



A field test of fisheries observer sampling methods for estimation of at-sea discards



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ABSTRACT

Estimation of at-sea discards is an issue that has received considerable attention worldwide. With this increasing focus, there is a need for greater precision of weight estimates for less common and fishery-limiting species. While one solution is to mandate full (100%) observer coverage to reduce uncertainty in estimation at the trip level, variance from on-deck sampling methods (e.g. within-haul) should also be properly addressed. Commercial fishing vessels are not perfect sampling platforms and all sampling methods suffer from implementation issues that potentially impact the quality of the data collected and the resulting estimates. We conducted a cooperative study with industry to evaluate two observer sampling methods on trawl vessels delivering their catch to shoreside processors. The alternative observer sampling method that targets the portion of the haul that would be discarded directly at-sea, relying on shoreside reports of retained catch to generate total catch estimates, was tested against the standard methods currently used by the NMFS North Pacific Groundfish and Halibut Observer Program that sample the entire catch, both retained and discarded portions (combined). Methods were tested simultaneously by deploying two observers to sample each haul on study trips within three Gulf of Alaska trawl fisheries that varied widely in amount and species composition of discards: Rockfish Program, arrowtooth flounder, and shallow water flatfish. Although the alternative method was successfully implemented in two of the three fisheries, logistical constraints decreased sampling effectiveness in the third. In some situations, observers were unable to collect multiple samples under both methods, preventing variance estimation. This occurred more often for the observer using standard methods. Detection of less common and rare species was higher using the alternative sampling method. Discard estimates from the two methods were found to be significantly different in two of the fisheries examined (Rockfish Program and arrowtooth flounder). Discard estimates under the alternative method tended to have smaller variances than for the standard method, although this was not universally the case. These results provide an important comparison of the relative performance of different on-deck sampling methods under varying catch conditions and fisheries.

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1. Introduction

Estimating at-sea discards is an issue that has received considerable attention worldwide. Global and local fisheries catch including discards has been estimated (e.g., Alverson et al., 1996; Rochet et al., 2002; Kelleher, 2005), optimal sample sizes have been deter-

mined for programs that employ hierarchical designs (e.g., Allen et al., 2002), factors that are associated with discards have been identified (Feekings et al., 2012), and the best ways to estimate catch and discards have been explored (Tamsett and Janacek, 1999; Borges et al., 2004). Despite these important endeavors, we are aware of few studies that compare the perhaps more limited, but no less important, relative performance of on-deck sampling methods under varying catch conditions and fisheries (see, e.g., Tamsett et al., 1999a,b).

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The design of on-board sampling methods for observer programs needs to take into account the logistics of fishing operations (feasibility of implementation, see Tamsett et al., 1999a,b) as well as the management needs for data. As such, sampling methods used by observers in different programs will differ. For example, observers in the NMFS West Coast Observer Program sample the at-sea discards directly, usually weighing all discards (NWFSC, 2015). Retained catch is determined from industry landings data. However, haul-specific fishing locations are not available from these landings data. In contrast, in Alaska trawl fisheries, the volume of catches and discards often exceeds amounts that can be weighed directly by the observer. On many vessels, estimates of both retained catch and discarded catch are based on observer data, particularly on larger factory trawlers (Cahalan et al., 2014). While on vessels that deliver their catches to shoreside processors (catcher vessels, CVs), estimates of catch discarded at sea are based on observer data, and retained catches are based on industry-reported landings data. Observer sample methods in Alaska are focused on sampling the total catch and estimating the proportion of species-specific catch that is retained to be consistent in monitoring of fisheries across a wide range of vessel types and to provide haul-specific estimates of total catch size.

Monitoring of catch from the Alaska groundfish fisheries is the responsibility of the Alaska Regional Office Division of Sustainable Fisheries and the Alaska Fisheries Science Center's Fisheries Monitoring and Analysis Division (FMA). The FMA manages the North Pacific Groundfish and Halibut Observer Program (Observer Program) which deploys observers into commercial fisheries to collect catch data. In the North Pacific, there has been an increasing fishery management focus on individual vessel accountability of bycatch, and consequently there is an increasing need for higher precision of weight estimates for less common and fishery-limiting species discarded at sea, such as Pacific halibut (*Hippoglossus stenolepis*) and salmon (*Oncorhynchus* spp.).

In Alaska, non-pelagic (demersal) trawl catcher vessels (CVs) present one of the most challenging at-sea sampling situations that observers encounter (Cahalan, 2010). Individual hauls are generally 4.6–16.5 t, and crews sort catch directly from the trawl alley. On these vessels, observers work on the trawl deck where sampling space and access to catch is limited; the mean haul-level sample fraction in these situations is 6.6% of the total haul weight.

Many factors contribute to the variance of estimates of species-specific catches and at-sea discards, including difficulty in: (1) collecting samples and resulting small sample fractions, (2) estimating the weight of the total catches, and (3) determining the percentage of catch that is discarded at sea for each species. The haul-specific catch estimates may have high variance due to these sampling challenges. Sampling methods that are tailored specifically to this sampling environment may provide data for unbiased, lower variance estimation of catches.

Sampling efficiency on catcher vessels may be gained by using methods that target the portion of the total catch that is of interest, in this case at-sea discarded catches. Because the total weight of samples is limited by logistical constraints, the sample fraction achieved by observers collecting the same weight of sample from a smaller (e.g., discarded) portion of the catch is likely to be greater than that obtained using the standard Observer Program methodology (AFSC, 2011).

Our research compared two observer sampling methods in the trawl catcher vessel fleet: (1) the standard sampling method currently used by the Observer Program that samples from the entire catch (retained and discarded), and (2) an alternative method that is based on sampling the discarded portion of the catch thereby relying on industry-reported landings data of retained catch (at-sea methods similar to those used by the NMFS West Coast Observer Program; NWFSC, 2015). Specifically, we evaluated the potential

gains in precision resulting from a more targeted sample method (sample discards only at the haul level; retained catch is based on landings data at trip level) against standard methods where total catch is sampled (both retained and discarded) at the haul level. Although the bias of the data resulting from these two sampling methods is not directly estimated because the actual weight of discards is not known, the relative accuracy of the two methods can be evaluated by comparing species-specific discard estimates for each haul. The objective of this research was to: (1) evaluate the feasibility of implementing this proposed alternative at-sea discard sampling method that targeted at-sea discards instead of total catches across a range of fisheries and fishing operations, (2) assess the potential for bias in the proposed sampling method relative to the standard method, and (3) evaluate the precision of estimated at-sea discard for these two methods.

2. Methods

2.1. Study fisheries

Participating vessels fished several trips in three fisheries; Gulf of Alaska rockfish (Rockfish Program), Arrowtooth flounder (*Atheresthes stomias*), and shallow water flatfish. The Rockfish Program is a catch share fishery with full observer coverage (observers onboard for every fishing trip), with catches dominated by rockfish species (*Sebastes* spp.) and generally small amounts of low diversity at-sea discard. The shallow water flatfish complex consists of northern rock sole (*Lepidopsetta polyxystra*), southern rock sole (*Lepidopsetta bilineata*), yellowfin sole (*Limanda aspera*), butter sole (*Isopsetta isolepis*), starry flounder (*Platichthys stellatus*), English sole (*Parophrys vetulus*), sand sole (*Psettichthys melanos-tictus*) and Alaska plaice (*Pleuronectes quadrituberculatus*). The arrowtooth flounder and shallow water flatfish fisheries have observers onboard for some of their fishing trips. Discards in the latter two fisheries are more diverse and the total amount of at-sea discard is much higher than seen in the Rockfish Program.

2.2. At-sea sampling methods

Two observers were deployed on each trip and hauls were sampled simultaneously by both observers: one observer sampled using the standard sampling method in which the total (unsorted) catch is sampled while the other observer used the alternative sampling method to only sample the at-sea discards (paired analysis). In this study we compared the precision and relative bias of the two methods. The precision of estimates was assessed for the two methods by comparing the estimated variances of the discards. Bias of the two estimates based on data from the two methods was evaluated in a relative sense; the species-specific catch was not weighed and hence the true value was not known.

The major difference between the standard and alternative sampling methods is in the definition of the sampled population within each haul. The standard Observer Program method for at-sea sampling in Alaska defines the sampled population as the *entire* catch (retained and discarded), while the alternative method defines the sampled population as the *portion of the catch that was discarded*. The objective of sampling in both situations is to collect data to estimate the at-sea discard of catch for each sampled haul, as well as include recording haul-specific catch locations (latitude and longitude), collecting biological data (e.g. fish lengths, otoliths, and halibut injury data), monitoring for marine mammals and seabirds, including recording and monitoring gear interaction with US Endangered Species Act species.

The standard Observer Program protocols were used to select which hauls on a trip were sampled; that is, both observers sampled

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