	19	142	239
Expected after CS (Exp.)	2,284	220	1,185	3,689
From landings (Actual)	2,391	264	1,322	3,977
Percent difference (Exp. vs. Actual)	4.5	16.7	10.4	7.2

Table 2. -- Coverage in trip units for full and trip selection; vessels for vessel selection.

Stratum	Date		Trips (#)		Vessels (#)		Coverage (%)		95% percentile		Meets or exceeds expected?
	Start	End	Total	Observed	Total	Observed	Actual	Expected	Lower	Upper	
Full coverage											
Regulatory	Jan. 1	Dec. 31	4,485	4,482	173	170	99.9	100.00			**Yes**
Voluntary			353	353	35	35	100.0				**Yes**
Total Full	Jan. 1	Dec. 31	4,840	4,835	178	175	99.9	100.00			
Partial coverage: Trip selection											
CV 1	Jan. 1	Jun. 21	2,375	386	267	151	16.2	14.8	13.3	16.2	**Yes**
CP 1			confidential				18.8		0.0	31.2	**Yes**
CV 2	Jun. 22	Aug. 16	250	23	69	15	9.2	11.1	7.6	15.2	**Yes**
CP 2			confidential				7.1		0.0	28.6	**Yes**
CV 3	Aug. 17	Dec. 31	1,308	177	206	96	13.5	14.8	12.9	16.7	**Yes**
CP 3			confidential				0.0		0.0	35.7	**Yes**
Total Trip	Jan. 1	Dec. 31	3,977	590	302	187	14.8	14.5[4]			
Partial coverage: Vessel selection											
1	Jan. 1	Feb. 28	262	16	51	3	5.9	13.7			**No**
2	Mar. 1	Apr. 30	453	45	146	13	8.9	11.6			**No**
3	May 1	Jun. 30	549	22	212	9	4.2	11.8			**No**
4	Jul. 1	Aug. 31	384	15	151	6	4.0	12.5			**No**
5	Sep. 1	Oct. 31	483	29	164	12	7.3	12.8			**No**
6	Nov. 1	Dec. 31	118	27	47	7	14.9	14.9			**Yes**
Total Vessel	Jan. 1	Dec. 31	2,249	154	388	41	10.6	11.0			
Partial coverage: No selection											
NMFS Do Not Deploy	Jan. 1	Dec. 31	3,040	0	610	0	0	0			**Yes**
Dockside											
Pollock	Jan. 1	Dec. 31	2,695[5]	2,972[3]			90.7	100.0			**No**

[4] Calculated from (sum(r_t*N_t))/ sum (N_t).
[5] Represents landings, not trips.

Table 3. -- The number of vessels that fall under specific criteria within the vessel selection strata.

Row	**Time strata**	**1**	**2**	**3**	**4**	**5**	**6**
	Coverage duration	**Jan.-Feb.**	**Mar.-Apr.**	**May-Jun.**	**Jul.-Aug.**	**Sep.-Oct.**	**Nov.-Dec.**
	Number of vessels in the sampling frame						
1	..anticipated to fish (for ADP rates; 2011 data)	65	153	231	169	194	66
2	..in selection frame (2012 data); F	74	181	234	170	203	47
3	..in frame and fished; f_Y	42	114	165	102	117	15
4	..in frame and did not fish; f_N (over-coverage= inefficiency)	32	67	69	68	86	32
5	..not in frame fished; f_0 (under-coverage=potential bias)	9	32	47	49	47	32
6	..active (fished=true frame); $f_* = f_0 + f_Y$	51	146	212	151	164	47
	Selected vessels						
7	..desired number to be observed; v_t	7	17	25	19	21	7
8	..selected for coverage; v_s	9	29	39	45	65	47
9	..selected did not fish (non-response); v_N	5	14	16	24	38	32
10	..selected and fished; v_f	4	15	23	21	27	15
	Released vessels						
11	..selected, fished, never released	4	11	10	7	11	5
12	..selected, fished, and had some release; v_R	0	4	13	14	16	10
13	..selected, fished, and released entire period	0	2	12	14	16	9
14	..selected, fished, released part of the period	0	2	1	0	0	1
	Observed vessels						
15	..selected and observed total; v	3	13	9	6	12	7
16	..selected, not released, all data present	2	10	9	6	9	5
17	..selected, not released, some data missing	1	3	0	0	0	0
18	..selected, not released, all data missing	1	0	2	1	2	1
19	..selected, released, but observer data; $v_?$	0	0	0	0	3	2

Table 4. -- Vessel-selection rates expressed as percentages (all rate formulations multiplied by 100). Abbreviations follow Table 3.

Row	Percent errors in Sampling Frame						
1	over-coverage (% of Sample Frame); f_N / F	43.2	37.0	29.4	40.0	42.3	68.1
2	under-coverage (% of true frame); f_0 / f_*	17.6	21.9	22.2	32.4	29.0	68.1
	Percent errors due to non-response						
3	Selected and did not fish; v_N / v_s	55.5	48.3	41.0	53.3	58.5	68.1
4	Selected, fished and not observed; $(v_f - v)$ / v_f	25.0	13.3	60.1	71.4	55.5	53.3
	Percent chance of selection						
5	..in frame, fished, and selected; v_f / f_Y	9.5	13.1	13.9	20.6	23.1	100.0
6	..if not in frame (rate for under-coverage boats)	0.0	0.0	0.0	0.0	0.0	0.0
	Percent Selected						
7	..fished and given some sort of release; v_R / v_f	0.0	26.7	56.5	66.7	59.2	66.7
	Percent coverage						
8	Desired coverage; v_t / f_*	13.7	11.6	11.8	12.5	12.8	14.9
9	Achieved coverage; v / f_*	5.8	8.9	4.2	4.0	7.3	14.9

Table 5. -- The total number of trips and vessels in the vessel selection strata that were either observed or conditionally released. The number of vessels and trips are not unique among individual cells of this table (trips and vessels can cross NMFS Reporting areas), so totals should be interpreted with caution.

	Trips (resulting from vessels)			**Vessels (1° sampling unit)**		
NMFS Reporting Area	Observed	Released	Non-response (%)	Observed	Released	Non-response (%)
517	0	1	100	0	1	100
518	5	1	16	3	1	25
519	4	0	0	3	0	0
541	2	10	83	1	1	50
542	1	6	86	1	1	50
610	17	21	55	4	5	56
620	14	6	30	5	4	44
630	77	61	44	21	25	54
640	3	5	63	3	4	57
649	4	3	43	3	2	40
650	19	41	68	8	15	65
659	20	10	33	11	8	42
Total	166	165	50	63	67	52

Table 6. -- Pollock and non-pollock landings by port and observed status (O = observed U = Unobserved) where observers recorded salmon information, length, or specimen information.

		Pollock deliveries				Non- Pollock deliveries			
Port	Landings	O	U	Total	% O	O	U	Total	% O
Full-Coverage									
Akutan	894	774	0	774	100.0	0	654	654	0
Dutch Harbor	851	784	0	784	100.0	0	120	120	0
Inshore Floating Processor	442	304	1	305	99.7	0	67	67	0
King Cove	89	84	0	84	100.0	0	137	137	0
Kodiak	189	0	2	2	0.0	0	5	5	0
Sand Point	10	10	0	10	100.0	0	138	138	0
Other	138	0	0	0	0.0	0	187	187	0
Total- Full Coverage	2,613	1,956	3	1,959	99.8	0	0	0	0
Partial-Coverage, Trip- and Vessel-Selection									
Akutan	307	5	40	45	11.1	0	262	262	0.0
Dutch Harbor	505	0	0	0	0.0	6	499	505	1.2
Inshore Floating Processor	186	7	12	19	36.8	0	167	167	0.0
King Cove	453	8	63	71	11.3	9	373	382	2.4
Kodiak	2,305	710	54	764	92.9	0	1,541	1,541	0.0
Seward	504	0	6	6	0.0	0	498	498	0.0
Sand Point	717	9	99	108	8.3	3	606	609	0.5
Other	2,074	0	0	0	0.0	0	2,074	2,074	0.0
Total- Trip and Vessel	7,051	739	274	1,013	73.0	18	6,020	6,038	0.3
Partial-Coverage, No-Selection									
Total- No Selection	3,082	0	0	0	0.0	0	3,082	3,082	0.0
Grand total	**12,746**	**2,695**	**277**	**2,972**	**90.7**	**18**	**9,756**	**9,774**	**0.2**

Table 7. -- Summary of release from observer coverage metrics for trip-selection CVs. No trip-selection releases were granted for trip-selection CPs.

Time strata	1	2	3
Coverage duration	Jan. 1- Jun 21	Jun 22 – Aug. 16	Aug. 17 – Dec. 31
Total trips; T	2,375	250	1,308
Total trips observed; t	386	23	177
Vessel released trips; t_{RV}	14	2	0
Provider released trips; t_{RP}	25	1	3
Total released trips; $t_{RV} + t_{RP} = t_R$	39	3	3
Realized coverage rate; $(t / T) \times 100$	16.2	9.2	13.5
Unrealized potential coverage rate without releases; $[(t_R + t) / T] \times 100$	17.9	10.4	13.8

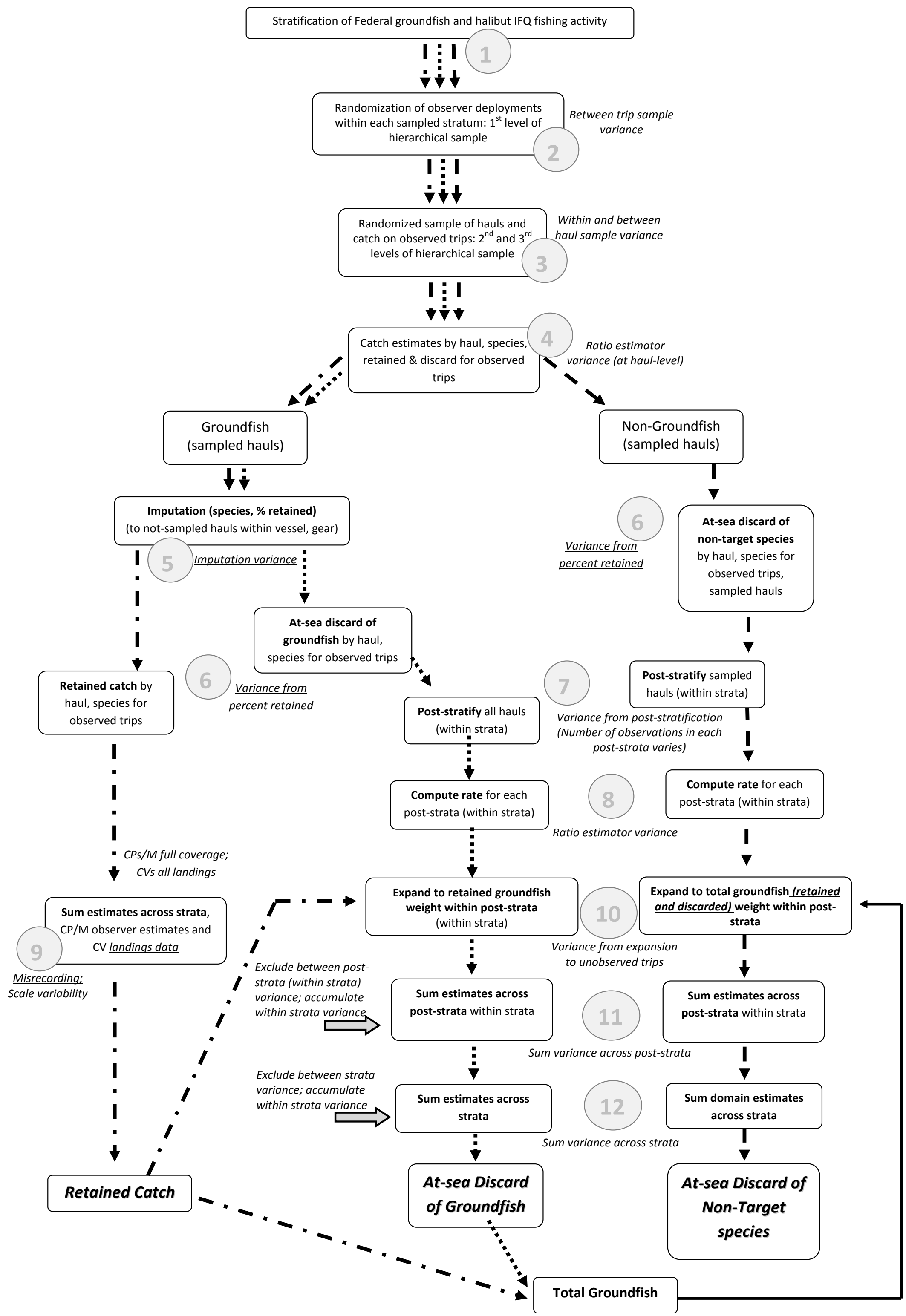

Figure 1. -- Schematic representation of the catch estimation process for retained catch, at-sea discard of groundfish species, and at-sea discard of non-target and prohibited species. Numbering indicates steps in the estimation process where uncertainty is accumulated.

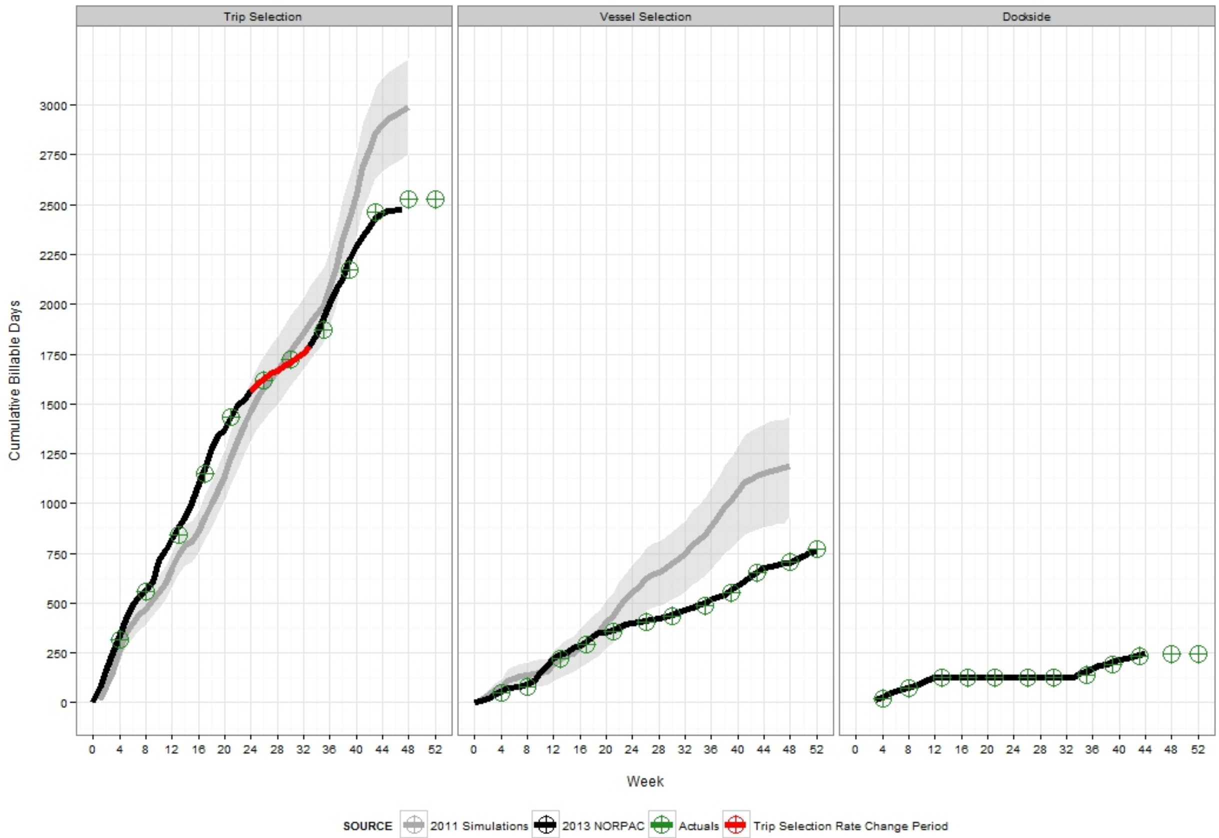

Figure 2. -- Trajectories of cumulative observer days expected from various sources within three deployment strata. Expected values from 2013 ADP simulations are depicted as gray bands, those from Observer Program databases are depicted as a black line, and those from NMFS observer provider invoices are depicted as green circles. The period denoting the change in the ODDS selection rate to and from 0.1115 is denoted in red.

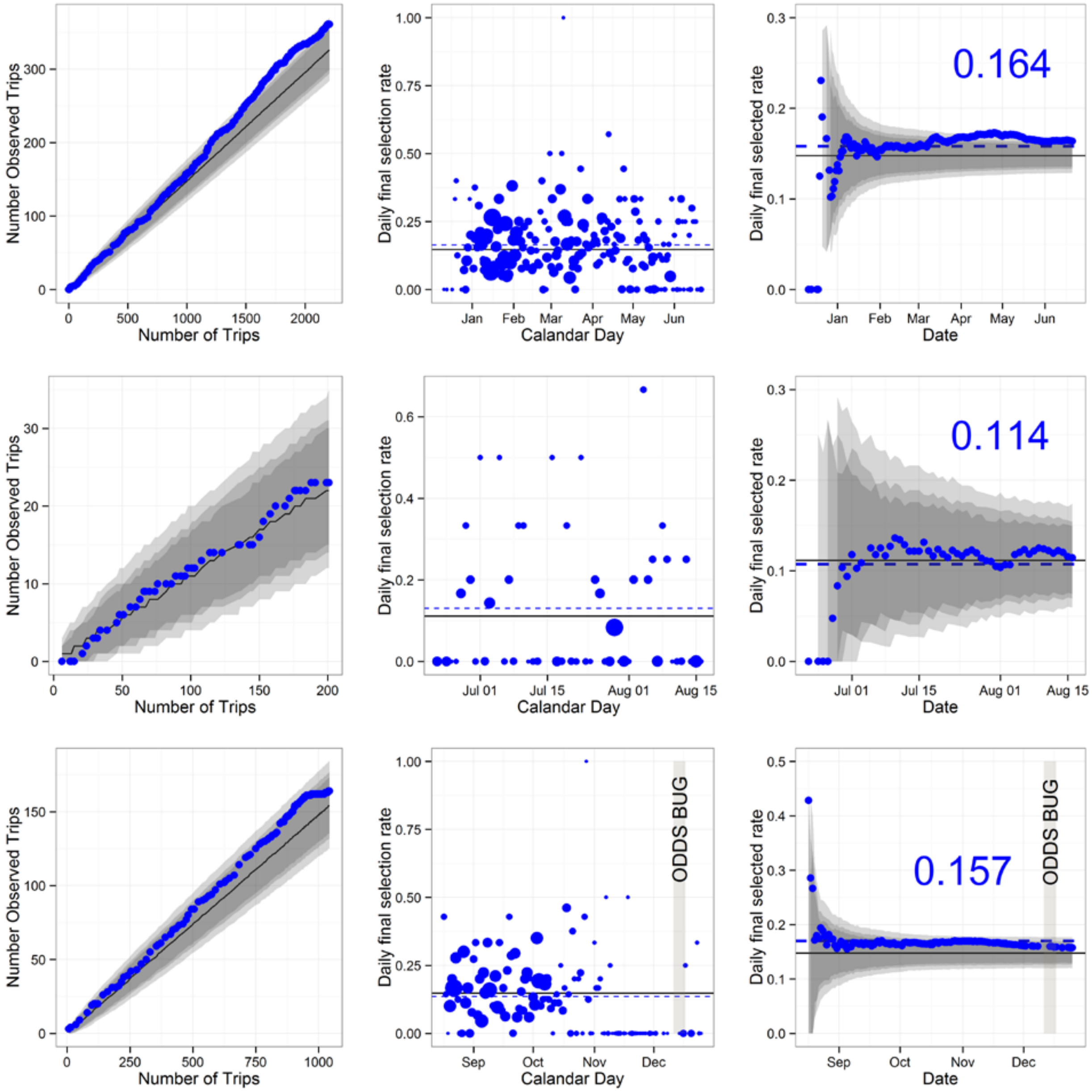

Figure 3. -- Diagnostic plots from the Observer Declare and Deploy System. All values depict values from the logged trips after considering all factors (inherited trips, cancellations, and releases). Each row corresponds to the three time periods of trip-selection from Table 1. The left column depicts the number of trips anticipated compared to that expected from a truly random selection at the programmed rate. The central column depicts the daily coverage rate with points sized to the number of trips logged in a day. Vertical dashed line is the average rate for the period compared to the programmed rate depicted as a solid line. The right column depicts the cumulative rate compared to the theoretical range of rates expected from a truly random selection at the programmed rate. The final rate is depicted as text.

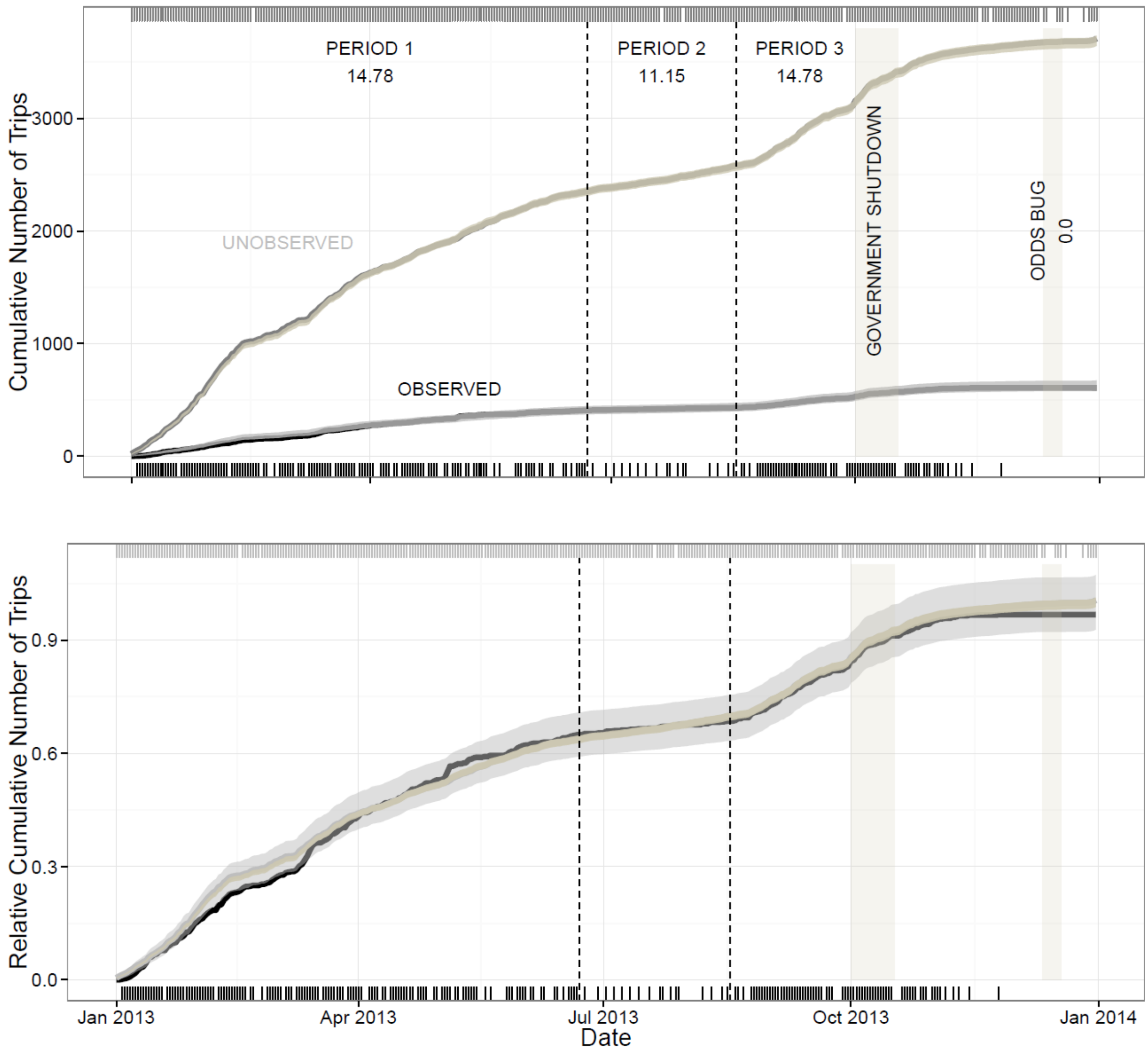

Figure 4. -- Accumulation of unobserved and observed trips within the trip selection deployment stratum during 2013. Observed trips are depicted as black lines with 0.025 and 0.975 percentiles depicted in gray. Unobserved trips are depicted as gray lines with brown percentile bounds. Days with unobserved trips are marked with ticks at the top of the upper panel, while days with observed trips are marked with ticks on the bottom of both panels. When the values in the top figure are divided by the respective total for the year, the result is the lower figure. The number of observed trips was lower than expected in the beginning of the year only, although there is a dearth of observed trips after December. The duration of the 2013 Federal Government Shutdown and a 7-day non-selection period due to a bug in ODDS are also depicted.

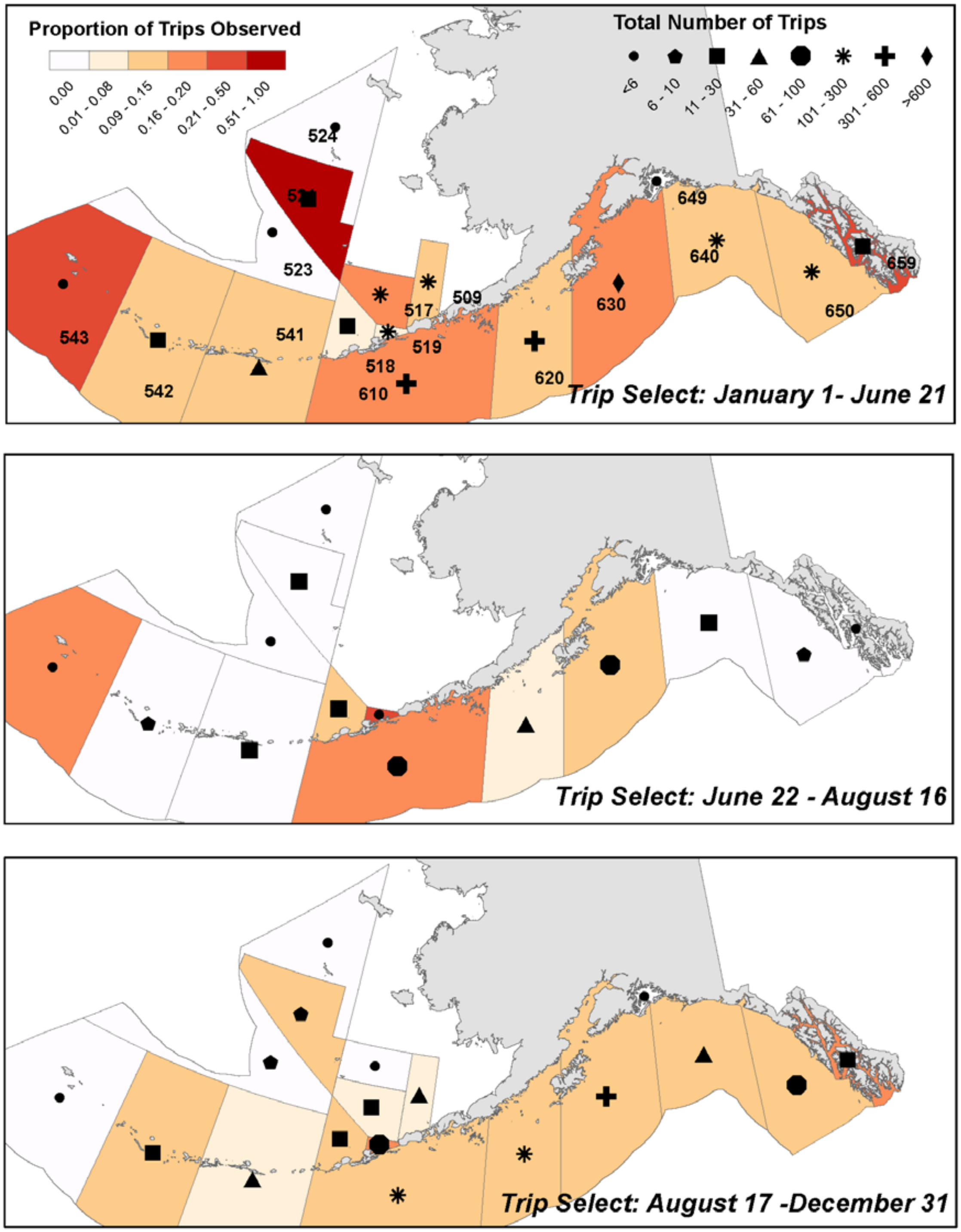

Figure 5. -- Proportion of trips observed in each NMFS Reporting Area in the trip selection strata. The color of the Reporting Area reflects the proportion of trips that were observed while the symbol indicates the total number of fishing trips that occurred in that area.

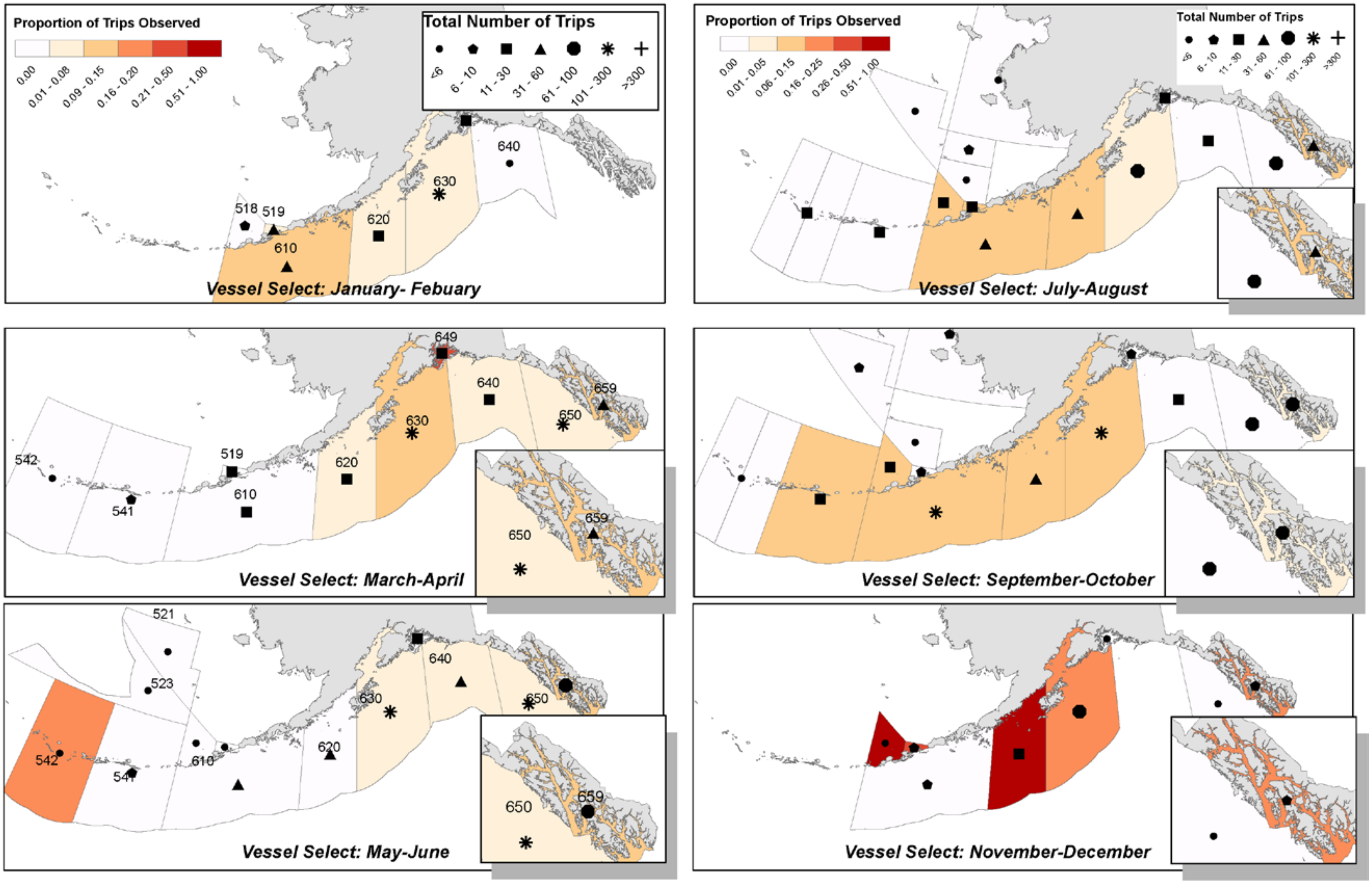

Figure 6. -- Proportion of trips observed in each vessel selection stratum.

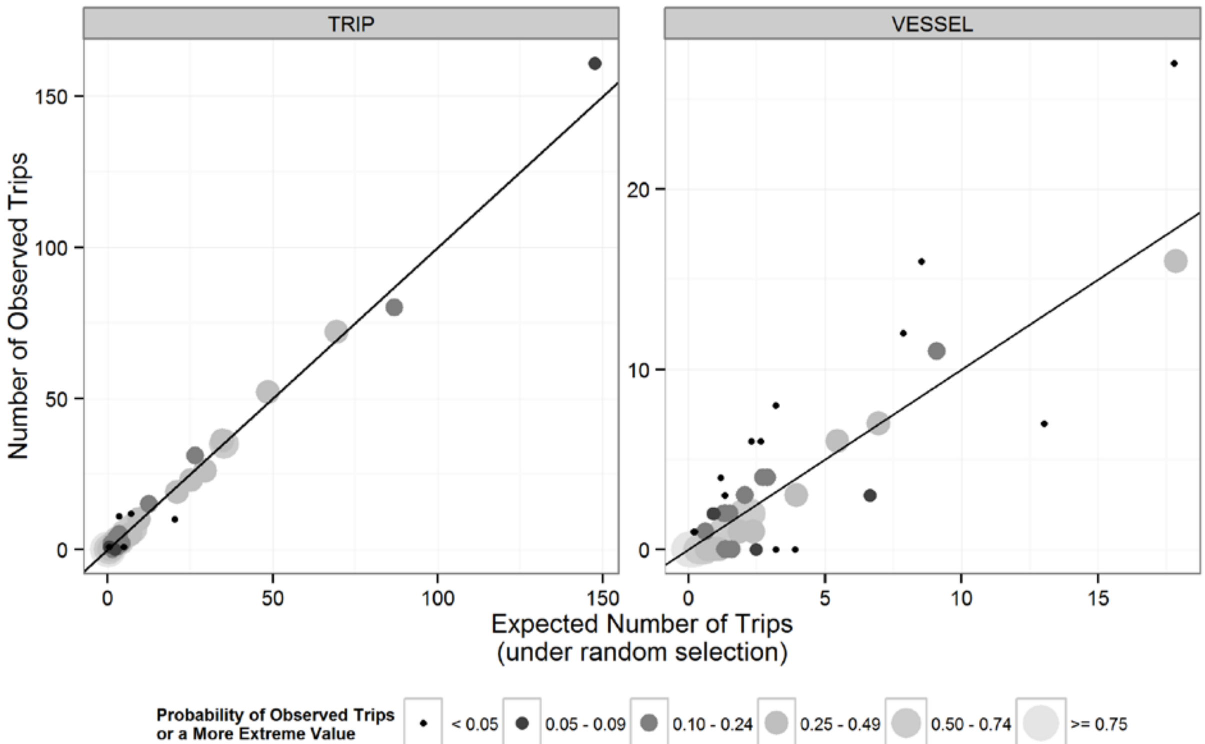

Figure 7. -- Comparison of the number of trips observed (y-axis) with the number of trips expected (x-axis) under random deployment of observers into trip (left frame) and vessel (right frame) selection strata. Each data point represents the number of trips in a NMFS Reporting Area and time period cell. Note the difference in scale between the two panels with trip selection cells having higher numbers of trips. The size of the data point corresponds to the probability of observing a number of trips as far or farther from expected than realized; the data points are plotted in layers from the largest probabilities (largest data points) at the lowest level while the smallest probabilities (smallest data points) are plotted on top of other data.

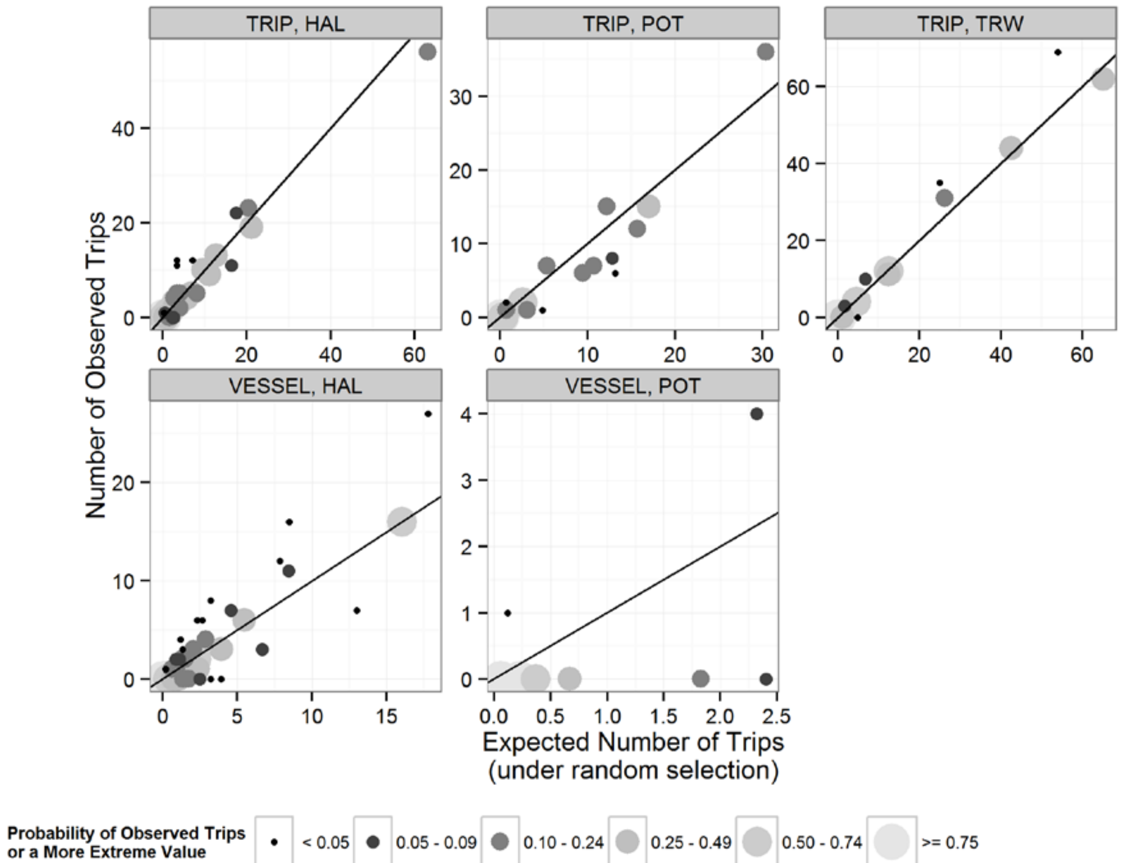

Figure 8. -- Comparison of the number of trips observed (y-axis) with the number of trips expected (x-axis) under random deployment of observers into trip (top row) and vessel (bottom row) selection strata and gear type (HAL = hook and line; POT = pot gear; TRW = trawl gear). Each data point represents the number of trips in a NMFS Reporting Area and time period cell. Note the difference in scale between the two panels with trip selection cells having higher numbers of trips. The size of the data point corresponds to the probability of observing a number of trips as far or farther from expected than realized; the data points are plotted in layers from the largest probabilities (largest data points) at the lowest level while the smallest probabilities (smallest data points) are plotted on top of other data.

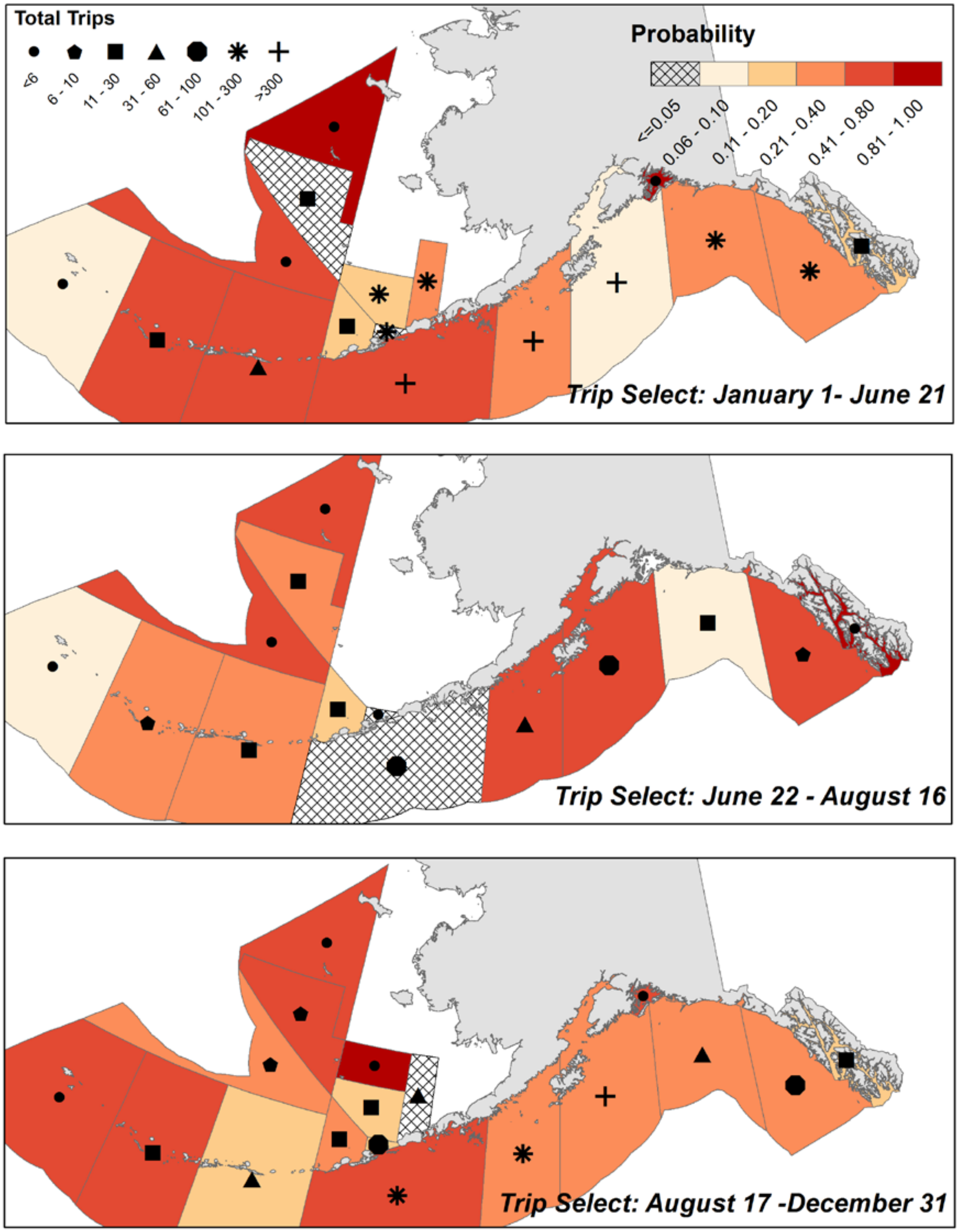

Figure 9. -- The probability of observing a number of trips as far or farther from the expected number than the sample contained (probability of observing a more extreme value).

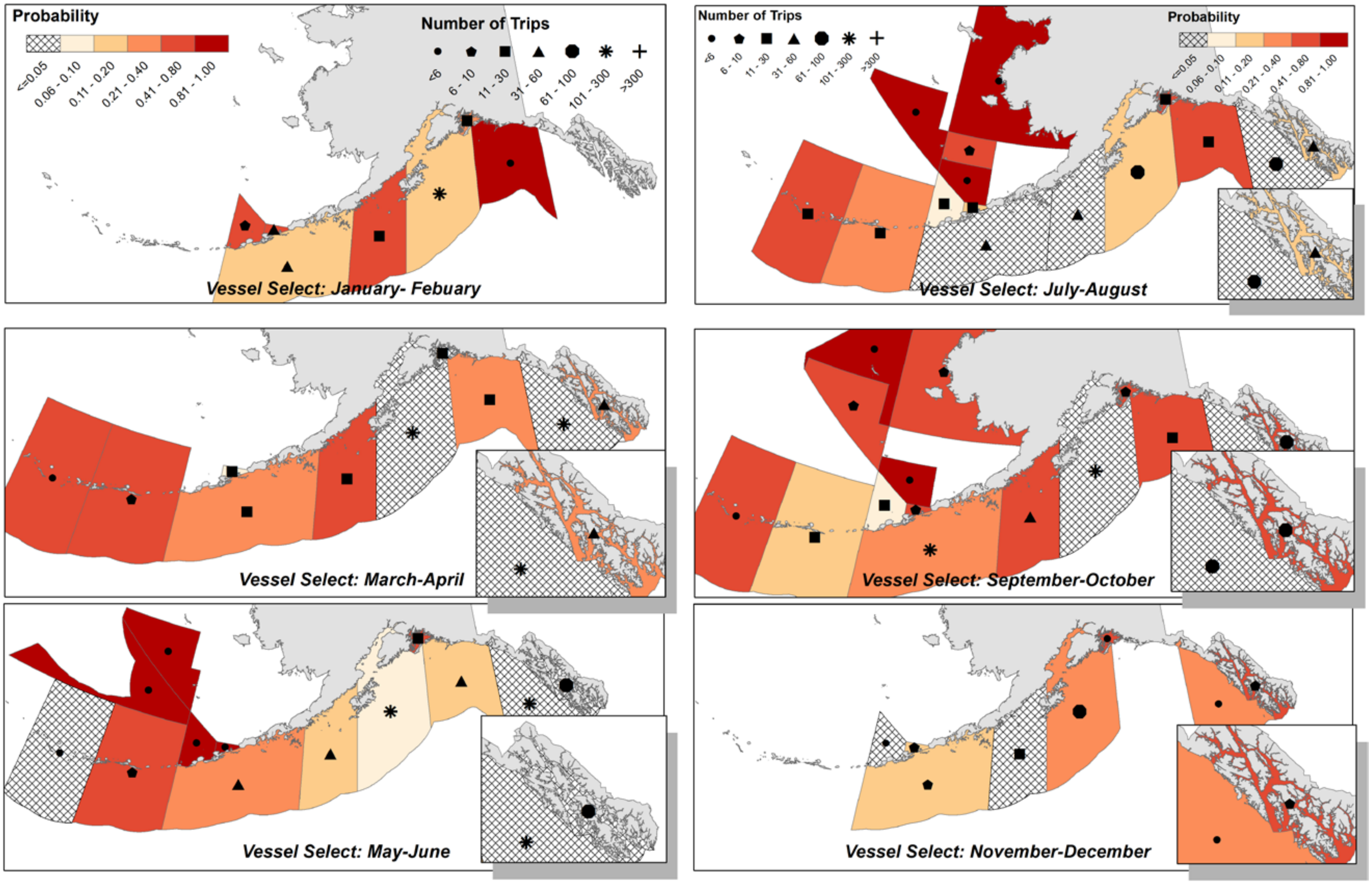

Figure 10. -- The probability of observing a number of trips as far or farther from the expected number than the sample contained (probability of observing a more extreme value).

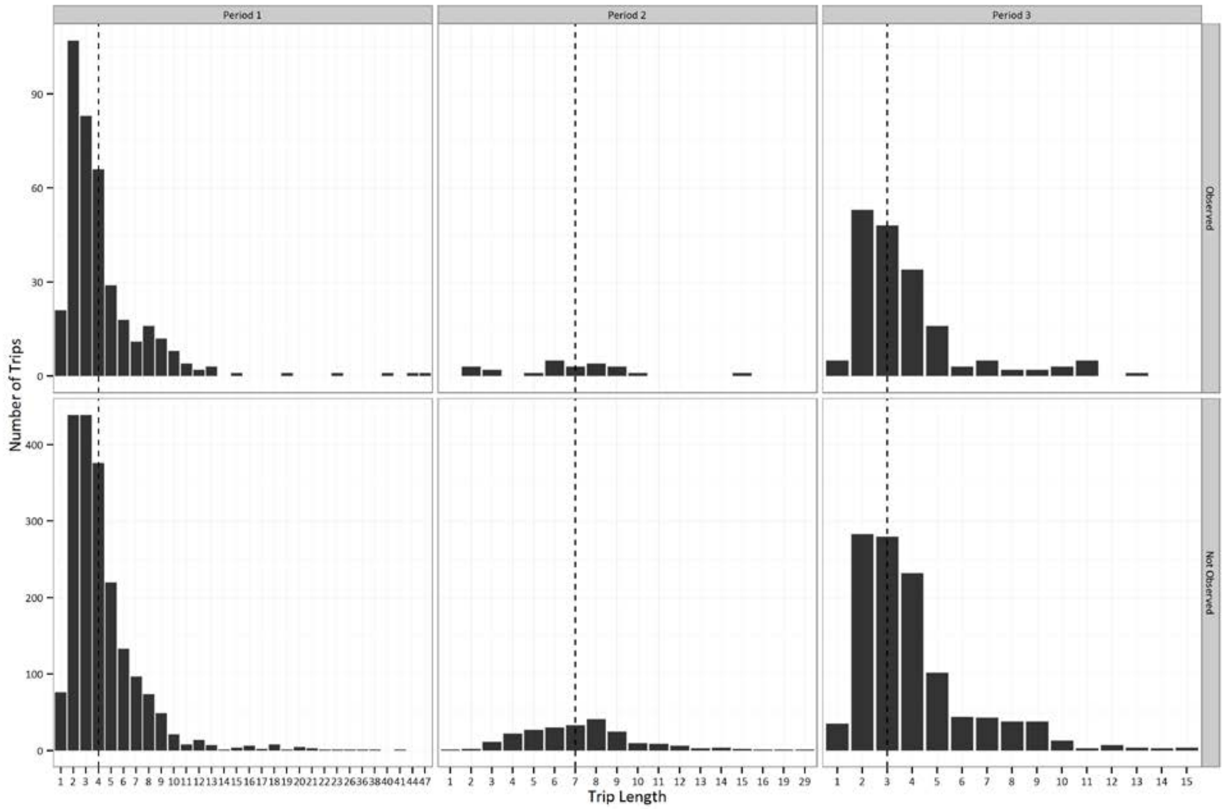

Figure 11. -- Distribution of trip length for trip selection strata, in number of days, for the observed and not observed trips. The median trip length for trips without observers is indicated in each time strata by the dashed line. Note that empty trip length intervals are not included.

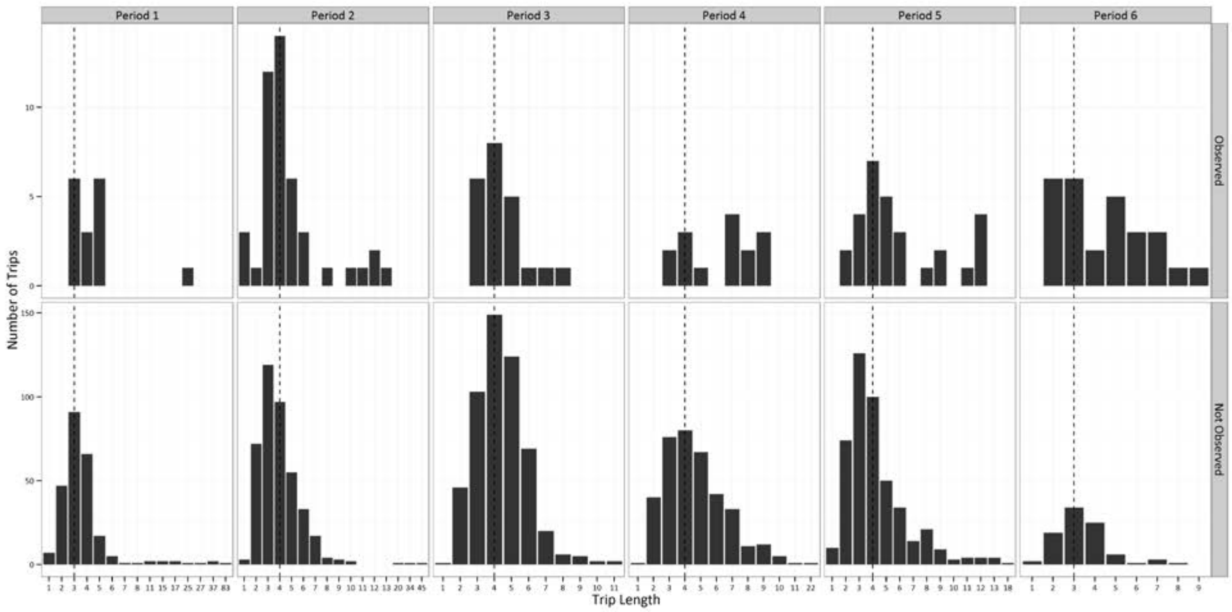

Figure 12. -- Distribution of trip length for vessel selection strata, in number of days, for the observed and not observed trips. The median trip length for trips without observers is indicated in each time strata by the dashed line. Note that empty trip length intervals are not included.

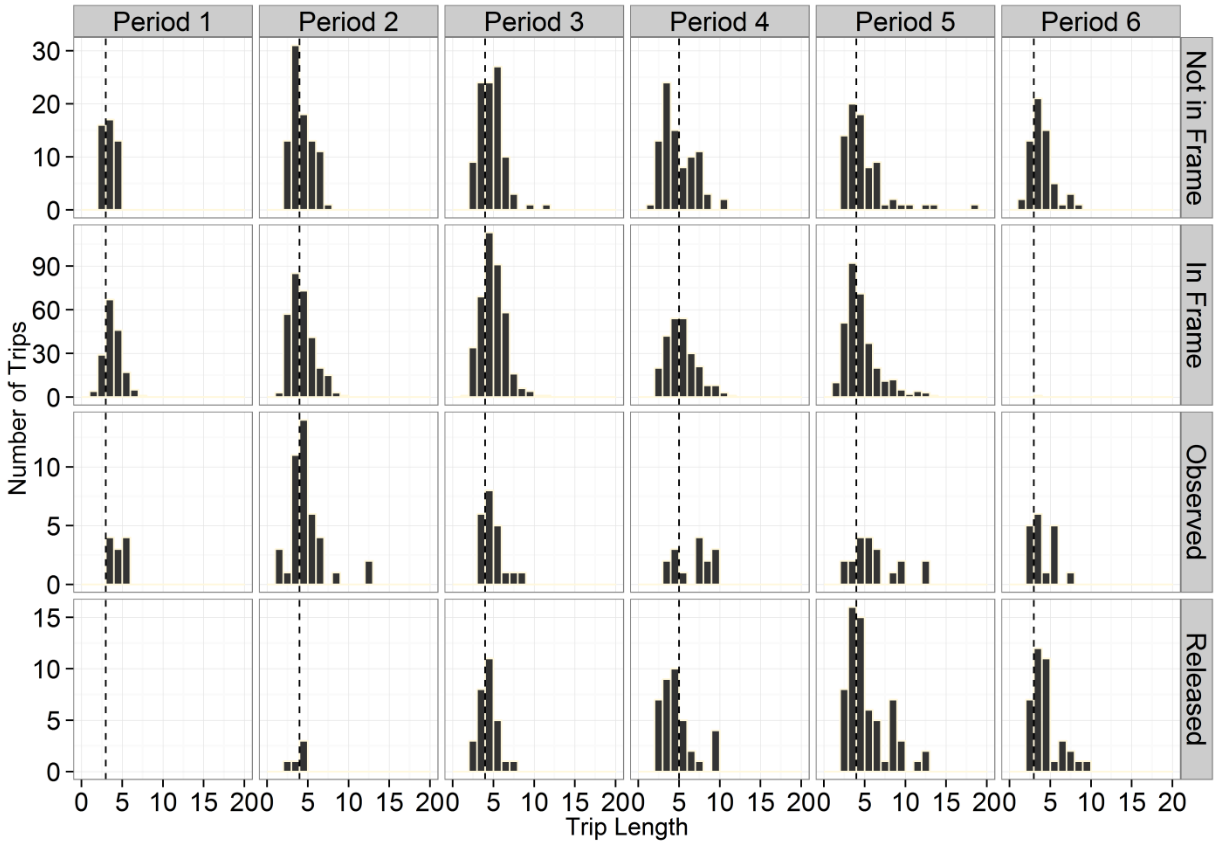

Figure 13. -- Distribution of trip length for trips in the vessel selection strata for observed trips and three groups of trips without observers: vessels not included in the sample frame, vessels released from coverage, and vessels that were not selected for coverage. The dashed line references the median trip duration for vessels in the frame that were not grated a release (In Frame group).

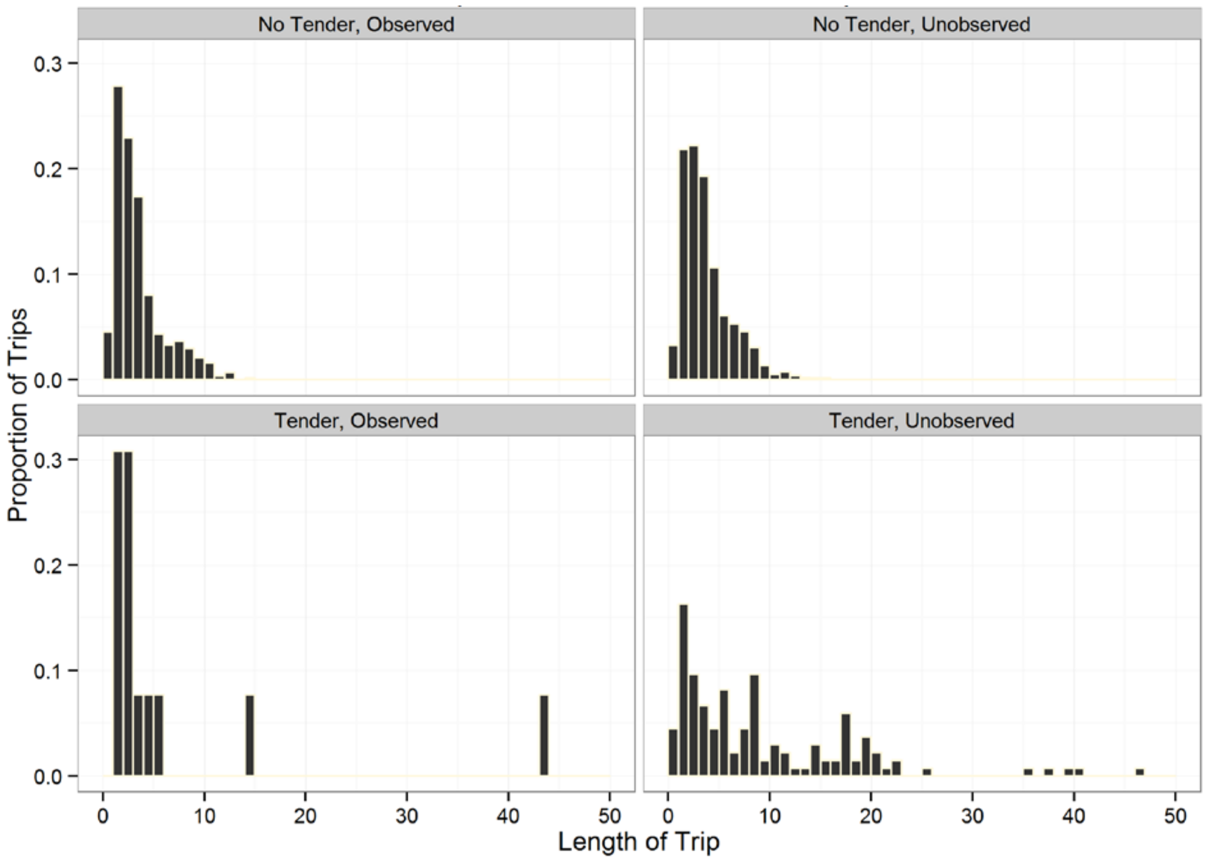

Figure 14. -- Distribution of trip length for vessels in the trip selection strata delivering their catch at-sea to tenders.

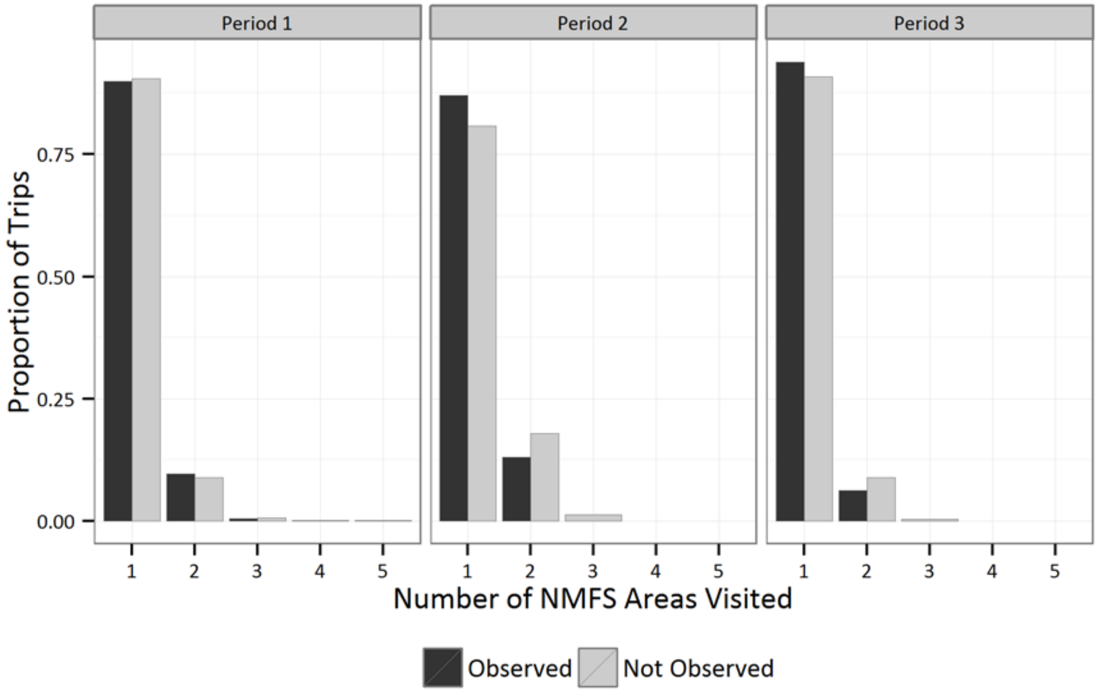

Figure 15. -- Number of NMFS Reporting Areas that are visited per trip in trip selection strata. Proportions are within the observed and unobserved categories (e.g., proportion of observed trips that visit one NMFS Area).

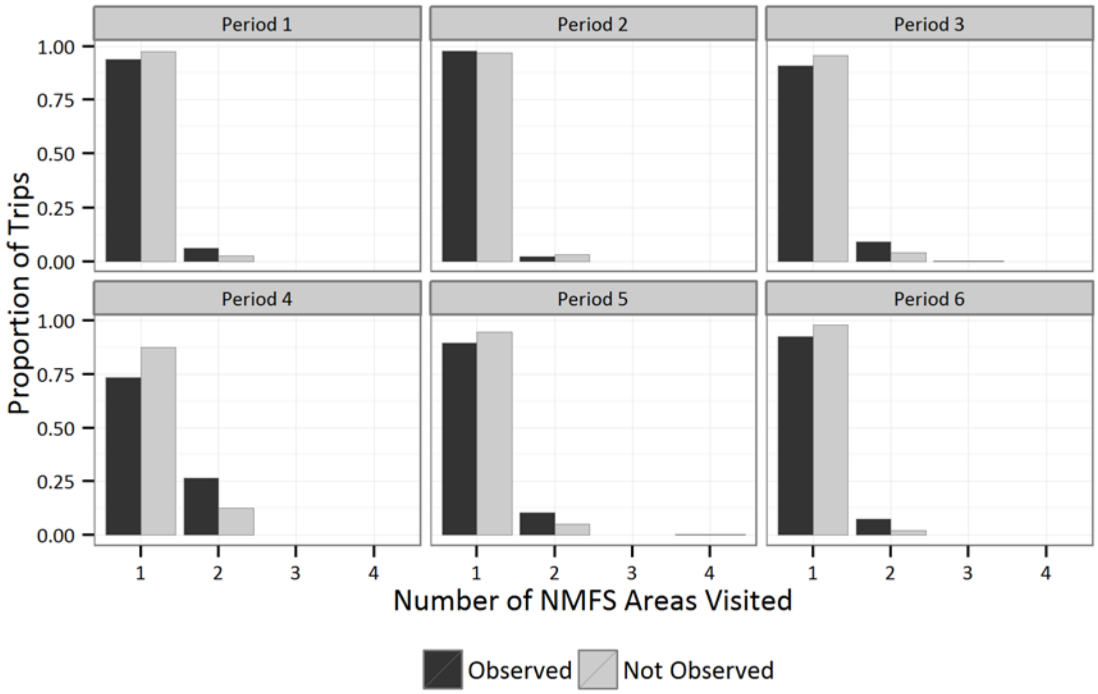

Figure 16. -- Number of NMFS Reporting Areas that are visited per trip in vessel selection strata. Proportions are within the observed and unobserved categories (e.g., proportion of observed trips that visit one NMFS Area).

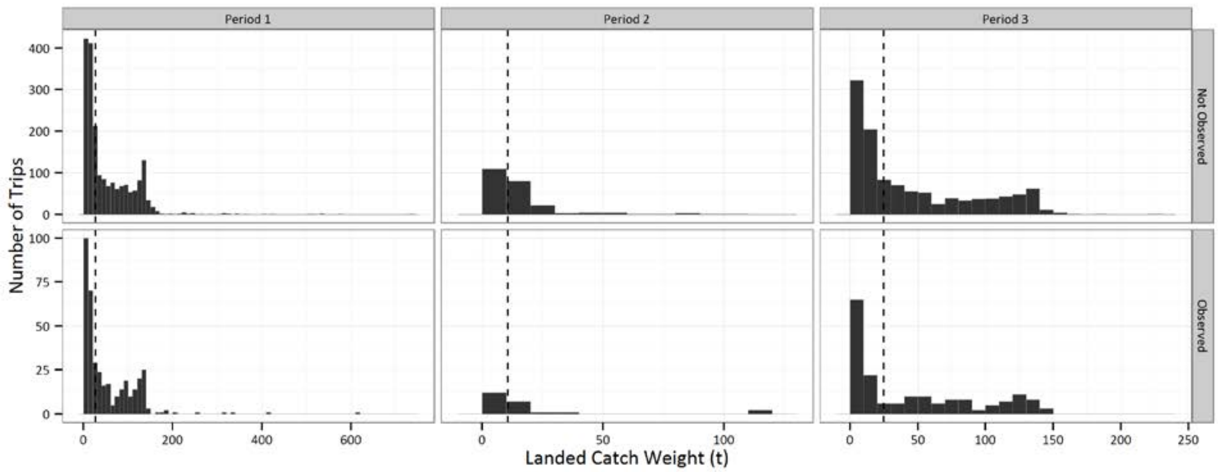

Figure 17. -- Distribution of landed catch for trips in the trip selection strata. Vertical dotted lines depict the median value from unobserved trips.

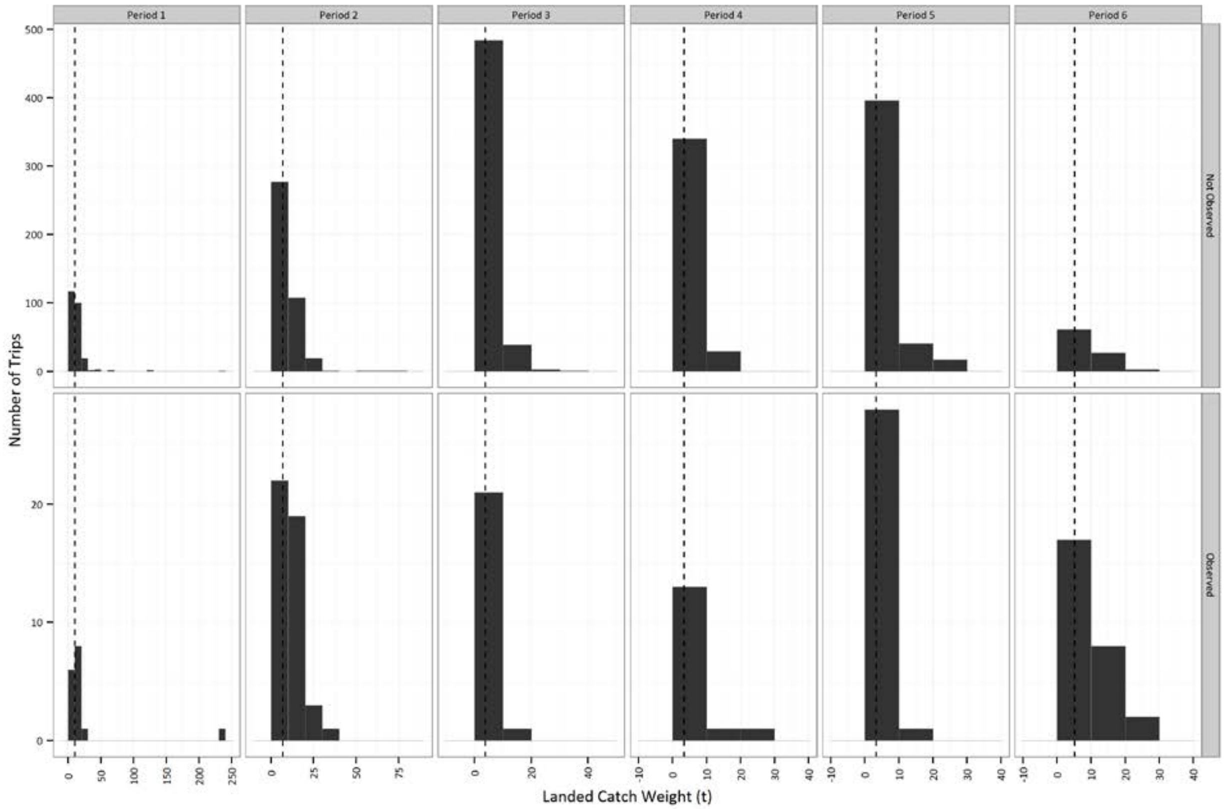

Figure 18. -- Distribution of landed catch for trips in the vessel selection strata. Vertical dotted lines depict the median value from unobserved trips.

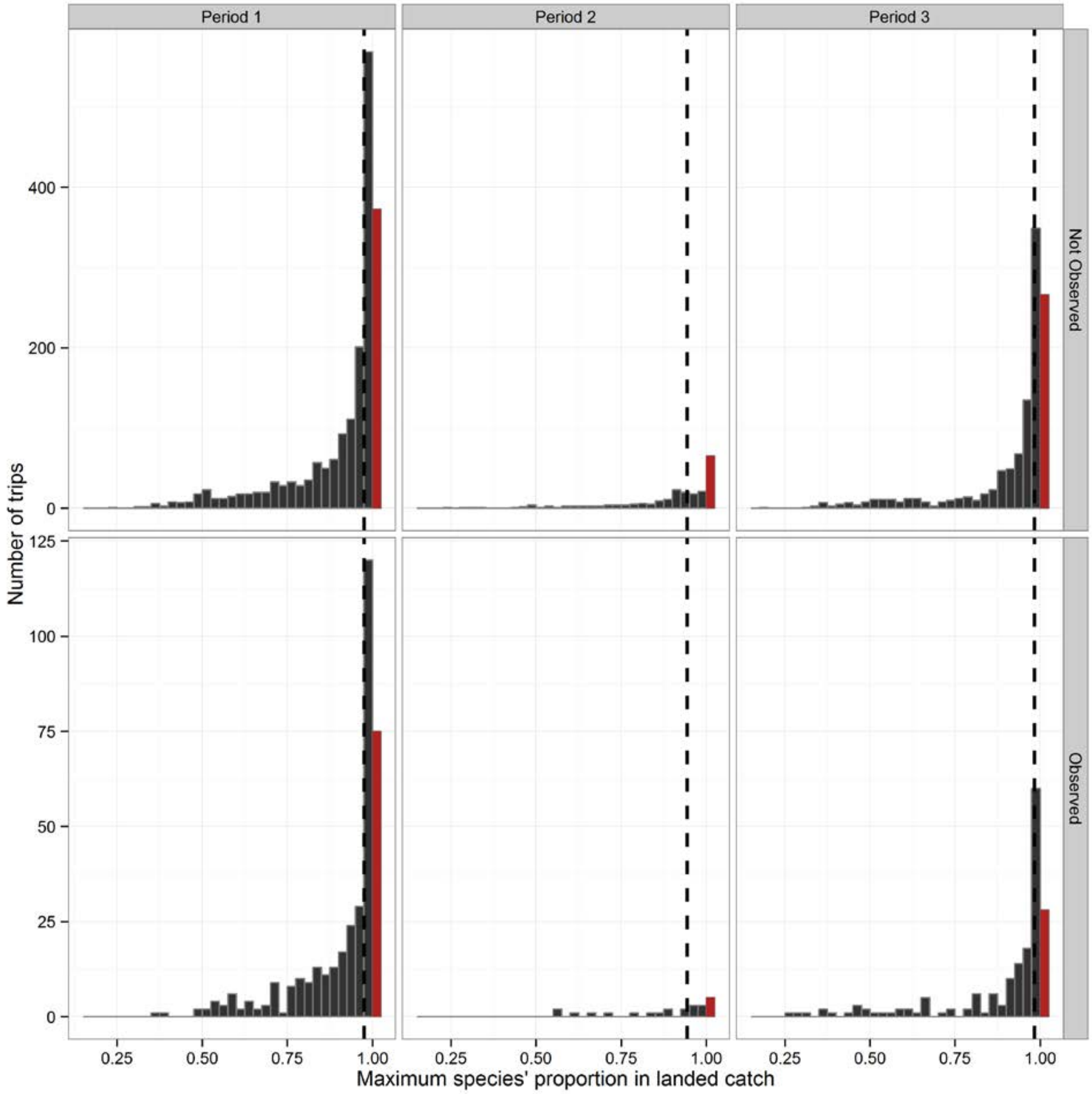

Figure 19. -- Distribution of the proportion of the total landed catch accounted for by the most abundant species landed in the trip selection strata. Vertical dotted lines depict the median value from unobserved trips.

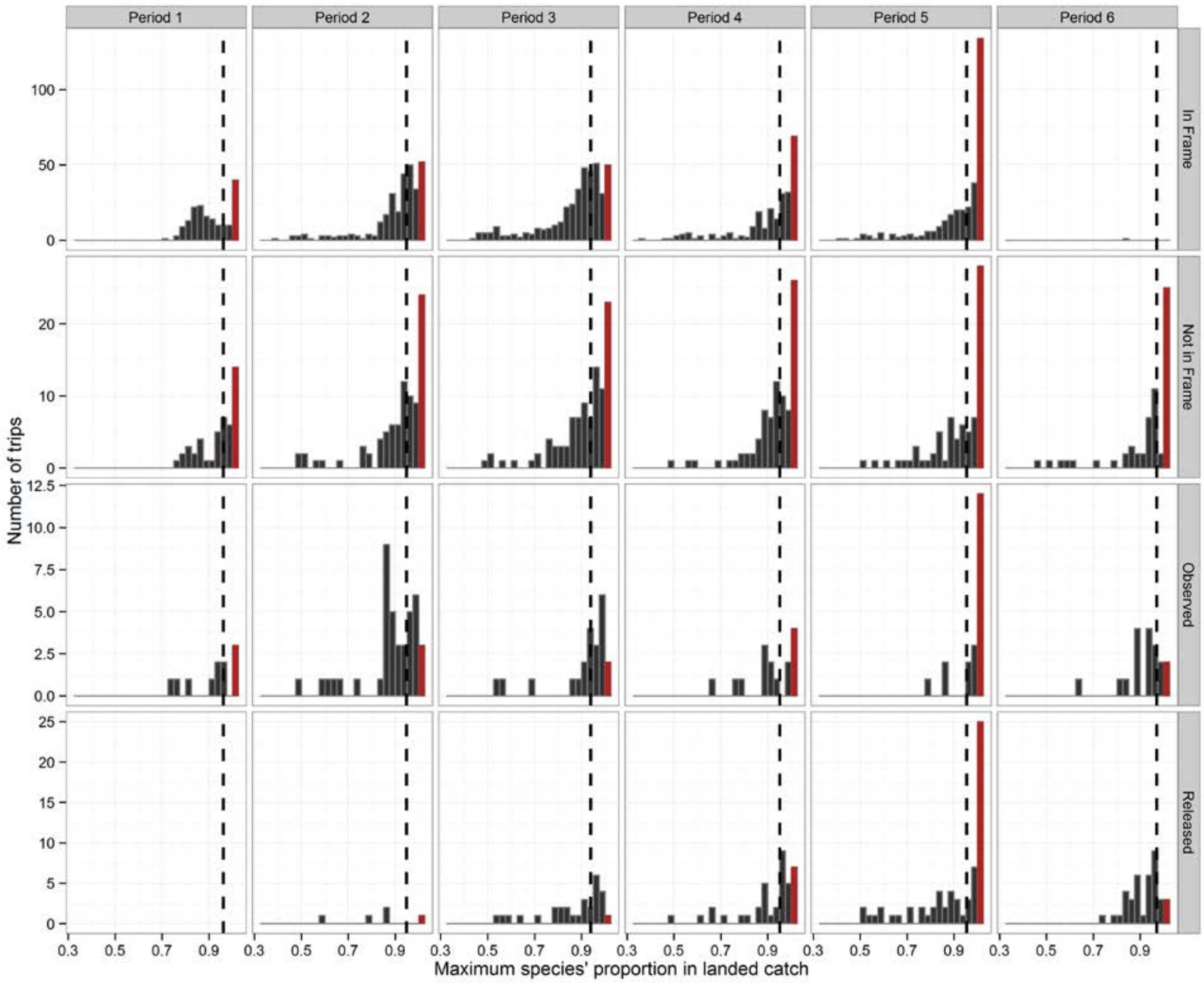

Figure 20. -- Distribution of the proportion of the total landed catch accounted for by the most abundant species landed in the vessel selection strata. Vertical dotted lines depict the median value from unobserved trips.

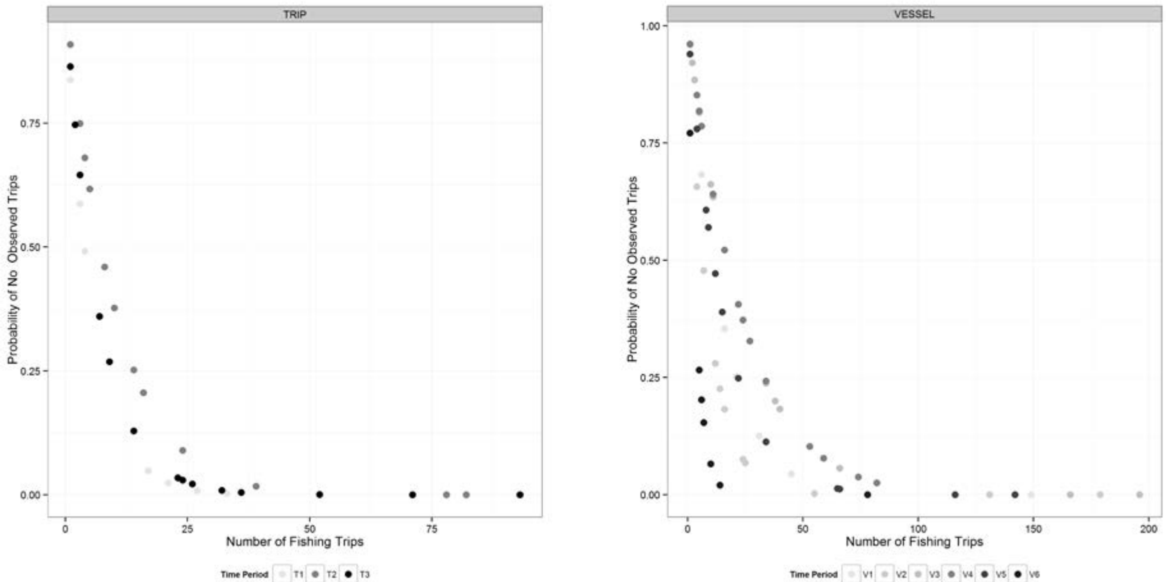

Figure 21. -- Probability of selecting a sample and observing no trips as a function of the number of trips that occurred in a NMFS Area, time period, and stratum (trip selection, left panel; vessel selection, right panel) cell. Each datum represents a NMFS Area and time period total. X-axis has been truncated to increase resolution at smaller numbers of fishing trips; none of the omitted probabilities were greater than 0 (rounded to 5 figures right of decimal).

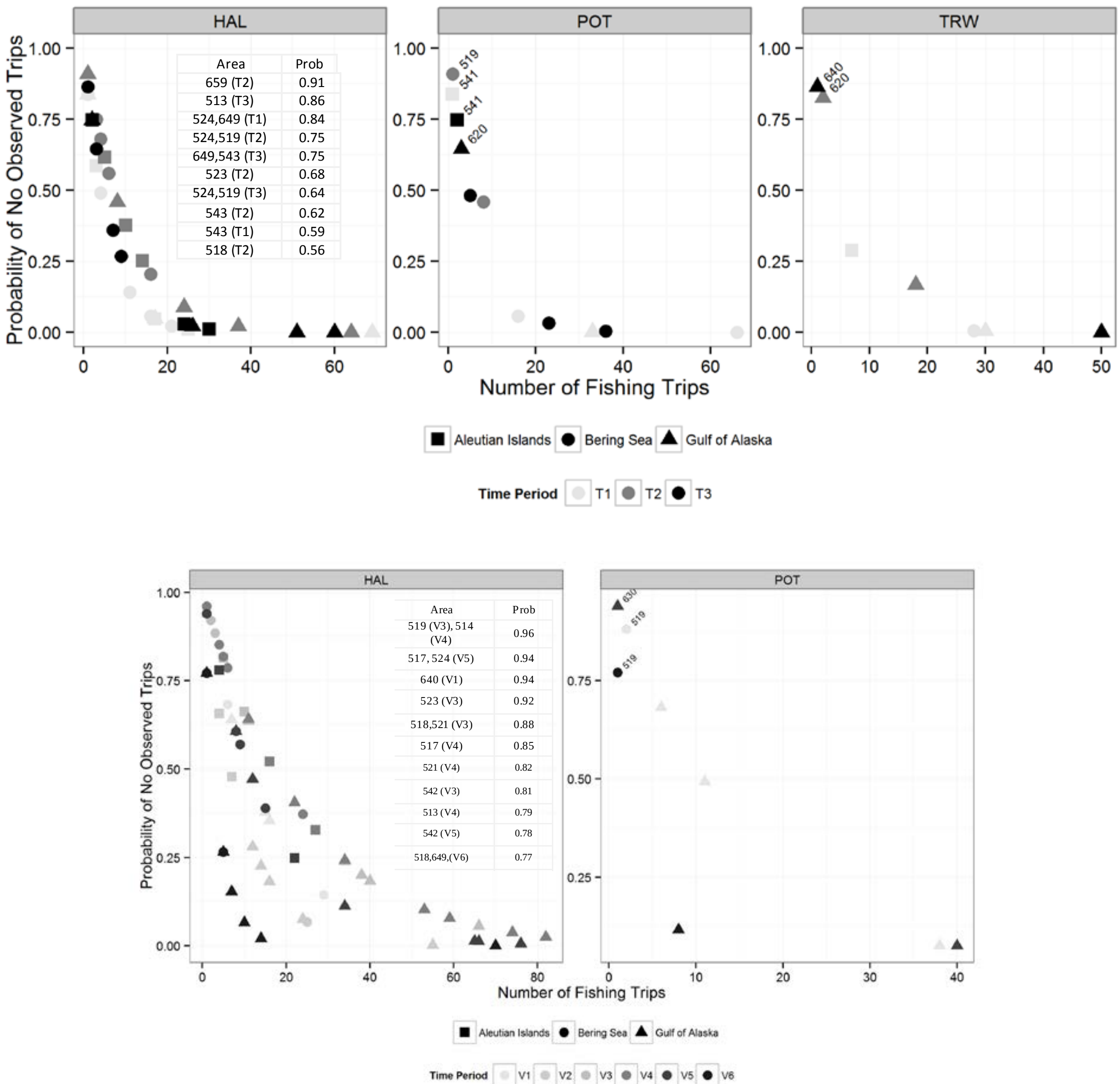

Figure 22. -- Probability of selecting a sample and observing no trips as a function of the number of trips that occurred in a NMFS Area, gear type, time period, and stratum (trip selection, top panels; vessel selection, lower panels) cell. Each datum represents a NMFS Area and time period total for each gear type. X-axis has been truncated to increase resolution at smaller numbers of fishing trips; none of the omitted probabilities were greater than 0 (rounded to 5 figures right of decimal). Numbers indicate NMFS Reporting Area for selected observations that are summarized in the table for hook and line gear.

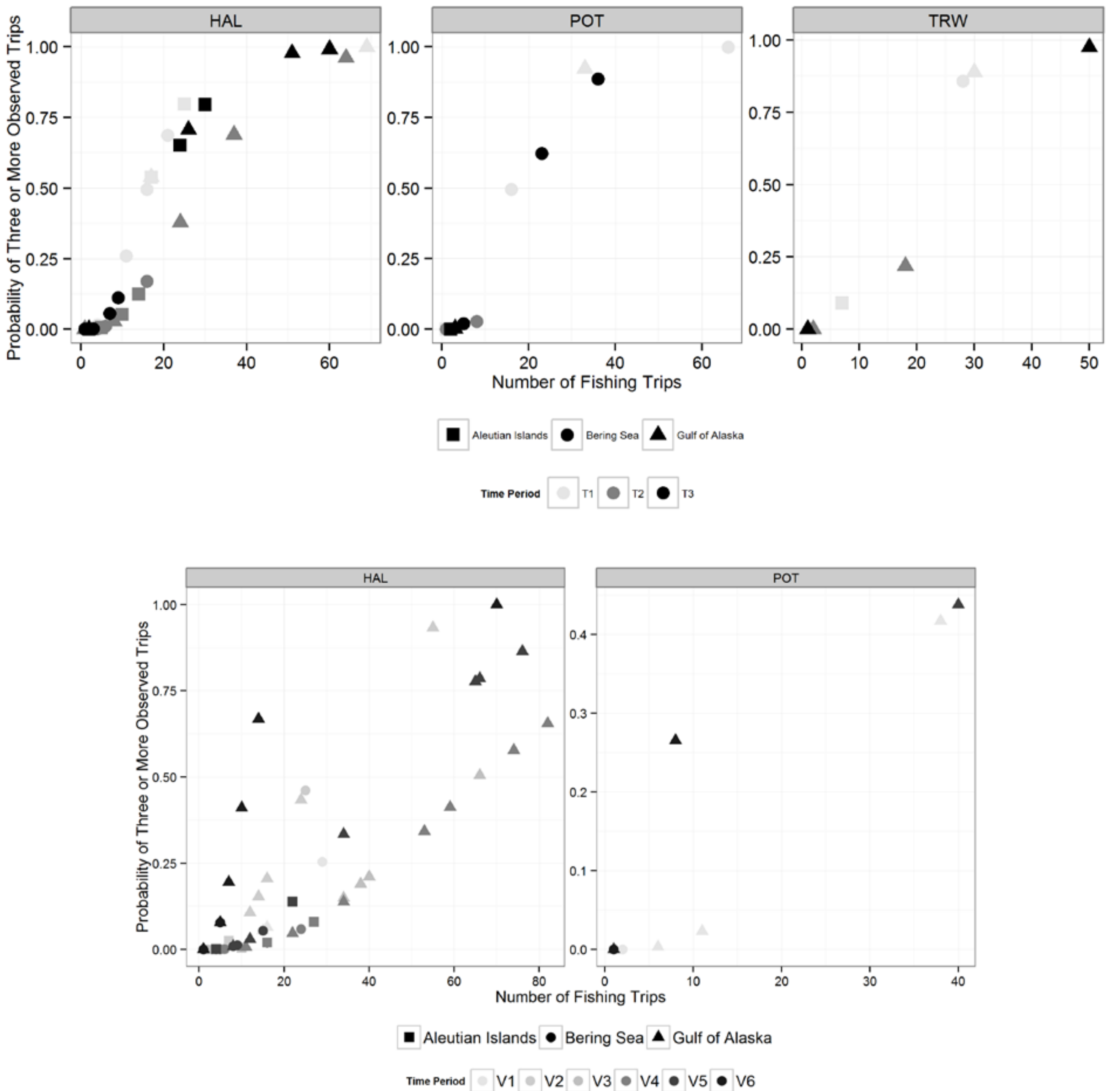

Figure 23. -- Probability of selecting a sample and observing 3 or more trips as a function of the number of trips that occurred in a NMFS Area, gear type, time period, and stratum (trip selection, top panels; vessel selection, lower panels) cell. Each datum represents a NMFS Area and time period total for each gear type. X-axis has been truncated to increase resolution at smaller numbers of fishing trips). Numbers indicate NMFS Reporting Area for selected observations.

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