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Northeast Fisheries Science Center Reference Document 11-09

Standardized Bycatch Reporting Methodology 3-year Review Report 2011 - Part 1

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Print publication date April 2011; web version posted June 8, 2011

Citation: Wigley SE, Blaylock J, Rago PJ, Tang J, Haas HL, and Shield G. 2011. Standardized Bycatch Reporting Methodology 3-year Review Report 2011- Part 1. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-09; 285 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at <http://www.nefsc.noaa.gov/nefsc/publications/>

Information Quality Act Compliance: In accordance with section 515 of Public Law 106-554, the Northeast Fisheries Science Center completed both technical and policy reviews for this report. These predissemination reviews are on file at the NEFSC Editorial Office.


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EXECUTIVE SUMMARY

The Standardized Bycatch Reporting Methodology (SBRM) Omnibus Amendment to the fishery management plans of the Northeast region was implemented in February 2008 to address the requirements of the Magnuson-Stevens Fishery Conservation and Management Act to include standardized bycatch reporting methodology in all FMPs of the New England Fishery Management Council and Mid-Atlantic Fishery Management Council. This report is a comprehensive 3-year summary of the discard and landings data that have supported the allocation of at-sea observers in the Northeast since April 2009. The SBRM uses the previous year's information on the precision of estimated discard totals to define sampling targets for an upcoming year.

The SBRM can be viewed as the combination of sampling design, data collection procedures and analyses used to estimate bycatch and allocate observer coverage in multiple fisheries. The SBRM provides a structured approach for evaluating the efficacy of the allocation of observer coverage (sea days) to multiple fisheries (52 fleets) to monitor a large number of species (15 SBRM species groups) under the 13 different fishery management plans, the Marine Mammal Protection Act, and the Endangered Species Act. The SBRM is not intended to be the definitive document on the estimation methods nor is it a compendium of discard rates and total discards (Wigley et al. 2007). Instead, the SBRM is intended to support the application of multiple bycatch estimation methods that can be used in specific stock assessments. The SBRM provides a general structure for defining fisheries into homogeneous groups and allocating observer coverage based on prior information and the expected improvement in overall performance of the program. The general structure helps identify gaps in existing coverage, similarities among groups that allow for realistic imputation, and the tradeoffs associated with coverage levels for different species. The SBRM allows for continuous improvement in allocation as new information on the results of the previous year's data is obtained.

The SBRM Omnibus Amendment requires annual consultations with the Councils and public to summarize observed discard rates in the preceding year and more importantly to review and refine plans for monitoring commercial fishing fleets in the upcoming year. This annual cycle is synchronized with the availability of previous years' data (July to June), time to acquire and audit data (July-September), sufficient time to conduct the statistical analyses (October-December), annual Council meetings (January-April), and the normal federal budget and contracting cycle.

The SBRM also requires a more comprehensive 3-year report that has two basic requirements: (1) annual estimates of discard totals and (2) a review of the overall efficacy of the sampling design. This report summarizes part one of that 3-year requirement and reviews the annual information presented in SBRM reports for years 2009, 2010, and 2011 with regard to the recent levels of observer coverage and observed encounters with species. This report also presents estimates of total discards and their associated precision for SBRM species groups and the individual species comprising these groups, by fleet and SBRM year.

The Northeast Fisheries Observer Program (NEFOP) and Vessel Trip Reports (VTR) databases are used to define the size of the sample and the size of the strata, respectively. The NEFOP and VTR data summarized in this report include data collected from July 2007 through June 2010.

The annual number of NEFOP trips and sea days and the annual number of VTR trips and sea days are summarized by fleet and SBRM year. The percent coverage of trips, summed over all fleets, ranged between 2% and 3.5%; percent coverage for sea days ranged between 4.4% and 6.1%. Finer scale coverage rates vary among fleet and SBRM year. The highest coverage (>50% in terms of trips) occurred in the Industry-funded scallop dredge access area fleets. The majority of fleets have less than 10% coverage of trips, sea days, or landings. It should be noted that percent coverage is only one measure for monitoring adequacy, and that precision of the discard estimates is the specified metric for monitoring adequacy within SBRM.

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For all NEFOP trips, observed catch quantities (kept and/or discarded) were summed for each species/species group and SBRM year and for each species/species group, fleet, and SBRM year. The NEFOP has recorded 311 unique species by weight and 42 species by numbers over the 3-year period from July 2007 to June 2010. The SBRM species groups represent approximately 90% of the total weight of all species recorded by NEFOP observers. The percentage of trips that encountered a species group/species by fleet and SBRM year are summarized. In general, the percentage of trips encountering a species group/species varied across region and fleet; however, the percentages across SBRM years were similar and indicate persistent fleet/species group interactions. The skate complex, large-mesh groundfish, and monkfish were the three most frequently encountered species groups on NEFOP trips. Sea turtles were recorded in 10 fleets during the July 2007 through June 2010 period. The majority of encounters were reported in MA fleets, and the majority of encounters were loggerhead turtles.

To estimate total annual discards and precision, a combined d/k ratio estimator was used where d = discard pounds of a given species and k = kept pounds of all species. The VTR landings of all species combined, corresponding to each fleet and SBRM year were used to expand the discard rate to estimate total discard weight of each SBRM species/species group, fleet and SBRM year.

Based on these analyses, spiny dogfish and the skate complex had the highest (greater than 60%) percentage of discards of the 14 SBRM species groups. In SBRM 2010, red crab also experienced high discards (exceeded 60%) when both New England (NE) and Mid-Atlantic (MA) red crab pot fleets were observed. In SBRM 2009, only the MA red crab pot fleet was observed and in SBRM 2011 neither the MA nor NE red crab pot fleets were observed. Due to regulations prohibiting possession of female red crabs, discarding is expected to be higher in these directed red crab pot fleets than for other SBRM species and other fleets without such regulations. Red crab discards did occur in other fleets, most notably in the NE large-mesh otter trawl. The majority of SBRM species groups had discard percentages that were less than 25%. For several individual species, such as yellowtail flounder and halibut, the percentages of discards were high (greater than 37%) due to regulatory reasons (trip limits), while for other individual species, such as ocean pout, windowpane flounder, and red hake, the percentage of discards were high (generally greater than 50%) due to no or low market demand coupled with regulatory reasons (no possession) in fishing year 2010. The percentage of butterfish discards was high (greater than 70%) in the MA and NE small-mesh otter trawl fleets in SBRM 2010 and SBRM 2011.

With regard to precision of the discard estimates, many of the species groups/species in the scallop Industry-funded fleets have coefficients of variation (CVs) below 30%. The numbers of observer sea days in the scallop fleets are based on the total fraction of landed value allocated to discard monitoring and the daily compensation rate. The compensation rate is designed to avoid biases that might arise if vessels avoided observers at low compensation rates and vice versa at high compensation rates. Realized coverage rates generally exceed the SBRM standard sea days. Additionally, most of the species group/species in the NE large-mesh otter trawl have precision estimates below 30% CV due to the increased monitoring of NE groundfish fleets as part of the coverage for special access programs and, more recently, for Amendment 16 to the Northeast Multispecies fishery management plan. Conversely, many of the species groups/species in MA and NE small-mesh otter trawl fleets have precision estimates at or above the SBRM standard of 30% CV due to constraints of available funds that prevent sea days from being allocated to these fleets. None of the precision estimates for the sea turtle species group in the 3 SBRM years were less than 30% CV.

The annual SBRM sea day analyses were conducted to estimate the number of baseline trips and sea days needed to monitor the 15 species groups in each fleet for each SBRM year. The number of trips and sea days needed to achieve a given precision level was based on the variance of the total discard estimate for a species group. The use of an importance filter is a key feature to the SBRM in that it focuses the sampling to fleets where it is needed most and is not wasted on small imprecisely estimated discards. The SBRM sea day standard (numbers of sea days needed to achieve a 30% CV for all SBRM species groups within a fleet) and the prioritized funded sea days by fleet and SBRM year are presented. In each of the 3 years, the sum of the SBRM standard sea days exceeded the total funding for sea days. The shortfall in funding invoked the SBRM consultation and prioritization process which resulted in prioritized sea days.

This report highlights the comprehensive data collection program of the NEFOP and that SBRM covers the majority of species encountered by commercial fleets as well as the discarded weight associated with these species. When prioritizing fleets, low encounters and low magnitude of discards of important/critical species can be considered. The precision (CV) of the discard estimates for SBRM species groups and the individual species that were considered important varied by species groups/species, fleet, and SBRM year. For the 14 SBRM species groups in the 3 SBRM years, 89 of the 128 precision estimates (70%) were less than or equal to 30% CV.

The annual SBRM reporting process provides a process and a structure to summarize the Northeast region's at-sea monitoring program, describes the methodology used in the estimation of discards, and specifies the deployment of observers to achieve observer coverage that will yield discard estimates with the desired level of precision through a transparent process that include consideration of Councils' priorities and public comment.

The Standardized Bycatch Reporting Methodology represents one of the most comprehensive programs for planning and executing observer monitoring coverage of federally managed fisheries. The first 3 years of the program, summarized in this report, illustrate the utility of the approach for monitoring discards in these fisheries and the real-world limitations of implementing an ideal system. Variations in the overall magnitude of funding, constraints on the uses of funding, and competing objectives among fishery management plans are some of the factors that impede attainment of the overall target level of precision.

LIST OF ACRONYMS AND ABBREVIATIONS

ACE = annual catch entitlements
 CV = coefficient of variation
 d/k = discard/kept
 FMP = fishery management plan
 MA = Mid-Atlantic
 MAFMC = Mid-Atlantic Fishery Management Council
 MRIP = Marine Recreational Information Program
 MRFSS = Marine Recreational Fisheries Statistical Survey
 NE = New England
 NEFMC = New England Fishery Management Council
 NEFOP = Northeast Fisheries Observer Program
 NEFSC = Northeast Fisheries Science Center

NERO = (NMFS) Northeast Regional Office
 NMFS = National Marine Fisheries Service
 NRCC = Northeast Regional Coordinating Council
 SBRM = Standardized Bycatch Reporting Methodology
 SE = standard error
 TAC = total allowable catch
 VTR = Vessel Trip Report

BACKGROUND

SBRM Omnibus Amendment

The Standardized Bycatch Reporting Methodology (SBRM) Omnibus Amendment to the fishery management plans (FMPs) of the Northeast Region (NEFMC 2007; NMFS 2008) was implemented in February 2008 to address the requirements of the Magnuson-Stevens Fishery Conservation and Management Act to include standardized bycatch reporting methodology in all FMPs of the New England Fishery Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC).

The SBRM can be viewed as the combination of sampling design, data collection procedures and analyses used to estimate bycatch and allocate observer coverage in multiple fisheries. The SBRM provides a structured approach for evaluating the efficacy of the allocation of observer coverage (sea days) to multiple fisheries to monitor a large number of species under the 13 different fishery management plans, the Marine Mammal Protection Act, and the Endangered Species Act. The SBRM is not intended to be the definitive document on the estimation methods nor is it a compendium of discard rates and total discards (Wigley et al. 2007). Instead, the SBRM is intended to support the application of multiple bycatch estimation methods that can be used in specific stock assessments. The SBRM provides a general structure for defining fisheries into homogeneous groups and allocating observer coverage based on prior information and the expected improvement in overall performance of the program. The general structure helps identify gaps in existing coverage, similarities among groups that allow for realistic imputation, and the tradeoffs associated with coverage levels for different species. The SBRM allows for continuous improvement in allocation as new information on the results of the previous year's data are obtained.

The SBRM requires annual consultations with the Councils and public to summarize observed discard rates in the preceding year and more importantly to review and refine plans for monitoring commercial fishing fleets in the upcoming year. As part of this review the Northeast Fisheries Science Center (NEFSC) and Northeast Regional Office (NERO) prepare a large data summary report and deliver an initial report on proposed observer coverage rates. These reports, delivered at the first Council meetings in the calendar year, are followed by a comment period, and a revised observer allocation plan. A revised observer coverage plan is delivered to the Northeast Regional Coordinating Committee (NRCC) at their spring meetings. This annual cycle is synchronized with the availability of data, the annual Council meetings, and the normal federal budget and contracting cycle.

The SBRM also requires a more comprehensive 3-year report that has two basic requirements: (1) annual estimates of discard totals, and (2) a review of the overall efficacy of the sampling design (a full description 3-year report is given below). This report summarizes part one of that 3-year requirement. The second task will be completed in early fall of 2011.

Review of Annual SBRM Reporting Process

To utilize the most recent available data, the annual SBRM analyses use data collected during a 12-month period from July through June. Generally, Northeast Fisheries Observer Program (NEFOP) data are audited and available for analysis 90 days after collection; hence these data are ready to be analyzed beginning in October. During October to January, annual analyses are performed; these include: (1) summarizing the NEFOP data for the Annual Discard Report, (2) updating the sea day analysis to derive SBRM standard sea days (the sea days needed to achieve a 30% coefficient of variation, CV, and (3) prioritizing sea days based on a preliminary budget. The Annual Discard Report and the Sea Day Analysis and Prioritization document are posted on-line [1] and presented to the Councils. A comment period follows. The NEFOP budget is generally known by March and a finalized sea day schedule that considers Council comments is developed for a 12-month period ranging from April through March. A document summarizing the comments, the final funded sea days, and the re-prioritized sea days is prepared concurrently with the NEFOP sea day schedule in April/May and is presented to the NRCC. Annual SBRM reports have been completed for 2009, 2010, and 2011. A summary of the annual reporting cycle is given below.

Annual SBRM Reporting Cycle	SBRM 2009	SBRM 2010	SBRM 2011
Data Used (12-month period)	Jul 2007 - Jun 2008	Jul 2008 - Jun 2009	Jul 2009 - Jun 2010
Data Analysis and Document Preparation	Oct 2008 - Jan 2009	Oct 2009 - Jan 2010	Nov 2010 - Jan 2011
Annual Report, Sea Day Analysis, and Prioritization documents available;			
Presentation to NEFMC and MAFMC;	Jan 2009 – Mar 2009	Jan 2010 – Mar 2010	Jan 2011 – Mar 2011
Prioritization Comment Period;			
Final Budget received, Consideration of Comments, Re-prioritization			
Response to Comments and Re-prioritization document to NRCC	Apr 2009	May 2010	Apr 2011

NEFOP Sea Day Schedule (12 month period)	Apr 2009 - Mar 2010	Apr 2010 - Mar 2011	Apr 2011 - Mar 2012
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The SBRM annual information is documented in the following reports:

- SBRM Annual Discard Reports for 2009, 2010, and 2011 (NEFSC 2011a, NEFSC 2011b, NEFSC 2011c, respectively);
- SBRM Sea Day Analysis and Prioritization for 2009, 2010, and 2011 (NEFSC 2009, NEFSC 2010, and NEFSC and NERO 2011, respectively);
- Council comments, response to the Council comments, and re-prioritized sea days are also documented.

The SBRM annual documents are available on-line at: http://www.nefsc.noaa.gov/femad/fsb/SBRM/SBRM_Annual_Discard_Reports.htm

Summary statistics from the annual SBRM 2009 (July 2007 through June 2008), SBRM 2010 (July 2008 through June 2009), and SBRM 2011 (July 2009 through June 2010) documents are given in the table below.

Summary Statistics	SBRM 2009	SBRM 2010	SBRM 2011
Number of Fleets	44	51	52
Fleets with Pilot ^[2] coverage	24	28	30
Baseline Sea Days	54,631	51,252	52,651
SBRM Standard Sea Days	15,125	14,147	19,507
Funded Sea Days	6,161	14,375	13,904
Sea Day Shortfall	-7,746	*	-5,603
Final Funded Sea Days	6,283	13,950	14,004
Number of Fleets with Sea Days	17	30	32

* Sea day shortfall existed in some fleets due to funding constraints.

Changes between SBRM 2009, 2010, 2011 Annual Reports

During the 3 SBRM years, the following changes have occurred regarding the SBRM annual reports and analysis:

- Atlantic wolffish was added to the large-mesh groundfish species group beginning with SBRM 2010 to reflect the inclusion of this species in the Northeast Multispecies FMP during the implementation of Amendment 16 in May 2010.
- In SBRM 2009, training trips were not included; however, beginning with SBRM 2010, training trip data were included. NEFOP clarified that the quality of training trip data was the same as non-training trips, thus these data can be combined with non-training trips.
- The sea turtle importance filters^[3] (unlikely filter, total discard filter, and the total mortality due to discards filter) were changed beginning with SBRM 2010. The sea turtle unlikely filters were updated based upon a review of the NEFOP data (H. Haas, pers. comm.), and the total discard and total mortality due to discard filters, which were not utilized for sea turtles in 2009, were utilized beginning with SBRM 2010. The application of the importance filters is now similar for both sea turtles and fish/invertebrates.
- Each year industry activity is reviewed and, as needed, new fleets are added into SBRM. Beginning with SBRM 2010, several fleets were added to SBRM 2009 fleets. Additional fleets include: Mid-Atlantic and New England beam trawl, New England Rühle trawl, New England Haddock Separator trawl, New England shrimp pot, Mid-Atlantic Access Area General and Limited scallop trawl, Mid-Atlantic and New England floating trap, and Mid-Atlantic other dredge. There are "minor" fleets that are not considered in SBRM and are comprised of trips using the following gear types: harpoon, cast nets, diving, weir, rakes, mussel dredge, urchin dredges, and other various gears. The landings from these fleets, in aggregate, are a minor component of total landings.
- Monitoring requirements in the nine Industry-funded fleets are explicitly included in the sea day analysis and prioritization beginning with SBRM 2010. The nine Industry-funded fleets include the New England and Mid-Atlantic scallop dredge and scallop trawl general and limited category access area fleets. The sea scallop resource set-aside program and the compensation rate analysis used in the annual SBRM analyses are described in letters^[4] from the Regional Administrator to vessel owners. In 2009, these nine fleets were handled externally to the SBRM process.
- Each year there are some fleets for which confidentiality rules apply. In the SBRM 2009-2011 period, there are two fleets where this applies: Mid-Atlantic and New England Menhaden purse seine fleets. Data from these fleets are included in the observed coverage but excluded from fleet summaries of observed encounters and discard estimation. Data from these fleets have been included in the summaries by species groups.

SBRM 3-year Review Report

The SBRM Omnibus Amendment specifies that a review and evaluation of the Northeast Region's SBRM will be conducted every 3 years. Specifically, the SBRM amendment states:

Every 3 years, the Regional Administrator and the Science and Research Director will appoint appropriate staff to work with staff appointed by the Executive Directors of the Councils to obtain and review available data on discards and to prepare a report assessing the effectiveness of the Northeast Region SBRM. This report will include, at a minimum:

1. a review of the recent levels of observer coverage in each applicable fishery;
2. a review of recent observed encounters with each species in each fishery, and a summary of observed discards by weight;

3. *a review of the CV of the discard information collected for each fishery;*
4. *an estimate of the total discards associated with each fishery;*
5. *an evaluation of the effectiveness of the SBRM at meeting the performance standard for each fishery;*
6. *a description of the methods used to calculate the reported CV's and to determine observer coverage levels, if those methods are different from those described and evaluated in the SBRM Amendment;*
7. *an updated assessment of potential sources of bias in the sampling program and analyses of accuracy; and*
8. *an evaluation of the implications for management of the discard information collected under the SBRM, for any cases in which the evaluation performed for item 5 indicates that the performance standard is not met.*

(Federal Register, Vol. 73, No. 18, Monday, January 28, 2008, Page 4738)

The Northeast Regional Coordinating Council, whose membership includes the Northeast Regional Administrator, the Northeast Fisheries Science Center's Science and Research Director, and the Executive Directors of the New England Fisheries Management Council and the Mid-Atlantic Fisheries Management Council, decided/agreed during their October 2010 meeting that the 2011 SBRM 3-year Review Report would be partitioned into two parts: Part 1 would contain the first four components (1 through 4 above) and Part 2 would contain the last four components (5 through 8 above). Part 1 would be delivered in the Spring of 2011 and Part 2 would be delivered in the Autumn of 2011. By partitioning the 3-year SBRM Review Report into two parts, the third annual SBRM year (2011) could be fully incorporated into the review without alternating the SBRM annual reporting cycle. This is particularly important for the analytic components (5 through 8 above) of the 3-year SBRM Review Report which require more extensive analysis to complete.

INTRODUCTION

This document represents Part 1 of the 2011 SBRM 3-year Review Report and reviews the annual information presented in SBRM 2009, 2010 and 2011 with regard to the recent levels of observer coverage and observed encounters with species. This report also presents estimates of total discards and their associated precision for SBRM species groups and the individual species comprising these groups, by fleet[5] and SBRM year. These annual discard estimates have not previously been presented.

The four components associated with Part 1 of the 2011 SBRM 3-year Review Report have been grouped into the following three sections:

Observer Coverage: A review of recent levels of observer coverage in each applicable fishery;

Observed Encounters: A review of recent observed encounters with each species in each fishery, and a summary of observed discards by weight;

Discard Estimation and Precision: An estimate of total discards associated with each fishery and a review of the CV of the discard information collected for each fishery.

This review utilizes the stratification and methods described in the initial SBRM analysis (Wigley et al. 2007) and summarizes the data reported in SBRM annual reports for 2009, 2010, and 2011 (NEFSC 2011a, NEFSC 2011b, NEFSC 2011c). These data were collected from July 2007 through June 2010 for 61 fleets and 15 species groups and the individual species that comprise these groups (subsequently referred to as "species/species groups") to encompass all federal FMP-managed species and sea turtles in the Northeast (Table 1).

Row numbers have been assigned to each unique fleet. The data used in each of the three sections of this report will vary, based on the nature/topic of the section, thus the associated fleets examined will vary. The unique fleet row numbers will facilitate cross-referencing between tables.

We use the term "bycatch" synonymously with "discard". In basic terms, bycatch is defined as living organisms that are captured by fishing gear and returned to the water. This is consistent with the definition provide in the Magnuson-Stevens Act where "*the term "bycatch" means fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch and release fishery management program*" (NMFS 2007). We do not define bycatch as the capture and retention of non-target species nor do we account for potential survival of organisms returned to the water. Most importantly, we do not base any of our analyses on the potential mortality associated with unobserved encounters with fishing gear. Our omission of these mortality sources does not confirm or deny their potential importance. Rather it explicitly recognizes that such events cannot be observed even when an observer is present on a given trip. Therefore, when using a design-based estimator, there is no basis for extrapolation of unobserved encounters to unobserved sampling units (i.e., trips).

METHODS

Data Sources

The sampling unit used in these analyses is the trip. Trip characteristics are recorded in both the NEFOP and Fishing Vessel Trip Reports (VTR) data sets. Together, these databases are used to define the size of the sample and the size of the strata, respectively. Data from each source are retrieved and prepared separately before they are combined. Additionally, data from the NEFSC's commercial fisheries database and recreational landings collected through the Marine Recreational Fisheries Statistical Survey (MRFSS; recently renamed the Marine Recreational Information Program, MRIP) have been used in the importance filters to further refine the base sea days derived in the sample size analyses.

Northeast Fisheries Observer Program (NEFOP) Data

The NEFOP is a comprehensive, multi-purpose program that collects a broad range of data on all species that are encountered during a fishing trip, as well as gear characteristics data, economic information and biological samples (Northeast Fisheries Observer Program 2010). The NEFOP employs trained, sea-going observers and monitors to collect these data that also includes weight, by species and disposition (retained and discarded), of the entire catch. Fish/invertebrate species are recorded in pounds while the interactions of incidental take species are recorded in numbers.

Standard sampling protocols, at the trip-level, have been established and are utilized throughout the various fisheries[6]. For most gear types, observers use a “complete” sampling protocol that includes obtaining species weights for both kept and discarded portions of all species in the catch on every haul. In addition to the “complete” sampling protocol, there is a “limited” sampling protocol that is used on some gillnet trips where specific information for marine mammals is collected. In a “limited” sampling scenario, only kept species weights are obtained (no discard weights) since the observer must watch the gillnet gear during haul-back to observe if marine mammals roll out of the gear before the gear returns to the deck. An observed haul is defined as one where all of the catch is recorded, regardless of disposition. An unobserved haul is defined as one where complete discard information from the haul is not collected.

Due to these two sampling protocols for data collection, two data sets were formed using the NEFOP data: one data set for fish (FISH) that utilized the “complete” sampling protocols and another for turtles, marine mammals, and birds (PSP) that utilized both the “complete” and “limited” sampling protocols. The NEFOP data summarized in this report includes data collected from July 2007 through June 2010[7].

As described in Wigley et al. (2007), the NEFOP data have been classified into fleets using geographical region, gear type, mesh size, access area, and trip category. Trips are classified into two broad geographical regions, New England (NE) and Mid-Atlantic (MA), based upon the port landed: ports located from Maine to Rhode Island were grouped together to form the NE region and ports located in states from Connecticut southward comprised the MA region. Gear type is based upon Northeast gear codes (*negear*). Some gear codes were combined into a single category (e.g., mid-water paired trawl and mid-water single trawl; mackerel and herring purse seine; drift, anchored and sink gillnet). Mesh size groups were formed for the otter trawl and gillnet gear types. For otter trawl, two mesh groups were formed: small (sm; less than 5.5 inches) and large (lg; 5.5 inches and greater). For gillnet, three mesh groups were formed: small (sm; less than 5.5 inches), large (lg; from 5.5 to 7.99 inches) and extra large (xlg; 8 inches and greater). NEFOP trips were assigned to one of two access area categories[8] based on the NEFOP program code, Open or Access Area (AA). Trips that used either scallop trawl or scallop dredge were further classified into two trip categories: General (GEN) or Limited Access (LIM)[9]; trips using other gear types were assigned a trip category of “all.”

Stratification abbreviations used.

Abbreviation	Definition
MA	Mid-Atlantic ports (CT and southward)
NE	New England ports (RI and northward)
sm	Small mesh (less than 5.5 inches)
lg	Large mesh (5.5 to 7.99 inches)
xlg	Extra-large mesh (8 inches and greater)
LIM	Limited access category
GEN	General category
OPEN	Non-access area
AA	Access area

Data from “off-watch” hauls, data from aborted trips, and species haul weights with discard reason equal to 039 (previously discarded) [10] were excluded from all summaries. Additionally, eight “set-only” gillnet trips were excluded in SBRM 2011. All non-living matter (including debris consisting of rock, metal, glass, wood, rope, rubber, etc.), previously-living matter (including stomach contents or clappers), and eggs (fish, squid, or mollusk) have been excluded from this review report. Incidental takes that were classified as too decomposed to have been killed by the gear that captured them and seals and large whales that were not seriously injured by the gear have also been removed. Conversion factors were applied to convert any dressed weight data to live weight equivalents. Use of the NEFOP data is described within each of three sections of this report.

Fishing Vessel Trip Report (VTR) Data

The VTR data can be used as a basis for defining the sampling frame, since all federally permitted vessels are required to file a VTR for each fishing trip (see NMFS-NERO http://www.nero.noaa.gov/ro/fso/vtr_inst.pdf). These self-reported data[11] constitute the basis of the fishing activity of the commercial fleets. Because Dealer data do not contain mesh size and area fished information, the Dealer data[12] could not be used to expand discard ratios by fleet for the annual analyses. The VTR data were used as a surrogate for Dealer data and were used to expand the NEFOP discard ratios to total discards. For the SBRM analyses, the commercial VTR trips [excluding NY state (non-federal) vessels] were used. Conversion factors were applied to convert various units of measure to pounds and all weight to live weight. VTR trip data are collapsed into fleets as defined above. Trips participating in the US-Canada access area, B-day category programs and other special access programs could not be identified in the VTR data. These trips have been grouped by the other stratification variables and have not been partitioned separately.

We note that the discard estimation in stock assessments relies on the dealer data records that have been prorated by the VTR base allocation using the method of Wigley et al. (2008a). Given that the VTR estimates are usually less than the dealer records for a given fleet, the corresponding estimates of discards will be also be underestimated. The magnitude of the underestimation will vary by fleet and year.

Clam Logbook and Dealer Data Source = “09”

The clam fishery has a separate logbook system from the VTR logbook. The commercial clam logbook data were used to augment the VTR data for the clam dredge fishery.

Observer Coverage (Section 1)

In this section, NEFOP and VTR data sets are utilized. The annual number of NEFOP trips and sea days (for FISH and PSPP data sets) and the annual number of VTR trips and sea days are summarized by fleet and SBRM year. The comprehensive list of unique fleets within the 3 SBRM years can be classified into three groups: (1) fleets with VTR trips and NEFOP trips, (2) fleets with VTR trips but no NEFOP trips, and (3) fleets with NEFOP trips but no VTR trips. Fleets with NEFOP trips without corresponding VTR trips represent fleets without logbook requirements, and represent fleets without a sampling frame.

Observed coverage, in terms of trips, sea days, and landings of all species combined, is derived for each fleet and SBRM year by dividing the annual sum of the values for each metric in the NEFOP data sets (FISH and PSPP) by the annual sum of the values for each metric in the VTR data set. The fleets without VTR coverage are null. Total annual coverage is derived for trips and sea days by summing the values for each metric over all fleets for each SBRM year and then dividing the NEFOP total by the VTR total for each metric.

In some fleets there was little or no NEFOP coverage. As part of the feedback process for improving the sampling design, it is necessary to use imputed values as a basis for allocating coverage or to use pilot coverage. Pilot coverage is defined as a minimum level of coverage to acquire bycatch information with which to calculate variance estimates that in turn can be used to further define the level of sampling needed (NMFS 2004). Determination of pilot coverage was not based on annual percentage of observer coverage, but rather on the temporal distribution of trips throughout the 12-month period in order to support the method used for discard estimation and sample size analyses. As described in Wigley et al. (2007), four scenarios were developed to determine when to use imputation or pilot coverage:

1. If observer coverage exists in all 4 quarters with sufficient sample sizes to generate quarterly CVs, then no imputation or pilot coverage was used;
2. If observer coverage exists in 3 quarters with sufficient sample sizes to generate a CV, then the missing quarter was imputed using half-year estimate;
3. If observer coverage exists in 1 or 2 quarters with sufficient sample sizes to generate a CV and the other 2 or 3 quarters had zero or 1 trips, then there were insufficient data to apply simple imputation and pilot coverage was used; and
4. If no observer coverage exists in all 4 quarters; then pilot coverage was used.

The designation of pilot coverage was made for each NEFOP data set (FISH and PSPP). "P" indicates pilot coverage was used in the sample size analysis. If the pilot designation applies only to the NEFOP FISH data set, then "P*" is used.

Observed Encounters (Section 2)

The NEFOP data used in this section included all hauls from NEFOP trips using "limited" sampling or "complete" sampling protocols and includes observed and unobserved hauls. Any NEFOP data that required aggregation beyond the fleet level, or data that could not be stratified to a fleet due to confidentiality rules, missing gear or mesh information, were excluded from the fleet summaries. These data, however, are reported in the species group summaries.

A list of all unique species recorded by NEFOP observers over the 3-year period from July 2007 through June 2010 was compiled, by species recorded in pounds and by species recorded in number. For all NEFOP trips, observed catch quantities (kept and/or discarded) were summed for each species/species group and SBRM year and for each species/species group, fleet, and SBRM year (note: the fleet summaries excluded data that could not be classified to a fleet). Separate summaries are presented for fish/invertebrates (in live pounds) and sea turtles (in numbers).

The percentage of NEFOP trips that encountered a species/species group is derived by dividing the number of NEFOP trips that observed the given species/species group, regardless of catch disposition, by the number of NEFOP trips in each fleet and SBRM year. Annual percentage of observed trips that encountered the species/species group was derived by summing the NEFOP trips that encountered the species/species group over all fleets in each SBRM year and dividing by the sum of the number of NEFOP trips in each SBRM year.

Discard Estimation and Precision (Section 3)

Fish/Invertebrates

The NEFOP and VTR data were used in the analyses of this section. The NEFOP FISH data set ("complete" sampling protocol) with only observed hauls in which all kept and discarded species were recorded was used. In the majority of trips, all hauls were observed. The NEFOP trip data were collapsed into strata as defined above. For each fleet, the number of trips, the average number of days absent (trip length in days), kept weight of all species in the trip, and the discard weight of each species were calculated.

As mentioned above, simple imputation methods were used to fill quarterly cells for which there were one or no observed trips. Data from adjoining strata were pooled to impute estimates for cells with zero or one trip. In this imputation only the temporal stratification, calendar quarter, was relaxed to half year (or annual) recognizing that seasonal variation can occur for some species. This simple imputation could not be applied to fleets where observer coverage was low or missing throughout the year (i.e., too few data to support the simple imputation approach). In these cases, imputed values were not used, and the fleet was designated as a fleet in need of pilot coverage. If some data were available, then discard estimates were derived, but these results were not used in sample size analyses.

To estimate total annual discards and precision, a combined d/k ratio estimator (Cochran, 1963) was used where d = discard pounds of a given species and k = kept pounds of all species. The VTR landings of all species combined, corresponding to each fleet and SBRM

year were used to expand the discard rate to estimate total discard weight of each SBRM species/species group, fleet and SBRM year.

The combined ratio method is based on a ratio estimate pooled over all strata and trips within a fleet. Total discarded pounds for species j is defined as:

$$(1) \hat{D}_j = \sum_{k=1}^Q K_k r_{c,j}$$

where

$$(2) r_{c,j} = \frac{\sum_{h=1}^Q N_h \sum_{i=1}^{n_h} \frac{d_{jih}}{n_h}}{\sum_{h=1}^Q N_h \sum_{i=1}^{n_h} \frac{k_{ih}}{n_h}}$$

where \hat{D}_j is total discarded pounds for species j ; K_h is VTR total kept pounds in stratum h ; $r_{c,j}$ is the combined ratio of species j ; d_{jih} is discards of species j from trip i in stratum h ; k_{ih} is kept pounds of all species on trip i in stratum h ; N_h is the number of VTR trips in stratum h ; n_h is the number of observed trips in stratum h . In Eq. 2 the summation over strata $h = 1$ to Q is over calendar quarters and the other strata values are held constant. Equation 3 (below) requires a more explicit definition of the stratum designation since the summation over quarter relies on an annual average ratio defined in Eq. 2.

The variances of the total discards were also derived. The variance of \hat{D}_j for species j is defined as:

$$(3) V(\hat{D}_j) = \sum_{q=1}^4 K_{qh}^2 \left(\frac{N_{qh} - n_{qh}}{n_{qh} N_{qh}} \right) \frac{1}{\left(\frac{\sum_{i=1}^{n_{qh}} k_{iqh}}{n_{qh}} \right)^2} \left[\frac{\sum_{i=1}^{n_{qh}} \left(d_{jih}^2 + (r_{c,j})^2 k_{iqh}^2 - 2r_{c,j} d_{jih} k_{iqh} \right)}{n_{qh} - 1} \right]$$

where \hat{D}_j is total discarded pounds for species j ; K_{qh} is VTR total kept pounds in quarter q and stratum h ; $r_{c,j}$ is the combined ratio of species j ; d_{jih} is discards of species j from trip i in quarter q and stratum h ; k_{iqh} is kept pounds of all species on trip i in quarter q and stratum h ; N_{qh} is the number of VTR trips in quarter q and stratum h ; n_{qh} is the number of observed trips in quarter q and stratum h .

In this document, the coefficient of variation is defined as the ratio of the standard error of the total discards divided by the total discards. The coefficient of variation (CV) of \hat{D}_j is defined as:

$$(4) CV(\hat{D}_j) = \frac{\sqrt{V(\hat{D}_j)}}{\hat{D}_j}$$

For each species/species group, fleet and SBRM year, the landings from the VTR and clam logbook are presented to provide perspective for the discard estimates. The landings associated with the "minor" fleets not considered in SBRM have been aggregated into a single fleet labeled "Other fleets."

Sea Turtles

Using the NEFOP PSPP data set, the discard estimation method described above was used to derive variance estimates for sea turtles.

Sample Size Analysis

The annual SBRM sample size analyses[13] were conducted to estimate the number of baseline trips and sea days needed to monitor the 15 species groups in each fleet for each SBRM year. As described in Wigley et al. (2007), the number of trips and sea days needed to achieve a given precision level was based on the variance of the total discard estimate for a species group. Sample size (trips and sea days) associated with the SBRM precision standard for discard estimates (30% CV) were derived. The sample size analysis was performed using trips as the sampling unit, and then converting the number of trips to sea days by multiplying by the weighted mean trip length, where the weighting factor was the quarterly number of VTR trips.

The number of sea days and trips needed to achieve a 30% CV are derived based on the variance of the total discards using the combined ratio method and the d/k discard ratio (Eq. 3).

From Eq. 3, let

$$(5) \quad \hat{S}_{j,qh}^2 = \left[\frac{\sum_{i=1}^{n_{qh}} \left(d_{jih}^2 + (r_{c,jh})^2 k_{iqh}^2 - 2r_{c,j} d_{jih} k_{iqh} \right)}{n_{qh} - 1} \right] \quad \text{and}$$

$$(6) \quad \delta_{qh} = \frac{n_{qh}}{\sum_{q=1}^4 n_{qh}}$$

where δ_{qh} is the fraction of the trips in quarter q in stratum h ; $r_{c,jh}$ is the combined annual ratio of species j in stratum h ; d_{jih} is discards of species j from trip i in stratum h in quarter q ; k_{iqh} is kept pounds of all species on trip i in stratum h in quarter q ; and n_{qh} is the number of observed trips in stratum h in quarter q . The $r_{c,jh}$ in Eq. 5 is defined in Eq. 2 in which the summation is over quarters within a given strata defined by gear, region, access area, trip type and so forth.

The number of trips necessary to achieve a 30% CV based on the variance of the annual total discards for species group j in stratum h is defined as

$$(7) \quad \hat{T}D_{30,jh} = \frac{\sum_{q=1}^4 \left(\frac{K_{qh}^2}{F_{qh}^2} \delta_{jqh}^2 \frac{1}{\delta_{qh}} \right)}{(0.09) \hat{D}_{jh}^2 + \frac{\sum_{q=1}^4 \frac{K_{qh}^2 \delta_{jqh}^2}{F_{qh}^2}}{N_k}}$$

where $0.09 = 0.30^2$, the square of the 30% CV, the given target precision level.

The number of sea days necessary to achieve a 30% CV based on the variance of the annual total discards for species group j in stratum h is defined as

$$(8) \quad \hat{S}D_{30,jh} = \hat{T}D_{30,jh} * \overline{DA}_{jh}$$

where \overline{DA}_{jh} is the weighted average trip length of VTR trips in stratum h (weighted by the number of VTR trips in each quarter).

When total discards could not be estimated due to little or no observer coverage (no data), or when total discards are zero (no variance), sample size was determined by pilot coverage, where 2% of the quarterly VTR trips for a fleet, with a minimum of 12 trips per year (3 trips per quarter) and a maximum of 400 trips per year (100 trips per quarter), were multiplied by the quarterly mean VTR trip length to derive quarterly sea days. The quarterly trips and quarterly sea days were then summed for annual number of trips and sea days. Pilot coverage may result in too much coverage in cases where little or no observer coverage may actually be needed.

$$(9) \quad \hat{S}_{30,jh} = \hat{T}_{jh} * \overline{DA}_{jh}$$

where \hat{T}_{jh} is 2% of the VTR trips in stratum h and quarter q , and $3 \leq \hat{T}_{jh} \leq 100$ trips; \overline{DA}_{jh} is the average trip length of VTR trips in stratum h and quarter q . The quarterly trips and sea days were then summed for annual number of trips and sea days.

The SBRM Omnibus Amendment calls for attainment of CVs of no more than 30% in each fleet/species combination. Thus, for each fleet, a CV of 30% or less is to be attained for each species within that fleet. Some fleet/species combinations contribute very little to the total mortality or discard of the species, but may require significant resources to characterize the precision of the estimate. For example, a high variance estimate for a rare event within a fleet would require high levels of sampling, even though the total discard in that fleet was unimportant with respect to either the total discard or total mortality on the resource.

As in previous SBRM analyses, importance filters were used to provide a standardized protocol to further refine the number of baseline sea days based on: (a) the importance of the discarded species relative to the total amount of discards by a fleet, and (b) the total fishing mortality due to the discards. Three filters (i.e., unlikely cell filter, fraction of discard filter, and fraction of total mortality due to discards filter [14]) are applied simultaneously. The unlikely cell filter eliminates sea days associated with fleets where species and gear combinations are considered, *a priori*, as unlikely or infeasible. The unlikely cell filter can act as an "override" mechanism in situations where pilot coverage is evoked due to no variance (observer coverage indicates zero discards). A detailed description of the SBRM importance filters is given in Wigley et al. (2007).

The baseline sea days were filtered using a 95% cut-point in the discard filter, and a 98% cut-point for the total mortality filter due to discards. In other words, estimates of sea day coverage for a given species or species group were derived for those fleets where discards constituted 95% of the discard mortality and 98% of the total mortality. The unlikely cell filter was not updated for new fleets in SBRM 2010 and SBRM 2011 with regard to the 14 fish species groups; "likely" was assumed for the new fleets. The unlikely filters will be re-evaluated during Part 2 of this review.

To determine the number of sea days (referred to as "SBRM standard sea days") and trips needed to achieve a 30% CV within a fleet, the maximum number of sea days for the 15 species groups (i.e., the maximum number of sea days in a row) was used. This ensures that all species groups will have a 30% CV or less. In the event that sea days for each species group within a fleet are filtered out, then the number of sea days for the fleet will be based on pilot coverage to maintain monitoring coverage for that fleet. If the fleet is

designated as a pilot fleet, then pilot sea days are used.

RESULTS

Observer Coverage (Section 1)

The number of NEFOP trips, by NEFOP subset (FISH and PSPP), and the number of VTR trips, by fleet and SBRM year, are presented in [Table 2](#). The number of NEFOP sea days, by NEFOP subset (FISH and PSPP) and the number of VTR sea days, by fleet and SBRM year, are presented in [Table 3](#).

A total of 61 unique fleets have been reported in the three annual SBRM analyses. Fleets in Rows 1 to 52 have been used in the annual SBRM sea sample size analyses. These fleets have VTR trips but may or may not have NEFOP trips. Fleets in Rows 53 to 61 have sparse or no VTR trips resulting in no sampling frame and consequently have been excluded from the discard estimation and sample size analyses. The NEFOP trips associated with these fleets constitute a small fraction (0.01%) of the total trips reported ([Table 2](#)). The fisheries associated with the MA beach seine and NE and MA Menhaden purse fleets (Rows 59, 60, and 61, respectively) do not have VTR reporting requirements (unless vessels hold fishing permits for species that do have VTR reporting requirements).

It is possible for a trip to be partitioned if two or more gear types or mesh groups are used during a trip. The result of this partitioning may inflate the number of trips and sea days observed. The numbers of unique NEFOP trips, before applying the stratification and conditioning the data set for analysis, were 3,021, 3,024, and 3,326 in SBRM 2009, SBRM 2010 and SBRM 2011, respectively. The numbers of unique NEFOP sea days were 10,211, 11,249, and 10,362 in SBRM 2009, SBRM 2010, and SBRM 2011, respectively.

The percent coverage of trips, summed over all fleets, ranged between 2% and 3.5%; percent coverage for sea days ranged between 4.4% and 6.1% ([Tables 2 and 3](#)). The observed coverage is higher for sea days than for trips due to the high coverage for compliance monitoring of trips fishing in the US/CANADA resource sharing area. Trips fishing in this area generally have a greater mean trip length than other trips associated with NE large-mesh otter trawl (Row 8).

Finer scale coverage rates vary among fleet and SBRM year. Observer coverage rates, in terms of percentage of trips, sea days and landings, by fleet for 24 selected fleets and SBRM year, are given in [Figures 1, 2, and 3](#), respectively. The 24 selected fleets are: Rows 2, 4-8, 16, 19-24, and 26-36; these represent fleets for which discards were estimated in the majority of years. The highest coverage (>50% in terms of trips) occurred in the Industry-funded scallop dredge access area fleets (Rows 30 and 28; [Figure 1](#)). The majority of fleets have less than 10% coverage of trips, sea days or landings. It should be noted that percent coverage is only one measure for monitoring adequacy, and that precision of the discard estimates is the specified metric for monitoring adequacy within SBRM.

Within Rows 1 to 52 ([Tables 2 and 3](#)), there were two fleets for which the numbers of NEFOP trips and sea days are greater than the VTR trips and sea days. These data irregularities are attributed to improperly reporting the gear type used on the VTR. The Ruhle trawl (Row 13) and haddock separator trawl (Row 14) are newly-regulated gear types in the US/CANADA resource sharing area and are often misreported as otter trawl. The NERO continues to perform outreach and education directed towards those who use these new gear types to improve proper reporting of gear used. Another fleet with misreported gear type is the New England shrimp trawl (Row 16). In this fleet, a minor number of VTR trips reported using shrimp trawl when an otter trawl was used. Approximately 56, 43, and 12 trips misreported shrimp trawl during SBRM 2009, SBRM 2010 and SBRM 2011, respectively. Similarly, a minor number of VTR trips reported otter trawl when a shrimp trawl was used. Due to the minor numbers of trips with misreported gear types the data used in this analysis were not adjusted. The misreporting of gear types in the VTR data does not impact the observed coverage due to the insignificant number of trips. Further discussion in the implications of misreported gear on discard estimation is given below. Observed coverage for gillnet fleets were higher in the NEFOP PSPP data set than the FISH data set because both "complete" and "limited" sampling protocols contribute to the NEFOP PSPP, while only the "complete" sampling protocol trips contribute to the NEFOP FISH set ([Tables 2 and 3](#)).

Pilot fleet designation generally indicates little or no observer coverage, except in cases in which NEFOP trips were not temporally distributed throughout the year. Not all fleets considered within the SBRM have NEFOP coverage. Within Rows 1-52, there were 26 fleets which required pilot coverage in all 3 years, six fleets for which a change between pilot and non-pilot coverage occurred during the 3 years, and 20 fleets that had sufficient NEFOP coverage in all years ([Table 2](#)).

Within the SBRM, there were two confidential fleets, nine Industry-funded fleets, and eight fleets that were not initially considered in the annual SBRM analyses but were subsequently added during the 3-year period.

The two fleets where confidentiality rules applied in all SBRM years were:

- Row 60 MA Menhaden Seine
- Row 61 NE Menhaden Seine

The nine scallop resource set-aside Industry-funded fleets that were explicitly included in SBRM 2010 and SBRM 2011 were:

- Row 9 MA Access Area General Category Scallop Trawl
- Row 10 MA Access Area Limited Category Scallop Trawl
- Row 12 MA Open Limited Category Scallop Trawl
- Row 27 MA Access Area General Category Scallop Dredge
- Row 28 NE Access Area General Category Scallop Dredge
- Row 29 MA Access Area Limited Category Scallop Dredge
- Row 30 NE Access Area Limited Category Scallop Dredge
- Row 33 MA Open Limited Category Scallop Dredge
- Row 34 NE Open Limited Category Scallop Dredge

The eight fleets not considered in annual SBRM analyses (denoted by dark shading in the tables) but subsequently included were:

Row 13 NE large-mesh Ruhle Trawl (SBRM 2009 and SBRM 2010)
 Row 14 NE large-mesh Haddock Separator Trawl (SBRM 2009)
 Row 17 MA Floating Trap (SBRM 2009)
 Row 18 NE Floating Trap (SBRM 2009)
 Row 43 NE Shrimp Pots and Trap (SBRM 2009)
 Row 48 MA Beam Trawl (SBRM 2009)
 Row 49 NE Beam Trawl (SBRM 2009)
 Row 50 NE Other Dredge (SBRM 2009)

The MA shrimp trawl (Row 15) fleet was excluded in the 3-year review summaries due to the uncharacteristic nature of the two observed trips relative to the VTR trips in this fleet. These two observed trips constitute a unique sub-fleet within the MA shrimp fishery.

Previously Reported Information

Numbers of NEFOP and VTR trips and sea days by calendar quarter are available in Tables 2 and 3 of the Sea Day Analysis and Prioritization documents for SBRM 2010 and 2011 (NEFSC 2010 and NEFSC and NERO 2011, respectively). See [Appendix Tables 1, 2, and 3](#) of this report for SBRM 2009.

Observed Encounters (Section 2)

The NEFOP has recorded 311 unique[15] species by weight and 42 species by numbers ([Appendix Table 4](#)) over the 3-year period from July 2007 to June 2010. A summary of the 15 SBRM species groups (14 fish/invertebrates species groups, in weight by disposition, and sea turtles, in numbers) is given in [Table 4](#) for the SBRM species groups, the SBRM species groups combined, the non-SBRM species, and all species combined by SBRM year. The 14 SBRM species groups represent approximately 90% of the total weight of all species recorded by NEFOP observers ([Table 4](#)).

Fish/Invertebrates

Summaries of observed weight (kept and discarded), and the percentage of trips that encountered a species group/species by fleet and SBRM year, are presented in [Tables 5A and 5B](#). Only fleets with NEFOP trips have been summarized, resulting in non-consecutive row numbers within [Tables 5A and 5B](#). Additionally, two fleets (Rows 60 and 61) were omitted due to confidentiality and three fleets (Rows 25, 41, 53) did not encounter any of the 14 SBRM species groups. A total of 45 fleets over the 3-year period have been summarized.

In general, the percentage of trips encountering a species group/species varied across region and fleet; however, the percentages across SBRM years were similar and indicate persistent fleet/species group interactions. The skate complex, large-mesh groundfish, and monkfish were the three most frequently encountered species groups on NEFOP trips ([Table 5A](#)).

Sea Turtles

Sea turtles were recorded in 10 fleets during the July 2007 through June 2010 period ([Tables 6A and 6B](#)). The majority of encounters were reported in MA fleets (7 of the 10 fleets), and the majority of encounters were loggerhead turtles.

Previously Reported Information

Kept and discarded weights of all species recorded by NEFOP observers, by statistical area and calendar quarter, can be found in Section 2 of the Annual Discard Reports for 2009, 2010 and 2011 (NEFSC 2011a, NEFSC 2011b, NEFSC 2011c, respectively).

Discard Estimation and Precision (Section 3)

Fish/Invertebrates

Annual VTR landings and estimated discards (live pounds) with associated precision are summarized for 53 fleets (Rows 1 to 52, and "Other fleets" with landings only) as follows: (1) for each of the 14 SBRM species groups/species over all fleets for each SBRM year ([Tables 7A and 7B](#); [Figure 4](#)); (2) for the 14 SBRM species groups combined by fleet for each SBRM year ([Table 8](#); [Figure 5](#)); and (3) for each of the 14 SBRM species groups/species by fleet and SBRM year ([Tables 9A and 9B](#); [Figures 6A, 6B, and 7](#)).

Based on these analyses, spiny dogfish and the skate complex had the highest (greater than 60%) percentage of discards of the 14 SBRM species groups ([Table 7A](#); [Figures 4 and 6A](#)). In SBRM 2010, red crab also experienced high discards (exceeded 60%) when both NE and MA red crab pot fleets (Rows 46 and 47, respectively) were observed. In SBRM 2009, only the MA red crab pot fleet (Row 46) was observed and in SBRM 2011 neither the MA or NE red crab pot fleets were observed ([Tables 2 and 9A](#)). Due to regulations prohibiting possession of female red crabs, discarding is expected to be higher in these directed red crab pot fleets than for other SBRM species and other fleets without such regulations. Red crab discards did occur in other fleets, most notably in the NE large-mesh otter trawl (Row 8; [Table 9A](#), Species Group: Red Crab). The majority of SBRM species groups had discard percentages that were less than 25%.

For several individual species, such as yellowtail flounder and halibut, the percentages of discards were high (greater than 37%) due to regulatory reasons (trip limits), while for other individual species, such as ocean pout, windowpane flounder, and red hake, the percentage of discards were high (generally greater than 50%) due to no or low market demand coupled with regulatory reasons (no possession) in fishing year 2010 ([Figure 6B](#)). The percentage of butterfish discards was high (greater than 70%) in the MA and NE small-mesh otter trawl fleets (Rows 5 and 7 respectively; [Table 9B](#); [Figure 6B](#); Species: Butterfish) in SBRM 2010 and SBRM 2011.

For the 14 SBRM species groups combined, fleets with the highest percentage of discards included: NE shrimp trawl (Row 16); MA large-mesh otter trawl (Row 6); NE large-mesh otter trawl (Row 8) (Table 8; Figure 5). In SBRM 2009, the NE longline (Row 2) and MA large-mesh gillnet fleets also had high percentages of discards, both associated with the discards of spiny dogfish. It is unexpected that NE shrimp trawl (Row 16) would rank highest among these fleets when regulations require this fleet use a bycatch-excluding device, the Nordmore grate, and specify no possession of large-mesh groundfish. Misreporting of gear used in the VTR data is clearly evident in this fleet. The seasonal nature (December to April) of the northern shrimp fishery contributes to the inadvertent misreporting of gear code (OTS = otter trawl, shrimp and OTF = otter trawl, fish) by fisherman who switch between these two fisheries. While the percentage of discards in this fleet is high, the magnitude of discards is very low (less than 0.5%) of total discards of the SBRM species groups combined (Table 8). It is important to note that northern shrimp, the target species of the NE shrimp trawl fleet, is not an SBRM species. Due to the minor numbers of trips misreporting the gear type used and the resultant large percentages of SBRM discards for this fleet, the NE shrimp trawl fleet (Row 16) has not been included in Figure 5. The reader should cautiously consider the New England shrimp trawl fleet results that are associated with the VTR data (Tables 8, 9A and 9B; Figures 6 through 9). The fleet results associated with the NEFOP data (Tables 5A and 5B) are not impacted by this data quality issue.

For each of the 14 SBRM species groups, fleets with the highest percentage of discards in all 3 of the SBRM years included: MA large-mesh otter trawl (Row 6), MA General Category Open scallop dredge (Row 31); and NE large-mesh otter trawl (Row 8; Tables 9A and 9B; Figure 7).

The landings associated with the various minor fleets aggregated in "Other fleets" generally constituted less than 0.01% of the total landings across all fleets (Tables 8, 9A and 9B). However, in SBRM 2009, the percentage was slightly higher (but generally less than 0.5%) due to more fleets having been aggregated into the "Other fleets" in this year (there were the eight fleets not considered in the annual 2009 SBRM analyses but were included as separate fleets in SBRM 2010 and 2011).

Precision of the discard estimates are presented in Tables 9A and 9B and displayed in Figures 8A, 8B, 9A, and 9B for each of the 14 SBRM species groups and for the individual species that comprise these groups. The precision associated with the estimated discards of species groups/species in fleets for which discards were considered unimportant (i.e., these groups constituted the lower 5% of the discard mortality and lower 2% of the total mortality and were filtered out via the importance filter process) were not used in the sample size analysis to determine the SBRM sea day standard. Only the precision of the discard estimates of the SBRM species groups were used in the sample size analysis (precision of individual species were not used in sample size analyses) and the precision of the SBRM species groups that were filtered out are indicated in light shade in tables summarizing estimated discards and precision. The precision of the discard estimates of individual species that were filtered out are not indicated in Table 9B.

None of the precision estimates for five of the 14 SBRM species groups (bluefish, tilefish, Atlantic herring, surf clams/ocean quahog, and salmon) were used in the sample size analysis, thus these species groups are not presented in Figure 9A. The precision (CV) of the discard estimates for SBRM species groups and the individual species that were considered important varied by species groups/species, fleet and SBRM year. For the 14 SBRM species groups in the 3 SBRM years, 89 of the 128 precision estimates (70%) were less than or equal to 30% CV (Table 9A; Figures 8A and 9A). For the individual species that comprised the 14 SBRM species groups in the 3 SBRM years, 76 of the 188 precision estimates (40%) were less than or equal to 30% CV (Table 9B; Figures 8B and 9B).

With regard to precision of the discard estimates, many of the species groups/species in the scallop Industry-funded fleets have CVs below 30% (Figures 8A and 8B). The numbers of observer sea days in the scallop fleets are based on the total fraction of landed value allocated to discard monitoring and the daily compensation rate. The compensation rate [16] is designed to avoid biases that might arise if vessels avoided observers at low compensation rates and vice versa at high compensation rates. Realized coverage rates generally exceed the SBRM standard sea days. Additionally, most of the species group/species in the NE large-mesh otter trawl (Row 8) have precision estimates below 30% CV due to the increased monitoring of NE groundfish fleets as part of the coverage for special access programs and, more recently, for Amendment 16 to the Northeast Multispecies fishery management plan. Conversely, many of the species groups/species in MA and NE small-mesh otter trawl fleets (Rows 5 and 7) have precision estimates at or above the SBRM standard of 30% CV due to constraints of available funds that prevent sea days from being allocated to these fleets (Figures 8A, 8B, 9A, and 9B). None of the precision estimates for the sea turtle species group in the 3 SBRM years were less than 30% CV.

Sea Turtles

The precision of sea turtle interactions derived within the annual SBRM analyses to determine the numbers of sea days needed to achieve a 30% CV are given in Table 10. None of the precision estimates for the sea turtle species group in the 3 SBRM years were less than 30% CV (Table 10).

The estimates of sea turtle discards were calculated from model-based methods (Table 11) that have been tailored specifically to sea turtles. These methods differed from the design-based methods which were used to estimate the SBRM sea day standards (from CVs) for all SBRM species groups. The design-based estimators of precision and SBRM standard sea days are useful for allocating observer coverage in a comprehensive program. Model-based estimators are useful for estimating average annual discards of statistically-rare species like threatened and endangered sea turtles. The design-based approach only estimates observable interactions, whereas the model-based approach can estimate observable interactions plus unobservable/quantifiable interactions (Murray 2011). As a result of the differences between methods shown in Table 11, the design-based CVs for the sea turtle species group (Table 10) tend to be larger than the model-based CVs for the single species of loggerhead turtle (Table 12).

The most recently published average annual estimates of sea turtle interactions with Mid-Atlantic commercial fisheries [17] are given in Table 12. Annual model-based estimates are sometimes available (Murray 2009) in addition to these average annual estimates. The NEFSC's Protected Species Branch has produced a draft estimate of loggerhead interactions in the U.S. Mid-Atlantic bottom trawl fish and scallop fisheries for 2005-2008, but it is not included in Table 12 because it is still in review. (Note that Warden 2011 offers an approach to prorate loggerhead interactions by managed species landed, but the research documenting the methods for estimating the overall rate and magnitude of interactions is still under review.) Please see the references in Table 12 for more information.

The methodology used to estimate turtle interactions in this report are different from those used for finfish in two important ways. Turtle estimates rely on a model-based estimator that is derived from a post-stratification process. Post-stratification can be used to

improve design-based estimators as well. This is typically used when one is interested in estimates of discards by stock (e.g., Georges Bank cod versus Gulf of Maine cod). Model-based estimates in [Table 12](#) rely on the outcome of observed trips. The ability to develop improved estimates, e.g., specific to areas or temperature patterns, after the samples are taken is expected because more information is available to the analyst. These same methods could be used to improve sampling coverage before the trips are taken *if* it is possible to obtain a sampling frame of vessels that are destined to fish in areas of interest. Otherwise, improvements to the model-based estimator must rely on an *a priori* probability that a vessel within a defined fleet will actually fish in the area. As a consequence the ability to improve post-stratified estimates for turtles, or any species for that matter, will be less efficient because one cannot ensure that a given trip will actually provide useful information.

Sample Size Analysis

The SBRM sea day standard (numbers of sea days needed to achieve a 30% CV for all SBRM species groups within a fleet using the designed-based methodology), and the prioritized funded sea days by fleet and SBRM year, are given in [Table 13](#). In each of the 3 years, the sum of the SBRM standard sea days exceeded the total funding for sea days. The shortfall in funding invoked the SBRM consultation and prioritization process which resulted in prioritized sea days. The SBRM sea day standard varied across years for a given fleet due to the variability in discard estimates among the 15 SBRM species groups, changes in fishing patterns, and changes in both the distribution and abundance of the species groups. The use of the previous year's data to estimate appropriate sampling coverage in a future year is predicated upon two assumptions: (1) the discard ratio and its variance remain constant, and (2) the distribution and magnitude of fishing effort remains constant in the relevant strata.

DISCUSSION

Observer Coverage (Section 1)

Percentage of observed coverage (in terms of trips, sea days, or landings) derived in this report should not be confused with the SBRM performance standard (30% CV of discard estimate), the specified metric used to allocate observer coverage among fleets and used to evaluate monitoring adequacy within the SBRM. It is important to note that the percentage of observed coverage may result in either over or under sampling of the fleet. Observer monitoring of bycatch must meet multiple objectives that include: bycatch monitoring of individual species (fish and turtles), compliance monitoring of annual catch entitlements (ACEs), and quota-monitoring of hard total allowable catch (TAC). SBRM focuses on monitoring to achieve acceptable measures of precision. Quota monitoring (including monitoring for compliance with regulations) is more challenging since increased coverage may be necessary to ensure more frequent in-season reports of discards rates. Monitoring rates for compliance with regulations often must be higher to reduce the scope for potential bias in estimation. It must be emphasized that SBRM does not consider the additional monitoring requirements for compliance. Increases in monitoring for compliance issues are based on the expectation that the observed variability in discard rates will include the normal variation plus potential, but unquantified, bias.

The use of the previous year's data to estimate appropriate sampling coverage in a future year is predicated on two assumptions: (1) the discard ratio and its variance remain constant, and (2) the distribution and magnitude of fishing effort remains constant in the relevant strata. The sufficiency of the predicted number of sea days generated using data from one year can change in response to a number of factors that include: variability in the discard estimates among the 15 SBRM species groups, changes in fishing patterns, changes in distribution and abundance of species groups, etc. When such changes are likely it is prudent, if possible, to increase coverage rates.

Due to the annual SBRM reporting process, SBRM 2011 is the first year where the sea day allocations were directly influenced by the SBRM sea day prioritization (see text table). The sea day coverage resulting from the SBRM 2009 schedule does not enter the SBRM analysis until SBRM 2011 (i.e., data collected during July 2009 through June 2010 results from a combination of sea day schedules from SBRM 2009 (two calendar quarters) and SBRM 2010 (two calendar quarters). Although the SBRM 2009 (July 2007 through June 2008) and SBRM 2010 (July 2008 through SBRM June 2009) data were not directly influenced by SBRM process, sea days were optimized using an optimization algorithm described in Rago et al. (2005).

There are several fleets where VTR trips are missing or less than NEFOP trips. These are areas where improvements in reporting compliance are needed. Continued outreach and education are needed. The need for improved data auditing of the gear types reported in the VTR data have been previously identified (Wigley et al. 2008b); the need continues.

Observed Encounters (Section 2)

This is a comprehensive summary of the data collected on observed trips by NEFOP trained at-sea observers and monitors. No discard estimation, resulting from an expansion of discard ratios, has been performed for observed encounters summarization. It is improper to calculate discard-to-kept ratios using this summary ([Tables 5A](#) and [5B](#)) because the data utilized to generate this summary include data from all hauls for which an observer was "on-watch," including hauls where discard data were not collected due to incidental take sampling and trips with "limited" sampling protocols. It is also improper to compare discard amounts across fleets without accounting for the number of observed trips by fleet; the number of observed trips will vary by fleet. This summary is not intended to replace analyses that subset NEFOP data for discard estimation (see Discard Estimation and Precision below). Subsequent SBRM analyses and/or species-specific stock assessment analyses may differ from this report due to differences in stratification and data used.

The percentages of trips that encounter species groups are informative in the prioritization of sea days. The percentage of trips encountering a species group provides a measure of the expected value of a trip toward reducing the variance of an estimate for a particular species or species group. As noted earlier, not all trips will be informative for all species. The encounter rate estimates can help guide vessel selection to ensure that species- or stock-specific discard information is improved. For example, an encounter rate of 25% for species A in fleet B would mean that only one of four trips in fleet B is likely to provide information on species A discards.

Discard Estimation and Precision (Section 3)

Fish/Invertebrates

The SBRM discard estimation analysis uses a broad stratification (region, gear type, mesh group, access area and trip category) to encompass all federally managed species considered in the SBRM, and uses a combined ratio method (discard-to-kept of all species weight ratio). The discard estimates reported here may not necessarily correspond directly with the discard estimates derived for individual stock assessments due to differences in stratification and data. It is expected, however, that estimates would be in the same order of magnitude. **The SBRM discard estimates are not definitive estimates, but are indicative of where discarding is occurring among commercial fleets.**

This review report presents the discard estimates derived through the SBRM process. The following caveats apply:

- A broad stratification scheme has been used to encompass all the federally managed species in the Northeast region. Species-specific stock assessment analyses may differ from this report due to differences in stratification and data used that include calendar year versus SBRM year, region (based on port of departure) versus area fished, and VTR landings versus Dealer landings.
- Region, based on port of departure, is used for deploying observers, and it is recognized that area fished would provide a better stratification for discard estimation.
- The SBRM analysis utilizes the Vessel Trip Report data. Dealer (*CFDETS*) data does not contain mesh or area fished information until the trip-based allocation is performed. The trip-based allocation of Dealer (*CFDETT*) data is conducted annually and was not available when each of the annual SBRM analyses was initiated.
 - The VTR point location is used to determine access area for commercial scallop fleets.
 - There are differences in species pounds between the VTR and Dealer data sets: VTR reports the good-faith hail weights while Dealer data provide actual landings weight.
- The current databases do not contain the needed information to match trips directly (i.e. one-to-one match) across databases and hence ad-hoc methods were developed; some misclassification of trips to a fleet may have occurred. Some of the misclassifications of trips are evident in [Table 2](#), while other misclassifications are evident in [Tables 8, 9A](#) and [9B](#). Further efforts in outreach and education, and additional auditing of VTR data, are strongly encouraged.
- Some imputation was needed due to limited temporal observer coverage of some fleets. It is recognized that using half-year estimates may not be appropriate for all species and that in some cells quarterly discard ratios were based on small sample sizes. This will contribute to lower precision (higher variability) of the discard estimates.
- Due to data limitations, discards were not estimated for all fleets, thus *total* discards are underestimated.
- We have assumed 100% discard mortality, i.e., we do not account for potential survival of organisms returned to the water. When comparing discard estimates from this study with those from stock assessments, it is useful to note that survival ratios are applied in stock assessments for spiny dogfish, summer flounder (fluke) and southern New England and Gulf of Maine stocks of winter flounder.

Sample Size Analysis

Pilot coverage has been used when the bycatch ratio is zero or when variance of the bycatch ratio or the variance of the composite total discards is zero. It is recognized that pilot coverage may result in too much coverage in cases where no observer coverage is needed for a cell. As bycatch information is acquired, the use of the unlikely (gray-shaded) filter (one of the three filters comprising the importance filter) can be evaluated and potentially eliminated to prevent the overuse of pilot coverage. When the importance filters are applied, cells with pilot coverage are expected to be excluded when cells have little or no discards due to other factors (e.g., discard amount is extremely low compared to total landings, etc). It should be noted that pilot coverage plays an important role in determining coverage for protected species (species where bycatch may be a rare event).

The SBRM Omnibus Amendment calls for attainment of CVs of no more than 30% in each fleet/species combination. Thus, for each fleet, a CV of 30% or less is to be attained for each species within that fleet. Some fleet/species combinations contribute very little to the total mortality or discard of the species, but may require significant resources to characterize the precision of the estimate. For example, a high variance estimate for a rare event within a fleet would require high levels of sampling, even though the total discard in that fleet was unimportant with respect to either the total discard or total mortality on the resource. Thus, the use of the importance filter is a key feature to the SBRM in that it focuses the sampling to fleets where it is needed most and not wasted on small imprecisely estimated discards.

Further improvements in precision of discard estimates are limited by total funding and constraints on funding by region or species group. The SBRM feedback process with the Councils and public ensures that priorities other than precision standards alone can be incorporated into the planned sea day allocations.

SUMMARY

This report highlights the broad data collection program of the NEFOP and that SBRM covers the majority of species encountered by commercial fleets as well as the discarded weight associated with these species. When prioritizing fleets, low encounters and low magnitude of discards of important/critical species can be considered. Additionally, this report provides a comprehensive summary of discard estimates by species group and individual species for federally managed species.

The annual SBRM reporting process provides a process and a structure to summarize the Northeast region's at-sea monitoring program, describes the methodology used in the estimation of discards, and the deployment of observers to achieve observer coverage that will yield discard estimates with the desired level of precision through a transparent process that include consideration of Councils' priorities and public comment.

Overall, the Standardized Bycatch Reporting Methodology represents one of the most comprehensive programs for planning and executing observer monitoring coverage of federally managed fisheries. The first 3 years of the program, summarized in this report, illustrate the utility of the approach for monitoring discards in these fisheries and the real-world limitations of implementing an ideal system. Variations in the overall magnitude of funding, constraints on the uses of funding, and competing objectives among fishery management plans are some of the factors that impede attainment of the overall target level of precision. An analysis of the performance of the SBRM will follow in part two of this review report.

ACKNOWLEDGEMENTS

We wish to thank all the NEFOP observers for their diligent efforts to collect the data used in this report.

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ENDNOTES

[1] In 2009, the first year of SBRM, the sea day analysis was conducted but not formally documented. The SBRM 2009 prioritization document was distributed to the Councils, but not posted on-line until March 2011. The number of trips and sea days used in the SBRM 2009 sea day analysis and the number of sea days needed to achieve a 30%CV for each species group and fleet for SBRM 2009 are given in the [Appendix Tables 1 through 3](#).

[2] Pilot coverage is defined as a minimum level of coverage to acquire bycatch information with which to calculate variance estimates that in turn can be used to further define the level of sampling needed; pilot coverage is further described in the Methods section of this report.

[3] Importance filters were used to provide a standardized protocol to further refine the number of baseline sea days and are briefly described in the Methods section of this report.

[4] Letters to vessel owners are available on-line at: <http://www.nero.noaa.gov/nero/nr/nr10.html>
<http://www.nero.noaa.gov/nero/nr/nrdoc/11/11ScalCompRate2011.pdf> (2011 letter)
<http://www.nero.noaa.gov/nero/nr/nrdoc/10/10ScalObserveCompRates1.pdf> (2010 letter)

[5] "Fleet" is synonymous with the SBRM Omnibus amendment "fishing mode."

[6] On-vessel sampling of large-volume fisheries can be difficult. Subsampling protocols were under development for the purse seine and mid-water pair trawl fisheries during 2004. Sampling protocols have since been established for these large-volume fisheries in 2010; the standardized sampling protocols for all fisheries with observer coverage are given in the Northeast Fisheries Observer Program Manual.

[7] At-sea monitoring (ASM) was implemented May 1, 2010 as part of Amendment 16 of the Northeast Multispecies fisheries management plan. NEFOP at-sea monitors adhere to the same data collection standards as observers; however, monitors conduct limited biological sampling. Information regarding both the observers and the at-sea monitors are available on-line at: http://www.nefsc.noaa.gov/femad/fsb/Manuals/JANUARY%202010%20MANUALS/ASM_Biosampling_Manual_2010.pdf

[8] Although NEFOP data can be summarized to five access area (including HOOK, B-Day, US/CAN), trips participating in these programs cannot be identified in the VTR database, hence the NEFOP trips were grouped by the other stratification variables and therefore have not partitioned separately for this review.

[9] see <http://www.nefinc.org/scallops/index.html> for further information on the sea scallop FMP.

[10] The majority of the pounds reported as "previously discarded" are "Fish, nk" representing skates without wings and/or monkfish without tails.

[11] See Wigley et al. 2007 for more details on self-reported VTR data.

[12] The trip-based allocation of Dealer (CFDETT/Sy yyyyAA) data are conducted annually and the data were not available when the annual SBRM analyses were conducted.

[13] 'Sample size analysis' is synonymous with "sea day analysis."

[14] Fraction of total mortality due to discards is defined as the ratio of discards of species group j in fleet h (D_{jh}) to the sum of commercial landings (L_{jh}), recreational landings (R_{jh}), and discards (D_{jh}) summed over h .

[15] Unique species reflect the species codes used by observers. Some species have not been identified to the species level, such as starfish, sponge, and sea cucumbers, and there are some cases when species cannot be positively identified and are recorded as a species group not known, e.g., "flounder, NK."

[16] Considerations in the compensation rate analysis include: a compensation rate that does not induce bias in vessel selection, the cost of carrying an observer, LPUE, and expected scallop prices.

[17] The term "fishery" used in the model-based analyses for turtles is not synonymous with the SBRM term "fleet."

