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Using positional data from vessel monitoring systems (VMS) to validate the logbook-reported area fished and the stock allocation of commercial fisheries landings, 2004-2011¹

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Abstract

Vessel monitoring system (VMS) positional data from northeast United States fisheries were used to validate the statistical area fished and stock allocation of commercial landings derived from mandatory logbooks. A gear-specific speed algorithm was applied to VMS positions collected between 2004 and 2011 from the otter trawl, scallop dredge, sink gillnet and benthic longline fisheries to estimate the location of fishing activity. Estimated fishing locations were used to re-allocate the stock area landings of eight federally managed groundfish species. The accuracy of the VMS method relative to the mandatory logbooks was assessed using haul locations and catch data recorded by at-sea observers. VMS-based allocations generally outperformed VTR-based allocations; VMS methods achieved stock allocations more similar to observer-based allocations in 85 of the 144 cases examined (59.0%; 18 stocks over 8 years).

In more recent years, the performance of the VMS-based allocation has been more similar to that of the VTR-based algorithm. The similarities in the recent performance of the two allocation methods is likely attributable to a growing number of smaller vessels that are now required to use VMS whereas as historically, VMS was only required of the larger offshore trawlers participating in special management programs. The VMS algorithm tended to overestimate the number of statistical areas fished such that when a trip's fishing activity occurred in a single statistical area, logbooks more accurately reflected the true fishing location. On trips where fishing activity occurred in multiple statistical areas, the VMS algorithm showed appreciable gains relative to logbook data. VMS-based methods show promise as a means of validating the VTR-based allocations. However, given the limited extent of VMS both over time and in breadth of fisheries covered, it is not an acceptable surrogate for VTR-based allocations, but does provide a valuable tool for monitoring vessel reporting compliance and evaluating the potential impacts of vessel misreporting.

Introduction

Among the federally managed fish species in the northeast United States (U.S.), eight species are managed and assessed as two or more discrete stocks. The eight species are: Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), goosefish (*Lophius americanus*), silver hake (*Merluccius bilinearis*) and red hake (*Urophycis chuss*). Stock units are comprised of statistical area groupings (Fig. 1) with stocks defined by divisions that, in most cases, relate to oceanographic features (e.g., Gulf of Maine, Georges Bank; Table 1). All of the species are managed under the Northeast Multispecies Fisheries Management Plan (NEFMC, 1985), with the exception of goosefish which is managed under the Monkfish Fisheries Management Plan (NEFMC, 1998).

In the northeast U.S., dealer weighout data are assumed to be a census of commercial landings amounts. Commercial landings are allocated to management stocks using the statistical areas reported on the mandatory paper logbooks (Wigley et al., 1998). These logbooks are referred to as vessel trip reports (VTRs). Current VTR regulations require that on completion of a fishing trip, a logbook report must be submitted which documents the total catch by species for each statistical area in which fishing occurred (Title 50 of the U.S. Congressional Federal Register, Part 648.7). Despite the regulations, it is known that misreporting of statistical area occurs, most frequently in the form of underreporting the number of statistical areas fished when fishing occurs in more than one area (Palmer et al., 2007; A. Applegate and T. Nies pers. comm.). While, underreporting of statistical areas does not necessarily translate to the misclassification of commercial landings to stock areas, the potential exists and the magnitude of these effects on the allocation of commercial landings requires evaluation.

The most reliable source of fisheries-dependent catch and effort data in the northeast U.S. are available from the information collected by at-sea fisheries observers. However, because these data are limited in their coverage (e.g., generally < 5% of all certain fisheries in a given year, Wigley et al., 2007) they cannot provide the synoptic coverage necessary to allocate commercial landings to stock area with any regularity. Vessel monitoring systems (VMS) in the northeast were first implemented for the limited-access scallop fisheries in 1998 (NEFMC, 1993). The use of VMS has increased over time (Fig. 2) and expanded to cover many fisheries (Table 2). Historically the larger off-shore vessels participating in the limited-access scallop and special-access groundfish fisheries were more likely to be equipped with VMS compared to the smaller near-shore vessels. With the passage of Framework 17 to the Atlantic sea scallop Fishery Management Plan (FMP; NEFMC, 2005) and Framework 42 to the Multispecies FMP (NEFMC, 2006), VMS is now required for a greater proportion of the smaller near-shore scallop and groundfish fleets. While VMS does not provide census coverage of these fleets, it does provide census coverage of trips taken by those vessels equipped with VMS. Given the increasing use of VMS in the region, this represents a potential tool to conduct large-scale validation of the statistical areas reported on VTRs.

Vessel positions obtained from VMS have been used as a proxy for the location of fishing effort in prior work (Deng et al., 2005; Murawski et al., 2005; Mills et al., 2007). Commonly, the average vessel speed is used to differentiate fishing activity from non fishing activity (Deng et

al., 2005; Murawski et al., 2005). Many VMS programs do not require the transmission of instantaneous vessel speeds; only a vessel position and a date and time stamp. This has changed recently in some fisheries (Mills et al. 2007); however, most users of VMS data must infer vessel speed and course from averages calculated from successive positions. Northeast U.S. VMS regulations only require the transmission of the position and the associated date and time. Positions are typically collected once per 30 min from vessels participating in the limited access scallop fishery and once per 60 min from vessels participating in the groundfish fishery (Table 2). The classification error of fishing versus non-fishing activity will depend in part on whether the vessel speeds available to the analysis represent instantaneous vessel speeds or averaged vessel speeds calculated from the distance traveled between VMS polling events. As the VMS polling frequency increases, the relative accuracy of the calculated speeds decreases (Figure 3). The average vessel speed method can achieve accuracy levels as great as 99%, however it can also result in the incorrect classification of non-trawling activity (Mills et al., 2007) leading to an overestimation of fishing intensity. A more complex method utilizing both vessel speed and directionality has been attempted (Mills et al., 2007); however, this method did not improve the detection of fishing activity and reduced the inclusion of false positives only slightly (0.7%).

When using the vessel-speed method, the amount of classification error is sensitive to the VMS polling rate (Figure 3, Palmer, 2008), the speed ranges used to define fishing activity and the practices of the fishery under observation (e.g., how much overlap exists between the vessel-speed signals of fishing and non-fishing activity, how long are individual hauls). With the exception of Mills et al. (2007) much of the work so far published in the fisheries literature has utilized VMS data without a quantitative assessment of the classification error of fishing vs. non-fishing activity when the vessel-speed method is used. This paper assesses the ability of the VMS vessel-speed method to detect the statistical area fished and allocate fishery landings to stock area by comparing results to matching NEFOP trips. The method is then applied to assess VTR area reporting compliance and its impacts on the current VTR-based allocation method used in the northeast US.

Materials and methods

Data sources

VTR logbook trip, gear and species catch data were extracted from the VTR logbook reports from calendar years 2004 to 2011; prior to 2004, fewer than 500 vessels were equipped with VMS units in the Northeast Region, thus limiting the scope of a VMS-based allocation (Fig. 2). The analytical datasets were post-processed to remove any overlapping trips (i.e., trips taken by the same vessel with a date of sail occurring before the date of landing of a previous trip). Overlaps occur because of VTR reporting and/or data entry errors. This process resulted in the removal of between 1.2% and 2.2% of the total annual reported VTR trips from 2004 and 2011. Of the remaining trips, only those trips where at least one of the eight study species were reported as retained catch were retained in the dataset (Atlantic cod, haddock, yellowtail flounder, winter flounder, windowpane flounder, monkfish, silver hake, and red hake). Because the focus was on assessing the impact of statistical area misreporting on the proration of commercial landings, discards were not included in these analyses. All species weights were converted to live weight in kilograms (kg) using standard species conversion factors

established by the Northeast Fisheries Science Center (NEFSC). The VTR dataset was further restricted to include only the four major gear types responsible for species landings in the region: fish bottom otter trawl (OTF), scallop dredge (DRS), sink gillnet (GNS) and benthic longline (LLB). VTR species landings were then assigned to a stock area based on the statistical area fished reported on the logbook (Palmer and Wigley, 2007; Table 1). The final VTR subsets used in this analysis contained between 23,000 and 34,000 trips per year (Table 3).

All available VMS data were extracted from the VMS database for each vessel and assigned to the appropriate VTR trip by matching on the vessel and assigning all VMS point locations with dates between the VTR date of sailing and date landed to the respective trip. The average vessel speed was calculated by dividing the haversine distance (Sinnott, 1984) by the time difference between consecutive VMS positions. All positions were assigned to a National Marine Fisheries Service (NMFS) statistical area (Fig. 1). Summaries of the number of VMS-VTR matched trips by year are included in Table 3.

In the northeast U.S., at-sea fisheries observers are coordinated by the NEFSC's Northeast Fisheries Observer Program (NEFOP). Beginning in May, 2010 at-sea monitors (ASMs) were also deployed in the groundfish fishery. While the data collected by ASMs could be included in this analysis for the years 2010 and 2011, to date it has not been. Future updates of this work will attempt to incorporate ASM data. All NEFOP trips which could be matched to the list of VMS-VTR matched trips were extracted from the observer database. Matches were established using the vessel, date of sailing and date landed as reported on the VTR; trips with multiple matches were removed from the analyses. For all matched trips the associated haul duration, statistical area fished, species and retained catch weights were also extracted; retained catch weights were converted to live weight in kilograms (kg) using standard NEFSC conversion factors. Summaries of the number of matches by year are included in Table 3.

Method development and application

Past research using northeast U.S. VMS data have differentiated fishing activity from non-fishing activity by using only upper-speed bounds; < 3.5 knots for bottom trawl vessels (Murawski et al., 2005) and < 5.0 knots for scallop dredge vessels (Rago and McSherry, 2001). To our knowledge no attempt has been made to identify fishing activity from the VMS signals of fixed-gear vessels (i.e., sink gillnet, benthic longline). We attempted to improve vessel-speed classifications and extend the application to fixed-gear vessels through a combination of visual examination of the percent frequency distributions of VMS-derived average speeds, knowledge of fishing operations and observations from high-frequency polled GPS data.

Percent frequency distributions of VMS average vessel speed were plotted for all gear types (Fig. 4). These were then compared to percent frequency distributions of activity-specific (fishing vs. non-fishing) instantaneous vessel speeds from high-frequency polled GPS data (1 fix/10 seconds) collected from vessels involved in NMFS Cooperative Research projects (Fig. 5). These data sets included precise observations of the dates and times of fishing activity. Six trips taken by five separate vessels were analyzed; two groundfish bottom trawl trips, two scallop dredge trips and two gillnet trips. Individual vessel speed observations from all trips were combined by gear type and activity was classified as either 'fishing' or 'other'. For mobile

gear, 'fishing' was defined as the period from winch brake lock to winch brake release; presumably the period when the gear is actually in contact with the bottom. For fixed gillnet gear, 'fishing' was defined as the period when gear is being hauled back. Unfortunately, high frequency polling data were not available for benthic longline activity. It is assumed that fixed gears such as sink gillnet and benthic longline gear are likely to be fished in very specific and limited geographic areas on a given trip, thus it is unlikely fishing is occurring on multiple fish stocks on a single trip. If this assumption is true, these analyses will not be as sensitive to misclassification of fixed gear activity relative to mobile gear activity.

VMS-based bottom otter trawl activity exhibits a very pronounced bi-modal distribution of vessel speeds. It was assumed that the first mode (2.8 knots) represented fishing activity and the second mode (8.0 knots) was indicative of steaming activity. Fishing activity falls within a very narrow range from approximately 2.0 to 5.0 knots as evidenced by the distributions observed from the high-frequency GPS data. A fishing speed window of 2.0 knots < fishing activity < 4.0 knots was used. This window fits the high-frequency polled GPS well, correctly classifying 99.2% of fishing activity. However, it also incorrectly categorizes 31.8% of non-fishing activity as fishing activity (Fig. 5). It is expected, that a portion of the non-fishing activity falling inside the window of fishing speed represents activity associated with the hauling and setting of the gear, which suggests that the impact of false-positives on statistical area fished estimation may not be as great as the 31.8% figure implies.

The VMS-based average-vessel-speed distribution of scallop dredge activity has a nearly tri-modal distribution (Fig. 4). Unlike bottom otter trawl speed distributions there is a high percentage of activity close to 0.0 knots. This may be indicative of shucking activity when vessels are drifting and allowing the crew to shuck scallops and clear the deck. The primary mode (4.2 knots) was assumed to represent fishing activity and the 8.2 knot mode was assumed to represent steaming activity. Scallop dredge fishing activity occurs over a broader range compared to trawl activity, falling between approximately 2 to 7 knots as evidenced by the distributions observed from the high-frequency GPS data (Fig. 5). A fishing speed window of 2.5 knots < fishing activity < 6.0 knots was used. This window fit the high-frequency polled GPS well, correctly classifying 98.3% of fishing activity; however, it incorrectly categorized 69.3% of non-fishing activity.

Like scallop dredge activity, VMS-observed sink gillnet average speed distributions have a tri-modal distribution (Fig. 4). Based on personal knowledge of gillnet operations, the first mode (0.6 knots) was interpreted as representing the hauling of gillnet gear, the second mode (3.0 knots) as re-setting the nets and the third mode (8.2 knots) as steaming activity. The majority of presumed hauling activity occurred between the speeds of 0.1 and 1.3 knots. This window did not fit the high-frequency polled GPS well. Only 50.0 % of the fishing activity was correctly identified. Conversely, this speed window incorrectly classified only 25.3% of non-fishing activity. Given the limited scope of the high frequency polling data (i.e., 2 trips taken by 1 vessel) and the likelihood that the geographic extent of fixed gear vessels is somewhat limited, a decision was made to use the 0.1 and 1.3 knot speed window.

Benthic longline average speed distributions have a bimodal distribution (Fig. 4). The first mode (0.8 knots) was interpreted as representing the hauling and setting of the longline gear

and the second mode (10.0 knots) as steaming to and from the fishing grounds. For benthic longline gear the same speed used for gillnet gear was used ($0.1 < \text{fishing activity} < 1.3$ knots).

Those VMS locations identified as representative of fishing activity were then used to determine the statistical areas in which fishing occurred. Statistical areas fished were compared across data sources to assess whether the statistical areas derived from VMS-defined fishing activity represented an improvement over VTR reported statistical areas relative to NEFOP data. Trips were broken into two categories: single area trips (fishing occurs in only one statistical area per trip) and multi-area trips (fishing occurs in more than one statistical area per trip). Because all stock boundaries are divided along statistical area boundaries, correct reporting of multi-area trips are of the greatest concern. These are the trips having the potential to fish on multiple stocks of fish in a single trip and where misreporting of statistical area(s) may lead to incorrect estimates of stock removals. For each trip, the levels of agreement between the NEFOP, VMS and VTR statistical areas were categorized as in agreement ('Complete'), not in agreement ('None') or in partial agreement ('Partial'; at least one statistical area was in agreement, but not all). Agreement levels were contingent on agreement among both the number of statistical areas reported and the identity of those statistical areas. For example, if a VTR reports that fishing occurred in statistical areas 515 and 521 and VMS positions indicate that fishing occurred in 515 and 521 then the trip would be considered to be in agreement ('Complete'). If the VTR reported fishing in 515, and the VMS data suggests fishing occurred in 515 and 521, then the trip would be considered to be in partial agreement ('Partial'). If the VTR reported fishing in 515, and the VMS data suggests fishing occurred only in 521, then the trip would not be considered to be in agreement ('None'). The same analysis was repeated on the larger set of VMS and VTR matched trips.

A VMS-based allocation algorithm was devised using the statistical areas fished from the VMS data to re-allocate VTR-reported landings to stock area. Fishing activity was assigned to stock area based on the species landed and statistical area in which the fishing activity was occurring. The time spent fishing in each stock area was estimated as the sum of fishing activity blocks occurring in each stock area. The duration of one activity block is contingent on the VMS polling frequency which is variable, but generally once per 30 minutes for scallop vessels and once per hour for groundfish vessels. Total VTR trip landings for each species (s) were allocated to stock area (k) based on the ratio of time spent fishing in each stock area as determined from VMS locations (Equation 1).

$$(1) \quad \hat{L}_{sk} = \left(\left(\sum l_{si} \right) + l_{sk} \right) \cdot \left(\frac{t_k}{\left(\sum t_i \right) + t_k} \right)$$

where:

\hat{L}_{sk} = VMS prorated trip landings for species s , stock k (kg)

l_s = trip landings for species s in stock area, k , as derived from VTR reports (kg)

l_i = trip landings for species s in stock areas i , where $i \neq k$, as derived from VTR reports (kg)

t_k = time spent fishing in stock area, k , as derived from VMS positional data (days)

t_i = time spent fishing in stock area i , where $i \neq k$, as derived from VMS positional data (days)

The results of the VMS-based allocation were compared to landings allocation derived from both NEFOP and VTR data sources to assess the relative accuracy of the VTR-based allocation and determine if the VMS-based algorithm resulted in improved estimates of landings by stock area. VTR and NEFOP species landings were prorated by assigning landings to stock area based on the reported statistical area. All comparisons were performed through an examination of the percent allocation to stock area as opposed to absolute landings because percent allocations derived from the traditional VTR source are used to allocate the amounts of commercial landings as determined through dealer weighout data (Wigley et al., 1998). The same analysis was performed on the larger VMS-VTR matched data set.

The VMS-based allocation method assumes a constant species catch-per-unit-effort (CPUE) at all fishing locations (i.e., species catch is distributed only as a function of the time spent fishing in each stock area). This assumption neglects species habitat preferences (e.g., sediment composition, water depth and temperature, etc.) which would result in species being more likely to be caught in some locales and not others. To assess the degree to which this assumption was violated, individual species trip allocations from the VMS-method were compared to the same allocations as determined from NEFOP observations using linear regression.

Results

Method validation using NEFOP data

Statistical area agreement between NEFOP and VTR was > 94% for single area trips across all years between 2004 and 2011, but less than 17% for multi-area trips (Table 4). Nearly all disagreements among the 'partial' multi-area trips matches (> 98%) are due to under-reporting of statistical areas (fewer statistical areas reported on the VTR compared to NEFOP); for example there were 105 trips in 2004, 337 in 2005, 166 in 2006, 247 in 2007 and 219 in 2008. There was a general trend towards improved VTR reporting of multi-area trips between 2004 and 2006, though the level of accurate reporting has remained constant at approximately 15% since 2007, with the exception of 8% accurate reporting of multi-area trips in 2010. Given the small sample size, limited number of years of NEFOP comparisons and potential for observer-type effects on VTR-reporting, caution should be taken in inferring any meaningful conclusion based on these apparent trends.

The statistical area agreement between NEFOP and VMS-based statistical areas was lower (\geq 88.0%) for single-area trips compared to the NEFOP-VTR comparisons (Table 5). The cause of disagreement among single-area trips is primarily due to the overestimation of statistical areas fished by the VMS-based method. The overestimation results from the VMS-based method misclassifying non-fishing activity as fishing activity. Agreement among multi-area trips is greater (> 67%) when using the VMS-method compared to the VTR-reported statistical area trips, with only a single trip in complete disagreement across the time series (2009). Among statistical areas in partial agreement there was a tendency for the VMS-method to overestimate the number of statistical areas fished (e.g., 59.5% of partial matches in 2004, 53.3% in 2005, 50.8% in 2006, 57.3% in 2007, and 56.3% in 2008). The performance of the VMS-based method in detecting statistical areas fished is not equivalent for all gear types; a closer examination of the VMS-NEFOP statistical area comparison in 2005 showed that 80.3%

(535 of 666) of trawl trips, 65.4% (17 of 26) of dredge trips, 83.8% (88 of 105) of gillnet trips and 97.1% (101 of 104) of longline trips have agreement levels of 'Complete'. This finding supports the assumption that the misclassification of the location of fixed gear fishing activity is less likely compared to mobile gear activity.

The VMS-based allocation method arrived at annual stock allocations closer to NEFOP allocations relative to the VTR-based allocations for 85 of the 144 stock comparisons examined (eighteen stocks over five years; Tables 6 – 13). There were no species allocations for which the VMS-based allocation under-performed the VTR allocation in all eight years. There was a general improvement in the VMS-based allocation between 2004 and 2006 with the number of species for which it under-performed the VTR allocation decreasing from three in 2004 to only one in 2006. However, the VMS method did not outperform the VTR method in 2007 and 2010, and only marginally better in 2008 and 2009. The two methods were equal in 2011 in terms of number of stocks. Of all species, goosefish, silver hake and red hake had the greatest percent difference relative to the NEFOP allocation. Comparisons of the individual trip stock allocations between the VMS-based method and NEFOP allocation in 2005 showed strong agreement between VMS and NEFOP stock allocations ($r = 0.823$, $p < 0.001$, $n=514$; Fig. 6), however there was considerable spread in the residuals. There are large differences in the NEFOP landings compared to VTR landings shown in Tables 6 – 13 for some species, most notably monkfish (e.g., in 2004 NEFOP estimated 380 mt compared to the VTR estimate of 71 mt). The exact reasons for these discrepancies are unknown, however there is a tendency for self-reported haul weights to be biased low (Palmer et al., 2007). Additionally, monkfish tails constitute a large proportion of monkfish landings and these are often incorrectly reported on VTRs as whole monkfish (Palmer et al., 2007). A conversion factor of 3.32 is applied to monkfish tail landings to convert these to whole weights; incorrect reporting of monkfish tails as whole monkfish will result in the underestimation of VTR monkfish landings by approximately a factor of 3.

Extrapolation to larger VMS-VTR matched dataset

The NEFOP-VMS-VTR subset of data used to validate the VMS-based method is relatively small compared to the total population of VTR-recorded trips (Table 3). The validation results suggest that for some trips monitored through VMS, the VMS-based allocation method can be used to gauge the accuracy of the stock allocations as determined through VTR reports. The VMS-VTR matched set is a much larger dataset. The subset of VTR reports examined (eight species caught using the four gear types) account for only approximately a quarter of the total VTR reports in a given year (Table 3), however this dataset accounts for greater than 95% of the landings of all the study species across the time series through 2008 (Table 14). Interestingly, beginning in 2009, the percentage of species landings included in the VTR subset began to decline, most notably for haddock which declined precipitously to only 56.9% of the total haddock landings by 2011. This decline is almost definitely due to increased use of the haddock separator trawl and Ruhle trawl from 2009 through 2011. Future updates of this work should include these gear types in the trawl category.

Similarly, VMS coverage is available for only 5,892 to 25,924 of the VTR trips in a given year (Table 3), but these trips typically account for a majority of the total landings of individual species (Table 14). By 2006, VMS data were available for trips responsible for landing greater

than 70% of all species but goosefish; coverage of goosefish landings is low because there are no specific VMS requirements for the goosefish fishery (Table 2). Since 2008 VMS data covered > 70% of all species landings with the exception of monkfish, windowpane flounder and silver hake. The sole exception is the coverage of haddock landings in 2011 which is likely explained by the exclusion of the haddock separator and Ruhle trawl from this analysis. There has been a slight decline in the number of vessels covered by VMS since 2007 (Fig. 2). It is unclear whether this has contributed to the decrease in the percentage of landings covered by VMS or is reflective of vessel matriculation from the fishery.

All demersal species examined in this analysis are primarily caught by the otter trawl fishery except goosefish where gillnet gear is responsible for the majority of the landings. Gillnet is the secondary gear type for all species with the exception of haddock and silver hake which are secondarily targeted by benthic longline (Tables 15 -22). VMS coverage of the landings by most gear types is highly variable, though generally increasing with time; there is a general pattern of low gillnet coverage of the landings of most species during the time series.

Examination of the VTR statistical area reporting using VMS-based statistical areas fished showed similar patterns to those observed in the NEFOP-VMS-VTR comparisons. Agreement levels of single-area trips exceeded 92% in all years and always less than 8.6% for multi-area trips (Table 23). This level of agreement is less than that observed in the NEFOP-VTR comparison. It is unclear whether these lower rates of agreement in the single-area trips are due to the overestimation of the number of statistical areas fished by the VMS method, an observer-effect, or some other factor. Closer examination of the partial matches revealed that the number of vessels apparently under-reporting the number of statistical areas fished was 397 in 2004, 477 in 2005 and 629 in 2006. Those vessels that likely frequently under-report trips (> 5 trips in a year) are responsible for the majority of the potentially under-reported trips. In 2004 there were 179 vessels that appeared to frequently under-report accounting for 1,876 of 2,797 of partial agreement trips (67.1%). In 2005, there were 221 vessels in this category, accounting for 2,787 of the 3,837 partial agreement trips (72.6%) and in 2006 there were 268 vessels which potentially under-reported the number of areas fished, accounting for 3,815 of the 5,251 partial agreement trips (72.7%). The number of vessels in this category increased in 2007 to 307 vessels accounting for 4,485 of the 5,489 partial agreement trips (81.7%) before falling in 2008 to 199 vessels accounting for 2,747 of 3,686 partial agreement trips (74.5%). Since 2008 the numbers have increased substantially. In 2009 there were 629 vessels accounting for 5,221 of the 5,302 partial agreement trips (98.5%). The number of vessels in 2010 and 2011 were in 2009, 581 and 548, respectively accounting 4626 of 4700 partial agreement trips (98.4%) in 2010, and 4727 of 4831 partial agreement trips (97.8%) in 2011.

It is important to consider the implications of the matched trip set composition when interpreting the performance of the VMS-based method. The performance relative to the VTR method is contingent on the number of multi-area trips and the gear composition of the matched data set. For example; a higher proportion of multi-area trips in the examined dataset would appear to improve the performance of the method. The percentage of multi-stock trips recorded by VMS increased in 2005 followed by a decline in 2006 to levels below 2004 values for all but windowpane, silver hake and red hake trips (Table 24). The declines generally continued through 2009, but exhibited a slight increase for a few species in 2010 and 2011,

likely as result of the change in management regimes from the days-at-sea system to a sector-based system. Those trips fishing on multiple stocks are predominantly ($\geq 99.0\%$) mobile-gear vessels (Table 25), implying that fixed-gear fishing effort occurs primarily in localized geographic areas such that landings from fixed-gear trips are unlikely to have come from multiple stocks. This supports the prior assumption that the misinterpretation of the VMS speed signals from fixed-gear trips is unlikely to result in the misallocation of landings.

The perceived under-reporting of statistical areas in the VTR data led to minor ($< 5\%$) differences in the overall species allocations; only six stocks in the eight year time-series exhibited differences in stock allocations exceeding 4.0% (2006: northern and southern windowpane flounder, $\pm 4.7\%$; 2010: Georges Bank and southern New England winter flounder, $\pm 4.1\%$; 2011: Georges Bank and southern New England winter flounder, $\pm 4.1\%$; Tables 26 – 33). However, these small differences in percent allocation have a disproportionate effect on the less abundant stock such as Gulf of Maine haddock, southern New England yellowtail, southern windowpane and northern silver hake. For these, stocks, minor differences can be large ($\geq 5.0\%$) relative to the percent of the total species landings allocated to that stock (Tables 26 – 33). These impacts are most notable in the stock allocations of the southern New England/mid-Atlantic yellowtail flounder. Stock allocation differences between the VTR and VMS methods were $\leq 1.6\%$ for all years, however commercial landings of this stock were $\leq 6.4\%$ of the total stock landings as estimated from the VTR reports resulting in relative differences of 53.8, 61.9 and 25.0% for the years 2004, 2005 and 2006 respectively. In 2007 and 2008 the relative differences were $< 2\%$. Of the 144 stock/year combinations analyzed the VMS-based method stock allocations had $\geq 5.0\%$ relative difference compared to the VTR-based allocations for 36 of the comparisons.

There was a tendency for the VTR-method to over-allocate the Georges Bank Atlantic cod and haddock stocks relative to the VMS method (2004 haddock was an exception). In the case of cod, while there is evidence of directional bias, unlike haddock the differences have been small ($\leq 2\%$ from 2006-2011, Table 34). There were no consistent trends in the over/under-allocation of Georges Bank yellowtail and winter flounder stocks and under/over-allocate the Gulf of Maine and southern New England stocks. The direction of stock allocation differences for goosefish, windowpane flounder, silver hake and red hake was variable from year to year.

Discussion

The underreporting of statistical areas on VTR logbooks is a problem that affects greater than 80% of the multi-area trips examined. The VTR underreporting rates from this study agree closely with past studies that have used both NEFOP and haul-by-haul self reported data (Palmer et al., 2007). While the impacts of this underreporting are relatively small in regards to overall stock allocation percentages, the relative impacts on less abundant stocks such as southern New England/mid-Atlantic yellowtail can be substantial. This is in agreement with the findings of other studies that have examined this issue using more restrictive data sets (A. Applegate and T. Nies pers. comm.). These discrepancies have implications on the estimation of fishery removals and the assessment of these stocks. While the impacts are minimal for the majority of stocks examined, the extent of the impacts on those few stocks that are significantly

affected (e.g., southern New England yellowtail flounder) suggests that this is a problem deserving of attention.

Many of the stock assessments of these eight species use finer stratification of commercial landings (e.g., quarter and market category) to estimate landings at age numbers used in virtual population analysis (VPA), or similar assessment models (Mayo and Terceiro, 2005). This paper does not consider the impacts of statistical area reporting patterns on these finer scale stratifications of commercial landings, however the accuracy of finer-scale allocations would be sensitive to the number of multi-area trips included in each strata. It is possible that the effects of statistical area mis-reporting on stock allocations are reduced due to offsetting errors (i.e., a trip that misallocates 1,100 kg to the Georges Bank cod stock would be largely offset by a trip that misallocates 1,200 kg to the Gulf of Maine cod stock). However, the spatial accuracy of VTR reports is critical not only for the assessment of fish species, but also of protected species such as sea turtles (e.g., Murray, 2004, 2005, 2006; Orphanides and Bisak, 2006) and marine mammals (Belden et al., 2006). When these data are used at finer spatial scales the accuracy of VTR reports becomes increasingly important.

It is important to consider that the results of these analyses apply only to the trips monitored by VMS; however by 2006, trips responsible for the large majority of species landings examined were monitored by VMS (Table 14). VMS coverage of some fisheries such as the Northeast multispecies complex is nearing a census, with all vessels required to use a VMS unit when fishing on a Multispecies Days-At-Sea (DAS) (NEFMC, 2010). The increased coverage improves the utility of VMS data as a validation tool for managers and as a data set of spatial fishing patterns for analysts. The number of vessels responsible for the landings of the eight species examined has remained constant at slightly less than 1,200 (Table 3), however the number of these vessels monitored by VMS has increased from 38.5% (453 of 1,176) in 2004 to 80.5% (679 of 843) by 2011. The increase in VMS usage appears to have occurred primarily among the smaller-nearshore fleet in response to VMS requirements to participate in the general category scallop fishery (NEFMC, 2005) and the NE multispecies fishery (NEFMC, 2006) as indicated by the drop in percentage of multi-stock area trips recorded by VMS from 2004 to 2008 (Table 24). This decrease in the number of multiple stock area trips may explain the improved performance of VTR-based allocations in the later part of the time series (2007-2011, Tables 9-13). Increases in the number of multi-stock trips since 2010 are likely the result of the switch to sector management which may afford vessels greater flexibility to move among areas. For all allocated groundfish species (cod, haddock, yellowtail flounder and winter flounder), there has been an increase in the percentage of multi-stock trips since 2009.

The results are sensitive to the accuracy of average VMS vessel-speeds in differentiating fishing activity from non-fishing activity as well as the validity of the VMS-based allocation. This study defines fishing activity using narrower speed ranges than have been used in past studies which should lead to more conservative estimates of fishing effort. The speed range used for the mobile gears agree closely with the speeds obtained from high-frequency polling of vessels GPS units suggesting that these ranges are reasonable. The speed ranges used for gillnet gear did not correspond all that well with the high frequency GPS polling data; however, given the low percentage of fixed gear trips fishing on multiple stock areas (Table 25), the lack of agreement should not negatively impact these analyses. Additionally, this study relied on

average vessel speeds not instantaneous vessel speeds, which are more analogous to the speeds estimated from high-frequency GPS polling. The averaging process blurs activity from observation to observation, potentially leading to an incorrect determination of fishing activity (Fig. 3; Deng et al., 2005; Palmer, 2008). These impacts were not explicitly considered in this study and represent an area of uncertainty.

The speed ranges adequately classify fishing activity (> 98% success for mobile gear, \geq 50% success for gillnet gear), but tend to overestimate the amount of fishing by incorrectly classifying non-fishing effort as fishing (69.3% misclassification of non-fishing scallop activity). The overestimation was apparent in the comparisons of statistical areas fished between VMS and NEFOP data (Table 5). Future work should focus on the use of more advanced statistical procedures such as mixture distribution models (e.g., Marin et al., 2005) to decompose the mixed distributions of vessels speed. The fine scale observations taken from cooperative research vessels could be used identify likely parameterization of the underlying probability density functions.

VMS data indicate where it is likely that fishing effort is occurring but provide no information on catch composition. A critical assumption of the VMS-based allocation is that the proportion of species caught across multiple stock areas on a fishing trip is only a function of the time spent fishing in each stock area. In the Gulf of Mexico penaeid shrimp fishery, this assumption has generally held true (Cole et al., 2006), however, it may not be appropriate in a multispecies groundfish fishery where the species habitat preference is variable and the target species changes from trip to trip. While the relationship between VMS and NEFOP allocations was significant suggesting that an assumption of constant CPUE is valid, there was a considerable amount of variability (Fig. 6). However, the use of groundfish habitat models (e.g., Rooper et al., 2005) could be used to improve the catch allocation used in this paper. The large degree of variability in this relationship is not independent of overestimating the time spent in an area by the VMS method; disproportionate overestimation of time spent fishing in a particular stock area will have a direct affect on the VMS-based allocation.

The various uncertainties and shortcomings of the VMS allocation method point out that this is not a replacement for a VTR-based allocation. Additionally, the low vessel coverage of historical VMS data (Fig. 2) limits its use as a tool to correct historical misreporting. However, the results do show that VMS data can be used as a tool to monitor the accuracy and completeness of VTRs and guide efforts to improve VTR compliance. The number of vessels which are potentially under-reporting statistical areas on a frequent basis is smaller (< 700 vessels) relative to the total number of vessels submitting VTRs (> 2,000; Table 3). Improvements are needed in the compliance of VTR reporting regulations, particularly among those vessels likely to be fishing on multiple fish stocks. Given the manageable size of the problem and availability of tools to monitor these data, the quality of self-reported data should be monitored and improved through targeted outreach and education activities.

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Tables

Table 1. Statistical areas used to define species stock units for eight species examined.

| Species | Stock area | Statistical areas |
|---|--|---|
| Atlantic cod (<i>Gadus morhua</i>) | Georges Bank (GBK) | 521, 522, 525, 526, 533, 534, 537 - 539, 541 - 543, 551, 552, 561, 562, 611 - 616, 621 - 629, 631 - 639 |
| | Gulf of Maine (GOM) | 464, 465, 467, 511 - 515 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | Georges Bank (GBK) | 521, 522, 525, 526, 533, 534, 537 - 539, 541 - 543, 551, 552, 561, 562, 611 - 616, 621 - 629, 631 - 639 |
| | Gulf of Maine (GOM) | 464, 465, 467, 511 - 515 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | Georges Bank (GBK) | 522, 525, 551, 552, 561, 562 |
| | Cape Cod/Gulf of Maine (GOM) | 464, 465, 467, 511, 512, 513, 514, 515, 521 |
| | Southern New England/ Mid-Atlantic (SNE) | 526, 533, 534, 537 - 539, 541 - 543, 611 - 616, 621 - 629, 631 - 639 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | Georges Bank (GBK) | 522, 525, 551, 552, 561, 562 |
| | Gulf of Maine (GOM) | 464, 465, 467, 511, 512, 513, 514, 515 |
| | Southern New England/ Mid-Atlantic (SNE) | 521, 526, 533, 534, 537 - 539, 541 - 543, 611 - 616, 621 - 629, 631 - 639 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | North (NOR) | 464, 465, 467, 511 - 515, 521, 522, 525, 542, 543, 551, 552, 561, 562 |
| | South (SOU) | 526, 533, 534, 537 - 539, 541, 611 - 616, 621 - 629, 631 - 639 |
| Goosefish (<i>Lophius americanus</i>) | North (NOR) | 464, 465, 467, 511 - 515, 521, 522, 551, 561 |
| | South (SOU) | 525, 526, 533, 534, 537 - 539, 541 - 543, 552, 562, 611 - 616, 621 - 629, 631 - 639 |
| Silver hake (<i>Merluccius bilinearis</i>) | North (NOR) | 464, 465, 467, 511 - 515, 521, 522, 551, 561 |
| | South (SOU) | 525, 526, 533, 534, 537 - 539, 541 - 543, 552, 562, 611 - 616, 621 - 629, 631 - 639 |
| Red hake (<i>Urophycis chuss</i>) | North (NOR) | 464, 465, 467, 511 - 515, 521, 522, 551, 561 |
| | South (SOU) | 525, 526, 533, 534, 537 - 539, 541 - 543, 552, 562, 611 - 616, 621 - 629, 631 - 639 |

Table 2. Fishery management plan (FMP) actions passed by the Northeast Fisheries Management Council (NEFMC) and Mid-Atlantic Fisheries Management Council (MAFMC) affecting the use of Vessel Monitoring System (VMS) in the northeast United States through December 31, 2006. Note: if a vessel is subject to VMS regulations from multiple programs, the most restrictive regulation applies.

| Date effective | Fishery | Measure | Description | Reference |
|----------------|------------------------|--------------------------|---|-------------|
| May 1998 | Atlantic scallop | Amendment 4 | Required VMS for all limited access full- and part-time vessels (hourly polling). <i>Note: Amendment 4 effective March 1994, but VMS implementation delayed by NMFS until May 1998.</i> | NEFMC 1993 |
| May 1999 | Atlantic herring | Original FMP | Required VMS for all category 1 vessels (hourly polling). | NEFMC 1999 |
| May 2001 | Atlantic scallop | Framework Adjustment 14 | Required VMS for all limited access occasional-category vessels when participating in area access programs (half-hourly polling). | NEFMC 2001 |
| May 2004 | Northeast multispecies | Amendment 13 | Required VMS for all vessels accessing the US/Canada shared resource area (half-hour polling within US/Canada area, hourly polling outside). | NEFMC 2003 |
| November 2004 | Atlantic scallop | Framework Adjustment 16 | Required VMS for all general category vessels participating in area access programs (half-hour polling). | NEFMC 2004a |
| November 2004 | Northeast multispecies | Framework Adjustment 40A | Required VMS for all vessels participating in special access programs (SAP) and when fishing under the Regular B Days-at-Sea (DAS) Program (hourly polling). | NEFMC 2004b |
| October 2005 | Atlantic scallop | Framework Adjustment 17 | Required VMS for all general category vessels landing > 40 lb scallop meats (half-hour polling). | NEFMC 2005 |
| November 2006 | Northeast multispecies | Framework Adjustment 42 | Required VMS for all limited access NE multispecies DAS vessels using multispecies DAS (hourly polling). | NEFMC 2006 |
| May 2010 | Northeast multispecies | Amendment 16 | Required VMS for all limited access NE multispecies DAS vessels using multispecies DAS or on a sector trip (hourly polling). | NEFMC 2010 |

Table 3. Summary of the Vessel Trip Report (VTR), Vessel Monitoring System (VMS), and Northeast Fisheries Observer Program (NEFOP) 2004 to 2011 data sets, by number of trips and number of vessels.

| Year | Category | Number of trips | Number of Vessels |
|------|---------------------------|-----------------|-------------------|
| 2004 | VTR dataset | 114,491 | 2,629 |
| | VTR subset | 32,272 | 1,176 |
| | VMS-VTR matched set | 5,892 | 453 |
| | NEFOP-VMS-VTR matched set | 249 | 150 |
| 2005 | VTR dataset | 121,442 | 2,599 |
| | VTR subset | 33,090 | 1,161 |
| | VMS-VTR matched set | 9,909 | 622 |
| | NEFOP-VMS-VTR matched set | 901 | 252 |
| 2006 | VTR dataset | 118,548 | 2,497 |
| | VTR subset | 32,431 | 1,155 |
| | VMS-VTR matched set | 19,165 | 886 |
| | NEFOP-VMS-VTR matched set | 514 | 255 |
| 2007 | VTR dataset | 112,902 | 2,404 |
| | VTR subset | 33,288 | 1,102 |
| | VMS-VTR matched set | 25,924 | 957 |
| | NEFOP-VMS-VTR matched set | 771 | 328 |
| 2008 | VTR dataset | 105,352 | 2,271 |
| | VTR subset | 33,645 | 1,064 |
| | VMS-VTR matched set | 20,825 | 845 |
| | NEFOP-VMS-VTR matched set | 655 | 316 |
| 2009 | VTR dataset | 105,387 | 2,154 |
| | VTR subset | 31,525 | 983 |
| | VMS-VTR matched set | 25,128 | 826 |
| | NEFOP-VMS-VTR matched set | 1,006 | 392 |
| 2010 | VTR dataset | 103,425 | 2,171 |
| | VTR subset | 24,341 | 919 |
| | VMS-VTR matched set | 19,523 | 759 |
| | NEFOP-VMS-VTR matched set | 727 | 334 |
| 2011 | VTR dataset | 97,853 | 2,012 |
| | VTR subset | 23,054 | 843 |
| | VMS-VTR matched set | 18,347 | 679 |
| | NEFOP-VMS-VTR matched set | 901 | 306 |

Table 4. Summary of the agreement levels between statistical areas fished recorded by the Northeast Fisheries Observer Program (NEFOP) and the statistical areas fished reported on Vessel Trip Reports (VTR) from matched fishing trips from 2004 to 2011. Trip subcategories are based on the NEFOP-reported number of statistical areas fished. **Note: percentages may not sum to 100 due to rounding.*

| Year | Trip category | Number of trips | Agreement level | Number of trips | Percent of total category trips (%) |
|------|---------------|-----------------|-----------------|-----------------|-------------------------------------|
| 2004 | Single area | 135 | Complete | 129 | 95.6 |
| | | | None | 6 | 4.4 |
| | | | Partial | 0 | 0.0 |
| | Multi-area | 114 | Complete | 6 | 5.3 |
| | | | None | 2 | 1.8 |
| | | | Partial | 106 | 93.0 |
| 2005 | Single area | 490 | Complete | 462 | 94.3 |
| | | | None | 27 | 5.5 |
| | | | Partial | 1 | 0.2 |
| | Multi-area | 411 | Complete | 57 | 13.9 |
| | | | None | 13 | 3.2 |
| | | | Partial | 341 | 83.0 |
| 2006 | Single area | 305 | Complete | 293 | 96.1 |
| | | | None | 10 | 3.3 |
| | | | Partial | 2 | 0.7 |
| | Multi-area | 209 | Complete | 35 | 16.7 |
| | | | None | 6 | 2.9 |
| | | | Partial | 168 | 80.4 |
| 2007 | Single area | 469 | Complete | 442 | 94.6 |
| | | | None | 27 | 5.4 |
| | | | Partial | 0 | 0.0 |
| | Multi-area | 302 | Complete | 46 | 15.2 |
| | | | None | 9 | 3.0 |
| | | | Partial | 247 | 81.8 |
| 2008 | Single area | 385 | Complete | 367 | 95.3 |
| | | | None | 17 | 4.4 |
| | | | Partial | 1 | 0.3 |
| | Multi-area | 270 | Complete | 42 | 15.5 |
| | | | None | 5 | 1.9 |
| | | | Partial | 223 | 82.6 |
| 2009 | Single area | 671 | Complete | 650 | 96.9 |
| | | | None | 21 | 3.1 |
| | | | Partial | 0 | 0.0 |
| | Multi-area | 335 | Complete | 52 | 15.5 |
| | | | None | 15 | 4.5 |
| | | | Partial | 268 | 80.0 |
| 2010 | Single area | 491 | Complete | 468 | 95.3 |
| | | | None | 19 | 3.9 |
| | | | Partial | 4 | 0.8 |
| | Multi-area | 236 | Complete | 19 | 8.1 |
| | | | None | 12 | 5.1 |
| | | | Partial | 205 | 86.9 |
| 2011 | Single area | 635 | Complete | 605 | 95.3 |
| | | | None | 26 | 4.1 |
| | | | Partial | 4 | 0.6 |
| | Multi-area | 266 | Complete | 40 | 15.0 |
| | | | None | 12 | 4.5 |
| | | | Partial | 214 | 80.5 |

Table 5. Summary of the agreement levels between statistical areas fished recorded by the Northeast Fisheries Observer Program (NEFOP) and the statistical areas fished as determined using Vessel Monitoring System (VMS) positional data from matched fishing trips from 2004 to 2011. Trip subcategories are based on the NEFOP-reported number of statistical areas fished.
**Note: percentages may not sum to 100 due to rounding.*

| Year | Area category | Number of trips | Agreement level | Number of trips | Percent of total category trips (%) |
|------|---------------|-----------------|-----------------|-----------------|-------------------------------------|
| 2004 | Single area | 135 | Complete | 123 | 91.1 |
| | | | None | 0 | 0.0 |
| | | | Partial | 12 | 8.9 |
| | Multi-area | 114 | Complete | 77 | 67.5 |
| | | | None | 0 | 0.0 |
| | | | Partial | 37 | 32.5 |
| 2005 | Single area | 490 | Complete | 431 | 88.0 |
| | | | None | 1 | 0.2 |
| | | | Partial | 58 | 11.8 |
| | Multi-area | 411 | Complete | 306 | 74.5 |
| | | | None | 0 | 0.0 |
| | | | Partial | 105 | 25.5 |
| 2006 | Single area | 306 | Complete | 274 | 89.5 |
| | | | None | 0 | 0.0 |
| | | | Partial | 32 | 10.5 |
| | Multi-area | 208 | Complete | 149 | 71.6 |
| | | | None | 0 | 0.0 |
| | | | Partial | 59 | 28.4 |
| 2007 | Single area | 469 | Complete | 437 | 93.2 |
| | | | None | 0 | 0.0 |
| | | | Partial | 32 | 6.8 |
| | Multi-area | 302 | Complete | 227 | 75.2 |
| | | | None | 0 | 0.0 |
| | | | Partial | 75 | 24.8 |
| 2008 | Single area | 385 | Complete | 350 | 90.9 |
| | | | None | 2 | 0.5 |
| | | | Partial | 33 | 8.5 |
| | Multi-area | 270 | Complete | 190 | 70.4 |
| | | | None | 0 | 0.0 |
| | | | Partial | 80 | 29.6 |
| 2009 | Single area | 671 | Complete | 617 | 92.0 |
| | | | None | 3 | 0.4 |
| | | | Partial | 51 | 7.6 |
| | Multi-area | 335 | Complete | 225 | 67.2 |
| | | | None | 1 | 0.3 |
| | | | Partial | 109 | 32.5 |
| 2010 | Single area | 491 | Complete | 445 | 90.6 |
| | | | None | 2 | 0.4 |
| | | | Partial | 44 | 9.0 |
| | Multi-area | 236 | Complete | 148 | 62.7 |
| | | | None | 0 | 0.0 |
| | | | Partial | 88 | 37.3 |
| 2011 | Single area | 635 | Complete | 579 | 91.2 |
| | | | None | 1 | 0.2 |
| | | | Partial | 55 | 8.7 |
| | Multi-area | 266 | Complete | 184 | 69.2 |
| | | | None | 0 | 0.0 |
| | | | Partial | 82 | 30.8 |

Table 6. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2004 commercial landings based on 249 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|---|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 134,732 | 121,281 | GBK | 121,143 | 110,140 | 109,975 | 89.9 | 90.8 | -0.9 | 90.7 | -0.8 |
| | | | GOM | 13,588 | 11,141 | 11,306 | 10.1 | 9.2 | 0.9 | 9.3 | 0.8 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 507,806 | 501,287 | GBK | 499,955 | 493,985 | 494,177 | 98.5 | 98.5 | -0.1 | 98.6 | -0.1 |
| | | | GOM | 7,851 | 7,302 | 7,110 | 1.5 | 1.5 | 0.1 | 1.4 | 0.1 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 252,865 | 281,582 | GBK | 247,173 | 271,682 | 274,809 | 97.7 | 96.5 | 1.3 | 97.6 | 0.2 |
| | | | GOM | 5,582 | 9,900 | 6,684 | 2.2 | 3.5 | -1.3 | 2.4 | -0.2 |
| | | | SNE | 109 | | 88 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 170,741 | 203,914 | GBK | 152,184 | 168,733 | 184,100 | 89.1 | 82.7 | 6.4 | 90.3 | -1.2 |
| | | | GOM | 5,362 | 4,452 | 4,727 | 3.1 | 2.2 | 1.0 | 2.3 | 0.8 |
| | | | SNE | 13,194 | 30,729 | 15,087 | 7.7 | 15.1 | -7.3 | 7.4 | 0.3 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 153 | 66 | NOR | 144 | 66 | 42 | 94.4 | 100.0 | -5.6 | 64.3 | 30.0 |
| | | | SOU | 9 | 0 | 23 | 5.6 | 0.0 | 5.6 | 35.7 | -30.0 |
| Goosefish (<i>Lophius americanus</i>) | 380,531 | 71,311 | NOR | 335,799 | 54,720 | 55,942 | 88.2 | 76.7 | 11.5 | 78.4 | 9.8 |
| | | | SOU | 44,732 | 16,591 | 15,369 | 11.8 | 23.3 | -11.5 | 21.6 | -9.8 |
| Silver hake (<i>Merluccius bilinearis</i>) | 24,840 | 23,280 | NOR | 4,614 | 3,685 | 5,031 | 18.6 | 15.8 | 2.7 | 21.6 | -3.0 |
| | | | SOU | 20,226 | 19,595 | 18,250 | 81.4 | 84.2 | -2.7 | 78.4 | 3.0 |
| Red hake (<i>Urophycis chuss</i>) | 2,869 | 2,655 | NOR | 1,252 | 797 | 850 | 43.6 | 30.0 | 13.6 | 32.0 | 11.6 |
| | | | SOU | 1,617 | 1,858 | 1,805 | 56.4 | 70.0 | -13.6 | 68.0 | -11.6 |

Table 7. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2005 commercial landings based on 901 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|---|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 653,066 | 593,995 | GBK | 599,457 | 545,989 | 541,523 | 91.8 | 91.9 | -0.1 | 91.2 | 0.6 |
| | | | GOM | 53,609 | 48,006 | 52,472 | 8.2 | 8.1 | 0.1 | 8.8 | -0.6 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 1,456,503 | 1,481,989 | GBK | 1,431,364 | 1,440,899 | 1,433,354 | 98.3 | 97.2 | 1.0 | 96.7 | 1.6 |
| | | | GOM | 25,139 | 41,090 | 48,635 | 1.7 | 2.8 | -1.0 | 3.3 | -1.6 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 780,959 | 817,279 | GBK | 758,539 | 773,181 | 791,561 | 97.1 | 94.6 | 2.5 | 96.9 | 0.3 |
| | | | GOM | 21,652 | 23,010 | 24,687 | 2.8 | 2.8 | 0.0 | 3.0 | -0.2 |
| | | | SNE | 768 | 21,088 | 1,030 | 0.1 | 2.6 | -2.5 | 0.1 | 0.0 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 548,666 | 640,737 | GBK | 463,772 | 520,883 | 534,598 | 84.5 | 81.3 | 3.2 | 83.4 | 1.1 |
| | | | GOM | 9,403 | 26,073 | 8,308 | 1.7 | 4.1 | -2.4 | 1.3 | 0.4 |
| | | | SNE | 75,491 | 93,781 | 97,831 | 13.8 | 14.6 | -0.9 | 15.3 | -1.5 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 16,477 | 13,851 | NOR | 16,460 | 13,398 | 13,780 | 99.9 | 96.7 | 3.2 | 99.5 | 0.4 |
| | | | SOU | 16 | 454 | 71 | 0.1 | 3.3 | -3.2 | 0.5 | -0.4 |
| Goosefish (<i>Lophius americanus</i>) | 1,277,812 | 268,890 | NOR | 898,895 | 166,563 | 172,457 | 70.3 | 61.9 | 8.4 | 64.1 | 6.2 |
| | | | SOU | 378,917 | 102,327 | 96,433 | 29.7 | 38.1 | -8.4 | 35.9 | -6.2 |
| Silver hake (<i>Merluccius bilinearis</i>) | 75,370 | 72,752 | NOR | 23,266 | 26,305 | 26,140 | 30.9 | 36.2 | -5.3 | 35.9 | -5.1 |
| | | | SOU | 52,104 | 46,447 | 46,612 | 69.1 | 63.8 | 5.3 | 64.1 | 5.1 |
| Red hake (<i>Urophycis chuss</i>) | 4,165 | 3,877 | NOR | 3,139 | 2,592 | 2,769 | 75.4 | 66.9 | 8.5 | 71.4 | 3.9 |
| | | | SOU | 1,025 | 1,285 | 1,107 | 24.6 | 33.1 | -8.5 | 28.6 | -3.9 |

Table 8. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2006 commercial landings based on 514 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). **Note: allocations may not sum to 100 due to rounding.*

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|---|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 234,013 | 207,562 | GBK | 201,266 | 176,561 | 177,335 | 86.0 | 85.1 | 0.9 | 85.4 | 0.6 |
| | | | GOM | 32,747 | 31,001 | 30,227 | 14.0 | 14.9 | -0.9 | 14.6 | -0.6 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 312,195 | 286,961 | GBK | 304,139 | 268,746 | 275,605 | 97.4 | 93.7 | 3.8 | 96.0 | 1.4 |
| | | | GOM | 8,056 | 18,215 | 11,356 | 2.6 | 6.3 | -3.8 | 4.0 | -1.4 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 270,492 | 288,175 | GBK | 256,683 | 277,142 | 275,958 | 94.9 | 96.2 | -1.3 | 95.8 | -0.9 |
| | | | GOM | 12,548 | 10,029 | 10,530 | 4.6 | 3.5 | 1.2 | 3.7 | 1.0 |
| | | | SNE | 1,261 | 1,004 | 1,686 | 0.5 | 0.3 | 0.1 | 0.6 | -0.1 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 193,511 | 202,203 | GBK | 165,082 | 168,158 | 171,834 | 85.3 | 83.2 | 2.1 | 85.0 | 0.3 |
| | | | GOM | 3,109 | 2,827 | 2,834 | 1.6 | 1.4 | 0.2 | 1.4 | 0.2 |
| | | | SNE | 25,321 | 31,219 | 27,535 | 13.1 | 15.4 | -2.4 | 13.6 | -0.5 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 11,167 | 8,308 | NOR | 10,964 | 7,745 | 8,026 | 98.2 | 93.2 | 5.0 | 96.6 | 1.6 |
| | | | SOU | 204 | 563 | 282 | 1.8 | 6.8 | -5.0 | 3.4 | -1.6 |
| Goosefish (<i>Lophius americanus</i>) | 697,289 | 150,874 | NOR | 450,096 | 105,992 | 110,857 | 64.5 | 70.3 | -5.7 | 73.5 | -8.9 |
| | | | SOU | 247,193 | 44,883 | 40,017 | 35.5 | 29.7 | 5.7 | 26.5 | 8.9 |
| Silver hake (<i>Merluccius bilinearis</i>) | 67,997 | 57,500 | NOR | 30,157 | 23,221 | 23,584 | 44.4 | 40.4 | 4.0 | 41.0 | 3.3 |
| | | | SOU | 37,840 | 34,278 | 33,916 | 55.6 | 59.6 | -4.0 | 59.0 | -3.3 |
| Red hake (<i>Urophycis chuss</i>) | 5,318 | 4,354 | NOR | 3,888 | 2,908 | 3,328 | 73.1 | 66.8 | 6.3 | 76.4 | -3.3 |
| | | | SOU | 1,431 | 1,447 | 1,027 | 26.9 | 33.2 | -6.3 | 23.6 | 3.3 |

Table 9. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2007 commercial landings based on 771 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|---|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 458,590 | 439,098 | GBK | 406,039 | 389,822 | 383,746 | 88.5 | 88.8 | -0.2 | 87.4 | 1.1 |
| | | | GOM | 52,552 | 49,276 | 55,352 | 11.5 | 11.2 | 0.2 | 12.6 | -1.1 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 434,982 | 445,240 | GBK | 420,707 | 427,180 | 423,005 | 96.7 | 95.9 | 0.8 | 95.0 | 1.7 |
| | | | GOM | 14,275 | 18,060 | 22,235 | 3.3 | 4.1 | -0.8 | 5.0 | -1.7 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 199,270 | 212,210 | GBK | 177,581 | 189,671 | 191,276 | 89.1 | 89.4 | -0.3 | 90.1 | -1.0 |
| | | | GOM | 17,868 | 19,131 | 17,445 | 9.0 | 9.0 | 0.0 | 8.2 | 0.7 |
| | | | SNE | 3,821 | 3,408 | 3,489 | 1.9 | 1.6 | 0.3 | 1.6 | 0.3 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 210,757 | 246,681 | GBK | 153,281 | 170,371 | 161,318 | 72.7 | 69.1 | 3.7 | 65.4 | 7.3 |
| | | | GOM | 5,526 | 5,257 | 8,429 | 2.6 | 2.1 | 0.5 | 3.4 | -0.8 |
| | | | SNE | 51,951 | 71,053 | 76,934 | 24.6 | 28.8 | -4.2 | 31.2 | -6.5 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 14,428 | 10,979 | NOR | 13,637 | 10,286 | 10,329 | 94.5 | 93.7 | 0.8 | 94.1 | 0.4 |
| | | | SOU | 792 | 693 | 650 | 5.5 | 6.3 | -0.8 | 5.9 | -0.4 |
| Goosefish (<i>Lophius americanus</i>) | 465,492 | 99,856 | NOR | 327,731 | 69,999 | 70,227 | 70.4 | 70.1 | 0.3 | 70.3 | 0.1 |
| | | | SOU | 137,761 | 29,857 | 29,629 | 29.6 | 29.9 | -0.3 | 29.7 | -0.1 |
| Silver hake (<i>Merluccius bilinearis</i>) | 74,105 | 100,047 | NOR | 26,292 | 37,105 | 34,143 | 35.5 | 37.1 | -1.6 | 34.1 | 1.4 |
| | | | SOU | 47,813 | 62,942 | 65,905 | 64.5 | 62.9 | 1.6 | 65.9 | -1.4 |
| Red hake (<i>Urophycis chuss</i>) | 13,803 | 14,055 | NOR | 8,698 | 7,163 | 7,051 | 63.0 | 51.0 | 12.1 | 50.2 | 12.9 |
| | | | SOU | 5,105 | 6,892 | 7,005 | 37.0 | 49.0 | -12.1 | 49.8 | -12.9 |

Table 10. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2008 commercial landings based on 655 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|--|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod | 401,344 | 357,702 | GBK | 351,095 | 315,830 | 311,392 | 87.5 | 88.3 | -0.8 | 87.1 | 0.4 |
| <i>(Gadus morhua)</i> | | | GOM | 50,249 | 41,872 | 46,310 | 12.5 | 11.7 | 0.8 | 12.9 | -0.4 |
| Haddock | 752,855 | 737,893 | GBK | 743,721 | 725,050 | 719,921 | 98.8 | 98.3 | 0.5 | 97.6 | 1.2 |
| <i>(Melanogrammus aeglefinus)</i> | | | GOM | 9,134 | 12,843 | 17,971 | 1.2 | 1.7 | -0.5 | 2.4 | -1.2 |
| Yellowtail flounder | 211,839 | 232,198 | GBK | 197,165 | 218,113 | 215,660 | 93.1 | 93.9 | -0.9 | 92.9 | 0.2 |
| <i>(Limanda ferruginea)</i> | | | GOM | 12,527 | 11,436 | 12,813 | 5.9 | 4.9 | 1.0 | 5.5 | 0.4 |
| | | | SNE | 2,147 | 2,649 | 3,725 | 1.0 | 1.1 | -0.1 | 1.6 | -0.6 |
| Winter flounder | 271,056 | 325,728 | GBK | 229,437 | 273,771 | 256,775 | 84.6 | 84.0 | 0.6 | 78.8 | 5.8 |
| <i>(Pseudopleuronectes americanus)</i> | | | GOM | 7,419 | 5,975 | 8,527 | 2.7 | 1.8 | 0.9 | 2.6 | 0.1 |
| | | | SNE | 34,201 | 45,982 | 60,426 | 12.6 | 14.1 | -1.5 | 18.6 | -5.9 |
| Windowpane flounder | 8,190 | 8,169 | NOR | 7,265 | 7,096 | 6,942 | 88.7 | 86.9 | 1.8 | 85.0 | 3.7 |
| <i>(Scophthalmus aquosus)</i> | | | SOU | 926 | 1072 | 1226 | 11.3 | 13.1 | -1.8 | 15.0 | -3.7 |
| Goosefish | 338,356 | 63,624 | NOR | 180,968 | 32,766 | 35,171 | 53.5 | 51.5 | 2.0 | 55.3 | -1.8 |
| <i>(Lophius americanus)</i> | | | SOU | 157,388 | 30,857 | 28,453 | 46.5 | 48.5 | -2.0 | 44.7 | 1.8 |
| Silver hake | 46,151 | 48,412 | NOR | 9,805 | 13,200 | 13,130 | 21.2 | 27.3 | -6.0 | 27.1 | -5.9 |
| <i>(Merluccius bilinearis)</i> | | | SOU | 36,346 | 35,212 | 35,282 | 78.8 | 72.7 | 6.0 | 72.9 | 5.9 |
| Red hake | 14,864 | 11,068 | NOR | 11,410 | 7,531 | 7,536 | 76.8 | 68.0 | 8.7 | 68.1 | 8.7 |
| <i>(Urophycis chuss)</i> | | | SOU | 3,454 | 3,538 | 3,532 | 23.2 | 32.0 | -8.7 | 31.9 | -8.7 |

Table 11. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2009 commercial landings based on 1,006 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|--|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod | 477,580 | 470,386 | GBK | 336,421 | 346,404 | 345,761 | 70.4 | 73.6 | -3.2 | 73.5 | -3.1 |
| (<i>Gadus morhua</i>) | | | GOM | 141,159 | 123,983 | 125,335 | 29.6 | 26.4 | 3.2 | 26.6 | 2.9 |
| Haddock | 793,867 | 865,024 | GBK | 770,053 | 841,010 | 838,998 | 97.0 | 97.2 | -0.2 | 97.0 | 0.0 |
| (<i>Melanogrammus aeglefinus</i>) | | | GOM | 23,814 | 24,014 | 26,071 | 3.0 | 2.8 | 0.2 | 3.0 | 0.0 |
| Yellowtail flounder | 189,484 | 201,137 | GBK | 169,600 | 178,475 | 178,403 | 89.5 | 88.7 | 0.8 | 88.7 | 0.8 |
| (<i>Limanda ferruginea</i>) | | | GOM | 16,480 | 17,261 | 18,584 | 8.7 | 8.6 | 0.1 | 9.2 | -0.5 |
| | | | SNE | 3,404 | 5,401 | 4,177 | 1.8 | 2.7 | -0.9 | 2.1 | -0.3 |
| Winter flounder | 268,576 | 306,702 | GBK | 254,628 | 272,175 | 289,696 | 94.8 | 88.7 | 6.1 | 94.5 | 0.4 |
| (<i>Pseudopleuronectes americanus</i>) | | | GOM | 10,297 | 10,687 | 10,816 | 3.8 | 3.5 | 0.3 | 3.5 | 0.3 |
| | | | SNE | 3,651 | 23,840 | 7,974 | 1.4 | 7.8 | -6.4 | 2.6 | -1.2 |
| Windowpane flounder | 3,218 | 3,982 | NOR | 2,205 | 2,827 | 2,824 | 68.5 | 71.0 | -2.5 | 70.9 | -2.4 |
| (<i>Scophthalmus aquosus</i>) | | | SOU | 1013 | 1154 | 1157 | 31.5 | 29.0 | 2.5 | 29.1 | 2.4 |
| Goosefish | 340,239 | 77,648 | NOR | 233,820 | 40,655 | 40,010 | 68.7 | 52.4 | 16.4 | 51.5 | 17.2 |
| (<i>Lophius americanus</i>) | | | SOU | 106,419 | 36,993 | 37,583 | 31.3 | 47.6 | -16.4 | 48.4 | -17.1 |
| Silver hake | 206,506 | 315,393 | NOR | 43,000 | 84,301 | 83,801 | 20.8 | 26.7 | -5.9 | 26.6 | -5.7 |
| (<i>Merluccius bilinearis</i>) | | | SOU | 163,506 | 231,092 | 231,592 | 79.2 | 73.3 | 5.9 | 73.4 | 5.7 |
| Red hake | 21,629 | 25,593 | NOR | 9,550 | 10,600 | 10,542 | 44.2 | 41.4 | 2.7 | 41.2 | 3.0 |
| (<i>Urophycis chuss</i>) | | | SOU | 12,079 | 14,993 | 15,051 | 55.8 | 58.6 | -2.7 | 58.8 | -3.0 |

Table 12. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2010 commercial landings based on 727 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). **Note: allocations may not sum to 100 due to rounding.*

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|--|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod | 284,645 | 260,226 | GBK | 143,671 | 140,947 | 139,454 | 50.5 | 54.2 | -3.7 | 53.6 | -3.1 |
| <i>(Gadus morhua)</i> | | | GOM | 140,974 | 119,280 | 120,766 | 49.5 | 45.8 | 3.7 | 46.4 | 3.1 |
| Haddock | 622,662 | 630,758 | GBK | 612,033 | 620,650 | 604,853 | 98.3 | 98.4 | -0.1 | 95.9 | 2.4 |
| <i>(Melanogrammus aeglefinus)</i> | | | GOM | 10,629 | 10,107 | 25,904 | 1.7 | 1.6 | 0.1 | 4.1 | -2.4 |
| Yellowtail flounder | 76,204 | 78,583 | GBK | 64,490 | 67,521 | 66,250 | 84.6 | 85.9 | -1.3 | 84.3 | 0.3 |
| <i>(Limanda ferruginea)</i> | | | GOM | 9,862 | 9,422 | 9,828 | 12.9 | 12.0 | 1.0 | 12.5 | 0.4 |
| | | | SNE | 1,852 | 1,639 | 2,499 | 2.4 | 2.1 | 0.3 | 3.2 | -0.7 |
| Winter flounder | 77,951 | 90,730 | GBK | 73,330 | 86,314 | 80,868 | 94.1 | 95.1 | -1.1 | 89.1 | 4.9 |
| <i>(Pseudopleuronectes americanus)</i> | | | GOM | 4,229 | 4,228 | 4,500 | 5.4 | 4.7 | 0.8 | 5.0 | 0.5 |
| | | | SNE | 392 | 188 | 5,361 | 0.5 | 0.2 | 0.3 | 5.9 | -5.4 |
| Windowpane flounder | 76 | 118 | NOR | 4 | 0 | 0 | 4.8 | 0.0 | 4.8 | 0.0 | 4.8 |
| <i>(Scophthalmus aquosus)</i> | | | SOU | 73 | 118 | 118 | 95.2 | 100.0 | -4.8 | 100.0 | -4.8 |
| Goosefish | 247,706 | 54,784 | NOR | 182,516 | 26,102 | 24,233 | 73.7 | 47.6 | 26.0 | 44.2 | 29.4 |
| <i>(Lophius americanus)</i> | | | SOU | 65,190 | 28,682 | 30,551 | 26.3 | 52.4 | -26.0 | 55.8 | -29.4 |
| Silver hake | 319,059 | 300,199 | NOR | 81,561 | 56,569 | 60,826 | 25.6 | 18.8 | 6.7 | 20.3 | 5.3 |
| <i>(Merluccius bilinearis)</i> | | | SOU | 237,499 | 243,629 | 239,418 | 74.4 | 81.2 | -6.7 | 79.8 | -5.3 |
| Red hake | 16,816 | 27,715 | NOR | 7,854 | 7,278 | 7,264 | 46.7 | 26.3 | 20.4 | 26.2 | 20.5 |
| <i>(Urophycis chuss)</i> | | | SOU | 8,961 | 20,437 | 20,451 | 53.3 | 73.7 | -20.4 | 73.8 | -20.5 |

Table 13. Comparison of the Northeast Fisheries Observer Program (NEFOP), Vessel Trip Reports (VTR), and Vessel Monitoring System (VMS) stock allocations of 2011 commercial landings based on 901 matched trips. Bold text is used to indicate which method, VTR or VMS, achieve results closest to NEFOP allocations. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total Observer species landings (kg) | Total VTR species landings (kg) | Stock area | NEFOP landings allocation (kg) | VTR landings allocation (kg) | VMS landings allocation (kg) | NEFOP stock allocation (%) | VTR stock allocation (%) | VTR difference (%) | VMS stock allocation (%) | VMS difference (%) |
|--|--------------------------------------|---------------------------------|------------|--------------------------------|------------------------------|------------------------------|----------------------------|--------------------------|--------------------|--------------------------|--------------------|
| Atlantic cod | 394,128 | 370,635 | GBK | 106,932 | 107,776 | 119,092 | 27.1 | 29.1 | -1.9 | 32.1 | -5.0 |
| <i>(Gadus morhua)</i> | | | GOM | 287,196 | 262,859 | 251,588 | 72.9 | 70.9 | 1.9 | 67.9 | 5.0 |
| Haddock | 207,598 | 239,773 | GBK | 176,998 | 210,062 | 205,862 | 85.3 | 87.6 | -2.3 | 85.9 | -0.6 |
| <i>(Melanogrammus aeglefinus)</i> | | | GOM | 30,601 | 29,712 | 33,911 | 14.7 | 12.4 | 2.3 | 14.1 | 0.6 |
| Yellowtail flounder | 108,937 | 120,694 | GBK | 64,746 | 76,096 | 68,656 | 59.4 | 63.0 | -3.6 | 56.9 | 2.5 |
| <i>(Limanda ferruginea)</i> | | | GOM | 38,569 | 39,085 | 42,800 | 35.4 | 32.4 | 3.0 | 35.5 | -0.1 |
| | | | SNE | 5,623 | 5,513 | 9,238 | 5.2 | 4.6 | 0.6 | 7.7 | -2.5 |
| Winter flounder | 94,025 | 111,265 | GBK | 84,797 | 100,683 | 96,331 | 90.2 | 90.5 | -0.3 | 86.6 | 3.6 |
| <i>(Pseudopleuronectes americanus)</i> | | | GOM | 8,998 | 10,370 | 10,228 | 9.6 | 9.3 | 0.3 | 9.2 | 0.4 |
| | | | SNE | 229 | 213 | 4,706 | 0.2 | 0.2 | 0.1 | 4.2 | -4.0 |
| Windowpane flounder | 2 | 0 | NOR | 2 | 0 | 0 | 100.0 | | | | |
| <i>(Scophthalmus aquosus)</i> | | | SOU | 0 | 0 | 0 | 0.0 | | | | |
| Goosefish | 297,315 | 73,541 | NOR | 166,622 | 25,309 | 26,989 | 56.0 | 34.4 | 21.6 | 36.7 | 19.3 |
| <i>(Lophius americanus)</i> | | | SOU | 130,693 | 48,232 | 47,001 | 44.0 | 65.6 | -21.6 | 63.9 | -20.0 |
| Silver hake | 261,664 | 342,592 | NOR | 44,687 | 72,689 | 64,031 | 17.1 | 21.2 | -4.1 | 18.7 | -1.6 |
| <i>(Merluccius bilinearis)</i> | | | SOU | 216,977 | 269,903 | 278,562 | 82.9 | 78.8 | 4.1 | 81.3 | 1.6 |
| Red hake | 14,191 | 20,471 | NOR | 6,095 | 6,124 | 5,754 | 42.9 | 29.9 | 13.0 | 28.1 | 14.8 |
| <i>(Urophycis chuss)</i> | | | SOU | 8,096 | 14,347 | 14,716 | 57.1 | 70.1 | -13.0 | 71.9 | -14.8 |

Table 14. Species-level summary of the Vessel Monitoring System (VMS) dataset and Vessel Trip Reports (VTR) subset compared to total VTR landings (kg) from 2004 to 2011.

| Year | Species | Total VTR landings (kg) | VTR subset | Percent of total | VMS | Percent of total |
|------|--|-------------------------|------------|------------------|------------------|------------------|
| | | | (kg) | (%) | matched set (kg) | (%) |
| 2004 | Atlantic cod (<i>Gadus morhua</i>) | 5,611,244 | 5,432,809 | 96.8 | 1,874,015 | 33.4 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 6,919,871 | 6,837,521 | 98.8 | 5,096,088 | 73.6 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 6,954,627 | 6,899,760 | 99.2 | 5,378,986 | 77.3 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 4,515,996 | 4,483,488 | 99.3 | 3,127,780 | 69.3 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 92,640 | 91,522 | 98.8 | 18,217 | 19.7 |
| | Goosefish (<i>Lophius americanus</i>) | 7,561,854 | 7,440,979 | 98.4 | 1,332,178 | 17.6 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 7,454,395 | 7,392,633 | 99.2 | 2,071,931 | 27.8 |
| | Red hake (<i>Urophycis chuss</i>) | 875,228 | 863,357 | 98.6 | 236,830 | 27.1 |
| 2005 | Atlantic cod (<i>Gadus morhua</i>) | 5,072,510 | 4,983,113 | 98.2 | 2,754,687 | 54.3 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 6,198,222 | 6,155,937 | 99.3 | 5,700,737 | 92.0 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 3,925,078 | 3,922,078 | 99.9 | 3,475,993 | 88.6 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 3,473,132 | 3,457,729 | 99.6 | 2,800,639 | 80.6 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 81,693 | 81,532 | 99.8 | 45,771 | 56.0 |
| | Goosefish (<i>Lophius americanus</i>) | 7,377,131 | 7,259,875 | 98.4 | 2,129,989 | 28.9 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 7,526,280 | 7,522,877 | 100.0 | 3,531,069 | 46.9 |
| | Red hake (<i>Urophycis chuss</i>) | 549,641 | 547,200 | 99.6 | 154,666 | 28.1 |
| 2006 | Atlantic cod (<i>Gadus morhua</i>) | 4,623,801 | 4,546,055 | 98.3 | 3,428,790 | 74.2 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 2,810,657 | 2,713,290 | 96.5 | 2,513,767 | 89.4 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 1,891,367 | 1,867,650 | 98.7 | 1,681,115 | 88.9 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 2,589,643 | 2,583,503 | 99.8 | 2,128,052 | 82.2 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 87,187 | 87,012 | 99.8 | 61,654 | 70.7 |
| | Goosefish (<i>Lophius americanus</i>) | 6,109,614 | 6,026,365 | 98.6 | 3,246,832 | 53.1 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 5,331,664 | 5,327,921 | 99.9 | 4,606,490 | 86.4 |
| | Red hake (<i>Urophycis chuss</i>) | 559,679 | 553,489 | 98.9 | 458,731 | 82.0 |
| 2007 | Atlantic cod (<i>Gadus morhua</i>) | 6,278,969 | 6,171,416 | 98.3 | 5,838,287 | 93.0 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 3,071,154 | 3,054,852 | 99.5 | 3,013,511 | 98.1 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 1,675,883 | 1,668,462 | 99.6 | 1,623,035 | 96.8 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 2,517,944 | 2,499,538 | 99.3 | 2,172,096 | 86.3 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 180,091 | 179,389 | 99.6 | 144,231 | 80.1 |
| | Goosefish (<i>Lophius americanus</i>) | 4,797,261 | 4,677,828 | 97.5 | 2,969,033 | 61.9 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 6,198,030 | 6,179,560 | 99.7 | 5,749,198 | 92.8 |
| | Red hake (<i>Urophycis chuss</i>) | 614,724 | 606,624 | 98.7 | 544,902 | 88.6 |
| 2008 | Atlantic cod (<i>Gadus morhua</i>) | 7,026,980 | 6,942,829 | 98.8 | 4,987,617 | 71.0 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 5,213,529 | 5,190,698 | 99.6 | 4,072,033 | 78.1 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 1,624,491 | 1,616,847 | 99.5 | 1,239,577 | 76.3 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 2,226,518 | 2,210,008 | 99.3 | 1,875,233 | 84.2 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 117,138 | 116,527 | 99.5 | 59,340 | 50.7 |
| | Goosefish (<i>Lophius americanus</i>) | 4,189,612 | 4,046,358 | 96.6 | 1,791,932 | 42.8 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 5,767,216 | 5,583,469 | 96.8 | 3,801,904 | 65.9 |
| | Red hake (<i>Urophycis chuss</i>) | 754,050 | 716,744 | 95.1 | 535,823 | 71.1 |
| 2009 | Atlantic cod (<i>Gadus morhua</i>) | 7,213,351 | 6,987,840 | 96.9 | 6,238,260 | 86.5 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 4824825 | 4,767,456 | 98.8 | 4,715,435 | 97.7 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 1574303 | 1,563,004 | 99.3 | 1,496,519 | 95.1 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 1,987,276 | 1,977,504 | 99.5 | 1,913,871 | 96.3 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 82,230 | 81,911 | 99.6 | 71,742 | 87.2 |
| | Goosefish (<i>Lophius americanus</i>) | 3,393,612 | 3,268,159 | 96.3 | 1,968,113 | 58.0 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 7,237,088 | 7,043,396 | 97.3 | 6,691,037 | 92.5 |
| | Red hake (<i>Urophycis chuss</i>) | 839,694 | 792,563 | 94.4 | 743,386 | 88.5 |
| 2010 | Atlantic cod (<i>Gadus morhua</i>) | 6,406,843 | 6,046,419 | 94.4 | 5,581,321 | 87.1 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 7,967,547 | 6,386,646 | 80.2 | 6,357,935 | 79.8 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 1,253,948 | 1,210,135 | 96.5 | 1,163,424 | 92.8 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 1,424,320 | 1,298,805 | 91.2 | 1,279,475 | 89.8 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 24,777 | 23,684 | 95.6 | 7,840 | 31.6 |
| | Goosefish (<i>Lophius americanus</i>) | 2,767,345 | 2,704,886 | 97.7 | 1,653,139 | 59.7 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 7,448,905 | 7,387,146 | 99.2 | 7,152,985 | 96.0 |
| | Red hake (<i>Urophycis chuss</i>) | 720,282 | 702,341 | 97.5 | 671,390 | 93.2 |
| 2011 | Atlantic cod (<i>Gadus morhua</i>) | 6,329,892 | 5,869,780 | 92.7 | 5,736,502 | 90.6 |
| | Haddock (<i>Melanogrammus aeglefinus</i>) | 4,845,051 | 2,758,417 | 56.9 | 2,737,682 | 56.5 |
| | Yellowtail flounder (<i>Limanda ferruginea</i>) | 1,723,480 | 1,587,645 | 92.1 | 1,577,599 | 91.5 |
| | Winter flounder (<i>Pseudopleuronectes americanus</i>) | 1,934,920 | 1,728,472 | 89.3 | 1,714,978 | 88.6 |
| | Windowpane flounder (<i>Scophthalmus aquosus</i>) | 22,316 | 22,211 | 99.5 | 1,993 | 8.9 |
| | Goosefish (<i>Lophius americanus</i>) | 3,434,132 | 3,348,161 | 97.5 | 1,995,796 | 58.1 |
| | Silver hake (<i>Merluccius bilinearis</i>) | 7,362,619 | 7,331,558 | 99.6 | 7,116,346 | 96.7 |
| | Red hake (<i>Urophycis chuss</i>) | 656,697 | 641,792 | 97.7 | 606,409 | 92.3 |

Table 15. 2004 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR gear code | VTR | | | VMS | | | Percent of VTR landings (%) |
|---|---------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | |
| Atlantic cod (<i>Gadus morhua</i>) | OTF | 444 | 9,167 | 3,507,919 | 189 | 2,724 | 1,829,688 | 52.2 |
| | DRS | 6 | 9 | 535 | 3 | 3 | 14 | 2.5 |
| | GNS | 171 | 6,972 | 1,726,238 | 4 | 116 | 25,959 | 1.5 |
| | LLB | 67 | 1,221 | 198,117 | 21 | 253 | 18,355 | 9.3 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | OTF | 384 | 6,323 | 5,908,548 | 187 | 2,472 | 4,619,014 | 78.2 |
| | DRS | 1 | 1 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 137 | 3,313 | 133,401 | 3 | 86 | 9,789 | 7.3 |
| | LLB | 55 | 986 | 795,572 | 21 | 261 | 467,285 | 58.7 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | OTF | 404 | 7,337 | 6,749,688 | 181 | 2,061 | 5,373,053 | 79.6 |
| | DRS | 36 | 62 | 4,346 | 33 | 48 | 4,072 | 93.7 |
| | GNS | 93 | 1,541 | 145,727 | 2 | 31 | 1,862 | 1.3 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | OTF | 471 | 9,866 | 4,393,835 | 184 | 2,314 | 3,125,651 | 71.1 |
| | DRS | 18 | 37 | 750 | 16 | 26 | 660 | 87.9 |
| | GNS | 129 | 3,029 | 88,606 | 2 | 57 | 1,433 | 1.6 |
| | LLB | 9 | 67 | 298 | 2 | 10 | 37 | 12.3 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | OTF | 158 | 1,291 | 90,880 | 46 | 105 | 18,217 | 20.0 |
| | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 12 | 63 | 642 | 0 | 0 | 0 | 0.0 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Goosefish (<i>Lophius americanus</i>) | OTF | 555 | 9,467 | 1,870,948 | 208 | 2,325 | 880,759 | 47.1 |
| | DRS | 226 | 1,226 | 381,761 | 214 | 1,179 | 380,203 | 99.6 |
| | GNS | 268 | 8,119 | 5,186,982 | 4 | 118 | 70,362 | 1.4 |
| | LLB | 26 | 146 | 1,288 | 16 | 75 | 854 | 66.3 |
| Silver hake (<i>Merluccius bilinearis</i>) | OTF | 234 | 3,212 | 7,334,373 | 68 | 721 | 2,069,807 | 28.2 |
| | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 63 | 415 | 21,948 | 2 | 7 | 1,976 | 9.0 |
| | LLB | 4 | 17 | 36,311 | 2 | 4 | 148 | 0.4 |
| Red hake (<i>Urophycis chuss</i>) | OTF | 172 | 2,226 | 769,215 | 56 | 510 | 235,494 | 30.6 |
| | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 26 | 353 | 93,767 | 1 | 33 | 1,044 | 1.1 |
| | LLB | 7 | 21 | 376 | 3 | 7 | 292 | 77.6 |

Table 16. 2005 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR gear code | VTR | | | VMS | | | Percent of VTR landings (%) |
|---|---------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | |
| Atlantic cod (<i>Gadus morhua</i>) | OTF | 381 | 9,005 | 3,201,456 | 229 | 4,415 | 2,491,742 | 77.8 |
| | DRS | 8 | 11 | 1,209 | 7 | 10 | 100 | 8.3 |
| | GNS | 157 | 6,711 | 1,574,496 | 21 | 697 | 164,299 | 10.4 |
| | LLB | 89 | 1,373 | 205,952 | 45 | 638 | 98,546 | 47.8 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | OTF | 342 | 6,471 | 5,246,396 | 217 | 3,670 | 5,036,560 | 96 |
| | DRS | 3 | 4 | 15 | 2 | 3 | 14 | 93.9 |
| | GNS | 125 | 3,054 | 59,757 | 15 | 292 | 4,494 | 7.5 |
| | LLB | 80 | 1257 | 849,769 | 44 | 650 | 659,669 | 77.6 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | OTF | 352 | 7,138 | 3,815,235 | 218 | 3,175 | 3,473,828 | 91.1 |
| | DRS | 30 | 45 | 2,059 | 28 | 42 | 1,883 | 91.5 |
| | GNS | 77 | 1,180 | 104,756 | 5 | 30 | 259 | 0.2 |
| | LLB | 5 | 19 | 28 | 3 | 16 | 23 | 83.6 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | OTF | 413 | 9,225 | 3,407,204 | 229 | 3,458 | 2,786,325 | 81.8 |
| | DRS | 37 | 65 | 13,237 | 36 | 64 | 12,772 | 96.5 |
| | GNS | 118 | 2,530 | 36,739 | 12 | 189 | 1,069 | 2.9 |
| | LLB | 11 | 84 | 549 | 6 | 66 | 473 | 86.1 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | OTF | 158 | 1,057 | 80,999 | 78 | 227 | 45,762 | 56.5 |
| | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 9 | 77 | 523 | 0 | 0 | 0 | 0.0 |
| | LLB | 4 | 9 | 10 | 3 | 8 | 9 | 91.3 |
| Goosefish (<i>Lophius americanus</i>) | OTF | 493 | 9,197 | 1,857,280 | 260 | 3,603 | 1,359,021 | 73.2 |
| | DRS | 317 | 2,722 | 335,072 | 266 | 1,498 | 321,271 | 95.9 |
| | GNS | 246 | 8,736 | 5,065,683 | 34 | 801 | 448,437 | 8.9 |
| | LLB | 36 | 212 | 1,841 | 30 | 182 | 1,260 | 68.4 |
| Silver hake (<i>Merluccius bilinearis</i>) | OTF | 193 | 2,689 | 7,391,321 | 96 | 1197 | 3,489,085 | 47.2 |
| | DRS | 2 | 2 | 365 | 2 | 2 | 365 | 100.0 |
| | GNS | 41 | 255 | 20,219 | 1 | 8 | 4,400 | 21.8 |
| | LLB | 7 | 30 | 110,972 | 5 | 20 | 37,219 | 33.5 |
| Red hake (<i>Urophycis chuss</i>) | OTF | 143 | 1,838 | 482,879 | 69 | 757 | 152,655 | 31.6 |
| | DRS | 1 | 1 | 125 | 1 | 1 | 125 | 100.0 |
| | GNS | 24 | 239 | 64,020 | 2 | 25 | 1,810 | 2.8 |
| | LLB | 4 | 10 | 176 | 2 | 6 | 76 | 43.3 |

Table 17. 2006 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR gear code | VTR | | | VMS | | | Percent of VTR landings (%) |
|---|---------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | |
| Atlantic cod (<i>Gadus morhua</i>) | OTF | 350 | 7,493 | 2,913,548 | 301 | 5,799 | 2,680,732 | 92.0 |
| | DRS | 5 | 8 | 420 | 4 | 7 | 184 | 43.8 |
| | GNS | 153 | 6,764 | 1,427,295 | 95 | 2739 | 656,843 | 46.0 |
| | LLB | 80 | 1,154 | 204,792 | 42 | 511 | 91,031 | 44.5 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | OTF | 296 | 4,938 | 2,242,491 | 252 | 3,994 | 2,186,209 | 97.5 |
| | DRS | 5 | 5 | 1,303 | 4 | 4 | 1,299 | 99.7 |
| | GNS | 122 | 2,964 | 65,539 | 75 | 1275 | 26,864 | 41.0 |
| | LLB | 76 | 1091 | 403,958 | 42 | 496 | 299,395 | 74.1 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | OTF | 319 | 6,402 | 1,772,976 | 282 | 4,938 | 1,674,672 | 94.5 |
| | DRS | 24 | 36 | 4,098 | 23 | 35 | 4,076 | 99.4 |
| | GNS | 67 | 1,293 | 90,562 | 32 | 244 | 2,355 | 2.6 |
| | LLB | 5 | 12 | 14 | 4 | 11 | 13 | 96.7 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | OTF | 381 | 8,460 | 2,534,691 | 310 | 5,530 | 2,115,716 | 83.5 |
| | DRS | 36 | 73 | 4,951 | 34 | 71 | 4,926 | 99.5 |
| | GNS | 109 | 2,825 | 43,398 | 64 | 979 | 6,983 | 16.1 |
| | LLB | 8 | 57 | 463 | 7 | 42 | 428 | 92.5 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | OTF | 151 | 1,246 | 86,897 | 117 | 607 | 61,621 | 70.9 |
| | DRS | 1 | 2 | 7 | 1 | 2 | 7 | 100.0 |
| | GNS | 9 | 37 | 107 | 3 | 7 | 24 | 22.6 |
| | LLB | 1 | 1 | 2 | 1 | 1 | 2 | 100.0 |
| Goosefish (<i>Lophius americanus</i>) | OTF | 459 | 8,032 | 1,574,844 | 380 | 5,747 | 1,417,361 | 90.0 |
| | DRS | 336 | 3,917 | 323,214 | 333 | 3,650 | 317,777 | 98.3 |
| | GNS | 261 | 8,050 | 4,127,303 | 114 | 2910 | 1,510,988 | 36.6 |
| | LLB | 22 | 113 | 1,004 | 20 | 99 | 706 | 70.3 |
| Silver hake (<i>Merluccius bilinearis</i>) | OTF | 197 | 3,098 | 5,294,681 | 162 | 2242 | 4,590,130 | 86.7 |
| | DRS | 1 | 3 | 14 | 1 | 3 | 14 | 100.0 |
| | GNS | 37 | 251 | 18,600 | 22 | 98 | 11,729 | 63.1 |
| | LLB | 4 | 13 | 14,628 | 3 | 5 | 4,616 | 31.6 |
| Red hake (<i>Urophycis chuss</i>) | OTF | 152 | 1,983 | 525,546 | 119 | 1346 | 447,917 | 85.2 |
| | DRS | 2 | 2 | 29 | 2 | 2 | 29 | 100.0 |
| | GNS | 22 | 257 | 27,383 | 10 | 112 | 10,260 | 37.5 |
| | LLB | 4 | 6 | 531 | 3 | 5 | 524 | 98.7 |

Table 18. 2007 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR | VTR | | | VMS | | | |
|---|-----------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | gear code | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | Percent of VTR landings (%) |
| Atlantic cod <i>(Gadus morhua)</i> | OTF | 333 | 7,166 | 3,722,919 | 322 | 6,538 | 3,592,723 | 96.5 |
| | DRS | 6 | 11 | 122 | 6 | 11 | 122 | 100.0 |
| | GNS | 145 | 7,724 | 2,224,006 | 135 | 7059 | 2,038,677 | 91.7 |
| | LLB | 62 | 1,048 | 224,369 | 54 | 952 | 206,764 | 92.2 |
| Haddock <i>(Melanogrammus aeglefinus)</i> | OTF | 273 | 4,508 | 2,623,998 | 270 | 4,220 | 2,603,164 | 99.2 |
| | DRS | 3 | 5 | 29 | 3 | 5 | 29 | 100.0 |
| | GNS | 113 | 2,985 | 60,006 | 113 | 2851 | 58,541 | 97.6 |
| | LLB | 60 | 1007 | 370,818 | 55 | 946 | 351,777 | 94.9 |
| Yellowtail flounder <i>(Limanda ferruginea)</i> | OTF | 306 | 6,360 | 1,592,293 | 298 | 5,718 | 1,558,752 | 97.9 |
| | DRS | 21 | 34 | 991 | 21 | 34 | 991 | 100.0 |
| | GNS | 78 | 2,089 | 73,751 | 76 | 1872 | 63,226 | 85.7 |
| | LLB | 6 | 8 | 1,427 | 5 | 7 | 66 | 4.6 |
| Winter flounder <i>(Pseudopleuronectes americanus)</i> | OTF | 360 | 8,748 | 2,442,367 | 327 | 6,449 | 2,120,496 | 86.8 |
| | DRS | 37 | 76 | 6,369 | 37 | 76 | 6,369 | 100.0 |
| | GNS | 124 | 3,877 | 50,230 | 104 | 3474 | 44,687 | 89.0 |
| | LLB | 6 | 45 | 572 | 5 | 43 | 545 | 95.3 |
| Windowpane flounder <i>(Scophthalmus aquosus)</i> | OTF | 182 | 1,865 | 179,240 | 159 | 1133 | 144,127 | 80.4 |
| | DRS | 1 | 1 | 5 | 1 | 1 | 5 | 100.0 |
| | GNS | 7 | 51 | 144 | 4 | 46 | 99 | 68.9 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Goosefish <i>(Lophius americanus)</i> | OTF | 412 | 6,928 | 811,850 | 367 | 5,586 | 782,931 | 96.4 |
| | DRS | 330 | 3,458 | 421,485 | 323 | 3,223 | 417,292 | 99.0 |
| | GNS | 249 | 7,546 | 3,444,297 | 169 | 5152 | 1,768,626 | 51.3 |
| | LLB | 16 | 53 | 195 | 16 | 51 | 184 | 94.2 |
| Silver hake <i>(Merluccius bilinearis)</i> | OTF | 201 | 3,830 | 6,112,602 | 180 | 3023 | 5,685,483 | 93.0 |
| | DRS | 3 | 3 | 8 | 3 | 3 | 8 | 100.0 |
| | GNS | 50 | 562 | 24,962 | 45 | 538 | 23,987 | 96.1 |
| | LLB | 5 | 32 | 41,988 | 5 | 31 | 39,720 | 94.6 |
| Red hake <i>(Urophycis chuss)</i> | OTF | 157 | 2,637 | 590,951 | 130 | 2043 | 531,345 | 89.9 |
| | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 18 | 247 | 15,673 | 14 | 235 | 13,557 | 86.5 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |

Table 19. 2008 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR | VTR | | | VMS | | | |
|--|-----------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | gear code | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | Percent of VTR landings (%) |
| Atlantic cod | OTF | 319 | 8,051 | 3,980,275 | 283 | 5,545 | 2,782,826 | 69.9 |
| <i>(Gadus morhua)</i> | DRS | 3 | 3 | 20 | 1 | 1 | 9 | 45.5 |
| | GNS | 145 | 9,193 | 2,776,208 | 130 | 6811 | 2,052,888 | 73.9 |
| | LLB | 59 | 871 | 186,327 | 47 | 652 | 151,893 | 81.5 |
| Haddock | OTF | 250 | 4,469 | 4,740,122 | 230 | 3,129 | 3,667,918 | 77.4 |
| <i>(Melanogrammus aeglefinus)</i> | DRS | 1 | 2 | 41 | 1 | 2 | 41 | 100.0 |
| | GNS | 111 | 3,128 | 55,863 | 106 | 2402 | 42,170 | 75.5 |
| | LLB | 56 | 657 | 394,672 | 46 | 540 | 361,904 | 91.7 |
| Yellowtail flounder | OTF | 290 | 6,869 | 1,499,440 | 257 | 4,825 | 1,163,165 | 77.6 |
| <i>(Limanda ferruginea)</i> | DRS | 14 | 35 | 1,301 | 14 | 34 | 1,251 | 96.2 |
| | GNS | 90 | 2,725 | 111,067 | 84 | 1773 | 74,741 | 67.3 |
| | LLB | 6 | 59 | 5,039 | 4 | 9 | 420 | 8.3 |
| Winter flounder | OTF | 346 | 8,642 | 2,150,549 | 294 | 5,328 | 1,832,963 | 85.2 |
| <i>(Pseudopleuronectes americanus)</i> | DRS | 24 | 41 | 2,139 | 19 | 30 | 1,424 | 66.6 |
| | GNS | 125 | 4,402 | 56,329 | 100 | 3149 | 40,113 | 71.2 |
| | LLB | 8 | 102 | 992 | 6 | 49 | 733 | 73.9 |
| Windowpane flounder | OTF | 167 | 1,863 | 115,475 | 127 | 796 | 58,557 | 50.7 |
| <i>(Scophthalmus aquosus)</i> | DRS | 1 | 1 | 1 | 0 | 0 | 0 | 0.0 |
| | GNS | 19 | 80 | 1,051 | 8 | 33 | 782 | 74.4 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Goosefish | OTF | 378 | 5,872 | 614,655 | 300 | 3,595 | 405,446 | 66.0 |
| <i>(Lophius americanus)</i> | DRS | 323 | 2,800 | 304,618 | 290 | 1,971 | 233,700 | 76.7 |
| | GNS | 237 | 6,226 | 3,126,971 | 147 | 3362 | 1,152,723 | 36.9 |
| | LLB | 7 | 24 | 114 | 4 | 15 | 62 | 54.4 |
| Silver hake | OTF | 205 | 3,518 | 5,541,597 | 164 | 2186 | 3,767,703 | 68.0 |
| <i>(Merluccius bilinearis)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 62 | 804 | 41,852 | 54 | 690 | 34,181 | 81.7 |
| | LLB | 3 | 4 | 20 | 3 | 4 | 20 | 100.0 |
| Red hake | OTF | 161 | 2,558 | 708,281 | 124 | 1532 | 527,891 | 74.5 |
| <i>(Urophycis chuss)</i> | DRS | 1 | 1 | 16 | 0 | 0 | 0 | 0.0 |
| | GNS | 19 | 298 | 8,284 | 14 | 257 | 7,783 | 94.0 |
| | LLB | 3 | 5 | 163 | 2 | 4 | 149 | 91.6 |

Table 20. 2009 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR gear code | VTR | | | VMS | | | |
|--|---------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | Percent of VTR landings (%) |
| Atlantic cod | OTF | 295 | 8,044 | 3,960,249 | 277 | 6,793 | 3,555,956 | 89.8 |
| <i>(Gadus morhua)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 150 | 9,611 | 2,856,758 | 136 | 8491 | 2,535,301 | 88.7 |
| | LLB | 52 | 728 | 170,833 | 38 | 524 | 147,003 | 86.1 |
| Haddock | OTF | 234 | 4,065 | 4,285,009 | 232 | 3,726 | 4,246,875 | 99.1 |
| <i>(Melanogrammus aeglefinus)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 116 | 2,498 | 80,316 | 116 | 2356 | 77,884 | 97.0 |
| | LLB | 37 | 424 | 402,131 | 32 | 386 | 390,676 | 97.2 |
| Yellowtail flounder | OTF | 276 | 6,642 | 1,469,547 | 258 | 5,585 | 1,419,921 | 96.6 |
| <i>(Limanda ferruginea)</i> | DRS | 22 | 35 | 2,424 | 21 | 33 | 2,356 | 97.2 |
| | GNS | 94 | 2,655 | 86,331 | 87 | 2247 | 73,983 | 85.7 |
| | LLB | 11 | 72 | 4,702 | 7 | 21 | 260 | 5.5 |
| Winter flounder | OTF | 296 | 6,165 | 1,935,314 | 266 | 4,861 | 1,874,929 | 96.9 |
| <i>(Pseudopleuronectes americanus)</i> | DRS | 13 | 27 | 1,069 | 13 | 26 | 1,046 | 97.9 |
| | GNS | 101 | 3,699 | 40,438 | 91 | 3253 | 37,332 | 92.3 |
| | LLB | 11 | 97 | 684 | 9 | 62 | 564 | 82.5 |
| Windowpane flounder | OTF | 124 | 1,136 | 80,821 | 111 | 907 | 70,935 | 87.8 |
| <i>(Scophthalmus aquosus)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 15 | 118 | 1,090 | 12 | 97 | 807 | 74.1 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Goosefish | OTF | 331 | 4,916 | 436,569 | 290 | 4,147 | 424,758 | 97.3 |
| <i>(Lophius americanus)</i> | DRS | 290 | 2,163 | 205,913 | 287 | 2,009 | 203,695 | 98.9 |
| | GNS | 219 | 5,340 | 2,625,544 | 141 | 3498 | 1,339,537 | 51.0 |
| | LLB | 7 | 23 | 133 | 6 | 20 | 123 | 92.2 |
| Silver hake | OTF | 201 | 4,317 | 6,989,607 | 171 | 3761 | 6,642,081 | 95.0 |
| <i>(Merluccius bilinearis)</i> | DRS | 2 | 5 | 27,234 | 2 | 5 | 27,234 | 100.0 |
| | GNS | 72 | 1145 | 26,487 | 66 | 1064 | 21,723 | 82.0 |
| | LLB | 1 | 1 | 69 | 0 | 0 | 0 | 0.0 |
| Red hake | OTF | 144 | 2,747 | 770,336 | 117 | 2299 | 721,569 | 93.7 |
| <i>(Urophycis chuss)</i> | DRS | 1 | 2 | 435 | 1 | 2 | 435 | 100.0 |
| | GNS | 20 | 258 | 21,761 | 14 | 227 | 21,377 | 98.2 |
| | LLB | 3 | 4 | 31 | 1 | 1 | 5 | 14.7 |

Table 21. 2010 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR gear code | VTR | | | VMS | | | |
|--|---------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | Percent of VTR landings (%) |
| Atlantic cod | OTF | 270 | 5,589 | 3,703,838 | 250 | 5,041 | 3,491,117 | 94.3 |
| <i>(Gadus morhua)</i> | DRS | 1 | 3 | 23 | 1 | 3 | 23 | 100.0 |
| | GNS | 130 | 7,065 | 2,207,779 | 116 | 6309 | 1,980,710 | 89.7 |
| | LLB | 41 | 461 | 134,779 | 30 | 341 | 109,471 | 81.2 |
| Haddock | OTF | 201 | 2,719 | 6,004,469 | 197 | 2,650 | 5,989,006 | 99.7 |
| <i>(Melanogrammus aeglefinus)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 100 | 1,725 | 41,953 | 99 | 1664 | 41,106 | 98.0 |
| | LLB | 30 | 346 | 340,225 | 22 | 310 | 327,823 | 96.4 |
| Yellowtail flounder | OTF | 244 | 4,380 | 1,087,740 | 233 | 3,920 | 1,051,766 | 96.7 |
| <i>(Limanda ferruginea)</i> | DRS | 65 | 89 | 1,885 | 65 | 89 | 1,885 | 100.0 |
| | GNS | 92 | 2,643 | 118,973 | 84 | 2339 | 109,636 | 92.2 |
| | LLB | 9 | 48 | 1,538 | 7 | 20 | 137 | 8.9 |
| Winter flounder | OTF | 225 | 3,633 | 1,276,975 | 193 | 2,735 | 1,260,099 | 98.7 |
| <i>(Pseudopleuronectes americanus)</i> | DRS | 8 | 10 | 430 | 8 | 10 | 430 | 100.0 |
| | GNS | 92 | 2,585 | 19,849 | 83 | 2332 | 18,636 | 93.9 |
| | LLB | 7 | 59 | 1,551 | 6 | 37 | 310 | 20.0 |
| Windowpane flounder | OTF | 41 | 543 | 23,459 | 28 | 177 | 7,753 | 33.1 |
| <i>(Scophthalmus aquosus)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 7 | 67 | 215 | 4 | 54 | 76 | 35.3 |
| | LLB | 1 | 4 | 11 | 1 | 4 | 11 | 100.0 |
| Goosefish | OTF | 300 | 3,713 | 376,389 | 263 | 3,161 | 365,238 | 97.0 |
| <i>(Lophius americanus)</i> | DRS | 242 | 1,381 | 123,871 | 239 | 1,330 | 123,056 | 99.3 |
| | GNS | 210 | 4,482 | 2,204,506 | 126 | 2755 | 1,164,724 | 52.8 |
| | LLB | 7 | 23 | 121 | 7 | 23 | 121 | 100.0 |
| Silver hake | OTF | 186 | 4,029 | 7,382,976 | 165 | 3587 | 7,149,060 | 96.8 |
| <i>(Merluccius bilinearis)</i> | DRS | 1 | 1 | 5 | 1 | 1 | 5 | 100.0 |
| | GNS | 50 | 599 | 4,072 | 44 | 575 | 3,827 | 94.0 |
| | LLB | 2 | 3 | 93 | 2 | 3 | 93 | 100.0 |
| Red hake | OTF | 139 | 2,646 | 695,607 | 115 | 2328 | 665,318 | 95.6 |
| <i>(Urophycis chuss)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 15 | 51 | 6,731 | 9 | 39 | 6,069 | 90.2 |
| | LLB | 2 | 3 | 3 | 2 | 3 | 3 | 100.0 |

Table 22. 2011 summary of the Vessel Monitoring System (VMS) data subsets compared to the subset of Vessel Trip Reports (VTR) landings (kg), by species and gear type (bottom otter trawl gear = OTF, scallop dredge gear = DRS, sink gillnet = GNS, and benthic longline = LLB).

| Species | VTR gear code | VTR | | | VMS | | | |
|--|---------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-----------------------------|
| | | Number of Vessels | Number of trips | VTR landings (kg) | Number of Vessels | Number of trips | VMS landings (kg) | Percent of VTR landings (%) |
| Atlantic cod | OTF | 216 | 4,712 | 4,187,183 | 202 | 4,514 | 4,130,595 | 98.6 |
| <i>(Gadus morhua)</i> | DRS | 2 | 3 | 14 | 2 | 3 | 14 | 100.0 |
| | GNS | 123 | 5,627 | 1,420,454 | 100 | 5218 | 1,362,184 | 95.9 |
| | LLB | 28 | 517 | 262,129 | 21 | 456 | 243,710 | 93.0 |
| Haddock | OTF | 160 | 2,865 | 2,562,449 | 157 | 2,834 | 2,545,237 | 99.3 |
| <i>(Melanogrammus aeglefinus)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 81 | 2,114 | 51,043 | 78 | 2025 | 48,748 | 95.5 |
| | LLB | 23 | 408 | 144,925 | 19 | 389 | 143,697 | 99.2 |
| Yellowtail flounder | OTF | 205 | 3,647 | 1,469,998 | 195 | 3,542 | 1,462,375 | 99.5 |
| <i>(Limanda ferruginea)</i> | DRS | 74 | 116 | 8,528 | 74 | 116 | 8,528 | 100.0 |
| | GNS | 74 | 1,619 | 109,083 | 68 | 1511 | 106,660 | 97.8 |
| | LLB | 5 | 13 | 36 | 5 | 13 | 36 | 100.0 |
| Winter flounder | OTF | 189 | 3,335 | 1,695,391 | 160 | 2,625 | 1,684,355 | 99.3 |
| <i>(Pseudopleuronectes americanus)</i> | DRS | 25 | 38 | 1,639 | 24 | 36 | 1,628 | 99.4 |
| | GNS | 80 | 2,571 | 31,213 | 66 | 2263 | 28,765 | 92.2 |
| | LLB | 4 | 30 | 229 | 4 | 30 | 229 | 100.0 |
| Windowpane flounder | OTF | 21 | 430 | 21,731 | 10 | 38 | 1,986 | 9.1 |
| <i>(Scophthalmus aquosus)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 4 | 50 | 479 | 1 | 4 | 7 | 1.4 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Goosefish | OTF | 291 | 3,117 | 432,850 | 247 | 2,676 | 425,111 | 98.2 |
| <i>(Lophius americanus)</i> | DRS | 215 | 1,652 | 119,021 | 215 | 1,562 | 118,006 | 99.1 |
| | GNS | 201 | 5,748 | 2,796,087 | 117 | 3539 | 1,452,480 | 51.9 |
| | LLB | 3 | 32 | 202 | 3 | 31 | 198 | 98.2 |
| Silver hake | OTF | 194 | 4,354 | 7,322,111 | 163 | 3844 | 7,107,312 | 97.1 |
| <i>(Merluccius bilinearis)</i> | DRS | 1 | 1 | 1,361 | 1 | 1 | 1,361 | 100.0 |
| | GNS | 72 | 1311 | 8,086 | 62 | 1248 | 7,673 | 94.9 |
| | LLB | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| Red hake | OTF | 137 | 2,746 | 641,584 | 110 | 2234 | 606,341 | 94.5 |
| <i>(Urophycis chuss)</i> | DRS | 0 | 0 | 0 | 0 | 0 | 0 | N/A |
| | GNS | 12 | 19 | 204 | 4 | 6 | 67 | 33.0 |
| | LLB | 1 | 1 | 4 | 0 | 0 | 0 | 0.0 |

Table 23. Summary of the agreement levels between statistical areas recorded on Vessel Trip Reports (VTR) and the statistical areas fished as determined using Vessel Monitoring System (VMS) positional data from matched fishing trips from 2004 to 2011. Trip subcategories are based on the VMS determined number of statistical areas fished. **Note: percentages may not sum to 100 due to rounding.*

| Year | Trip category | Number of trips | Agreement level | Number of trips | Percent of total category trips (%) |
|------|---------------|-----------------|-----------------|-----------------|-------------------------------------|
| 2004 | Single area | 2,895 | Complete | 2,688 | 92.8 |
| | | | None | 194 | 6.7 |
| | | | Partial | 13 | 0.4 |
| | Multi-area | 2,997 | Complete | 74 | 2.5 |
| | | | None | 139 | 4.6 |
| | | | Partial | 2,784 | 92.9 |
| 2005 | Single area | 5,630 | Complete | 5,267 | 93.6 |
| | | | None | 334 | 5.9 |
| | | | Partial | 29 | 0.5 |
| | Multi-area | 4,279 | Complete | 265 | 6.2 |
| | | | None | 206 | 4.8 |
| | | | Partial | 3,808 | 89.0 |
| 2006 | Single area | 13,488 | Complete | 12,869 | 95.4 |
| | | | None | 590 | 4.4 |
| | | | Partial | 29 | 0.2 |
| | Multi-area | 5,677 | Complete | 234 | 4.1 |
| | | | None | 221 | 3.9 |
| | | | Partial | 5,222 | 92.0 |
| 2007 | Single area | 19,917 | Complete | 19,104 | 95.9 |
| | | | None | 785 | 3.9 |
| | | | Partial | 28 | 0.1 |
| | Multi-area | 6,007 | Complete | 284 | 4.7 |
| | | | None | 234 | 3.9 |
| | | | Partial | 5,489 | 91.4 |
| 2008 | Single area | 16,797 | Complete | 16,124 | 96.0 |
| | | | None | 641 | 3.8 |
| | | | Partial | 32 | 0.2 |
| | Multi-area | 4,028 | Complete | 172 | 4.3 |
| | | | None | 170 | 4.2 |
| | | | Partial | 3,686 | 91.5 |
| 2009 | Single area | 19,336 | Complete | 18,546 | 95.9 |
| | | | None | 750 | 3.9 |
| | | | Partial | 40 | 0.2 |
| | Multi-area | 5,792 | Complete | 290 | 5.0 |
| | | | None | 240 | 4.1 |
| | | | Partial | 5,262 | 90.8 |
| 2010 | Single area | 14,302 | Complete | 13,776 | 96.3 |
| | | | None | 496 | 3.5 |
| | | | Partial | 30 | 0.2 |
| | Multi-area | 5,221 | Complete | 343 | 6.6 |
| | | | None | 208 | 4.0 |
| | | | Partial | 4,670 | 89.4 |
| 2011 | Single area | 12,885 | Complete | 12,192 | 94.6 |
| | | | None | 643 | 5.0 |
| | | | Partial | 50 | 0.4 |
| | Multi-area | 5,467 | Complete | 472 | 8.6 |
| | | | None | 214 | 3.9 |
| | | | Partial | 4,781 | 87.5 |

Table 24. Frequency of trips fishing on multiple stocks based on Vessel Monitoring System (VMS) data from 2004 to 2011.

| Species | 2004 | | | 2005 | | | 2006 | | | 2007 | | |
|--|-------------|---------------------------|-------------|-------------|---------------------------|-------------|-------------|---------------------------|-------------|-------------|---------------------------|-------------|
| | Total trips | Multiple stock area trips | Percent (%) | Total trips | Multiple stock area trips | Percent (%) | Total trips | Multiple stock area trips | Percent (%) | Total trips | Multiple stock area trips | Percent (%) |
| Atlantic cod (<i>Gadus morhua</i>) | 3,096 | 304 | 9.8 | 5,760 | 600 | 10.4 | 9,056 | 555 | 6.1 | 14,560 | 539 | 3.7 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 2,819 | 295 | 10.5 | 4,615 | 562 | 12.2 | 5,769 | 517 | 9 | 8,022 | 464 | 5.8 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 2,140 | 186 | 8.7 | 3,263 | 352 | 10.8 | 5,228 | 367 | 7 | 7,631 | 436 | 5.7 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 2,407 | 286 | 11.9 | 3,777 | 604 | 16 | 6,622 | 453 | 6.8 | 10,042 | 490 | 4.9 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 105 | 19 | 18.1 | 236 | 24 | 10.2 | 617 | 28 | 4.5 | 1180 | 47 | 4.0 |
| Goosefish (<i>Lophius americanus</i>) | 3,697 | 254 | 6.9 | 6,084 | 511 | 8.4 | 12,406 | 580 | 4.7 | 14,012 | 426 | 3.0 |
| Silver hake (<i>Merluccius bilinearis</i>) | 732 | 17 | 2.3 | 1,227 | 28 | 2.3 | 2,348 | 38 | 1.6 | 3,595 | 59 | 1.6 |
| Red hake (<i>Urophycis chuss</i>) | 550 | 9 | 1.6 | 789 | 8 | 1 | 1,465 | 23 | 1.6 | 2,278 | 40 | 1.8 |
| | | | | | | | | | | | | |
| Species | 2008 | | | 2009 | | | 2010 | | | 2011 | | |
| | Total trips | Multiple stock area trips | Percent (%) | Total trips | Multiple stock area trips | Percent (%) | Total trips | Multiple stock area trips | Percent (%) | Total trips | Multiple stock area trips | Percent (%) |
| Atlantic cod (<i>Gadus morhua</i>) | 13,009 | 340 | 2.6 | 15,808 | 487 | 3.1 | 11,694 | 555 | 4.7 | 10,191 | 727 | 7.1 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 6,073 | 306 | 5.0 | 6,468 | 426 | 6.6 | 4,624 | 516 | 11.2 | 5,248 | 670 | 12.8 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 6,641 | 264 | 4.0 | 7,886 | 275 | 3.5 | 6,368 | 314 | 4.9 | 5,182 | 442 | 8.5 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 8,556 | 327 | 3.8 | 8,202 | 328 | 4.0 | 5,114 | 379 | 7.4 | 4,954 | 574 | 11.6 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 829 | 44 | 5.3 | 1004 | 15 | 1.5 | 235 | 0 | 0.0 | 42 | 0 | 0.0 |
| Goosefish (<i>Lophius americanus</i>) | 8,943 | 300 | 3.4 | 9,674 | 362 | 3.7 | 7,269 | 240 | 3.3 | 7,808 | 234 | 3.0 |
| Silver hake (<i>Merluccius bilinearis</i>) | 2,880 | 28 | 1.0 | 4,830 | 51 | 1.1 | 4,166 | 61 | 1.5 | 5,093 | 53 | 1.0 |
| Red hake (<i>Urophycis chuss</i>) | 1,793 | 19 | 1.1 | 2,529 | 24 | 0.9 | 2,370 | 38 | 1.6 | 2,240 | 36 | 1.6 |

Table 25. Frequency of fixed (sink gillnet, benthic longline) and mobile (bottom otter trawl, scallop dredge) gear types used on trips fishing on multiple stocks based on Vessel Monitoring System (VMS) positional data from 2005 and 2011.

| 2005 | | | | | | |
|--|-----------------------|-------------------------------------|------------------------|---------------|-----------------|--------------------------------------|
| Species | Number of total trips | Number of multiple stock area trips | Percent of total trips | Gear category | Number of Trips | Percent of multiple stock area trips |
| | | | (%) | | | (%) |
| Atlantic cod | 5,760 | 600 | 10.4 | Fixed | 6 | 1.0 |
| <i>(Gadus morhua)</i> | | | | Mobile | 594 | 99.0 |
| Haddock | 4,615 | 562 | 12.2 | Fixed | 4 | 0.7 |
| <i>(Melanogrammus aeglefinus)</i> | | | | Mobile | 558 | 99.3 |
| Yellowtail flounder | 3,263 | 352 | 10.8 | Fixed | 0 | 0.0 |
| <i>(Limanda ferruginea)</i> | | | | Mobile | 352 | 100.0 |
| Winter flounder | 3,777 | 604 | 16.0 | Fixed | 1 | 0.2 |
| <i>(Pseudopleuronectes americanus)</i> | | | | Mobile | 603 | 99.8 |
| Windowpane flounder | 236 | 24 | 10.2 | Fixed | 0 | 0.0 |
| <i>(Scophthalmus aquosus)</i> | | | | Mobile | 24 | 100.0 |
| Goosefish | 6,084 | 511 | 8.4 | Fixed | 0 | 0.0 |
| <i>(Lophius americanus)</i> | | | | Mobile | 511 | 100.0 |
| Silver hake | 1,227 | 28 | 2.3 | Fixed | 0 | 0.0 |
| <i>(Merluccius bilinearis)</i> | | | | Mobile | 28 | 100.0 |
| Red hake | 789 | 8 | 1.0 | Fixed | 0 | 0.0 |
| <i>(Urophycis chuss)</i> | | | | Mobile | 8 | 100.0 |
| 2011 | | | | | | |
| Species | Number of total trips | Number of multiple stock area trips | Percent of total trips | Gear category | Number of Trips | Percent of multiple stock area trips |
| | | | (%) | | | (%) |
| Atlantic cod | 10,191 | 727 | 7.1 | Fixed | 40 | 5.5 |
| <i>(Gadus morhua)</i> | | | | Mobile | 687 | 94.5 |
| Haddock | 5,248 | 670 | 12.8 | Fixed | 27 | 4.0 |
| <i>(Melanogrammus aeglefinus)</i> | | | | Mobile | 643 | 96.0 |
| Yellowtail flounder | 5,182 | 442 | 8.5 | Fixed | 9 | 2.0 |
| <i>(Limanda ferruginea)</i> | | | | Mobile | 433 | 98.0 |
| Winter flounder | 4,954 | 574 | 11.6 | Fixed | 20 | 3.5 |
| <i>(Pseudopleuronectes americanus)</i> | | | | Mobile | 554 | 96.5 |
| Windowpane flounder | 42 | 0 | 0.0 | Fixed | 0 | N/A |
| <i>(Scophthalmus aquosus)</i> | | | | Mobile | 0 | N/A |
| Goosefish | 7,808 | 234 | 3.0 | Fixed | 40 | 17.1 |
| <i>(Lophius americanus)</i> | | | | Mobile | 194 | 82.9 |
| Silver hake | 5,093 | 53 | 1.0 | Fixed | 1 | 1.9 |
| <i>(Merluccius bilinearis)</i> | | | | Mobile | 52 | 98.1 |
| Red hake | 2240 | 36 | 1.6 | Fixed | 0 | 0.0 |
| <i>(Urophycis chuss)</i> | | | | Mobile | 36 | 100.0 |

Table 26. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2004. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). **Note: allocations may not sum to 100 due to rounding.*

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|---|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 1,874,015 | GBK | 1,384,752 | 1,375,601 | 9,151 | 0.98 | 73.9 | 73.4 | 0.5 | 0.7 |
| | | GOM | 489,263 | 498,414 | 9,151 | | 26.1 | 26.6 | -0.5 | -1.9 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 5,096,088 | GBK | 4,763,038 | 4,806,095 | 43,057 | 1.69 | 93.5 | 94.3 | -0.8 | -0.9 |
| | | GOM | 333,050 | 289,993 | 43,057 | | 6.5 | 5.7 | 0.8 | 12.3 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 5,378,987 | GBK | 5,094,590 | 5,176,798 | 82,208 | 3.06 | 94.7 | 96.2 | -1.5 | -1.6 |
| | | GOM | 215,710 | 172,386 | 43,324 | | 4.0 | 3.2 | 0.8 | 20.0 |
| | | SNE | 68,687 | 29,802 | 38,885 | | 1.3 | 0.6 | 0.7 | 53.8 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 3,127,781 | GBK | 2,420,182 | 2,459,208 | 39,026 | 2.59 | 77.4 | 78.6 | -1.2 | -1.6 |
| | | GOM | 94,235 | 95,648 | 1,413 | | 3.0 | 3.1 | 0.0 | 0.0 |
| | | SNE | 613,364 | 572,925 | 40,439 | | 19.6 | 18.3 | 1.3 | 6.6 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 18,217 | NOR | 16,807 | 16,725 | 82 | 0.90 | 92.3 | 91.8 | 0.5 | 0.5 |
| | | SOU | 1,410 | 1,492 | 82 | | 7.7 | 8.2 | -0.5 | -6.5 |
| Goosefish (<i>Lophius americanus</i>) | 1,332,178 | NOR | 787,572 | 801,448 | 13,876 | 2.08 | 59.1 | 60.2 | -1.0 | -1.7 |
| | | SOU | 544,606 | 530,730 | 13,876 | | 40.9 | 39.8 | 1.0 | 2.4 |
| Silver hake (<i>Merluccius bilinearis</i>) | 2,071,930 | NOR | 404,972 | 343,720 | 61,252 | 5.91 | 19.5 | 16.6 | 3.0 | 15.4 |
| | | SOU | 1,666,958 | 1,728,210 | 61,252 | | 80.5 | 83.4 | -3.0 | -3.7 |
| Red hake (<i>Urophycis chuss</i>) | 236,830 | NOR | 61,461 | 64,355 | 2,894 | 2.44 | 26.0 | 27.2 | -1.2 | -4.6 |
| | | SOU | 175,369 | 172,475 | 2,894 | | 74.0 | 72.8 | 1.2 | 1.6 |

Table 27. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2005. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta$ /total species landings (%) | VTR stock allocation (%) | VMS stock allocation (%) | Difference (%) | Relative difference (%) |
|---|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 2,754,687 | GBK | 1,920,110 | 1,879,800 | 40,310 | 2.93 | 69.7 | 68.2 | 1.5 | 2.2 |
| | | GOM | 834,577 | 874,887 | 40,310 | | 30.3 | 31.8 | -1.5 | -5.0 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 5,700,737 | GBK | 5,319,329 | 5,285,374 | 33,955 | 1.19 | 93.3 | 92.7 | 0.6 | 0.6 |
| | | GOM | 381,408 | 415,363 | 33,955 | | 6.7 | 7.3 | -0.6 | -9.0 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 3,475,993 | GBK | 3,115,140 | 3,164,191 | 49,051 | 2.82 | 89.6 | 91.0 | -1.4 | -1.6 |
| | | GOM | 286,276 | 281,958 | 4,318 | | 8.2 | 8.1 | 0.1 | 1.2 |
| | | SNE | 74,577 | 29,844 | 44,733 | | 2.1 | 0.9 | 1.3 | 61.9 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 2,800,638 | GBK | 1,976,251 | 1,985,963 | 9,712 | 1.39 | 70.6 | 70.9 | -0.3 | -0.4 |
| | | GOM | 132,155 | 112,737 | 19,418 | | 4.7 | 4.0 | 0.7 | 14.9 |
| | | SNE | 692,232 | 701,939 | 9,707 | | 24.7 | 25.1 | -0.3 | -1.2 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 45,772 | NOR | 43,740 | 44,337 | 597 | 2.61 | 95.6 | 96.9 | -1.3 | -1.4 |
| | | SOU | 2,032 | 1,435 | 597 | | 4.4 | 3.1 | 1.3 | 29.5 |
| Goosefish (<i>Lophius americanus</i>) | 2,129,989 | NOR | 1,188,433 | 1,223,924 | 35,491 | 3.33 | 55.8 | 57.5 | -1.7 | -3.0 |
| | | SOU | 941,556 | 906,065 | 35,491 | | 44.2 | 42.5 | 1.7 | 3.8 |
| Silver hake (<i>Merluccius bilinearis</i>) | 3,531,070 | NOR | 400,744 | 380,084 | 20,660 | 1.17 | 11.3 | 10.8 | 0.6 | 5.3 |
| | | SOU | 3,130,326 | 3,150,986 | 20,660 | | 88.7 | 89.2 | -0.6 | -0.7 |
| Red hake (<i>Urophycis chuss</i>) | 154,666 | NOR | 39,360 | 37,097 | 2,263 | 2.93 | 25.4 | 24.0 | 1.5 | 5.9 |
| | | SOU | 115,306 | 117,569 | 2,263 | | 74.6 | 76.0 | -1.5 | -2.0 |

Table 28. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2006. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta_i$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|---|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod (<i>Gadus morhua</i>) | 3,428,790 | GBK | 2,012,366 | 2,009,838 | 2,528 | 0.15 | 58.7 | 58.6 | 0.1 | 0.2 |
| | | GOM | 1,416,424 | 1,418,952 | 2,528 | | 41.3 | 41.4 | -0.1 | -0.2 |
| Haddock (<i>Melanogrammus aeglefinus</i>) | 2,513,766 | GBK | 2,175,084 | 2,171,158 | 3,926 | 0.31 | 86.5 | 86.4 | 0.2 | 0.2 |
| | | GOM | 338,682 | 342,608 | 3,926 | | 13.5 | 13.6 | -0.2 | -1.5 |
| Yellowtail flounder (<i>Limanda ferruginea</i>) | 1,681,115 | GBK | 1,253,693 | 1,283,732 | 30,039 | 3.57 | 74.6 | 76.4 | -1.8 | -2.4 |
| | | GOM | 319,177 | 315,714 | 3,463 | | 19.0 | 18.8 | 0.2 | 1.1 |
| | | SNE | 108,245 | 81,669 | 26,576 | | 6.4 | 4.9 | 1.6 | 25.0 |
| Winter flounder (<i>Pseudopleuronectes americanus</i>) | 2,128,053 | GBK | 837,904 | 847,487 | 9,583 | 0.91 | 39.4 | 39.8 | -0.5 | -1.3 |
| | | GOM | 151,351 | 151,497 | 146 | | 7.1 | 7.1 | 0.0 | 0.0 |
| | | SNE | 1,138,798 | 1,129,069 | 9,729 | | 53.5 | 53.1 | 0.5 | 0.9 |
| Windowpane flounder (<i>Scophthalmus aquosus</i>) | 61,653 | NOR | 36,421 | 39,349 | 2,928 | 9.50 | 59.1 | 63.8 | -4.7 | -8.0 |
| | | SOU | 25,232 | 22,305 | 2,927 | | 40.9 | 36.2 | 4.7 | 11.5 |
| Goosefish (<i>Lophius americanus</i>) | 3,246,832 | NOR | 1,591,261 | 1,624,922 | 33,661 | 2.07 | 49.0 | 50.0 | -1.0 | -2.0 |
| | | SOU | 1,655,571 | 1,621,910 | 33,661 | | 51.0 | 50.0 | 1.0 | 2.0 |
| Silver hake (<i>Merluccius bilinearis</i>) | 4,606,490 | NOR | 876,514 | 950,975 | 74,461 | 3.23 | 19.0 | 20.6 | -1.6 | -8.4 |
| | | SOU | 3,729,976 | 3,655,515 | 74,461 | | 81.0 | 79.4 | 1.6 | 2.0 |
| Red hake (<i>Urophycis chuss</i>) | 458,731 | NOR | 142,190 | 145,968 | 3,778 | 1.65 | 31.0 | 31.8 | -0.8 | -2.6 |
| | | SOU | 316,541 | 312,763 | 3,778 | | 69.0 | 68.2 | 0.8 | 1.2 |

Table 29. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2007. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta_i$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|--|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod | 5,838,287 | GBK | 2,971,618 | 2,948,151 | 23,466 | 0.8 | 50.9 | 50.5 | 0.4 | 0.8 |
| (<i>Gadus morhua</i>) | | GOM | 2,866,669 | 2,890,135 | 23,466 | | 49.1 | 49.5 | -0.4 | -0.8 |
| Haddock | 3,013,511 | GBK | 2,475,073 | 2,471,087 | 3,985 | 0.3 | 82.1 | 82.0 | 0.1 | 0.2 |
| (<i>Melanogrammus aeglefinus</i>) | | GOM | 538,438 | 542,423 | 3,985 | | 17.9 | 18.0 | -0.1 | -0.7 |
| Yellowtail flounder | 1,623,035 | GBK | 1,107,416 | 1,128,478 | 21,062 | 2.6 | 68.2 | 69.5 | -1.3 | -1.9 |
| (<i>Limanda ferruginea</i>) | | GOM | 376,016 | 356,443 | 19,574 | | 23.2 | 22.0 | 1.2 | 5.5 |
| | | SNE | 139,603 | 138,114 | 1,488 | | 8.6 | 8.5 | 0.1 | 1.1 |
| Winter flounder | 2,172,096 | GBK | 766,057 | 713,963 | 52,094 | 4.8 | 35.3 | 32.9 | 2.4 | 7.3 |
| (<i>Pseudopleuronectes americanus</i>) | | GOM | 193,425 | 204,320 | 10,895 | | 8.9 | 9.4 | -0.5 | -5.3 |
| | | SNE | 1,212,614 | 1,253,813 | 41,199 | | 55.8 | 57.7 | -1.9 | -3.3 |
| Windowpane flounder | 144,231 | NOR | 110,327 | 110,067 | 260 | 0.4 | 76.5 | 76.3 | 0.2 | 0.2 |
| (<i>Scophthalmus aquosus</i>) | | SOU | 33,904 | 34,164 | 260 | | 23.5 | 23.7 | -0.2 | -0.8 |
| Goosefish | 2,969,033 | NOR | 1,106,535 | 1,094,480 | 12,056 | 0.8 | 37.3 | 36.9 | 0.4 | 1.1 |
| (<i>Lophius americanus</i>) | | SOU | 1,862,497 | 1,874,553 | 12,056 | | 62.7 | 63.1 | -0.4 | -0.6 |
| Silver hake | 5,749,198 | NOR | 1,045,749 | 1,065,613 | 19,865 | 0.7 | 18.2 | 18.5 | -0.3 | -1.9 |
| (<i>Merluccius bilinearis</i>) | | SOU | 4,703,449 | 4,683,584 | 19,865 | | 81.8 | 81.5 | 0.3 | 0.4 |
| Red hake | 544,902 | NOR | 106,960 | 105,305 | 1,655 | 0.6 | 19.6 | 19.3 | 0.3 | 1.6 |
| (<i>Urophycis chuss</i>) | | SOU | 437,942 | 439,597 | 1,655 | | 80.4 | 80.7 | -0.3 | -0.4 |

Table 30. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2008. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\sum \Delta_i$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|--|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|---|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod | 4,987,617 | GBK | 1,977,321 | 1,964,655 | 12,666 | 0.5 | 39.6 | 39.4 | 0.3 | 0.6 |
| (<i>Gadus morhua</i>) | | GOM | 3,010,296 | 3,022,962 | 12,666 | | 60.4 | 60.6 | -0.3 | -0.4 |
| Haddock | 4,072,033 | GBK | 3,801,155 | 3,748,015 | 53,140 | 2.6 | 93.3 | 92.0 | 1.3 | 1.4 |
| (<i>Melanogrammus aeglefinus</i>) | | GOM | 270,879 | 324,018 | 53,140 | | 6.7 | 8.0 | -1.3 | <i>-16.4</i> |
| Yellowtail flounder | 1,239,577 | GBK | 772,304 | 770,172 | 2,132 | 0.3 | 62.3 | 62.1 | 0.2 | 0.3 |
| (<i>Limanda ferruginea</i>) | | GOM | 358,242 | 358,411 | 169 | | 28.9 | 28.9 | 0.0 | 0.0 |
| | | SNE | 109,030 | 110,993 | 1,963 | | 8.8 | 9.0 | -0.2 | -1.8 |
| Winter flounder | 1,875,233 | GBK | 915,033 | 849,254 | 65,779 | 7.0 | 48.8 | 45.3 | 3.5 | 7.7 |
| (<i>Pseudopleuronectes americanus</i>) | | GOM | 187,557 | 193,399 | 5,843 | | 10.0 | 10.3 | -0.3 | -3.0 |
| | | SNE | 772,643 | 832,579 | 59,936 | | 41.2 | 44.4 | -3.2 | -7.2 |
| Windowpane flounder | 59,340 | NOR | 33,564 | 31,550 | 2,014 | 6.8 | 56.6 | 53.2 | 3.4 | 6.4 |
| (<i>Scophthalmus aquosus</i>) | | SOU | 25,776 | 27,789 | 2,014 | | 43.4 | 46.8 | -3.4 | -7.2 |
| Goosefish | 1,791,932 | NOR | 428,672 | 445,051 | 16,379 | 1.8 | 23.9 | 24.8 | -0.9 | -3.7 |
| (<i>Lophius americanus</i>) | | SOU | 1,363,260 | 1,346,881 | 16,379 | | 76.1 | 75.2 | 0.9 | 1.2 |
| Silver hake | 3,801,904 | NOR | 616,304 | 633,309 | 17,005 | 0.9 | 16.2 | 16.7 | -0.4 | -2.7 |
| (<i>Merluccius bilinearis</i>) | | SOU | 3,185,600 | 3,168,595 | 17,005 | | 83.8 | 83.3 | 0.4 | 0.5 |
| Red hake | 535,765 | NOR | 105,091 | 105,101 | 10 | 0.0 | 19.6 | 19.6 | 0.0 | 0.0 |
| (<i>Urophycis chuss</i>) | | SOU | 430,673 | 430,664 | 10 | | 80.4 | 80.4 | 0.0 | 0.0 |

Table 31. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2009. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta_i$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|--|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod | 6,237,409 | GBK | 2,364,181 | 2,340,975 | 23,206 | 0.7 | 37.9 | 37.5 | 0.4 | 1.0 |
| (<i>Gadus morhua</i>) | | GOM | 3,873,229 | 3,896,795 | 23,566 | | 62.1 | 62.5 | -0.4 | -0.6 |
| Haddock | 4,715,389 | GBK | 4,366,878 | 4,252,054 | 114,823 | 4.9 | 92.6 | 90.2 | 2.4 | 2.7 |
| (<i>Melanogrammus aeglefinus</i>) | | GOM | 348,512 | 463,284 | 114,772 | | 7.4 | 9.8 | -2.4 | -24.8 |
| Yellowtail flounder | 1,496,367 | GBK | 1,015,204 | 1,015,104 | 99 | 0.4 | 67.8 | 67.8 | 0.0 | 0.0 |
| (<i>Limanda ferruginea</i>) | | GOM | 334,514 | 337,213 | 2,699 | | 22.4 | 22.5 | -0.2 | -0.8 |
| | | SNE | 146,650 | 144,127 | 2,523 | | 9.8 | 9.6 | 0.2 | 1.8 |
| Winter flounder | 1,912,030 | GBK | 1,548,132 | 1,567,046 | 18,914 | 2.1 | 81.0 | 82.0 | -1.0 | -1.2 |
| (<i>Pseudopleuronectes americanus</i>) | | GOM | 223,636 | 225,689 | 2,052 | | 11.7 | 11.8 | -0.1 | -0.9 |
| | | SNE | 140,262 | 121,079 | 19,183 | | 7.3 | 6.3 | 1.0 | 15.8 |
| Windowpane flounder | 71,731 | NOR | 37,889 | 37,889 | 0 | 0.0 | 52.8 | 52.8 | 0.0 | 0.0 |
| (<i>Scophthalmus aquosus</i>) | | SOU | 33,842 | 33,853 | 11 | | 47.2 | 47.2 | 0.0 | 0.0 |
| Goosefish | 1,968,113 | NOR | 492,458 | 459,188 | 33,269 | 3.4 | 25.0 | 23.3 | 1.7 | 7.2 |
| (<i>Lophius americanus</i>) | | SOU | 1,475,656 | 1,508,707 | 33,051 | | 75.0 | 76.7 | -1.7 | -2.2 |
| Silver hake | 6,690,492 | NOR | 908,843 | 931,201 | 22,358 | 0.7 | 13.6 | 13.9 | -0.3 | -2.4 |
| (<i>Merluccius bilinearis</i>) | | SOU | 5,781,649 | 5,759,732 | 21,917 | | 86.4 | 86.1 | 0.3 | 0.4 |
| Red hake | 743,204 | NOR | 141,457 | 144,454 | 2,997 | 0.8 | 19.0 | 19.4 | -0.4 | -2.1 |
| (<i>Urophycis chuss</i>) | | SOU | 601,747 | 598,932 | 2,816 | | 81.0 | 80.6 | 0.4 | 0.5 |

Table 32. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2010. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta_i$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|--|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod | 5,580,277 | GBK | 1,916,429 | 1,878,475 | 37,954 | 1.4 | 34.3 | 33.7 | 0.7 | 2.0 |
| (<i>Gadus morhua</i>) | | GOM | 3,663,849 | 3,702,420 | 38,571 | | 65.7 | 66.3 | -0.7 | -1.0 |
| Haddock | 6,340,880 | GBK | 5,953,868 | 5,858,956 | 94,912 | 3.3 | 93.9 | 92.4 | 1.5 | 1.6 |
| (<i>Melanogrammus aeglefinus</i>) | | GOM | 387,012 | 498,543 | 111,531 | | 6.1 | 7.9 | -1.8 | -22.4 |
| Yellowtail flounder | 1,163,424 | GBK | 615,685 | 646,871 | 31,186 | 5.4 | 52.9 | 55.6 | -2.7 | -4.8 |
| (<i>Limanda ferruginea</i>) | | GOM | 447,942 | 418,252 | 29,689 | | 38.5 | 36.0 | 2.6 | 7.1 |
| | | SNE | 99,797 | 98,286 | 1,511 | | 8.6 | 8.4 | 0.1 | 1.5 |
| Winter flounder | 1,279,175 | GBK | 1,139,194 | 1,085,974 | 53,219 | 8.3 | 89.1 | 84.9 | 4.2 | 4.9 |
| (<i>Pseudopleuronectes americanus</i>) | | GOM | 92,046 | 92,866 | 820 | | 7.2 | 7.3 | -0.1 | -0.9 |
| | | SNE | 47,936 | 100,630 | 52,694 | | 3.7 | 7.9 | -4.1 | -52.4 |
| Windowpane flounder | 7,840 | NOR | 590 | 309 | 281 | 7.2 | 7.5 | 3.9 | 3.6 | 91.0 |
| (<i>Scophthalmus aquosus</i>) | | SOU | 7,250 | 7,531 | 281 | | 92.5 | 96.1 | -3.6 | -3.7 |
| Goosefish | 1,653,053 | NOR | 368,804 | 361,684 | 7,120 | 0.8 | 22.3 | 21.9 | 0.4 | 2.0 |
| (<i>Lophius americanus</i>) | | SOU | 1,284,249 | 1,291,117 | 6,868 | | 77.7 | 78.1 | -0.4 | -0.5 |
| Silver hake | 7,152,804 | NOR | 1,528,251 | 1,591,907 | 63,656 | 1.8 | 21.4 | 22.3 | -0.9 | -4.0 |
| (<i>Merluccius bilinearis</i>) | | SOU | 5,624,553 | 5,561,078 | 63,474 | | 78.6 | 77.7 | 0.9 | 1.1 |
| Red hake | 671,376 | NOR | 113,947 | 116,104 | 2,157 | 0.6 | 17.0 | 17.3 | -0.3 | -1.9 |
| (<i>Urophycis chuss</i>) | | SOU | 557,429 | 555,286 | 2,143 | | 83.0 | 82.7 | 0.3 | 0.4 |

Table 33. Results of the Vessel Monitoring System (VMS) based stock area allocation compared to the stock area allocation based on the Vessel Trip Reports (VTR) reported statistical area for 2011. Relative difference is determined as % difference/VTR stock allocation; allocations $\geq 5.0\%$ relative differences are italicized. Stock areas are Gulf of Maine (GOM), Georges Bank (GBK), southern New England/mid-Atlantic (SNE), northern (NOR), and southern (SOU). *Note: allocations may not sum to 100 due to rounding.

| Species | Total species landings (kg) | Stock area | VTR landings allocation (kg) | VMS landings allocation (kg) | Δ landings allocation abs(kg) | $\Sigma\Delta_i$ /total species landings (%) | VTR stock allocation (%) | VMS Stock allocation (%) | Difference (%) | Relative difference (%) |
|--|-----------------------------|------------|------------------------------|------------------------------|--------------------------------------|--|--------------------------|--------------------------|----------------|-------------------------|
| Atlantic cod | 5,580,277 | GBK | 1,916,429 | 1,878,475 | 37,954 | 1.4 | 34.3 | 33.7 | 0.7 | 2.0 |
| (<i>Gadus morhua</i>) | | GOM | 3,663,849 | 3,702,420 | 38,571 | | 65.7 | 66.3 | -0.7 | -1.0 |
| Haddock | 6,340,880 | GBK | 5,953,868 | 5,858,956 | 94,912 | 3.3 | 93.9 | 92.4 | 1.5 | 1.6 |
| (<i>Melanogrammus aeglefinus</i>) | | GOM | 387,012 | 498,543 | 111,531 | | 6.1 | 7.9 | -1.8 | -22.4 |
| Yellowtail flounder | 1,163,424 | GBK | 615,685 | 646,871 | 31,186 | 5.4 | 52.9 | 55.6 | -2.7 | -4.8 |
| (<i>Limanda ferruginea</i>) | | GOM | 447,942 | 418,252 | 29,689 | | 38.5 | 36.0 | 2.6 | 7.1 |
| | | SNE | 99,797 | 98,286 | 1,511 | | 8.6 | 8.4 | 0.1 | 1.5 |
| Winter flounder | 1,279,175 | GBK | 1,139,194 | 1,085,974 | 53,219 | 8.3 | 89.1 | 84.9 | 4.2 | 4.9 |
| (<i>Pseudopleuronectes americanus</i>) | | GOM | 92,046 | 92,866 | 820 | | 7.2 | 7.3 | -0.1 | -0.9 |
| | | SNE | 47,936 | 100,630 | 52,694 | | 3.7 | 7.9 | -4.1 | -52.4 |
| Windowpane flounder | 7,840 | NOR | 590 | 309 | 281 | 7.2 | 7.5 | 3.9 | 3.6 | 91.0 |
| (<i>Scophthalmus aquosus</i>) | | SOU | 7,250 | 7,531 | 281 | | 92.5 | 96.1 | -3.6 | -3.7 |
| Goosefish | 1,653,053 | NOR | 368,804 | 361,684 | 7,120 | 0.8 | 22.3 | 21.9 | 0.4 | 2.0 |
| (<i>Lophius americanus</i>) | | SOU | 1,284,249 | 1,291,117 | 6,868 | | 77.7 | 78.1 | -0.4 | -0.5 |
| Silver hake | 7,152,804 | NOR | 1,528,251 | 1,591,907 | 63,656 | 1.8 | 21.4 | 22.3 | -0.9 | -4.0 |
| (<i>Merluccius bilinearis</i>) | | SOU | 5,624,553 | 5,561,078 | 63,474 | | 78.6 | 77.7 | 0.9 | 1.1 |
| Red hake | 671,376 | NOR | 113,947 | 116,104 | 2,157 | 0.6 | 17.0 | 17.3 | -0.3 | -1.9 |
| (<i>Urophycis chuss</i>) | | SOU | 557,429 | 555,286 | 2,143 | | 83.0 | 82.7 | 0.3 | 0.4 |

Table 34. Relative differences between VTR and VMS-based allocations by species, stock and year (summary of Tables 26-33).

| Year | Atlantic cod (<i>Gadus morhua</i>) | | Haddock (<i>Melanogrammus aeglefinus</i>) | | Yellowtail flounder (<i>Limanda ferruginea</i>) | | | Winter flounder (<i>Pseudopleuronectes americanus</i>) | | | Windowpane flounder (<i>Scophthalmus aquosus</i>) | | Goosefish (<i>Lophius americanus</i>) | | Silver hake (<i>Merluccius bilinearis</i>) | | Red hake (<i>Urophycis chuss</i>) | |
|------|--------------------------------------|------|---|-------|---|------|------|--|------|-------|---|------|---|------|--|------|-------------------------------------|------|
| | GBK | GOM | GBK | GOM | GBK | GOM | SNE | GBK | GOM | SNE | NOR | SOU | NOR | SOU | NOR | SOU | NOR | SOU |
| 2004 | 0.7 | -1.9 | -0.9 | 12.3 | -1.6 | 20.0 | 53.8 | -1.6 | 0.0 | 6.6 | 0.5 | -6.5 | -1.7 | 2.4 | 15.4 | -3.7 | -4.6 | 1.6 |
| 2005 | 2.2 | -5.0 | 0.6 | -9.0 | -1.6 | 1.2 | 61.9 | -0.4 | 14.9 | -1.2 | -1.4 | 29.5 | -3.0 | 3.8 | 5.3 | -0.7 | 5.9 | -2.0 |
| 2006 | 0.2 | -0.2 | 0.2 | -1.5 | -2.4 | 1.1 | 25.0 | -1.3 | 0.0 | 0.9 | -8.0 | 11.5 | -2.0 | 2.0 | -8.4 | 2.0 | -2.6 | 1.2 |
| 2007 | 0.8 | -0.8 | 0.2 | -0.7 | -1.9 | 5.5 | 1.1 | 7.3 | -5.3 | -3.3 | 0.2 | -0.8 | 1.1 | -0.6 | -1.9 | 0.4 | 1.6 | -0.4 |
| 2008 | 0.6 | -0.4 | 1.4 | -16.4 | 0.3 | 0.0 | -1.8 | 7.7 | -3.0 | -7.2 | 6.4 | -7.2 | -3.7 | 1.2 | -2.7 | 0.5 | 0.0 | 0.0 |
| 2009 | 1.0 | -0.6 | 2.7 | -24.8 | 0.0 | -0.8 | 1.8 | -1.2 | -0.9 | 15.8 | 0.0 | 0.0 | 7.2 | -2.2 | -2.4 | 0.4 | -2.1 | 0.5 |
| 2010 | 2.0 | -1.0 | 1.6 | -22.4 | -4.8 | 7.1 | 1.5 | 4.9 | -0.9 | -52.4 | 91.0 | -3.7 | 2.0 | -0.5 | -4.0 | 1.1 | -1.9 | 0.4 |
| 2011 | 2.0 | -1.0 | 1.6 | -22.4 | -4.8 | 7.1 | 1.5 | 4.9 | -0.9 | -52.4 | 91.0 | -3.7 | 2.0 | -0.5 | -4.0 | 1.1 | -1.9 | 0.4 |

Figures

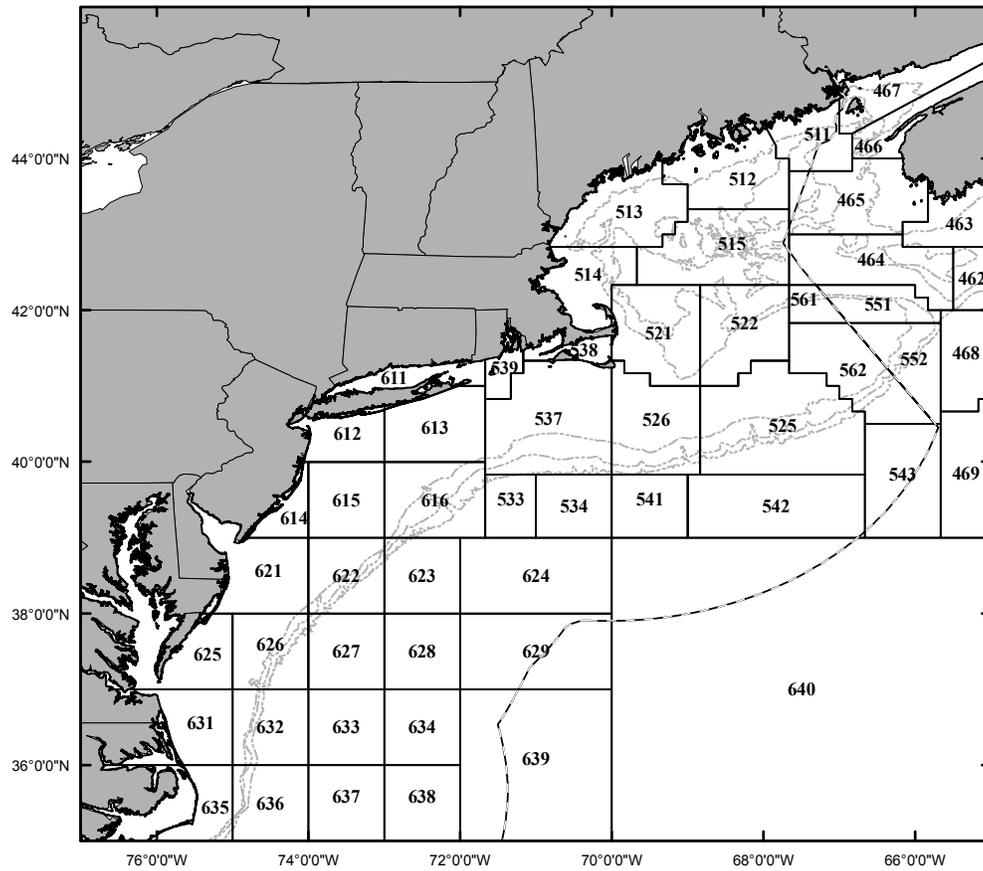


Figure 1. Statistical areas used for commercial fisheries data collection by the National Marine Fisheries Service in the Northeast Region. The 50, 100 and 500 fa bathymetric lines are shown in light gray and the U.S. Exclusive Economic Zone is indicated by the dashed black line.

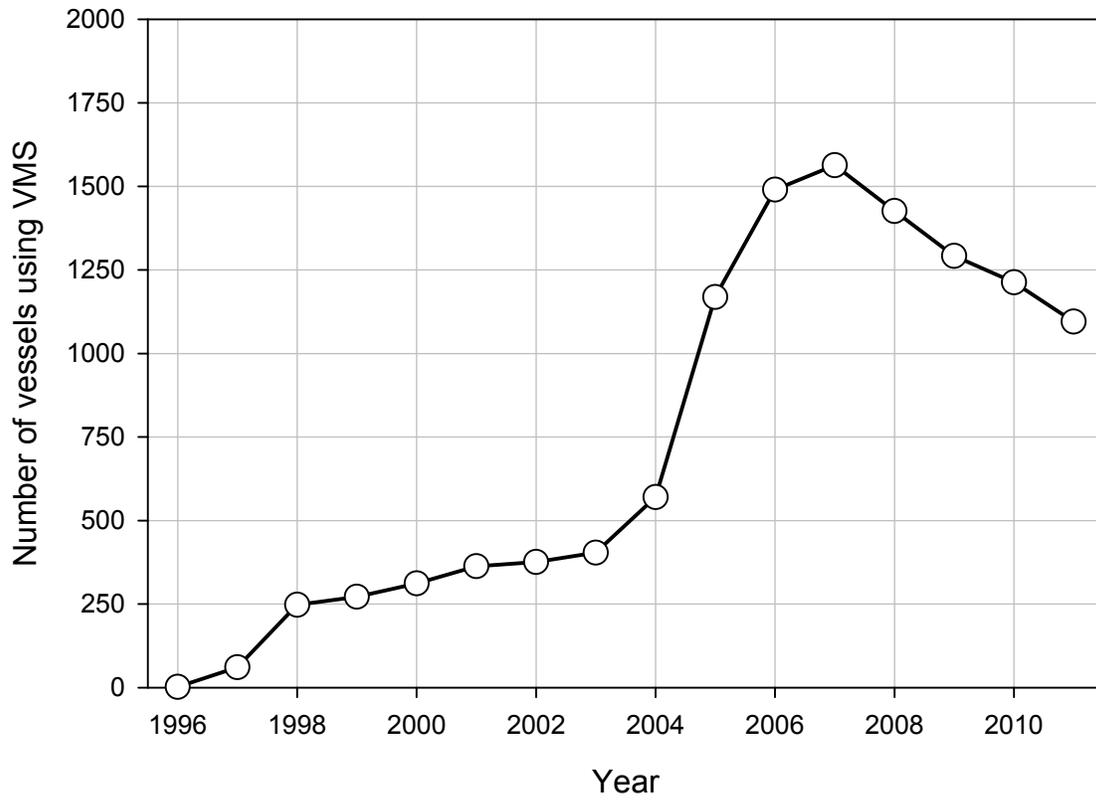


Figure 2. Number of vessels using Vessel Monitoring System (VMS) in the northeast United States between 1998 and 2011.

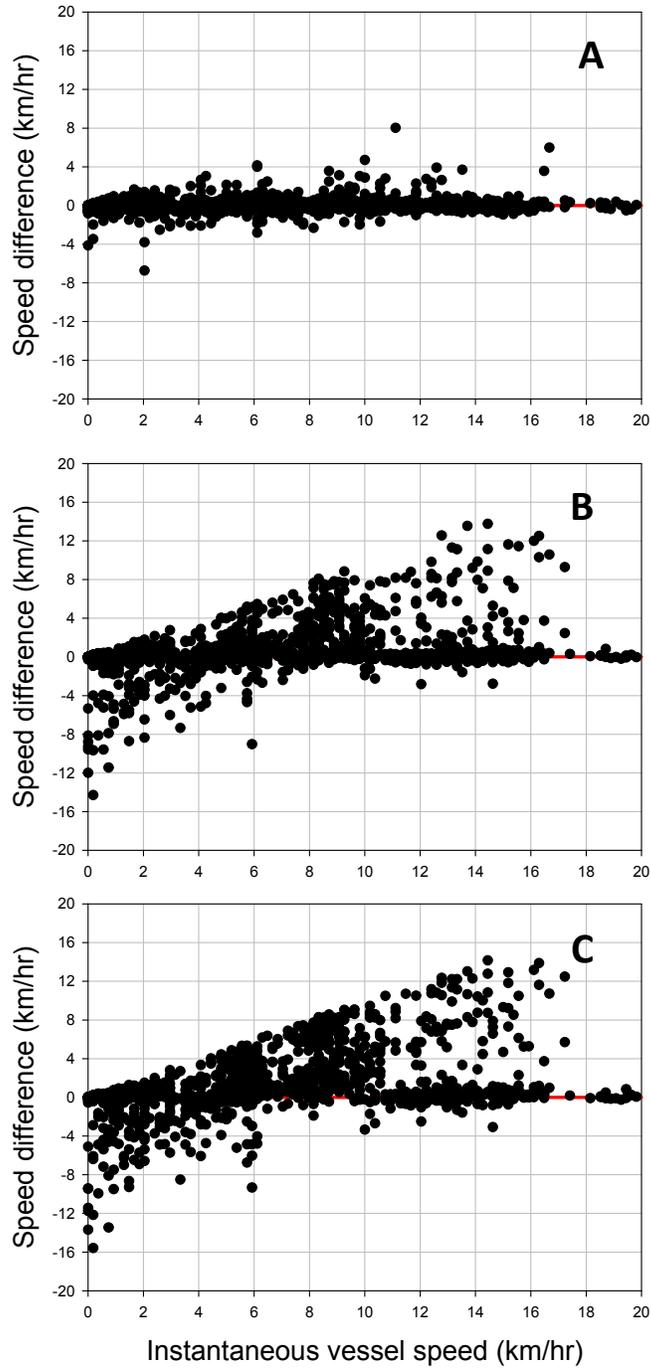


Figure 3. Vessel speeds calculated from sequential GPS polling positions to the compared to a vessel's instantaneous speed recorded directly from the GPS unit. Plot A shows the comparison of the calculated average speed of a fishing vessel compared to the vessel's instantaneous speed when the VMS polling frequency is 1 position/minute. Plot B shows the effect when the VMS polling frequency is 1 position/30 minutes. Plot C shows the effect when the VMS polling frequency is 1 position/hour.

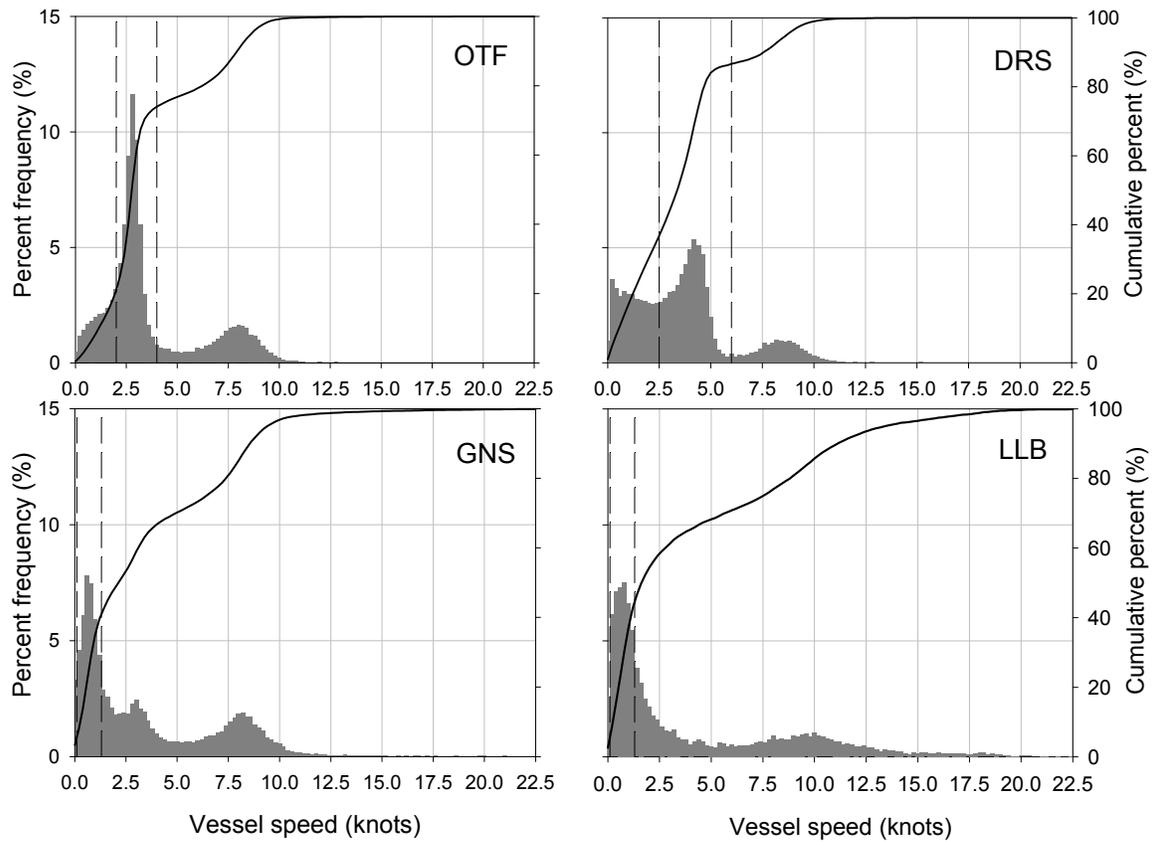


Figure 4. Percent frequency and cumulative percent distributions of average vessel speed (knots) as determined from Vessel Monitoring System (VMS) positions for vessels fishing fish bottom otter trawl (OTF), scallop dredge (DRS), sink gillnet (GNS) and benthic longline (LLB). The dashed lines represent the bounds used in this study to define fishing activity (OTF = 2.0 – 4.0 knots, DRS = 2.5 – 6.0 knots, GNS = 0.1 – 1.3 knots, LLB = 0.1 – 1.3 knots).

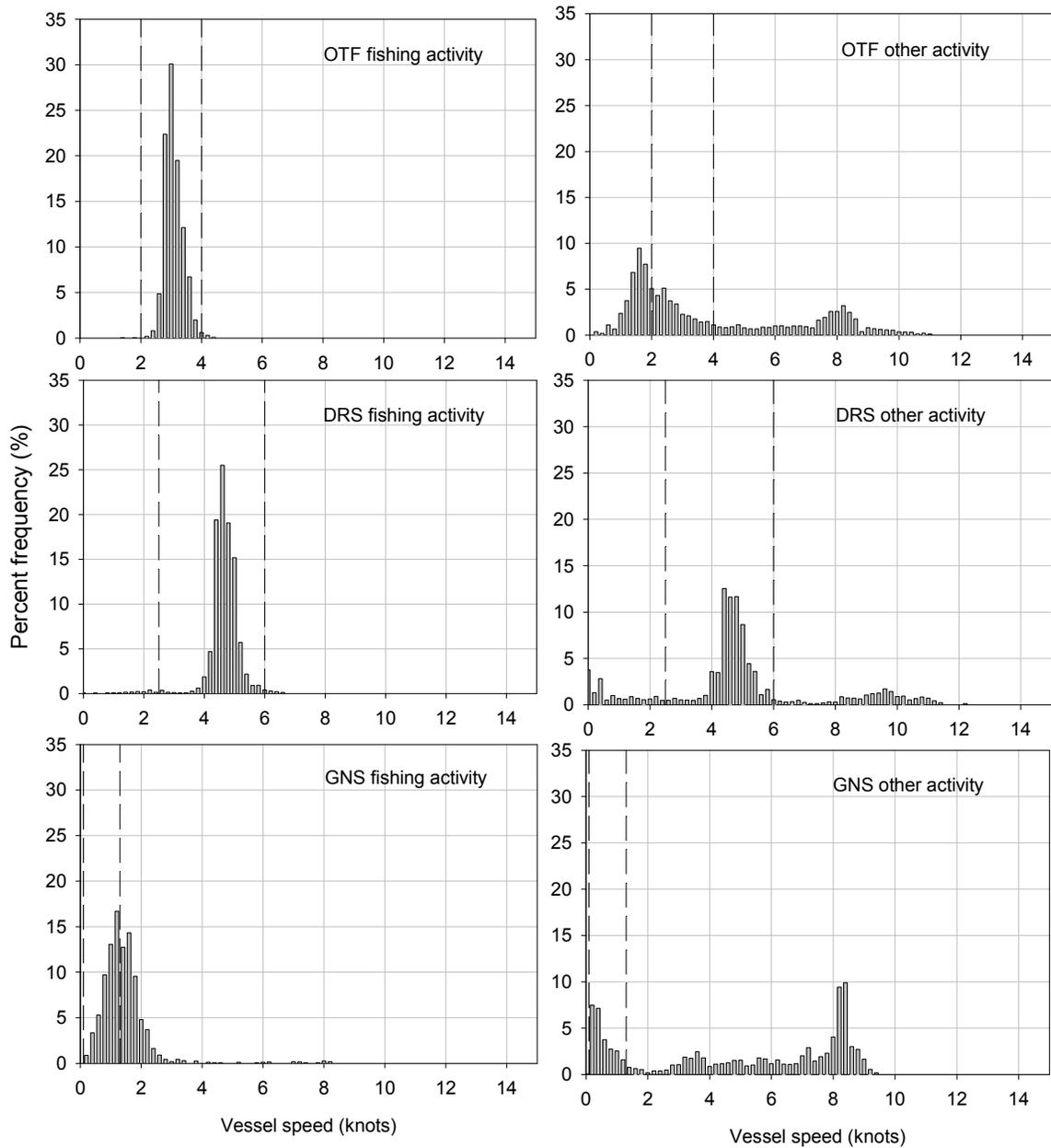


Figure 5. Percent frequency distribution of instantaneous vessel speed (knots) of vessels fishing fish bottom otter trawl gear (OTF), scallop dredge gear (DRS) and sink gillnet (GNS) characterized by both 'fishing' and 'other' activity. These data were collected using high-frequency polling of the vessel's global positioning unit (>1 observation/20 seconds) and represent the aggregate of multiple fishing trips. The dashed lines represent the bounds used in this paper to define fishing activity (OTF = 2.0 – 4.0 knots, DRS = 2.5 – 6.0 knots, GNS = 0.1 – 1.3 knots).

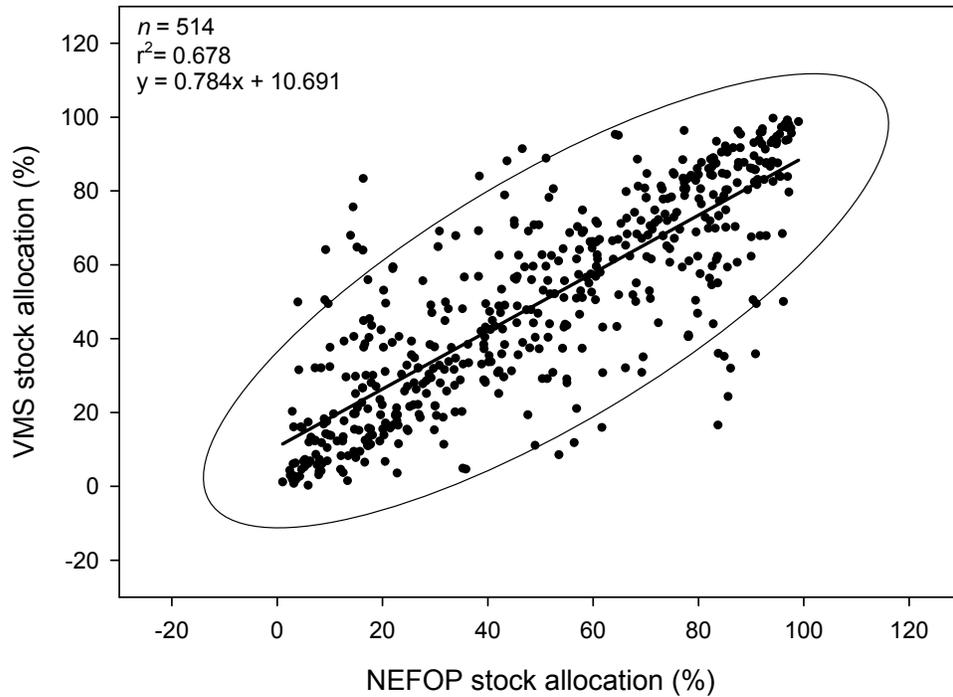


Figure 6. Comparison of 2005 Vessel Monitoring System (VMS) – Northeast Fisheries Observer Program (NEFOP) species stock allocations at the trip-level and associated 95 % confidence ellipse. Only those species-trip allocations where VMS and NEFOP-based methods agreed on the number of stock areas fished and the number of stock areas fished > 1 were compared.