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Dan Hull, Chairman
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Re: Agenda Item C-3 Observer Supplemental EA

Dear Mr. Hull:

Thank you for the opportunity to comment on Agenda Item C-3. The Boat Company's challenge to the NMFS's adoption of the restructured observer program reflected the concern that the reductions in observer coverage levels diminished the statistical reliability of bycatch estimates. TBC recognizes NMFS's effort to fix one of the major pre-existing problems with the observer program - "deployment bias" – i.e. the bias that arose when vessels chose for themselves when to take an observer, resulting in non-representative data. But this emphasis resulted in a reduction in observer coverage levels well below levels anticipated in the EA/RIR/IRFA. The U.S. District Court for the District of Alaska subsequently ruled that the initial EA/RIR/IRFA was inadequate for failing to address risks to data quality associated with lower levels of observer coverage realized under the restructured program. It is important to note that the specific data quality concerns identified in The Boat Company's briefs pertained primarily to NMFS' ability to assess and manage bycatch under the restructured program, particularly the need to improve estimation of halibut and chinook salmon bycatch in the Gulf of Alaska (GOA) trawl fisheries.

A prevailing theme reiterated throughout the SEA is that the restructured program represents an improvement relative to the previous program due largely to the expansion of the sampling effort to smaller vessels, most of which participate in IPHC managed halibut fisheries.[1] NMFS cites improved representativeness of data because of the increase in nearshore data and inclusion of smaller vessels, even with "very low deployment rates." [SEA at 105]. In particular,

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[1] *See* SEA at 89 (identifying the expansion of the program to smaller vessels as representing "a significant improvement in the statistical reliability of estimates" and 106 (the main highlights of the restructure action were improvements in the sampling methods and sampling frame, that, taken together, have greatly improved the reliability of observer information compared to the previous program").

spatial distribution of observer coverage improved, with coverage in southeast Alaska as the "largest improvement" and with additional improvements in other nearshore areas associated with monitoring the IFQ halibut fishery for the first time. [*Id.* at 48].

However, the court was aware that NMFS had improved coverage where there had been none before. The issue this SEA needed to evaluate pertained to when observer coverage levels are too low to generate statistically reliable data, particularly with regard to bycatch estimates. The SEA ultimately concludes that there was neither "a specific level of observer coverage below which the data cease to be statistically reliable" nor a specific amount of coverage which would limit NMFS' ability to manage the groundfish fisheries. [*Id.* at 107-108.] Instead the primary consequence of low coverage levels would be that "there are levels of observer coverage at which NMFS may not have data in specific strata or fisheries." [*Id.* at 108]. In drawing these conclusions, NMFS defines statistical reliability as "the degree to which data collected by at-sea observers is representative of the sampling frame and the target populations." [*Id.* at 37].

The SEA's conclusions, and definition of statistical reliability, are not adequately explained. A primary Council objective for the restructured program was to obtain "*accurate and precise* … bycatch information." [NMFS 2011 (Amt. 86/76 EA/RIR/IRFA) at 9]. As explained in Babcock and Pikitch's 2003 study, "How Much Observer Coverage is Enough to Adequately Estimate Bycatch," "the precision of an estimate depends on the size of the sample, the size of the fishery, and the variability of the bycatch. The accuracy of an estimate depends on these measurements, as well as whether the sampled part of the fishery is representative of the entire fishery."[2]

The SEA approach appears to measure statistical reliability primarily, if not exclusively, by representativeness (accuracy) thus omits needed analysis regarding the precision of its bycatch estimates. The restructured program explicitly attempted to follow NMFS national guidance for bycatch monitoring programs, which sets performance standards in terms of precision goals.[3] The SEA's approach is a significant departure from other bycatch reporting methodologies and previous Alaska Fisheries Science Center analyses and a major flaw, as explained in the University of British Columbia (UBC) Fisheries Centre's review of the SEA.[4] TBC requests that the Council direct NMFS to revise the draft and squarely answer the question of how much coverage is needed to meet the Council's objectives for accurate and precise bycatch estimates needed to guide observer deployments, and to identify ways to meet those objectives.

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[2] Babcock, E.A. & E.K. Pikitch. 2002. How much observer coverage is enough to adequately estimate bycatch? Unpublished report. 35 p.

[3] NMFS. 2004. Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs.

[4] McAllister, M. & Hawkshaw, M. 2015. Review of the DRAFT Supplement to the Environmental Assessment for Restructuring the Program for Observer Procurement and Deployment in the North Pacific (May 2015).

<u>Precision: The SEA needed to analyze and/or disclose the potential for error in its PSC estimates</u>

The Magnuson-Stevens Act requires that Fishery Management Plans (FMPs) include a "standardized" bycatch reporting methodology. [16 U.S.C. § 1853(a)(11)]. TBC's testimony and handout at the October 2014 Council meeting requested that the SEA evaluate coverage levels in light of national performance standards, past analyses and other recommendations with an emphasis on providing statistically reliable bycatch estimates. Specifically, TBC hoped that the analysis would address how well the restructured program would meet performance standards in terms of precision goals. Precision standards are essential to determining the appropriate level of observer coverage for differing management needs. [*See, e.g.* 73 Fed. Reg. at 4737].[5] In its Final Rule, NMFS agreed that:

> … performance standards, such as the acceptable amount of error (precision) represent an important and necessary step towards a fully optimized deployment of observers. 77 Fed. Reg. at 70070; *see also* EA/RIR/IRFA at 171 (identifying performance standards as necessary in order to achieve fully optimized observer deployments)].[6]

The initial EA reflected a guidance document that NMFS used to implement the restructured program – "Evaluating Bycatch: A National Approach to Standardized Monitoring Programs", which provides information for NMFS regions to develop standardized bycatch reporting methodologies. Evaluating Bycatch explains that the adequacy of a bycatch data collection program "must be viewed in terms of both the precision and accuracy of the resulting bycatch estimates" and that a "full evaluation requires estimates of both elements." [NMFS 2004 at 38].[7] The "standard measure of precision" for the Evaluating Bycatch approach is a "coefficient of variation," or CV. [*Id.* at 47]. Evaluating Bycatch thus recommends that the statement of observer program objectives identify a desired level of precision and recommends a precision goal of a 20-30% CV for bycatch estimates. [*Id.* at 49, 60].

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[5] Magnuson-Stevens Fishery Conservation and Managemetn Act Provisions; Fisheries of the Northeastern United Staes; Northeat Region Standardized Bycatch Reporting Methodology Omnibus Amendment, Final Rule. 73 Fed. Reg. 4736 (January 28, 2008).

[6] Groundfish Fisheries of the Exclusive Economic Zone Off Alaska and Pacific Halibut Fisheries: Observer Program. Final Rule. 77 Fed. Reg. 70062 (November 21, 2012); see73 Fed. Reg. at 4737-38 (January 28, 2008)(explicitly establishing precision standards for bycatch estimation in the Northeast Region so that there is a performance measure by which the effectiveness of the SBRM "can be measured, tracked, and utilized to effectively allocate the appropriate number of observer sea days;" allocating observer coverage aimed at a 30% CV precision level, and requiring triennial reports to evaluate the effectiveness at meeting the standard).

[7] "Evaluating Bycatch" explains that "[t]he accuracy of an estimate is the difference between the mean of the sample and true population value. The precision of an estimate is essentially how repeatable an observation would be if a number if independent trials were to be conducted."

The 30% coverage level identified as a target coverage rate by the Council reflected an effort to meet the precision standards set forth in "Evaluating Bycatch." The EA identified the 30% coverage level as a "minimum standard" and "least conservative rate" for the randomized, restructured program. [NMFS 2011 at 180]. The 30% target was not selected because it was the mandatory rate under the pre-existing program. Rather, it reflected prior analyses showing that lower levels of observer coverage were associated with high levels of error for many species and in order to achieve national performance standards for bycatch estimates, coverage levels of 30 – 78% were needed. [*Id.* at 173-177]. These prior analyses showed that:

> … low levels of observer coverage are associated with relatively high levels of error for most target and non-target species (Fig. 1). For target species and some non-target species, error decreases rapidly as coverage increases from 10% to 30% and much more slowly under further coverage increases. For some bycatch species, however, uncertainty remains high, even when all vessels are observed. [Karp & McElderry 1999].[8]

Karp and McElderry further explained that "[i]f random selection is possible, and ***the observer effect was not of concern***" bycatch estimates for frequently occurring species with acceptable levels of error were achievable at 30% coverage levels, with much more coverage needed for less frequently occurring species such as Chinook salmon. [*Id.*]. The SEA does discuss variance in bycatch estimates but now asserts that: "CVs are not an appropriate performance metric to measure representative sampling (a primary goal of observer restructuring)." [SEA at 37].[9] It explains that "[a]n analytical focus on variance does not evaluate the overall quality (representativeness, sample size adequacy of the underlying data collect process." [*Id.*] Instead the SEA asserts that collected data will be of high quality if the sample is large enough to represent the entire target population. [*Id.*]

As explained in the UBC Fisheries Centre's review of the draft SEA, it is possible to successfully achieve a random sample and still fail to deliver accurate and precise bycatch estimates. TBC requests that the Council and Science and Statistical Committee consider pages 1-7 in McAllister and Hawkshaw's review which recommends that NMFS staff prepare additional analysis prior to finalizing the SEA:

- "This is not a sufficient analysis … to generate useful information on bycatch …. These data are only useful if they produce estimates of bycatch that are sufficiently accurate and precise. There's no way around this. It is thus vital to evaluate the expected

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[8] Karp, W.A. & H. McElderry. 1999. Catch monitoring by fisheries observers in the United States and Canada. P. 261-284 in Nolan, C.P. (ed.), *Proceedings of the international conference on integrated fishery monitoring*. Sydney, Australia: 1-5 February 1999.

[9] Notably, the SEA's discussion of Cahalan et al's 2015 investigation of precision of estimates on full coverage vessels in the Bering Sea determined that "overall, the magnitudes of variance for the fisheries in this study were generally within the 20% to 30% goal recommended in the 2004 NMFS report "Evaluating Bycatch."

precision and accuracy of [bycatch estimates] and estimation methods that provide sufficient precision and accuracy for bycatch estimates for all key species."

- "… the methodology does not address the biases and variability associated with the estimation of parameters of interest from data that has a large proportion of zeroes and large variation in the positive bycatch records."
- The SEA's assessment of data quality, which evaluates the degree of representativeness of a sample or focuses on gaps[10] is "an obvious flaw in the report" because "it is not sufficient to identify whether the chief results obtained could be expected to be precise and accurate enough for management purposes." Thus the analysis should consider different and more complex estimation methods, particularly for situations with a high incidence of zero inflated data and highly skewed distributions of bycatch.
- Cahalan's 2015 evaluation of estimation methods reflects data from from a fully observed fleet and is thorough in that context, but an evaluation of the reliability of methods for developing bycatch estimates from the partially observed fleet with low coverage rates is needed.

Thus, on the important issue of whether the restructured program can generate statistically reliable bycatch estimates, McAllister and Hawkshaw conclude that:

> It is surprising that given 2 years of improved observer coverage no analysis of the improvements in estimation of bycatch has been done. Given current and alternative methods of bycatch estimation and given improvements in data collection a key missing piece of this analysis is an evaluation of the expected bias and coefficient of variation in bycatch estimates for bycatch species for different Alaskan fishery cells that have so far been obtained and could be expected to be obtained from the implementation of the new program, even using the simple expansion methods that are currently implemented in the CAS.

In sum, TBC requests that the Council direct NMFS to substantially revise the draft SEA with analysis that responds to the UBC Fisheries Centre's review. Such analysis is essential to ensuring that the restructured program can meet the Council's objectives and NMFS' obligations under the Magnuson-Stevens Act and NEPA.

Observer Effect

TBC's comments at the October 2014 Council meeting requested that the SEA evaluate coverage levels and other program elements relevant to accounting for the observer effect, including a review of scientific literature that compares landings and trip data from observed and

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[10] *See* SEA at 37, 70, 88. The SEA's conclusions about data quality reflected an evaluation of the probability of gaps in the estimation process at different coverage levels, using a standard of a more than 50% probability of a post-strata being empty. Based on this analysis, it concluded that "even at observer deployment rates of less than 15% there was generally sufficient observer coverage to provide estimates of discards and at FMP level for all size vessels."

unobserved trips. The literature shows that bycatch rates from observed trips do not reflect actual bycatch rates and bias the estimates. [Sampson 2002;[11] Benoit and Allard 2009]. The SEA acknowledges that "since bycatch accounting relies on at-sea data collection from observers, incentives exist to fish differently when an observer is on board a vessel than when a vessel is unobserved (i.e. to fish in areas where bycatch is expected to be lower). [SEA at 112]. "Evaluating Bycatch" explains that PSC limits can effect both the "nature and magnitude" of bias arising from the observer effect: "if there are bycatch limits that can either close a fishery or trigger time and area closures, fishermen will have a greater incentive to take actions that result in observer effect bias." [NMFS 2004]. The inherent difficulty in determining the representativeness of observed catch and effort is also magnified for "programs with low levels of coverage, where knowledge is limited regarding the unobserved portion of the fleet." [NMFS 2004 at 38]. At the recent NPFMC/IPHC Halibut Bycatch Workshop, IPHC Executive Director Bruce Leaman explained that the observer effect significantly undermined confidence in the estimate of halibut bycatch in the GOA:

> The estimation of total bycatch mortality in the Gulf of Alaska therefore rests on the assumption that observations on observed vessels are representative of fishing activities and halibut bycatch estimates for unobserved vessels. There is amply evidence and analyses to deny the validity of this assumption. The biases in observer deployment and behavioral modifications … make it impossible to estimate the magnitude of bias embedded in current estimation procedures. [Raab & Stern 2013].[12]

But the analysis does not consider whether higher levels of observer coverage could reduce observer effect bias by providing a financial incentive to fish differently and thus improve the accuracy of PSC estimates. [Babcock and Pikitch at 8]. McAllister and Hawkshaw's review of the SEA indicates that additional tests to determine the differences between observed and unobserved vessels should occur at a finer scale, [McAllister and Hawkshaw 2015]. TBC requests that a revised SEA provide this information and a more detailed analysis of the potential for statistical bias due to the observer effect.

<u>Specific Concerns Re: PSC Estimates</u>

As previously noted, the briefs reviewed by the court in *TBC v. Blank* emphasized the problem of whether the restructured program would generate statistically reliable PSC estimates. The SEA recognizes a management concern with halibut and salmon PSC in the GOA and notes a priority

[11] Sampson, D.B. 2002. Final Report to Oregon Trawl Commission: analysis of data from the at-sea data collection project. Oregon State University. Newport, Oregon (finding that the species composition of landings from observed and unobserved trips were significantly different, implying that total estimates of bycatch based on observer data may not be reliable).

[12] Raab, J. & S. Stern. 2013. NPFMC/IPHC workshop on halibut bycatch estimation, halibut growth and migration, and effects on harvest strategy: Meeting Summary. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2012: pp. 277 – 325.

on covering PSC vessels. [SEA at 56]. Babcock and Pikitch explain that bycatch estimates must be made with high levels of precision when the bycatch species is a protected species (i.e. some Chinook salmon populations) or an important target species in another fishery (i.e. halibut). [Babock and Pikitch 2003 at 12 (citing Karp and McElderry 1999)]. In particular, more precise data can improve management when estimation of impacts to juvenile fish is an issue, or when the bycatch is an important commercial species, "the precision of bycatch estimates should be quite high, particularly if bycatch is large compared to the catch." [Babcock and Pikitch 2003 at 13].

In general, the SEA indicates that restructuring addressed some of the representativeness issues associated with monitoring of the trawl fisheries under the previous program through a flattening of coverage spikes near Kodiak and a small increase in the number of areas observed in the Western GOA. [SEA at 48]. It improved the tracking of actual fishing effort on a temporal scale. [*Id.* at 116]. But overall, "spatial coverage in the trawl fishery showed small changes in the distribution across the GOA and large changes in the footprint of observer coverage are not noted." [*Id.* at 48]. Ultimately, the SEA only provides roughly three pages of analysis specific to Chinook and halibut PSC. [*Id.* at 118-120]. TBC submits that the analysis needs to do more than demonstrate improvements in the representativeness of the data – particularly in light of past and ongoing concern about the relationship between low coverage levels and the statistical reliability of halibut and Chinook PSC estimates.

With regard to Chinook salmon, a series of Biological Opinions (BiOps) related to ESA-listed Chinook salmon stocks require NMFS to ensure sufficient observer coverage to monitor chinook bycatch in the groundfish fisheries on an inseason basis. [NMFS 2004b at 356].[13] The SEA identifies an important improvement in the restructured program through the extension of coverage to ,<60 foot vessels and acquisition of data throughout the season. [SEA at 118]. But even so, the analysis identifies only small increases in coverage in the western GOA which previously had coverage levels of less than 10% annually. [*Id.* at 48; NMFS 2012b at 187]. The SEA then explains that these changes addressed concerns raised in the 2012 Supplemental BiOp, which identified problems with substantial extrapolations from observed vessels over 60 feet to unobserved vessels. [SEA at 119]. This explanation, however, addresses only one of two problems identified in that BiOp: (1) "a relatively modest rate" of 30 percent coverage for vessels >60 feet and (2) the lack of coverage for vessels <60 feet. [NMFS 2012a at 4].[14] After identifying these two problems, the BiOp refers to "*__overall low observer coverage__*" as "problematic for by-catch estimation and the use of by-catch caps for the fishery."

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[13] NMFS. 2004b. Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement. NMFS Alaska Region, Juneau, AK: June 2004.

[14] NMFS. 2012a. Endangered Species Act (ESA) Section 7 Consultation – Supplemental Biological Opinion. Supplemental Biological Opinion reinitiating consultation on the January 11, 2007 Supplemental Biological Opinion regarding authorization of the Gulf of Alaska (GOA) groundfish fisheries. NMFS Northwest Region, January 9, 2012.

[*Id.*(emphasis added)]. It actually anticipated that NMFS would implement at least 30% observer coverage for both vessel size categories. [*Id.* at 7].

The SEA does not provide information needed to answer questions about chinook PSC estimation in the GOA, particularly relative to NMFS' monitoring obligations under the ESA and ongoing efforts to assess stock composition. For example, other prior reviews have indicated that "the accuracy and precision requirements for salmon bycatch estimates … are high" because of inseason management needs. [Karp & McElderry 1999]. Further, the SEA does not compare overall coverage of the pollock trawl fishery relative to the previous program. For example, coverage of pollock trawlers in the Central GOA averaged 31% prior to restructuring, and even exceeded 50% during some seasons. [NMFS 2012b at 57].[15] Even with the previous gap in coverage caused by the prior exemption of the <60 foot vessels, the percent of observed catch in the WGOA still ranged between 25% and 36%. [*Id.* at 186]. What level of catch coverage has been achieved under the restructured program? The SEA does not address this question.

The SEA fails to address scientific concerns about Halibut PSC estimation in the GOA trawl fisheries

The SEA provides only a brief discussion of halibut PSC estimation and cites the IPHC's comment that "[o]bservations on halibut bycatch in BSAI fisheries are among the more extensive for fisheries in Alaska (Stewart et al. 2014]." [SEA at 119-120]. But the SEA fails its NEPA obligation to disclose the IPHC's ongoing concerns about the program. The IPHC supported the efforts to ensure random sampling, address deployment bias, and expand coverage to the previously unobserved fleet. But it also identified problems with the reduction in observer coverage levels, and "considers the bycatch estimates for the groundfish fisheries as minimum estimates" with "unknown" accuracy. [IPHC 2014].[16] Indeed, the citation to Stewart 2014 is misleading – Stewart et al. 2015 note the BSAI coverage, and then identify "a substantial amount of uncertainty in the treatment of bycatch" due to low coverage levels in the GOA.[17] Similarly, the

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[15] NMFS. 2012b. Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis for Amendment 93 to the Fishery Management Plan for Groundfish in the Gulf of Alaska: Chinook Prohibited Species Catch in Gulf of Alaska Pollock Fishery, February 2012. While the 2012 EA/RIR/IRFA expressed particular concern about low coverage of <60 foot vessels in the Western GOA, the discussion implies considerable uncertainty about estimating chinook PSC with low levels of observer coverage: "[l]ow coverage rates will require limited observer data on Chinook salmon PSC rates to be applied to substantial amounts of unobserved catch. If the catch rates applied to the unobserved catch are greater than the actual rates, the estimated Chinook PSC will be overestimated. If the applied catch rates are lower than the actual PSC, Chinook salmon catch will be underestimated. *Information will not be available to know if Chinook salmon PSC is actually greater or less than the estimated numbers*."

[16] IPHC. 2014. Report of the Halibut Bycatch Work Group II. September 2014.

[17] Stewart et al. 2015. Accounting for and managing all Pacific halibut removals. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2014: pp. 221 – 266 (adding that when coverage levels are low, "observer data may not be representative of all fishing activity (observed and unobserved) and therefore there is no way to be certain that the estimates are unbiased, regardless of the statistical design.

IPHC's two most recent Reports of Assessment and Research Activities both express concerns with halibut PSC estimation in the GOA:

> Area 3 remains the area where bycatch mortality is estimated most poorly. Observer coverage for most fisheries is relatively low, as noted earlier, and the extrapolation of bycatch rates from a small set of observed vessels to a much larger unobserved fleet renders the estimates provided here uncertain.[18]

TBC submits that the analysis should disclose and respond to these concerns. Also, the analysis identifies some difficulties in evaluating some trawl fisheries – GOA flatfish fisheries - that have small numbers of trips. [SEA at 83, 108]. Babcock and Pikitch note that bias can be present in bycatch estimates when there are low sample sizes, even if observed trips are otherwise representative. [Babcock and Pikitch 2003 at 10-11]. GOA flatfish fisheries account for well over half of the trawl bycatch in Area 3A, and a revised draft should provide detailed discussion about ways to ensure adequate monitoring, including targeted sampling for these fisheries. [*Id.*; *see also* McAllister & Hawkshaw 2015 at 10 (recommending increased coverage to reduce bias in halibut bycatch estimates).

Conclusion

TBC requests that the Council direct NMFS staff to revise the SEA. The current draft did not respond to ongoing concerns such as the IPHC's comments regarding halibut bycatch estimation in the GOA and, as shown in McAllister and Hawkshaw's analysis, the SEA has significant analytical flaws and should consider additional testing and estimation methods. The SEA is thus not adequate to meet the overlapping analytical requirements imposed by NEPA and the MSA. [*See* 50 C.F.R. § 600.315(a), (b)(1)("conservation and management measures must be based on the best scientific information available" and the analysis must address differing opinions); 40 C.F.R. § 1502.9 (agencies "shall insure … the scientific integrity of the discussions and analyses); *Seattle Audubon Society v. Moseley,* 798 F.Supp.1473, 1478 (W.D. Wash. 1992)(environmental analyses must disclose risks and disclose and respond to scientific experts). It may be difficult to generate sufficiently precise and accurate bycatch estimates across the entire fishery given funding constraints, and TBC encourages the Council to request that the analysis consider coverage priorities and sector-specific objectives. Toward this end, TBC notes that the restructured program departs significantly from the approach taken in the 2006 public review

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Indeed, evidence indicates that the existing estimates are biased by harvester behavior (Benoit and Allard 2009, Faunce and Barbeaux 2011)").

[18] Williams, G. 2015. Incidental catch and mortality of Pacific halibut 1962-2014. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2014: pp. 313-336; Williams, G. 2014. Incidental catch and mortality of Pacific halibut 1962-2013. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2013: pp. 289-310; Stewart et al. 2015. Accounting for and managing all Pacific halibut removals. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2014: pp. 221 – 266.

EA for Amendments 86/76, which contemplated implementing more advanced deployments[19] for previously observed vessels using the prior data with unknown bias and baseline deployments for previously unobserved vessels.[20]

Sincerely,

Paul Olson

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[19] In 2004, "Evaluating Bycatch" identified the GOA Trawl, Pacific cod longline and pot observer programs as "Developing" meaning that it was ready for optimized sampling at that time, and the IFQ halibut fishery as "Pilot," meaning that the initial monitoring effort should be aimed at gathering baseline data.

[20] The Council's audio record from the December 2012 meeting includes testimony from NMFS staff describing prior GOA data from the observed fleet as "useless." However, a 2003 review of the program (MRGA Americas Inc., Field Sampling Evaluation, April 2003) explained that not using the data in any analysis at all would "create greater uncertainty than unknown bias" and recommended using the pre-existing data while recognizing the uncertainty associated with unknown bias.

Review of the DRAFT Supplement to the Environmental Assessment For Restructuring the Program for Observer Procurement and Deployment in the North Pacific (May 2015)

Murdoch McAlister and Mike Hawkshaw

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Background

Bycatch non-retention or discarding either because of regulations that limit landings of a species or because of economic reasons (keeping hold space free of less valuable fish) is a common problem in fisheries, and quantifying the magnitude of the bycatch is important for management. Understanding the productivity and resilience of the bycatch species is compromised if an unquantified source of fishing-related mortality is either not accounted for or inaccurately or imprecisely estimated. In many fisheries the amount of the discarded bycatch can often exceed the amount of fish taken in directed fisheries. The current observer program has as its goal to:

"obtain information necessary to conserve and manage the groundfish and halibut fisheries in the Gulf of Alaska (GOA) and the Bering Sea and Aleutian Islands (BSAI) management areas"(pg.19 NMFS 2015).

There is a large body of work concerned with the design of sampling protocols to assess population features, and methods to properly extrapolate from the samples obtained and make inferences about the populations of interest (e.g., Gunderson 1993). There exist many examples too of the problems created by poorly done extrapolations (e.g., Walters and Maguire 1996; Myers et al. 1996). The authors of this supplement to the environmental assessment correctly point out that there are two possible sources of bias in producing estimates of bycatch:

"In estimating total catch, two broad categories of bias reduce the quality of estimates: 1) bias resulting from non-representative sampling, and 2) bias related to the methods used for statistical estimation (Rago et al. 2005). "(pg.36 NMFS 2015)

They go on to state:

"Bias in the sample or resulting estimates can arise from different processes; the former are addressed through changes in deployment and sampling methods (e.g., randomization) and coverage of the target population, while the latter is addressed through determining appropriate estimators and post-stratification or sample weighting schemes"(pg. 39 NMFS 2015).

This review will evaluate how the observer program addresses these two sources of bias and comment on deficiencies and alternatives that need to be considered when evaluating the effectiveness of the choices made.

Method to estimate bycatch

Sampling design is an important component of quantifying the magnitude of the bycatch in groundfish and halibut fisheries in the Gulf of Alaska (GOA) and the Bering Sea and Aleutian Islands (BSAI) management areas. Even when there is relatively little sampling bias, the authors rightly point out that there are different methods available estimate bycatch and that from the same data, different methods could be expected to have different bias in estimates of bycatch. This is why there is a critical need to quantitatively evaluate the methods of estimation of bycatch in these fisheries, and to choose the best methods for extrapolating sampled bycatch to fleet and region wide estimates of bycatch. The supplement to the environmental assessment presents some discussion of the estimation of bycatch and the variance associated with those estimates given the sampled trips:

"However, because of the complex nature of the estimation of total catch, and the numerous points where variance is introduced into the estimates, final variance estimates are neither the only metric nor necessarily the best metric for evaluating stratification and randomization of sampling of primary sample units (trips, vessels). The use of a fixed CV in the Northeast Region has also illuminated cost tradeoffs; a fixed CV standard implies that a precise value is important regardless of the size of a sampling strata. This results in many more trips being needed on small sampling strata (holding estimation methods constant) to get a precise calculation and is likely not always a cost effective measure of deployment priorities (NEFMC 2012). An analytical focus on variance does not evaluate the overall quality (representativeness, sample size adequacy) of the underlying data collection process. A well-designed

sampling program will have a sample large enough to reasonably ensure that the sample data represent the entire target population and hence that the data collected are of high quality."(pg. 37 NMFS 2015)

This is incorrect, a program could focus on achieving a random sample and be successful at it but still be a failure should the program fails to deliver sufficiently accurate and precise results. The whole program will be a waste of money and effort if it fails to deliver sufficiently accurate and precise estimates of bycatch.

"For the purpose of this analysis, statistical reliability means the degree to which data collected by at-sea observers is representative of the sampling frame and the target population. The statistical reliability of the estimation methods was not part of the restructuring action since evaluation of estimation is focused on the CAS estimation methods, including definitions of post-strata, and estimation methods used throughout the estimation hierarchy, including the influence of haul-level sampling and estimation methods. However, in the context of changing deployment rates, low sample size can create gaps in estimation. Recognizing these potential estimation gaps, we evaluated the probability of gaps in the estimation process under varying observer coverage levels." (pg. 37 NMFS 2015)

This is not a sufficient analysis, in the end, the chief purpose of the sampling program is to generate useful information on bycatch in the groundfish and halibut fisheries. These data are only useful if they produce estimates of bycatch that are sufficiently accurate and precise. There's no way around this. It is thus vital to evaluate the expected precision and accuracy of estimates of bycatch obtained from the program and the goal should be to find the sampling approach and estimation methods that achieve sufficient precision and accuracy for bycatch estimates for all key species of concern given current logistical and cost constraints.

The least-cost and most rigorous approach to achieve a well-designed sampling program with a sufficiently large sample size is through simulation testing of candidate designs and their implementation and evaluation of the bias and precision associated with different methods to estimate the bycatch of different bycatch species. The plan does not present sufficient theoretical framework or evidence to link the observer coverage to variability in estimates of bycatch. There is a focus discussion of the bias that results from non-representative deployment of observers (deployment effect). However, the methodology does not address the biases and variability associated with estimation of parameters of interest from data that has a larger proportion of zeroes and large variation in the positive bycatch records.

"Bias in the sample or resulting estimates can arise from different processes; the former are addressed through changes in deployment and sampling methods (e.g., randomization) and coverage of the target population, while the latter is addressed through determining appropriate estimators and post-stratification or sample weighting schemes. "(pg. 39 NMFS 2015)

Work on determining appropriate estimators and weighting of samples is not presented in sufficient detail in the supplement to the environmental assessment to provide assurances that key data produced by the restructured program (e.g., on halibut and chinook salmon bycatch and discards) will be of sufficient quality to be useful in fisheries management:

"The statistical reliability of the estimation methods was not part of the restructuring action since evaluation of estimation is focused on the CAS estimation methods, including definitions of post-strata, and estimation methods used throughout the estimation hierarchy, including the influence of haul-level sampling and estimation methods."(pg. 37 NMFS 2015)

This is an obvious flaw in the report, evaluating the degree of representativeness of a sample or focusing on when gaps in the sampling frame occur at different levels of observer coverage is not sufficient to identify whether the chief results obtained could be expected to be precise and accurate enough for management purposes. If an important goal is to correctly reveal the magnitude of bycatch and trends in bycatch over time, an evaluation of the different estimation methods is essential. The current methods referred in the supplement (e.g., those methods evaluated in Cahalan et al. 2015) to the environmental assessment report to estimate bycatch are very simple ones:

"For trips where an observer is not on board, the catch estimation process (catch accounting system, CAS) produces catch and bycatch estimates by multiplying a discard rate by the amount of groundfish and halibut landed for a trip. The discard rate is derived from observer data and is calculated as the amount of species-specific discarded fish divided by the total retained groundfish and halibut caught on observed hauls" (pg. 41 NMFS 2015)

The variance calculations applied in the Cahalan et al. (2015) analysis appear to make assumptions, e.g., about the normality of parameter estimates, and may be inappropriate for situations with a high incidence of zero inflated data and highly skewed distributions of bycatch which may be the case for some of the bycatch species, fishing vessel and fishery types. The variance estimates provided for per trip bycatch and catch estimates may thus be biased in some instances. The challenge of zero inflated data is one encountered in many fishery and ecological applications and several different methods to address them have been tried at different times. This provides a strong body of theoretical and experiential work that can be drawn on to demonstrate the effectiveness of the current by-catch monitoring program. There are two main types of analysis that can be used to evaluate the variability of estimation of by-catch using zero inflated data, the first is a non-parametric or bootstrapping approach where the observed pattern of by-catch is used as a probability distribution; the second method is to formulate a probability distribution that models the observation process. In either case the chosen probability distribution is used to simulate observations and to model the variability in estimation associated with a given sampling rate. Jones (1998) uses simulation to demonstrate bias and variance in estimators of catch rate from sampling. McAlister and Tremblay-Boyer(2008) show how to apply the bootstrap method for estimating variance; in addition there are analysis of covariance and other methods that have been applied to these types of data where models are developed to jointly predict the probability of a zero and the magnitude of a positive observation should it be positive based on a limited set of factors and covariates (Ancelet et al 2010, Foster and Bravington 2013, Lecomte et al 2013, Barlow and Berkson 2012).

Some work has been identified as improving the estimation procedures (Cahalan et al 2015), which evaluates several methods for estimating bycatch rates by subsampling a fully observed fleet:

"Recent work by NMFS and Pacific States Marine Fisheries Commission has begun to evaluate the use of ratio estimators to estimate catch in Alaska waters. Cahalan et al (2015) used a simulation approach to evaluate the statistical properties of three estimators of trip-specific catch on fully observed CPs and catcher vessels in the BSAI and GOA: imputation, simple-mean, and a ratio estimator. The study expected the simple mean estimator to be more robust to biases and have higher variance

compared to the ratio estimator since the simple mean estimator does not rely on the use of auxiliary information (and is always unbiased). This was not the case. The study found the simple mean estimator to have a consistently lower bias and variance estimate then the ratio method. The degree to which the simple trips where species proportions were low (less than or equal to 15% of total catch), the simple mean estimator performed better, whereas, on trips where species proportions were high (greater than 50%), the ratio estimator performed similarly to the mean estimator. This was likely due to strong correlations between the species caught and the haul size for the more dominant species in the catch. Future evaluation of the post-strata will require that both the estimators and the sampling strata definitions in the ADP are considered. From this perspective, methods outlined in the ADP will influence the flexibility in any redesign of or use of CAS post-strata." (pg. 89 NMFS 2015)

Cahalan et al. (2015) offered a thorough evaluation of the reliability of methods to estimate catch and bycatch on a per trip basis for several components of the Alaska groundfish fishery. However, the Cahalan et al. (2015) study did not, evaluate the potential reliability of methods for expanding bycatch across the partially observed fleets or in the no-coverage fleets where the percentage of observed trips could be quite small, reported rates of coverage are as low as 10%-30% and the bycatch rates per trip are highly variable with a high frequency of zeros and highly skewed positive observations. This is a problem that is likely to persist even at higher levels of coverage:

"Data gaps at the FMP post-strata level for both small and large vessel strata are situations where no estimation can occur. The simulation results showed only a few gaps at the FMP post-strata level regardless of the vessel size category. Most gaps disappeared or were severely minimized at deployment rates less than or equal to 15% (relative to a 50% probability of a post-strata being empty). Data gaps in the small vessel estimation process that persist at higher coverage levels are linked to a sample frame that does not match the target population."(pg. 80 NMFS)

The issue of data gaps is a real one. However there are many suitable estimation methodologies that have been developed for these types of data. For example there are analysis of covariance methods that have been applied to zero-inflated data, with highly skewed positive values where models are developed to jointly predict the probability of a zero and the magnitude of a positive observation should it be positive based on a limited set of factors and covariates (e.g., BC inside waters yelloweye assessment, Yamanaka et al. 2012).

Simulation modeling is a standard practice for evaluating the effect of sampling design and should be applied to evaluate the effect of the current observer program's ability to generate useful estimates of bycatch. At a minimum this type of analysis can use both empirical fitting (McAlister and Tremblay-Boyer 2008) and fitted probability distributions similar to the methods outlined in Ancelet et al (2010).

It is surprising that given 2 years of improved observer coverage no analysis of the improvements in estimation of bycatch has been done. Given current and alternative methods of bycatch estimation and given improvements in data collection a key missing piece of this analysis is an evaluation of the expected bias and coefficient of variation in bycatch estimates for bycatch species for different Alaskan fishery cells that have so far been obtained and could be expected to be obtained from the implementation of the new program, even using the simple expansion methods that are currently implemented in the CAS.

Sampling design

It is a major challenge to design a sampling program that is representative of the fishery being studied (Jones et al 1995). Benoit and Allard (2009) point out two major impacts of observer deployment that must be considered when evaluating how representative a sampling program is when there is partial observer coverage. They point out that the deployment effect (i.e. non-random assignment of observers to vessels or trips) introduces one type of bias, and that the observer effect (i.e. changes in fisher behavior when observers are present) introduces a second type of bias.

Deployment effect

The method the observer program has chosen to address deployment bias is to have either full or partial observer coverage of groundfish and Halibut fisheries in the GOA and BSAI and to apply randomized design to achieved representative samples across the across the fishing fleets in the partial coverage category. The new sampling protocol (Alternative 3) that has been effectively adopted, offers a considerable improvement to the previous approach, which left many fleet, vessel type, size and area cells unsampled. The new sampling method attempts to achieve coverage of the full sampling frame for all of the different fishery and area cells with an attempt to implement random sampling of the population of samples in each complete sampling frame. However, due to logistical constraints, it appears that some sampling frames will be incomplete for a number of fishery type or area cells. The authors identify several areas where there are gaps in coverage that mean that there are elements of the groundfish and Halibut fisheries that are not sampled representatively (or at all). Figures 6 and Figure 7 (pg. 46-47 NMFS 2015) show that the program still sees poor coverage in some spatial areas, for example on the North Eastern nearshore area of GOA (Figure 6) and that there has been a change resulting in lower coverage levels in the EBS than in the earlier period.

There have been challenges associated with implementing the sampling methods in reported in this supplement to the environmental assessment and in the annual deployment plans demonstrating a serious problem with the deployment methodology for this sampling frame:

"In general, the report found sampling in the large vessel stratum to be representative, whereas the vessel selection stratum had numerous issues that were indicative of unrepresentative sampling."

The authors of this report point out in more detail that they were unable to achieve random samples in several reporting areas and times of the year, likely resulting in biases.

"<u>Vessel Selection</u>: The impact of non-response (i.e., a vessel was selected to be observed, but was released or exempted during the selection period) had significant impacts on the spatial distribution of observer coverage, with several reporting areas consistently having coverage levels different from expected for much of the year. The small sample sizes for each selection period made distinguishing differences in trip attributes between observed and unobserved vessels inconclusive. However, very large differences would have been detectable and these were not observed. Perhaps the largest problem was that coverage levels were less than expected during the first 5 selection periods (January through October) resulting from a poorly defined sampling frame and large number of conditional releases. In the last period this resulted in abandoning random

sampling in an effort to get enough vessels observed to conform to expected sampling rates.

The authors point out that the most recent deployment plan addresses the issues, but they do not elaborate on the expected results of these changes:

Results from the 2014 Annual Report (evaluating 2013 deployment) prompted the NMFS and Council to recommend and implement, changes to sampling methods from those used in 2013 and 2014. These changes were made in the 2015 ADP and are anticipated to improve the statistical reliability of observer data in 2015."

This represents a clear source of deployment effect whose bias into the estimation of bycatch is not quantified.

In addition to the problems with achieving the desired random sampling within the sample frames chosen for monitoring there is the additional impact of un-observed fleets or fleet elements. Some fleets are not monitored at all for logistical or other reasons. For example, the smaller boat fleet (<40 ft LOA) landing mainly Pacific cod is exempt from observer coverage:

"No selection: The "no selection" pool comprises of catcher vessels less than 40 ft LOA, or vessels fishing with jig gear, which includes handline, jig, troll, and dinglebar troll gear, or vessels that are conditionally released due to life raft capacity. In addition, vessels selected by NMFS to participate in the electronic monitoring cooperative research will be in the no selection pool while participating in the research." (pg. 30 and Figure 4 in NMFS 2015)

There are a number of other specific gaps in coverage for example Pollock trawlers delivering to Catcher processor vessels are exempt from observer coverage requirements:

"… are exempt from coverage when delivering unsorted cod ends to a CP or MS." (pg. 32 NMFS 2015)

This represents a clear source of deployment effect which may bias the estimation of bycatch.

The supplement to the environmental assessment reports that in those fisheries in which numerous species are brought aboard at once, observers are less efficient at sampling the catch and must reduce the number of samples that they process:

"Management programs with diverse fisheries require an observer to spend more time sorting and sampling catch to insure all species are adequately sampled. This increases sample process time and also limits the size and number of samples that can be taken by an observer. The smaller sample size causes higher estimated variance in more diverse fisheries, especially fisheries containing rare species." (pg. 37 NMFS 2015)

This is another area of potential failures to achieve the full sampling frame by reducing the effective number of samples taken on a trip.

Bycatch estimates of Pacific halibut in the Gulf of Alaska may be compromised due to low coverage in the shallow water flatfish fishery where there may be considerable bycatch rates of halibut:

A few of the post-strata categories with potential gaps are a result of the methods used to calculate trip target in the CAS or gear misidentification on the fish ticket. These include the pairing of shallow water flatfish, Pacific cod, or arrowtooth targets (target code "H", "C", or "W") with pelagic trawl gear, pot gear with other species ("O" target likely reflecting octopus), and non-pelagic trawl gear with a pollock target (generally caught with pelagic trawl gear). These categories generally had a small number of trips (Figure 28). (p. 83, SEA 2015)

Given the relatively small number of shallow water flatfish trawl trips observed and their potentially high rates of halibut bycatch, it appears that observer program adjustments to increase coverage of this fishery component may be necessary to avoid serious bias in halibut bycatch due to this data gap.

Observer Effect

The supplement to the environmental assessment outlines the steps that have been taken to evaluate the effect of observer effect that the randomized sampling procedure is meant to avoid, they go over the main diagnostics they use to check for the most obvious observer effects:

"Therefore, trip characteristics that can be measured such as trips length, retained species composition, number of areas fished, and trip duration are used to evaluate observer effects." (pg. 57 NMFS 2015)

Benoit and Allard (2009) point out that comparing trip characteristics such as total target species catch, total bycatch species catch and mobile gear effort can allow for detection of observer effect. It is important to do so at the vessel level in order to account for differences between fishing vessels and between fishing times within a fleet or larger area. Tests of observer effects that correct for spatial and seasonal variations if done at too large a scale can fail to detect the true observer effect. The supplement to the environmental assessment reports that the diagnostic tests for observer effects are as follows:

"Comparisons of trip characteristics between observed and unobserved vessels. A representative sample should not have statistical differences in attributes between observed and unobserved vessels." (pg. 57 NMFS 2015)

However these need to be combined with tests of the statistical difference between observed and unobserved trip of the same vessels within a short time period and in the same fishing areas. There is not enough detail presented to assess whether this specific type of diagnostic data is collected.

The authors rightly point out that all estimates of bycatch will necessarily be biased if there is sampling bias (deployment and observer effect) and no reliable way to make adjustments for sampling bias. Efforts to close identified sampling gaps above should be made a priority.

Other Outstanding Issues

Some issues arising from a review of the Draft supplement to the environmental assessment do not fit neatly into either the category of sampling design or of estimation of bycatch but require discussion nonetheless. These are 1) electronic monitoring, 2) Halibut bycatch, and 3) Chinook bycatch.

Electronic Monitoring

Electronic monitoring is briefly mentioned in the supplement to the environmental assessment:

"In addition to these proposed amendments to Observer Program regulations, the development of electronic monitoring (EM) in lieu of observer coverage is an initiative that will have important impacts and interactions with the Observer Program in the future. In general, the development of regulated EM options will not necessarily change the amount of the observer fee collected, but it likely will change the way observers are deployed and the distribution of the observer fee between observer coverage and EM.

…

The use of video technology has been proposed as a potential way to supplement existing observer coverage, enhance the value of the data NMFS receives, and/or fill data gaps that could be difficult to fill with human observers." (pg. 137 NMFS 2015)

Video monitoring of hook and line vessels in BC in combination with logbooks and an auditing and enforcement system has been found to yield accurate estimates of catch for this fleet. It could be considered as an alternative to full observer coverage in small vessel stratum, especially for hook and line vessels where it is possible for on board video cameras to accurately identify the processing of individual fish e.g. as either discarded or retained.

Pacific Halibut

Halibut bycatch is regulated under international treaty and as a result has some extra focus in the report and in the analysis of bycatch and fishery related impact. The volume of halibut by-catch discarded (live or dead) in non-halibut directed fisheries is estimated to have a pound-for-pound effect to lower commercial halibut catch. This is a source of concern for halibut fishermen and halibut by-catch is a strong limiting factor for the activity of non-halibut targeted fisheries. Current studies by the International Pacific Halibut Commission suggest that the by-catch of Halibut in non-halibut target fisheries is substantial (Williams 2014). U.S. regulations require that Halibut be returned to sea with no additional injury. However the handling of the by-caught fish is expected to lead to fishery caused mortality. This is addressed in the supplement to the environmental assessment, but not in a very robust way:

"The halibut fishery discards undersized halibut. This halibut wastage is estimated and accounted for by the IPHC. But, since 2013, NMFS and the IPHC have observer data from the directed halibut fishery on wastage from the IFQ halibut fishery (Williams 2015). However, as pointed out in the 2014 IPHC report, current observer coverage in the Alaskan directed halibut fishery is low, and therefore estimates of wastage are of unknown accuracy; however, improved monitoring via increased observer coverage and/or electronic monitoring offer potential for improvement in these estimates (Stewart et al. 2014). "(pg. 119 NMFS 2015)

"In the BSAI, most halibut bycatch in the groundfish fishery is taken by vessels in the full coverage category. The IPHC recognizes that the most reliable information on incidental catch is from on-board observers. Observations on halibut bycatch in BSAI fisheries are among the more extensive for fisheries in Alaska (Stewart et al 2014). "(pg. 120 NMFA 2015)

This report needs to present an analysis of potential bias and precision in bycatch estimates for Halibut. It is not sufficient cite Stewart et al (2014) and to say that observations are the most extensive for fisheries in Alaska. Bycatch management requires careful assessment of the arrangements to both monitor the bycatch and to estimate the total effect. Failing to present an estimate of the bias and variance of the estimates of bycatch is a serious omission in this report.

Chinook Salmon

Chinook salmon bycatch is addressed in the supplement to the environmental assessment especially in regards to improvements in sampling bycatch in pollock directed trawl fisheries where there was previously no observer coverage:

"The restructured program increased observer coverage to GOA pollock trawl vessels less than 60 ft LOA, a large part of the pollock fleet in the Central and Western GOA, improving our ability to estimate Chinook salmon bycatch and manage to the PSC limit. For the GOA, unlike the Bering Sea, approximately 40% of the pollock trawl catcher vessels that catch Chinook salmon as bycatch are less than 60 feet LOA and therefore had no observer coverage before 2013. Under the restructured Observer Program, NMFS expanded observer coverage to these pollock trawl fisheries in the GOA. Observers are now providing more data on Chinook salmon bycatch by the GOA pollock trawl catcher vessels than was previously available under the previous program." (pg. 118 NMFS 2015)

"Improving observer coverage by extending observer coverage to pollock trawl catcher vessels less than 60 ft LOA reduces the uncertainty in bycatch estimation identified for coded-wire tag expansions in order to improve bycatch estimation and reduce concerns that the PSC limits for the GOA pollock fishery might result in some unobserved catcher vessels discarding Chinook salmon bycatch. Under the restructured Observer Program, NMFS now deploys observers on pollock trawl catcher vessels less than 60 ft LOA." (pg. 119 NMFS 2015)

It is an improvement in sampling to begin to collect data from a previously unobserved fleet, but again this report makes no estimates of the bycatch of Chinook, nor is there any evaluation of the precision in the estimates of Chinook bycatch in this small trawler fleet. Failing to presenting this estimate of the bias and variance of the estimates of bycatch is also a serious omission in this report.

Conclusions

The supplement to the environmental assessment presents details of the goals of the changes to the observer program and the steps taken to meet those goals. The supplement discusses the issue of deployment bias, and though an improvement over the former sampling design there are still gaps in coverage that could lead to bias in estimates of bycatch. This is especially obvious in some fleet elements with partial or no coverage.

The supplement to the environmental assessment touches upon the challenges of estimating bycatch with a sufficiently representative sample, but does not undertake the necessary analysis to present a measure of precision and variance of bycatch estimates. There is a focus on eliminating sampling bias with an assumption that by eliminating sampling bias you will achieve a good estimate of bycatch.

It is however not sufficient to reduce sampling bias; careful examination of estimation methods must be combined with the sampling design in order to judge the ability of the observer program to provide accurate and precise estimates of bycatch. Failing to present this type of analysis is an obvious flaw in the report. If the goal of the program is to correctly reveal the magnitude of bycatch and trends in bycatch over time, an analysis of the different estimation methods is required.

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