Comparison of (Landed) Bycatch Estimates
from
Portside and At Sea Observer Sampling Programs
in the
Atlantic Herring Fishery

by

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WORKING DRAFT

1.0 INTRODUCTION

In the past, members of the Herring PDT have estimated total removals of river herring in the Atlantic herring fishery by a combination of portside and at-sea observations. This analysis hinges, however, on the comparability between these two very different methods of documenting bycatch.

Estimates and frequency of occurrence of bycatch in the sea herring fishery is monitored by two independent programs: Maine DMR and Massachusetts Marine fisheries joint Portside sampling program and NOAA' National Observer Program. There are three estimates that are worth comparing:

1) Proportion of trips with occurrences of species
2) The amount of agreement on occurrences of species within trips
3) The amount of agreement on catch weight estimates between the two methodology

This analysis compares the total estimated catch weight for bycatch species for trips that were sampled by both a portside sampling program and the Northeast Fisheries Observer Program (NEFOP).

2.0 SAMPLING METHODS

2.1 AT-SEA OBSERVATIONS

During at-sea operations, NEFOP observers use basket sampling to document occurrence of other species during targeted Atlantic herring and mackerel trips on a haul by haul basis and during normal fishing operations. These non-target species are then included in the data as retained or "Kept" (http://www.nefsc.noaa.gov/fsb/Manuals/JANUARY%202010%20MANUALS/NEFOPM_010110_BOOKMARKS_LONG1.pdf). Normally, ten 50 lbs basket sub-samples are taken at regular intervals during the pumping process from net to hold. These samples are then checked for bycatch, weighed and measures, and the results expanded based on the captains' estimate of that hauls total weight. Because the Atlantic herring fishery is a high volume fishery, much of the bycatch is retained during the pumping process; particularly so for co-occurring pelagic species such as river herring. However, observers do hand select larger bycatch species. In these cases, these species are listed as "discarded" in the database if they are not retained by the crew

2.2 PORTSIDE OBSERVATIONS BY MA DMF

Sampling methodology in the MA DMF portside sampling program attempts to be consistent with NOAA Observer Program protocols, with some modifications to decrease variance in extrapolation of bycatch estimates and reduce potential sampling bias. Due to the large quantities of fish that are typically landed in these fisheries, sub-sampling will be required. Sub-sampling is used when the volume of fish that the sampler is attempting to quantify is too large to obtain actual weights or if the amount of by-catch is too abundant. During sub-sampling, the sampler will collect smaller batches of fish, sort and weigh by species and then extrapolate to the total catch. All sub-sample weights will be actually weighed (actual weight), and hail weights (for both truckloads and fishing vessels) will be acquired from the plant managers or vessel's captain and therefore estimated (estimate weight).

In most situations, sampling is conducted over the entire offloading period to capture any stratification that may occur throughout the entire fishing activity (e.g. while being pumped aboard while out at sea, due to the difference in species size and composition between tows, settling in the vessel's holding tanks, etc.). Because the catch is not unloaded the same way at every dealer and plant, sampling techniques will vary. Typically samples will be collected systematically at set intervals with predetermined sample sizes. All samples are sorted by species and actual weights will be taken. Lengths will be taken according to the NOAA Observer Program species priority list by statistical area. Haddock, alewife, blueback herring, and American shad have been specified as specific species of concern by MA DMF and therefore if available, the number of lengths taken will be 200 per trip. Two length frequency samples will be randomly selected, one during the first half and the second during the second half of the offloading period.

Below is MA DMF's description of the sampling protocol at a processing plant. The majority of sampling occurs at these types of off loading facilities for this project.

Processing Plant

Sampler should position himself at the discard vat where all bycatch and damaged fish are deposited. The sampler must position themselves in a location that is safe and will not disrupt plant operations. The name of the vessel should be recorded and hail weight, date landed, and general location fished (statistical area, known piece of bottom, etc.) should be collected from the plant manager or vessel captain. Hail weight should be confirmed after unloading process is complete and all fish have been processed. A processing rate (kg of catch processed/minute) should be calculated by dividing hail weight by the time it took to offload the vessel. When calculating time to off load catch, note time spent not pumping/processing, such as coffee or lunch breaks and processing hold-ups. To eliminate bias caused by periodicity, prior to the beginning of the offloading process, the sampler will use a random number table and pick a random start time between 1 and 30 minutes. Once the start time has been determined, a basket will be positioned in the discard vat and a sample will be collected. Once the basket has been filled, it will be weighed, sorted by species, and then weighed by species. Lengths will be collected according to NOAA Observer Program sampling protocols. This process will be repeated for thirty minutes until the sub-sampling period has been completed. If fish being sent to the bycatch vat is too abundant and sampler cannot weigh all fish being sent to the discard vat, then sub-sampling may be required to get an estimate of total bycatch per 30-minute sampling period. This sampling process will be repeated every other 30-minute interval during the entire pump offloading process. After the offload process, the sampler should consult with the plant's quality control personnel to obtain an accurate, by the box, quantification of species being processed. Lastly, to verify pump rates and landings estimates, the sampler should obtain a report of landings and processed fish from the plant manager after the off loading is complete.

2.3 PORTSIDE OBSERVATIONS BY ME DMR

For the ME DMR portside sampling program, the samplers collect and quantify all bycatch from individual lots of fish (transported by trucks or vessels) that enter the processing facilities. Samplers position themselves at the point of entry into the facility along an assembly line or at the base of the hoppers where the fish are unloaded. Sampling is conducted before grading or sorting of the catch occurs. All bycatch is removed from the assembly line or hopper and placed in bushel baskets or buckets specific to each species. The total weight of any observed bycatch is recorded along with species identification, total species weight, individual lengths and weights of all fish according to a NMFS and ACCSP specified protocol. If there is a large amount of one species, the total weight is recorded and then length frequencies and weight are gathered from a sub sample of n=50. The information collected for each bycatch study is recorded on the data sheets (see "Data Sheets" section of packet) and entered into the DMR biological database.

A sub-sampling protocol is sometimes utilized when sampling a large volume of catch. Instances where this is likely to occur include sampling sites where vessels land an entire catch (as much as one million pounds) to a single facility. Sub-sampling is also appropriate in instances when there is an overwhelming amount of bycatch and/or non targeted species mixed in with the lot of fish. In these cases it can be impossible to use the complete sampling protocol regardless of the amount inspected (< 80,000 lbs.). These situations are likely to occur when vessels are fishing mixed groups of herring and mackerel, some of which have a 50-50 composition.

Sub-samples are to be collected using bushel baskets at timed intervals during the pumping or unloading process following the NMFS at-sea observer sampling protocol. To accomplish this type of sub-sampling, one needs to know the total lot weight and the duration of time it will take to unload the catch. After sampling, the bushel basket of fish should be sorted by species, and total weight of each species and length frequencies should be recorded (sub sample n=50, for length frequencies if more than fifty of any species occurs).

Example:

Lot size = 120,000 lbs (3 Trucks)
Pumping or unloading time = 3 hours (180 minutes)

If a sample basket is to be collected for every 10,000 lbs of fish, then **12 sample baskets** need to be collected over the entire pumping or unloading process.

120,000 lbs/10,000 lbs = 12

If the entire pumping or unloading process takes an estimated 180 minutes, then **a basket sample needs to be taken every 15 mins.**

If the catch composition from the bushel baskets is 99% Atlantic Herring, then one can extrapolate that out of the 120,000 lbs unloaded, then 118,800lbs is Atlantic Herring.

99% Atlantic Herring = 120,000 lbs x 0.99 = 118,800lbs of Atlantic Herring

If the remaining 1% of the catch composition is Atlantic Mackerel, then one can extrapolate that out of the 120,000 lbs unloaded, 1,200lbs is Atlantic Mackerel

1% Atlantic Mackerel = 120,000lbs x 0.01 = 1,200lbs of Atlantic Mackerel

3.0 STATISTICAL ANALYSIS

For this analysis, data were gathered from the various projects by either request or direct querying of the data. In some cases, vessel trip report number was not available, and so trips between portside and at sea programs we matched by hand.

Several species were pooled into a species grouping because of potential for mis-identification or to make the analysis easier to understand. River herring group consisted of alewives, bluebacks and herring unknown were grouped as river herring. American shad and hickory shad were grouped as shad. Long-fin squid, short-fin squid and squid unknown were grouped as squid.

The analysis compares the number of occurrences of bycatch species by sampling method using a paired t-test. The binomial exact test was also used to check whether the probability of number of occurrence of bycatch in port sampling exceeding the number of occurrence in the observer sampling differed from 0.5.

The analysis compares the proportion of trips containing a particular species groups using Wald test with correction for continuity. Fisher's exact test was used to convert the differences into odds ratios. The test was conducted on the seven species groups with the highest percent occurrence: river herring, squid, silver hake, spiny dogfish, butterfish haddock, and shad. The family-wise error rate for multiple comparisons was not corrected.

The percent agreement for presence/ absence of species group was measured for both sampling methods using two indices of similarity. The first index was a simple matching index constructed by dividing the total the number of trips with joint presence and joint absence for both sampling methods by the total trips. In this index, joint absence (double zeros) contributes to similarity. However, the absence of a species group from both sampling methodology could be due to the trip occurring in an area or time where the species are not present, and inflating the index. To address joint absences, the Jaccard coefficient was used: the number of trips with joint presence divided by the number of trips with joint presence and the two unique combinations of present in one method and absent in the other. The joint absences do not contribute to similarity in the Jaccard index. This method was applied to seven species groups: river herring, squid, silver hake, spiny dogfish, butterfish, haddock and shad.

The relationship between the observer and portside estimates of landed weight of bycatch species was assessed using Pearson's product moment correlation coefficient. Agreement was tested between port and observer trip landings estimates using a paired t-test. T-tests were performed for all trips, trips without joint absences, and log transformed for trips without joint absences. Assumption that differences were distributed normally was assessed using quantile-quantile normal plots and Shapiro test for normality.

The following summarizes the PDT's questions and methodology for statistical evaluation of the portside/at-sea data:

1. **Is the frequency of detection of bycatch species similar for portside and observer program?**
    a. Paired T-test for number of occurrences for portside and observer
    b. Exact binomial test for the probability of occurrence portside versus observer
2. **Does the estimate of percent occurrence differ between sampling methods for each bycatch species?**
    a. Test difference in proportions among methods using Wald's statistic with correction for continuity
    b. Get odds ratio using Fisher's exact test
3. **Describe similarity of occurrence of species by tows**
    a. Matching index (% agreement)
    b. Jaccard index (% agreement excluding joint absence)
4. **Does the estimation of bycatch weight differ by method?**
    a. Correlation between paired estimates by method
    b. Paired T-tests for differences in trip estimates by sampling methodology
    c. Provide estimates of total weight of landed bycatch with 95% confidence interval for each method

4.0 PRELIMINARY RESULTS (WORK IN PROGRESS)

A total of 52 trips were sampled with both portside and at sea observer sampling between 2005 and 2009 (Table 1). The number of trips containing bycatch species groups by sampling methodology is shown in Table 2, and the number of trips as a proportion of total trips is shown in Table 5.

The number of occurrences of bycatch species by methodology (at-sea versus portside) was significantly different (Table 3). Port sampling averaged 1.9 more occurrences than the observer program. The exact binomial test indicated that the probability of a species occurring portside versus at sea was significantly greater than 0.5, suggesting non-random effects (Table 4).

For the seven most frequently caught bycatch species, the Herring PDT compared the proportion of trips with observed bycatch by methodology using Wald test statistic without adjustment for multiple comparisons (Table 6). Overall, the proportions of trips with a particular species were significantly different for squid and for spiny dogfish only, with the portside sampling method having higher proportions than the observer.

Similarity index for presence/ absence of species is presented in Table 7. Similarity indices were relatively high for the simple matching coefficient (mean: 0.72, range: 0.54 to 0.87), but tended to be low for the Jaccard coefficient (mean: 0.30, range: 0.17 to 0.54). The joint absences influence the similarity indices, and the true similarity is bounded by these two values. Further work needs to be done to separate joint absences that reflect no occurrences in strata where the species occur from joint absences in strata where the species in not likely to occur.

Scatterplots of paired portside and observer estimates for eight species are shown in Figure 1. The paired comparisons indicate little relationship between weight estimates from the Portside and Observer projects. Correlation coefficients for these eight species are exhibited in Table 8. The correlations coefficients for 7 of the 8 species were low and not significantly different from zero. Correlation coefficient was moderately high (0.80, 0.79) and significantly different from zero for spiny dogfish. The correlation coefficient was highly influenced by one trip where both methods had high estimates of catch. The correlation coefficient estimated without this pair was low and not significantly different from zero.

Bland-Altman plots of the paired landings estimate between methods are shown in Figure 2. Variation is high, and differences are larger as might be expected given the low correlation between observer and paired estimates. The distribution of paired differences was significantly different from normal and was strongly leptokurtic with more observations in the middle and tails for the full dataset and for the dataset without joint absences. Only shad with removal of trips with joint absence were not significantly different from normal. A Bland-Altman plot of the log-transformed dataset is shown in Figure 3. This dataset does not include the joint absences. Distribution of paired differences for log transformed data were not significantly different from normal except for spiny dogfish ($p<0.01$). Paired T-test results are provided in Table 9 and Table 10. No differences were significant for untransformed data, which is not surprising given the large variances. Paired differences were not significant for the log transformed data except for spiny dogfish (0.02) and haddock (p=0.04). For non-significant tests, the confidence intervals were wide, indicating low power to detect differences. Spiny dogfish trip estimates from the observer sampling averaged 12% of the portside sampling estimates. Haddock trip estimates from the observer sampling averaged 5% of the portside sampling estimates.

Total estimates with 95% confidence intervals of landed catch by species and sampling method are shown in Table 11 and Table 12. Table 11 uses parametric statistic to derive 95% confidence interval and Table 12 uses bootstrap percentiles to estimate 95% confidence limits. These estimates were expanded using the trip estimates. They are only useful for comparing the estimates across sampling methods. As expected, confidence limits are wide. Note that estimates from the fishery would include stratification by month, area and gear types will improve precision.

5.0 PRELIMINARY CONCLUSIONS (WORK IN PROGRESS)

Portside and at sea sampling are two very different approaches to document bycatch in the directed Atlantic herring fish. During at-sea sampling observers have the ability to document discarded fish at sea and sample them. During portside operations, samplers cannot do so. However portside samplers have a much more stable platform, better working conditions and more time for a thorough examination.

The Herring PDT examined 52 trips which were sampled by both at sea and portside methods to test if both projects are similar in the amount and species composition detected. The PDT found large differences in retained bycatch between the two programs. More specifically, the portside sampling documented more occurrences of species, and a greater proportion of trips containing key bycatch species. However, at sea observation, when extrapolated to the entire retained weight, shows much higher weights of the more prevalent species. The lack of significant differences in many of the statically approaches taken here are a direct result of low sampling sizes. More co-occurring trips are needed by strata (gear type, sample mythology, area, quarter, and year) to detect significant differences; especially for species which occur infrequently in sampling. The analysis was further hampered by the number of co-occurring trips with either had no retained bycatch at all, or no bycatch of a particular species being tested.

It should be noted that the PDT is not suggesting one project or method is more useful or more accurate than the other. The PDT is, however, suggesting that pooling these two different methods of documenting bycatch may not be possible without further analysis and sampling. The PDT recommends a more thorough examination of both portside and at-sea observations to see if elucidation of these differences (and possible mathematical correction) is possible. By focusing on increasing the number of co-occurring trips statistical analysis may lead to increased comparability by analysis of the methods employed by both projects.

Summary of Herring PDT Conclusions to Date (Work in Progress)

1. Portside sampling method had more occurrences of bycatch than observer method. Proportion of occurrences in portside sampling is greater than at-sea observer sampling; and was significantly different from 0.5
2. The proportion of trips containing a bycatch species was not significantly different between Portside and Observer methods except for squid and spiny dogfish. Both of those species were significantly different
3. Relatively low levels of agreement of occurrences particularly with the Jaccard index.
4. No correlations between paired portside and observer trip estimates of weight
5. Paired T-test on log transformed estimates found no significant differences except for spiny dogfish and haddock. However, high variation in paired estimates lead to a loss of statistical power; and therefore the results cannot be taken as valid

Summary of Herring PDT Advice: Need to Examine Data to Find Sources of Variation (Work in Progress)

A. High variability in trip estimates in both the portside and observer sampling
B. Different methods for expanding within trip samples to trip estimates
C. Sampling design issues

Year	Quarter	Purse seine	Midwater trawl	Paired Midwater trawl
	1	0	0	3
	2	0	0	1
	3	1	0	2
2005	4	0	1	2
	1	0	0	0
	2	0	0	0
	3	0	1	1
2006	4	0	0	0
	1	0	0	1
	2	0	0	0
	3	0	0	0
2007	4	0	0	0
	1	0	1	2
	2	2	0	2
	3	3	0	1
2008	4	0	0	7
	1	0	0	4
	2	5	0	4
	3	3	0	4
2009	4	0	0	1
Total trips		14	3	35

Table 1 Count of trips sampled by both Portside and At Sea Observer Programs by gear type, year and quarter

Species Group	Purse seine		Midwater trawl		Paired Midwater trawl	
	Observer	Portside	Observer	Portside	Observer	Portside
River herring	2	3	2	1	15	20
Squid	2	6	1	2	10	19
Silver hake	3	6	0	2	12	15
Spiny dogfish	4	8	0	2	4	14
Butterfish	0	0	1	0	5	9
Haddock	0	0	0	1	4	10
Shad	0	0	0	1	5	8
Red hake	0	0	0	1	0	6
American plaice	0	1	0	1	0	3
Longhorn sculpin	1	0	0	0	0	2
Redfish	0	0	0	0	1	2
Cod	0	0	0	1	0	1
Fish unk	1	0	0	0	1	0
Lumpfish	1	0	0	0	0	1
Shrimp	0	1	0	0	0	1
Cunner	0	0	0	0	1	0
Cusk	0	0	0	1	0	0
Little skate	0	0	0	0	0	1
Menhaden	0	0	0	0	0	1
Pollock	0	0	0	0	0	1
Scup	0	0	0	0	0	1
Sea raven	0	0	0	0	0	1
Winter flounder	0	0	0	0	0	1
Number of trips	14	14	3	3	35	35

Table 2 Count of trips containing bycatch by species group, gear type and sampling program

Mean difference	95% confidence interval for mean difference	P-value	Degrees of Freedom
-1.9	-2.6 to -1.11	<0.001	41

Table 3 Summary of paired t-Test for number of occurrences of bycatch species by sampling methodology for in trips

Does not include trips with joint absence

Number of occurrences Port occurrences > observers	Proportion	95% confidence interval	Probability that Proportion is not different from 0.5
35	0.83	0.69-0.93	<0.001

Table 4 Summary for exact binomial test of number of occurrences of Port> Observer in number of occurrence of a bycatch species

Tests whether the true probability of Port occurrences > observer occurrences is not different from 0.5.

Species Group	Purse seine		Midwater trawl		Paired Midwater trawl	
	Observer	Portside	Observer	Portside	Observer	Portside
River herring	0.14	0.21	0.67	0.33	0.43	0.57
Squid	0.14	0.43	0.33	0.67	0.29	0.54
Silver hake	0.21	0.43	0.00	0.67	0.34	0.43
Spiny dogfish	0.29	0.57	0.00	0.67	0.11	0.40
Butterfish	0.00	0.00	0.33	0.00	0.14	0.26
Haddock	0.00	0.00	0.00	0.33	0.11	0.29
Shad	0.00	0.00	0.00	0.33	0.14	0.23
Red hake	0.00	0.00	0.00	0.33	0.00	0.17
American plaice	0.00	0.07	0.00	0.33	0.00	0.09
Longhorn sculpin	0.07	0.00	0.00	0.00	0.00	0.06
Redfish	0.00	0.00	0.00	0.00	0.03	0.06
Cod	0.00	0.00	0.00	0.33	0.00	0.03
Fish unk	0.07	0.00	0.00	0.00	0.03	0.00
Lumpfish	0.07	0.00	0.00	0.00	0.00	0.03
Shrimp	0.00	0.07	0.00	0.00	0.00	0.03
Cunner	0.00	0.00	0.00	0.00	0.03	0.00
Cusk	0.00	0.00	0.00	0.33	0.00	0.00
Little skate	0.00	0.00	0.00	0.00	0.00	0.03
Menhaden	0.00	0.00	0.00	0.00	0.00	0.03
Pollock	0.00	0.00	0.00	0.00	0.00	0.03
Scup	0.00	0.00	0.00	0.00	0.00	0.03
Sea raven	0.00	0.00	0.00	0.00	0.00	0.03
Winter flounder	0.00	0.00	0.00	0.00	0.00	0.03
Number of trips	14	14	3	3	35	35

Table 5 Counts of trips with occurrence of bycatch as proportion of total trips by species group, gear type and sampling method

Species group	Port sampling Proportion	Observer Proportion	95% confidence interval on difference	Odds ratio	95% confidence interval on odds ratio	Probability of odds ratio
River herring	0.46	0.37	-0.11 - 0.30	1.48	0.63 - 3.52	0.42
Butterfish	0.17	0.12	-0.10 - 0.21	0.58	0.46 - 5.94	0.58
Squid	0.52	0.25	0.07 - 0.47	3.20	1.31 - 8.14	<0.01
Silver hake	0.44	0.29	-0.05 - 0.36	1.94	0.81 - 4.79	0.15
Spiny dogfish	0.46	0.15	0.12 - 0.49	5.08	1.72 - 13.71	<0.01
Haddock	0.21	0.08	-0.02 - 0.29	3.18	0.86 - 14.7	0.09
Shad	0.17	0.10	-0.72 - 0.23	1.95	0.54 - 8.03	0.39

Table 6 Comparing the differences in proportion of trips with species in observer and portside trips for all gear types

Test is two sided.

Species group			Observer sampling +	Observer sampling -	Matching coefficient	Jaccard coefficient
River herring	Port	+	15	9	0.75	0.54
		-	4	24		
Butterfish	Port	+	4	5	0.87	0.36
		-	2	41		
Squid	Port	+	8	19	0.54	0.25
		-	5	20		
Silver hake	Port	+	9	14	0.62	0.31
		-	6	23		
Spiny dogfish	Port	+	6	18	0.62	0.23
		-	2	26		
Haddock	Port	+	3	8	0.83	0.25
		-	1	40		
Shad	Port	+	2	7	0.81	0.17
		-	3	40		

Table 7 Count of trips with species groups present (+) or absent (-) by sampling method and two measures of percent agreement between methods

Species group	All trips	Excludes trips with double-zeros.
River herring	-0.04	-0.13
Squid	0.06	-0.01
Silver hake	0.22	0.17
haddock	-0.02	-0.23
Spiny dogfish[1]	0.80	0.79
Spiny dogfish[2]	0.06	-0.08
Butterfish	0.25	0.12
Shad	-0.04	-0.30

Table 8 Pearson's product moment correlation coefficients for observer and portside estimates of landed weight

[1.] Correlation coefficients are significantly different from 0 at P=0.05, but correlation coefficients are highly influenced by one trip.

[2] Removing influential points lowers correlation coefficients to not significantly different from zero.

Species group	**Mean difference**	**95% Confidence interval for mean difference**	**P-value**	**Degrees of freedom**
		All trips		
River herring	1242.9	-131.4 - 2,617.2	0.08	51
Squid	-4.3	-98.1 - 89.6	0.93	51
Silver hake	57.7	-176.1 - 291.6	0.62	51
Spiny dogfish	57.8	-94.7 - 210.4	0.45	51
Butterfish	-158.1	-480.2 - 164.0	0.33	51
Haddock	-22.2	-206.9 - 162.6	0.81	51
Shad	21.1	-39.9 - 82.2	0.49	51
		Without trips with joint absence (double zeros)		
River herring	2308.3	-248.5 - 4,865.1	0.07	27
Squid	-7.0	-162.9 - 148.9	0.93	31
Silver hake	103.5	-326.8 - 533.9	0.63	28
Spiny dogfish	118.0	-203.2 - 439.2	0.46	24
Butterfish	-747.3	-2,439.2 - 944.5	0.35	10
Haddock	-96.1	-1,002.2 - 809.9	0.82	11
Shad	91.6	-203.7 - 386.9	0.51	11

Table 9 Summary of paired T-test for estimates of trip catch by sampling method (observer-port)

Upper table uses all 52 trips. Bottom table does not include trips with joint absence.

Species group	Mean difference	95% Confidence interval for mean difference	P-value	Degrees of freedom
		All trips		
River herring	2.68	0.46 - 15.58	0.26	27
Squid	0.78	0.23 - 2.64	0.69	31
Silver hake	0.62	0.17 - 2.26	0.45	28
Spiny dogfish	0.12	0.02 - 0.68	0.02	24
Butterfish	1.21	0.15 - 9.80	0.84	10
Haddock	0.05	0.00 - 0.91	0.04	11
Shad	0.79	0.04 - 15.70	0.86	11

Table 10 Back-transformed summary of paired T-test for estimates of log trip catch by sampling method (observer-port)

Analysis does not include trips with joint absence by both sampling methods. Back transformed values are ratio of observer estimate to port sampling estimate.

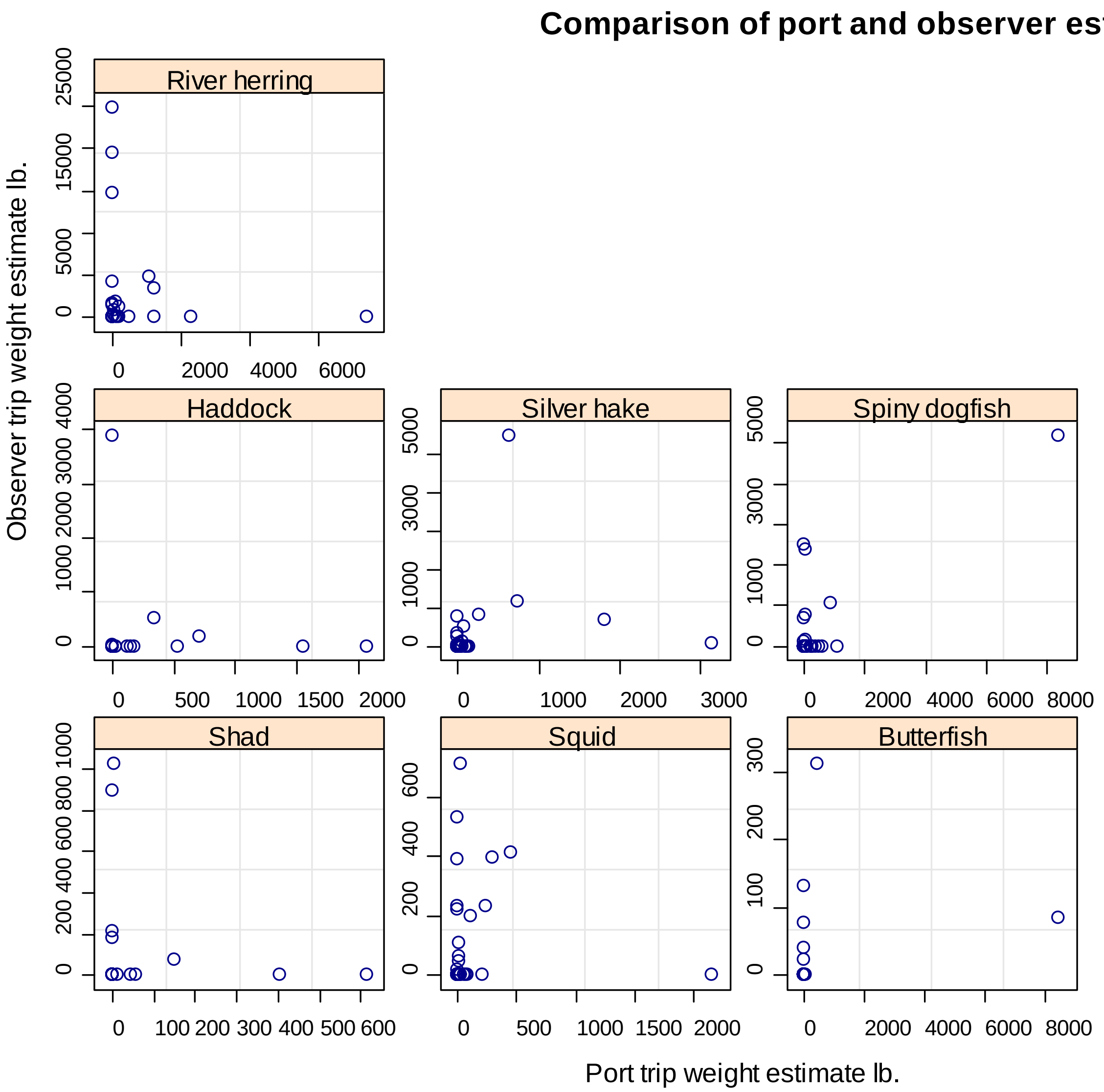

Figure 1 Scatterplot of Observer weight against Portside weight

Note that x and y scales differ among panels.
Plot includes estimates where both port and observer estimates are zero.

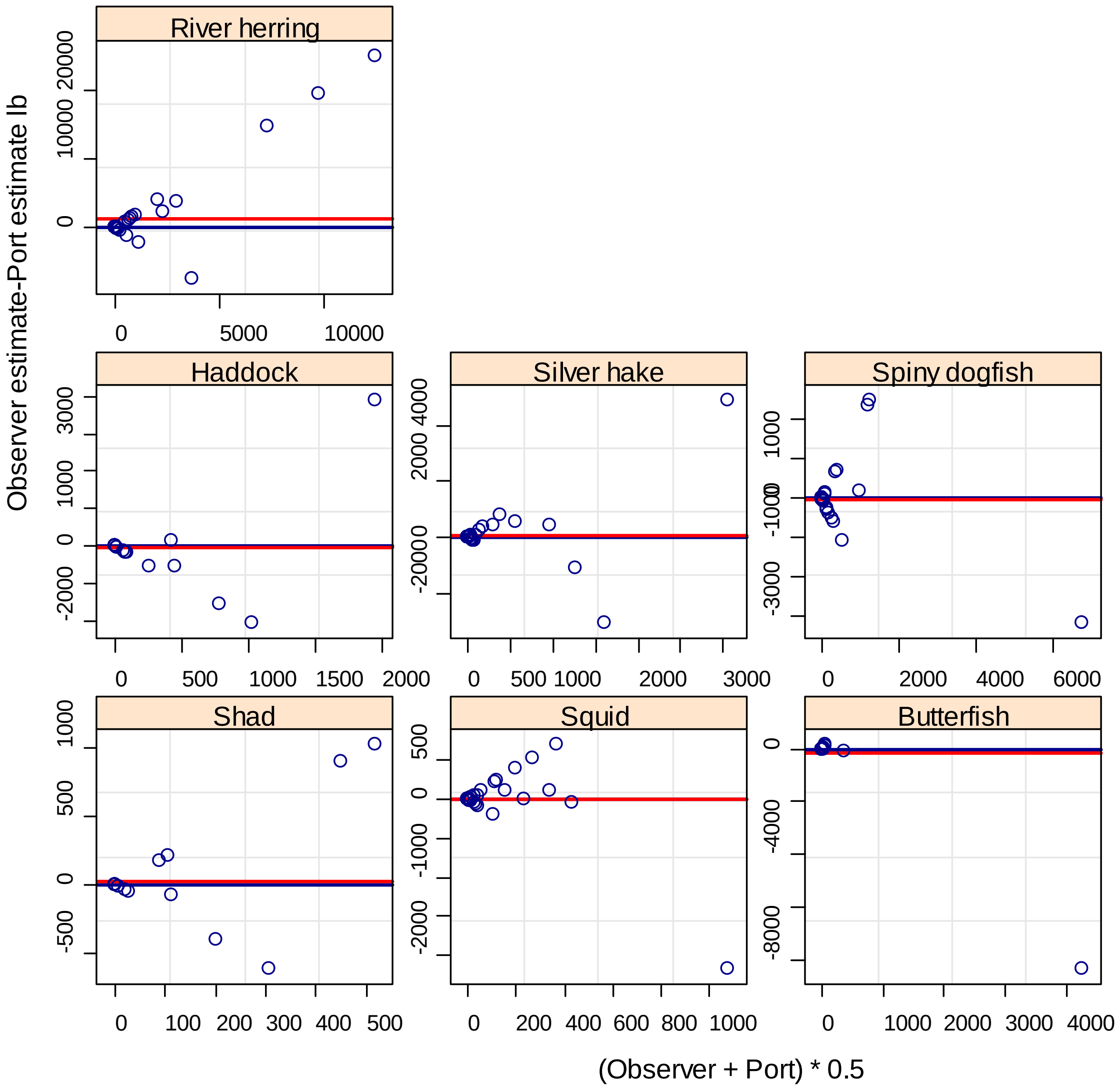

Figure 2 Bland-Altman plot of paired estimates of landings

Redline is average difference. Blue line indicates 0.   Dataset includes all trips including joint absence.

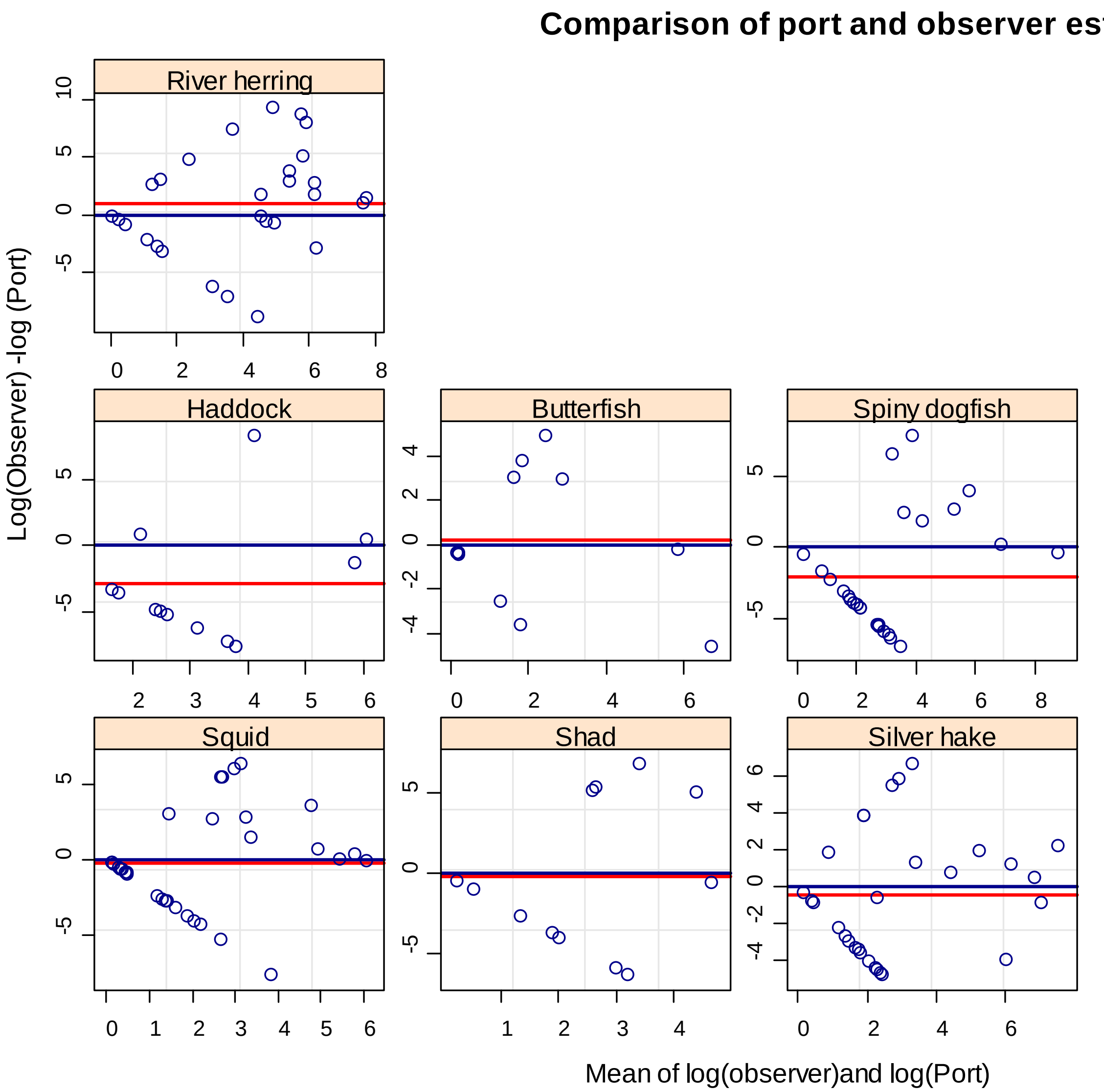

Figure 3 Bland-Altman plot of paired estimates of log landings

Redline is average difference. Blue line indicates 0. Dataset does not include trips with joint absence.

Species grouping	Total portside estimate (lb)	95% confidence interval		Total observer estimate lb	95% confidence interval	
Fish unk	0	0	0	100,000	-64,784	264,784
River herring	14,695	-1,030	30,420	79,327	10,313	148,341
Spiny dogfish	13,076	-3,821	29,973	12,852	379	25,325
Silver hake	7,372	5	14,739	10,375	-1,057	21,806
Haddock	5,743	364	11,122	4,590	-3,264	12,443
Butterfish	8,888	-8,023	25,798	667	-39	1,373
Squid	3,769	-687	8,225	3,546	1,295	5,797
Cunner	0			4,864	-4,901	14,629
Shad	1,288	-193	2,769	2,387	-359	5,133
Scup	1,667	-1,679	5,012	0		
Redfish	43	-38	124	210	-212	632
Red hake	238	-36	512	0		
Pollock	160	-161	482	0		
Longhorn sculpin	6	-5	17	54	-54	162
American plaice	35	-5	76	0		
Cod	17	-7	41	0		
Lumpfish	9	-9	27	6	-6	18
Winter flounder	12	-12	36	0		
Shrimp	4	-4	12	0		
Menhaden	3	-4	11	0		
Sea Raven	3	-3	10	0		
Cusk	3	-3	8	0		
Little skate	2	-2	5	0		

Table 11 Estimates of total landings in weight with 95% confidence intervals derived from Observer and Portside sampling for 52 trips

Total Estimate based on expansion of mean landings per individual trip.

Species grouping	Total portside estimate (lb)	95% confidence interval		Total observer estimate lb	95% confidence interval	
Fish unk	0			100,000	0	280,020
River herring	14,695	3,250	32,614	79,331	23,348	154,440
Spiny dogfish	13,076	2,777	36,156	12,849	2,621	26,140
Silver hake	7,372	1,560	15,220	10,375	2,444	23,322
Haddock	5,743	1,243	11,627	4,590	12	13,055
Butterfish	10,375	16	26,083	667	132	1,452
Squid	3,770	760	9,282	3,546	1,550	5,793
Cunner	0	0	0	4,864	0	14,592
Shad	1,288	142	3,124	2387	176	5,514
Scup	1,667	0	5,000	0		
Redfish	43	0	129	0		
Red hake	238	38	541	0		
Pollock	160	0	481	0		
Longhorn sculpin	6	0	21	54	0	162
American plaice	35	3	83	0		
Cod	17	0	46	0		
Lumpfish	9	0	27	6	0	24
Winter flounder	12	0	36	0		
Shrimp	4	0	12	0		
Menhaden	3	0	10	0		
Sea Raven	3	0	10	0		
Cusk	3	0	8	0		
Little skate	2	0	5	0		

Table 12 Estimates of total landings in weight with 95% confidence intervals based on bootstrap percentiles derived from Observer and Portside sampling for 52 trips

Total Estimate based on expansion of mean landings per individual trip.

Set type	species	r	95% confidence interval		P-value	Bootstrap problem indicator	95% confidence interval based on bootstrap	
All pairs	River herring	-0.04	-0.31	0.23	0.75		-0.11	0.19
Non-zero pairs	River herring	-0.13	-0.48	0.26	0.52		-0.37	0.98
All pairs	Squid	0.06	-0.22	0.32	0.70	B	-0.48	0.264
Non-zero pairs	Squid	-0.01	-0.36	0.34	0.95		-0.17	0.6196
All pairs	Silver hake	0.22	-0.06	0.47	0.12	B	0.04	0.91
Non-zero pairs	Silver hake	0.17	-0.21	0.51	0.37	B	-0.03	0.91
All pairs	Spiny dogfish[1]	0.80	0.68	0.88	<0.001	B	-0.10	0.98
Non-zero pairs	spiny dogfish[1]	0.79	-0.45	0.32	0.70	B	-0.27	0.98
All pairs	Butterfish-all	0.25	-0.03	0.49	0.08	B	-0.04	0.99
Non-zero pairs	Butterfish-pos	0.12	-0.51	0.67	0.72	B	-0.37	0.98
All pairs	Haddock	-0.02	-0.29	0.25	0.89	B,S	-0.08	0.64
Non-zero pairs	Haddock	-0.23	-0.71	0.40	0.47	B,S	-0.48	0.26

Table 13 Pearson's product moment Correlation coefficients, 95% confidence interval and 95% confidence interval from bootstrap for paired catches

[1.] Correlation coefficients are significantly different from 0 at P=0.05, but correlation coefficients are highly influenced by one trip.

[2] Removing influential points lowers correlation coefficients to not significantly different from zero. Bootstrap indicator: B= high bias, A= some bootstrap samples had zero standard deviations.