New England Fishery Management Council
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John Pappalardo, *Chairman* | Paul J. Howard, *Executive Director*

MEMORANDUM

DATE: **April 6, 2010**

TO: Skate PDT

FROM: Andrew Applegate

SUBJECT: **Skate wing possession limit model update status**

In January, the Council directed the Skate PDT to evaluate and provide advice on using the 2008 fall survey data to update the Skate ABC. These data were not used in Amendment 3 to set an ABC and skate fishery TALs because they had not been peer reviewed. More specifically, there was some concern that the nearly three-fold increase in the winter skate stratified mean weight per tow was anomalous and/or transient. The Council's SSC scheduled a meeting in March to review the PDT advice and possibly approve an update of the Skate ABC and skate fishery TALs. The process for changing these parameters was unclear since the next regular specification process would occur in 2011, to be implemented at the start of the 2012 fishing year.

Based largely on the PDT advice, the SSC approved an increase in the Skate ABC which translates into a 12,638 mt TAL, which Amendment 3 would allocate 7,677 mt to the wing fishery and 3,867 mt to the skate bait fishery. If approved by NMFS, these changes would increase the accountability measure triggers and keep the directed skate fishery open longer. As a follow up, the Council also directed the Skate PDT to evaluate what changes to the skate wing possession limit, if any, would be warranted[1]. This analysis could include an update to the possession limit model data and updated discard estimates. This document describes the model and data used to re-evaluate the skate wing possession limit.

For the purposes of estimating the effect of various possession limits on skate mortality, landings, and economics, the analysis described below substitutes dealer reports of skate landings for the vessel trip reports (VTR) to represent a trip. It incorporates a substantial number

[1] Only the skate wing possession limit would be modified, since Alternative 4 (seasonal quotas) was chosen for the final alternative in Amendment 3. A 20,000 lb. possession limit was added to Alternative 4 as a preventative measure against derby style fishing behavior, not as a technical measure intended to reduce mortality.

of trips that would have been classified as whole/bait skate fishing trips via the VTR data. These potential mis-classified trips have nearly the same profile as the trips that were correctly reported on VTRs and the additional data have very little change in the frequency distribution of landings. This correction comes at the expense of dealer reports representing partial or combined trips for a minority of reported landings.

Updating the possession limit model data for 2009 trips and changing the target mortality reduction from 45.5% (7,677 mt target vs. 14,081 mt landings in 2007) to 33.9% (8,404 mt target vs. 12,706 mt landings in 2009) indicates that a 2,100 lb. skate wing possession limit (4,767 lb. live wt. equivalent) would be appropriate. Other skate wing possession limit amounts could be appropriate depending on the reliance placed on possession limits to achieve mortality targets to prevent triggering accountability measures.

The Amendment 3 possession limit analysis

In lieu of the NEFSC's closed area model which was not available to evaluate the effect of skate management measures, the Skate PDT developed a simplified two-bin/possession limit model approach to evaluate the potential effect of technical measures in Amendment 3 alternatives. The objective of the model was to reduce the observed landings using a combination of closed areas and/or skate possession limits to achieve a 45.5% reduction in landed fishing mortality, thereby reducing 2007 skate wing landings from 14,081 mt to the 7,677 mt TAL, allocated from a total 11,544 mt skate TAL for the wing and bait fisheries. This limit without skate area closures was estimated to be 1,900 mt based on the 2007 skate trips reported on Vessel Trip Reports.

Following the Data Poor Assessment Workshop (DPWS), the Council decided that the final alternative would retain the 1,900 mt possession limit, even though the skate TAL was reduced to 9,427 mt, with a skate wing allocation of 6,269 mt.

The two-bin model component assigns average LPUE in open areas within three broad regions to trips that according to VTR data occurred within the boundaries of one of five proposed skate closed areas. The possession limit model component assigns one of two behaviors or responses on trips that land more than a proposed possession limit. Both model components are more fully described in the background technical documents in Appendix I of Amendment 3, available on the Council's skate management web page.

For trips that target skates and have relatively low landings of other species, the possession limit model assumes that the trip will end when the skate landings reach the proposed possession limit. In this case, trip length, skate landings, and landings of other species are reduced proportionally to the ratio of the proposed skate possession limit and skate landings on that trip. The difference between the observed skate landings and the possession limit contributed to mortality reduction. No adjustment was made to account for the potential for vessels to make more frequent trips to compensate. Mainly for this reason, the PDT thought that the possession limit would overestimate the effectiveness of skate possession limits to reduce catch, landings, and mortality.

For trips that target species other than skates and have daily revenues exceeding the estimated daily fishing costs, the possession limit assumes that the trips continue fishing as before, but discard the excess skates. Assuming a 50% skate discard mortality rate, the model assumes that 50% of the discarded skates survive and contribute to morality reduction. Landings of skates (but not other species) are estimated to decline to the proposed possession limit, but the mortality reduction is half as much as it is for trips which the model assumes do not continue fishing.

The PDT chose to use VTR data for this analysis for two primary reasons. First, VTRs provide information about where a vessel has fished and the gear used on each trip. This information is necessary for the two-bin component of the model. Secondly, the VTR reports are more consistent with an actual trip, defined as a vessel returning from sea with its catch. Vessel operators are instructed to report landings of skate wings using skate wing species codes ('SKATW', 'SKBARNW', 'SKCLW', 'SKLW', 'SKLWINW', 'SKROSEW', 'SKSMW', 'SKTHORW', 'SKWINW') in wing weight. Skates that are retained (and later landed) whole are to be reported with whole skate species codes ('SKATE', 'SKBARN', 'SKCL', 'SKL', 'SKLWIN', 'SKROSE', 'SKSM', 'SKTHOR', 'SKWIN') and are reported in whole weight.

Dealer reports, on the other hand, are sometimes composed of offloadings of partial or combined trips of a vessel, particularly where the product is trucked to a dealer that buys or transships the landings.

On one hand, a possession limit would be more likely to be checked when the vessel returned from sea and would therefore be more consistent with the landings that were reported on a vessel's VTR. On the other hand, the NMFS plans to use the utility code (UTILCD) to assign landings to the appropriate TAL based on the intended market for the landings, wings for the food market and whole skates for the bait market. Complicating the issue is the practice of some vessels and dealers to land whole skates and process them ashore for the skate wing market.

The problem

I became more suspicious of the quality of the reported kept skates on the VTR as I began updating the possession limit model with 2009 VTR data. VTR reported landings on some trips were well over the 20,000 lb. possession limit, sometimes 45,000 lbs. or more and were categorized as wings. The issue that I expected to encounter was vessel operators reporting whole weight landings of skates that were landed for the wing market, which had been treated as wing weight in the possession limit because of the VTR reporting instructions.

I began spot matching VTR trips with the dealer reports based on the VTR serial number supplied by the dealer. While this process does not match 100% of the trips, it matches a reasonable high number to help identify reporting inconsistencies. Although the above problem (reporting skate wings as whole landings, which came close to matching the live weight landings on dealer reports) was identified in some cases, a substantial number turned out also to be reported as whole skates on VTRs (either reported in wing or whole weight) and skates landed as wings (UTILCD=0) on matching dealer reports. As a result of the reporting problem, these trips

in the Amendment 3 analysis had been ignored. Had they been included, the VTR landed weights would have been treated as wing weight and overestimate the appropriate possession limit, because the VTRs wing landings were reported in whole weight for about half of these trips.

Data inconsistencies

Thus inspired, I expanded the analysis to include all 7,177 trips in calendar year 2009 with could be matched to dealer reports via the VTR serial number (the same as level A in the NEFSC 'AA' tables. These trips account for 10.0 million pounds of skate wings (landed weight) reported by dealers. The relationships between the two reports for matched trips are shown in Figure 1.

The figure in the upper left are 3,750 trips where landings of skate wings were reported on both the VTR and dealer reports. For the most part, the hail weights reported on VTRs are close to or identical with the landed weight reported by the dealer. There might be a slight overestimate on the VTRs, but there is some scatter among a few trips. This scatter may be caused by 'landings' or sale of combined or partial trips to dealers.

The figure in the upper right (Figure 1, shaded yellow) are 2,911 trips which were or would have been classified as whole/bait trips using VTR data, but were either reported as skate wings by dealers or whole skates landed for the food market. The plot has three clusters of points. One cluster with a slope equal to 1 represents trips that the VTR report was of whole skates reported in wing weight, both on the VTR and by the dealer. Another cluster of data has a slope of 0.44 are trips where the VTR report actually represented the whole weight and were reported by dealers in wing, or landed weight. A third cluster of points lie along the X axis, where the dealer reported landings of some skate wings, but the amount is clearly inconsistent with the amount reported by the fishermen on VTRs. These trips could be ones where large skates were landed as wings at dealers, but most of the small skates were sold elsewhere (directly to lobster vessels?).

There are also a few trips (Figure 1, lower left panel) of moderate volume that were reported by dealers as skate landings for bait, but matched VTRs with significantly lower amounts landed. They might be simply mis-reported as skate bait landings, but there is nothing to suggest that this is the case. Finally, there are other trips in the lower right panel of Figure 1 that were reported as skate bait landings by dealers, and whole weight landings on the matching VTR. Most landings are exact and lie on a line with slope = 1. But there are also a noticeable fraction of trips with higher VTR landings than reported by the dealer, possibly representing partial landings to dealers. And there are six trips that higher landings are reported by dealers, possibly resulting from a report combining multiple landings, or simply representing reporting errors.

Sea sampling and discard estimation

To add more detail to the mystery (and further complicate matters) 811 trips were also observed and the hail weights reported by sea samplers can be compared to landings reported by

dealers. Even here there is confusion and disagreement. For about half of the trips when sea samplers reported retention of skate wings and dealers reported landings of skate wings (upper right panel in Figure 2), many trips were in general agreement. But there were also a fair number of trips where the dealers reported significantly higher amounts of skate wing landings, probably caused by sub-sampling (i.e. unobserved hauls) on observed trips.

In the other half of the observed trips, the sea sampler reported landings of whole skates in wing weight (upper left panel in Figure 2). In some cases (lying along the X axis), the observer reported far higher amounts of skate landings than reported by the dealer. These trips could represent landings of skates for bait which were not (or underreported) by the dealer. In other cases, higher landings were reported by dealers and (as above) were probably from trips that were sub-sampled (i.e. had unobserved hauls).

Although this analysis of observed trips underscores and validates the reporting confusion described above, reporting inconsistencies and mis-reporting also may have some significant implications for discard estimation.

[The remaining portion of this section does not pertain to either possession limit or discard analysis, but provides some perspective on recent species composition and the status of species identification by observers. If it doesn't interest the reader, please skip to the next section.]

This analysis of observed trips also provides the opportunity to examine the species composition (as reported by trained observers) with the various skate fisheries by gear and region reported on matching VTR reports. Most skates in the Gulf of Maine on trips landing skate wings (as reported by dealers) are winter skate, whether the trip used trawls or gillnets (Figure 3). A substantial fraction of skates (about 10%) were reported as unclassified. The same held true for observed trips using trawls in the Georges Bank region, although the fraction of unclassified skates was smaller.

In the Southern New England region, about half of the skate wings landed by observed trips using trawls (Figure 3) were little skate and half were winter skate, with a very large fraction (~40%) reported by observers as unclassified species. In contrast, observed gillnet trips retained nearly all winter skate, with about 20% reported by observers as unclassified species. In the Southern New England skate bait fishery, nearly all the skates were identified by observers as little skate, with about a third of the retained skates were reported by observers as unclassified species.

In the Mid-Atlantic region, about half of the observed skates were identified as little skates when caught by vessels using trawls and landing wings (Figure 3). One-third was identified as little skates, with the remaining identified as unclassified skates. Nearly all the gillnet caught skates were identified as winter skates when landed as wings, whereas three-fourths of the whole skates landed were identified as little with about 12% each identified as being winter and clearnose skates.

Correcting for mis-classified VTR data by using dealer data to represent skate trips

Like the 2007 VTR data (Table 1), the 2009 VTR data classifies 2,618 trips (59%) using gillnets and 2,156 trips (43%) using trawls (OTF) to land skate wings (Table 2). These VTR data account for 12.8 million pounds (5,824 mt) of skate wing landings, compared to 12,706 mt of skate wing landings reported by dealers in 2009. Trips classified as whole/bait account for a substantial fraction of the total number of skate trips and accounted for 16.7 million pounds (7,590 mt) of skate landings, compared to 5,059 mt of landings reported by dealers. Some of the discrepancy with dealer landings can be attributed to failure to match VTR trips with prices and permit data, some of it attributed to missing VTR reports. But a significant part of the discrepancy now appears to be related to mis-reporting species codes and amount of landings on VTRs.

Using the dealer data to represent and classify skate trips, on the other hand, results in 3,935 trips (~100%) using gillnets and 3,746 trips (88%) using trawls to land skate wings (Table 3). These trips account for 23.0 million pounds (10,414 mt) of skate wing landings, compared to 12,706 mt of skate wing landings reported by dealers. A much smaller fraction of trips (525 trips) landed skates for the bait market according to the dealer data and accounted for 5.9 million pounds (2,675 mt) of skate landings, compared to total whole skate landings for bait of 5,059 mt. Some of the missing data are reported as aggregate trips and cannot therefore be used in this analysis, while other data does not match permit data which is used in the possession limit model analysis. Other than the missing aggregate trips (mostly state landings), the trips represent a substantial fraction of total landings and should therefore be relatively unbiased.

The additional trips (=2,911 trips) now classified as landing skate wings according to the dealer data have nearly the same landings frequency distribution as trips that were correctly reported on VTRs (Table 4). The mean of 1,583 lbs. (SD=3,313) for these trips is very close to the mean of 1,438 lbs. (SD=2660) for trips that the VTRs correctly identified the skate landings type. More important to the possession limit analysis, the 80th percentile of 1,745 lbs. is close to the 80th percentile of 2,040 lbs. for trips that were correctly reported on the VTRs. The same holds true for the 90th percentile, 4,704 lbs. vs. 4,788 lbs., respectively.

Possession limit model results

Using the same procedures to evaluate possession limit options to achieve a 33.9% reduction in landed mortality (assuming that existing discards remain constant), suggests that a 2,100 lb. skate wing possession limit would achieve the objective. Some trips are assumed to end when the observed average daily skate catch on a trip satisfies the possession limit, while others continue fishing and discard skates that would otherwise have been (and were in 2009) landed, with half assumed to survive discarding.

A graphical example of how the model treats the trips is shown in Figure 4 and Figure 5, for the 1,280 trips (out of 7,933) that would be affected by a 2,100 lb. possession limit. More trips using trawls (Figure 5) appear to target and land sufficient amounts of other species to continue fishing than for vessels using gillnets (Figure 4).

A summary and diagnostics for 2009 trips that are (and are not) affected by a 2,100 lb. skate wing possession limit is shown in Table 5. These data are separated into day trips (lasting less than 24 hours on matching VTRs) and longer trips, and also separated into levels of dependency of the vessel on annual skate revenue (see Amendment 3 IRFA for more details). A 2,100 lb. skate wing possession limit appears to affect vessels taking longer trips (739 trips or 29%) than day trips (541 trips or 10%). And as expected, vessels that rely on skates for a greater proportion of the vessels total annual revenue (for all species) tend to be more affected by the possession limit option than those that rely on skate revenue less, although the total number of trips affected is greater for the low dependency group. For comparison, the summary and diagnostics using 2009 dealer data to represent skate wing trips affected by a 1,900 lb. skate wing possession limit (the limit in the final rule to take effect on May 1, 2010) is given in Table 6.

Examining the range of possession limit options (Figure 6), a 2,100 lb. skate wing possession limit achieves the mortality reduction target with an 8.3% dead discard rate (as a percent of total 2009 skate wing landings). But a 3,500 lb. skate wing possession limit is estimated to achieve a 26% mortality reduction with a 5.3% dead discard rate, affecting fewer vessels and trips.

Another way to look at the issue is to use a different threshold for terminating a skate trip than was used in Amendment 3. In Amendment 3, a crew share threshold of $100 per day was applied. Trips that did not produce a $100 per day return to crew (assuming a 60/40 lay after expenses) were assumed to stop when the average daily landings of skate wings reached the candidate possession limit. Raising the bar to $200 or $300 per day would increase the 'cost' of continuing to fish and achieve the mortality reduction at a higher possession limit (at least on paper). With a $200 per day crew share threshold, the possession limit model achieves the 33.9% mortality reduction target with a 2,500 lb. skate wing possession limit, producing a 4.71% dead discard rate. With a $300 threshold, the target is achieved with a 2,700 lb. skate wing possession limit, producing a 2.9% dead discard rate. Since there is no data or model that indicates which is the right threshold, one way to evaluate this choice is estimating how much money it would take to keep the crewman (person) from going fishing (to make money fishing).

The effect on vessels, trips, and revenue is summarized for a wide range of possession limit options in Table 7. On trips landing skates, a 2,100 lb. possession limit affects 170 (36.6%) of vessels landing skates and 1,280 (16.1%) of trips landing skates. This compares to 178 (38.2%) vessels and 1,360 (17.1%) trips with a 1,900 lb. possession limit. Gross revenue from all species landed on trips with skate landings would decline by 20.6% to $33.2 million vs. 22.2% to $32.6 million with a 1,900 lb. wing possession limit. Total revenue net of daily fishing costs would likewise decline by nearly the same proportions. But due mainly to targeting trips that have a high proportion of landings from skates and the effect of additional discarding, revenue from skates would decline by 49.9% to $2.2 million with a 2,100 lb. limit vs. 52.7% to $2.1 million with a 1,900 lb. wing possession limit.

Table 1. Summary of 2007 VTR skate trips, classified by reported landings type and fishing gear.

		SKATE_FISHERY		
GEARCODE	Data	Whole/bait	Wings	Grand Total
GNS	Trips	2,287	2,492	4,779
	Total skate landings, live wt	4,115,150	7,227,471	11,342,621
	Total days absent	1,372	1,566	2,938
	Whole landings, lbs.	4,100,715	19,590	4,120,305
	Wing landings, landed wt lbs.	6,359	3,175,278	3,181,637
OTF	Trips	3,678	2,945	6,623
	Total skate landings, live wt	15,825,436	8,227,917	24,053,353
	Total days absent	5,793	5,783	11,576
	Whole landings, lbs.	15,754,067	21,583	15,775,650
	Wing landings, landed wt lbs.	31,440	3,615,125	3,646,565
Total Trips		5,965	5,437	11,402
Total Total skate landings, live wt		19,940,586	15,455,388	35,395,974
Total Total days absent		7,165	7,349	14,514
Total Whole landings, lbs.		19,854,782	41,173	19,895,955
Total Wing landings, landed wt lbs.		37,799	6,790,403	6,828,202

Table 2. Summary of 2009 VTR skate trips, classified by reported landings type and fishing gear.

		SKATE_FISHERY		
GEARCODE	Data	Whole/bait	Wings	Grand Total
GNS	Trips	1,847	2,618	4,465
	Total skate landings, live wt	4,394,149	8,139,163	12,533,312
	Total days absent	1,271	1,673	2,944
	Whole landings, lbs.	4,369,054	70,337	4,439,391
	Wing landings, landed wt. lbs.	11,055	3,554,549	3,565,604
OTF	Trips	2,870	2,156	5,026
	Total skate landings, live wt	12,340,062	4,701,381	17,041,443
	Total days absent	4,063	4,693	8,757
	Whole landings, lbs.	12,243,029	4,828	12,247,857
	Wing landings, landed wt. lbs.	42,746	2,068,966	2,111,712
Total Trips		4,717	4,774	9,491
Total Total skate landings, live wt		16,734,211	12,840,544	29,574,755
Total Total days absent		5,334	6,366	11,700
Total Whole landings, lbs.		16,612,083	75,165	16,687,248
Total Wing landings, landed wt. lbs.		53,801	5,623,515	5,677,316

Table 3. Summary of 2009 dealer landings of skates, classified by reported landings type and fishing gear.

		SKATE_FISHERY		
GEARCODE	Data	Whole/bait	Wings	Grand Total
GNS	Landing events reported	3	3,935	3,938
	Total skate landings, live wt	1,750	12,579,607	12,581,357
	Total days absent	3	2,586	2,589
	Whole/bait landings, lbs.	1,750	0	1,750
	Wing landings, landed wt. lbs.	0	5,541,677	5,541,677
OTF	Landing events reported	517	3,746	4,263
	Total skate landings, live wt	5,869,755	10,268,482	16,138,236
	Total days absent	371	8,613	8,983
	Whole/bait landings, lbs.	5,868,245	0	5,868,245
	Wing landings, landed wt. lbs.	665	4,523,560	4,524,225
OTH	Landing events reported	5	252	257
	Total skate landings, live wt	26,653	111,205	137,858
	Total days absent	4	170	175
	Whole/bait landings, lbs.	26,653	0	26,653
	Wing landings, landed wt. lbs.	0	48,989	48,989
Total Landing events reported		525	7,933	8,458
Total Total skate landings, live wt		5,898,158	22,959,293	28,857,451
Total Total days absent		378	11,369	11,747
Total Whole/bait landings, lbs.		5,896,648	0	5,896,648
Total Wing landings, landed wt. lbs.		665	10,114,226	10,114,891

Table 4. Frequency distribution of skate landings on dealer reports classified by identification of skate landings type on VTRs during 2009.

Results for FISHERY_VTR$ = Skate wing FISHERY_DLR$ = Skate wing

	SKATE_WINGS_DLR	SKATES_WHOLE_DL-R
N of Cases	3750	3750
Maximum	20000.000	0.000
Sum	5393963.850	0.000
Arithmetic Mean	1438.390	0.000
Standard Deviation	2660.253	0.000
Method = CLEVELAND		
1.000%	3.000	0.000
5.000%	10.000	0.000
10.000%	19.000	0.000
20.000%	50.000	0.000
25.000%	65.000	0.000
30.000%	85.000	0.000
40.000%	160.000	0.000
50.000%	300.000	0.000
60.000%	549.000	0.000
70.000%	1002.500	0.000
75.000%	1460.000	0.000
80.000%	2040.000	0.000
90.000%	4787.500	0.000
95.000%	7255.000	0.000
99.000%	12490.000	0.000

Results for FISHERY_VTR$ = Bait/whole FISHERY_DLR$ = Skate wing

	SKATE_WINGS_DLR	SKATES_WHOLE_DL-R
N of Cases	2911	2911
Maximum	20000.000	0.000
Sum	4606972.912	0.000
Arithmetic Mean	1582.608	0.000
Standard Deviation	3313.160	0.000
Method = CLEVELAND		
1.000%	3.000	0.000
5.000%	7.000	0.000
10.000%	16.000	0.000
20.000%	42.000	0.000
25.000%	60.000	0.000
30.000%	80.000	0.000
40.000%	166.000	0.000
50.000%	330.000	0.000
60.000%	500.000	0.000
70.000%	935.000	0.000
75.000%	1204.750	0.000
80.000%	1745.112	0.000
90.000%	4704.449	0.000
95.000%	8849.000	0.000
99.000%	18498.750	0.000

Figure 1. Kept/landings correspondence table for trips reporting skate landings in 2009, matched by VTRSERNO. Shaded cell represents trips mis-classified as whole/bait by VTR reports. Some of the mis-classified skate landings are reported as wing weight in agreement with dealer report, while others are reported as whole weight in agreement with the VTR instructions.

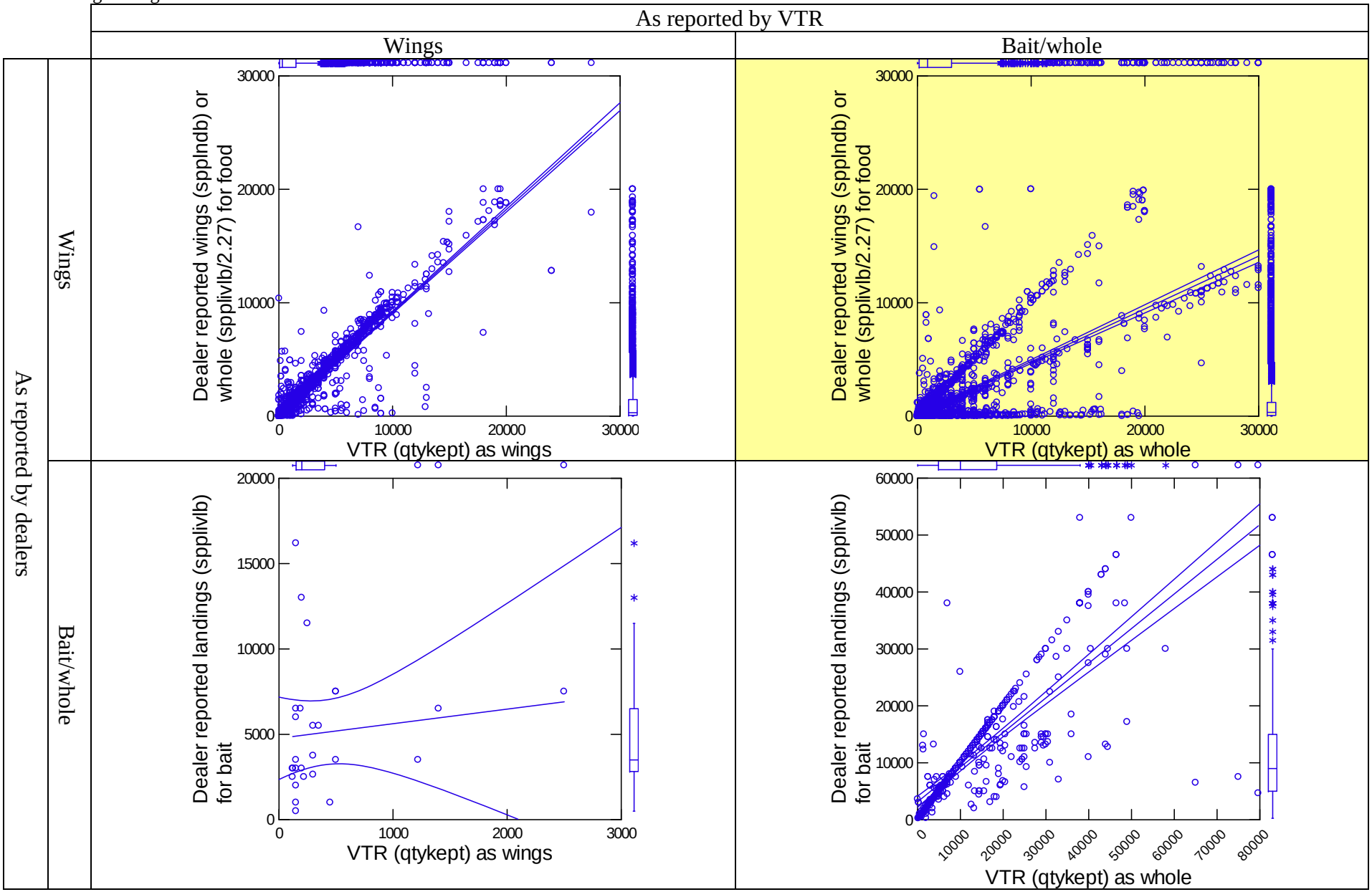


Figure 2. Comparison of observed hail weights and dealer landings for 8?? observed trips landing skates in 2009.

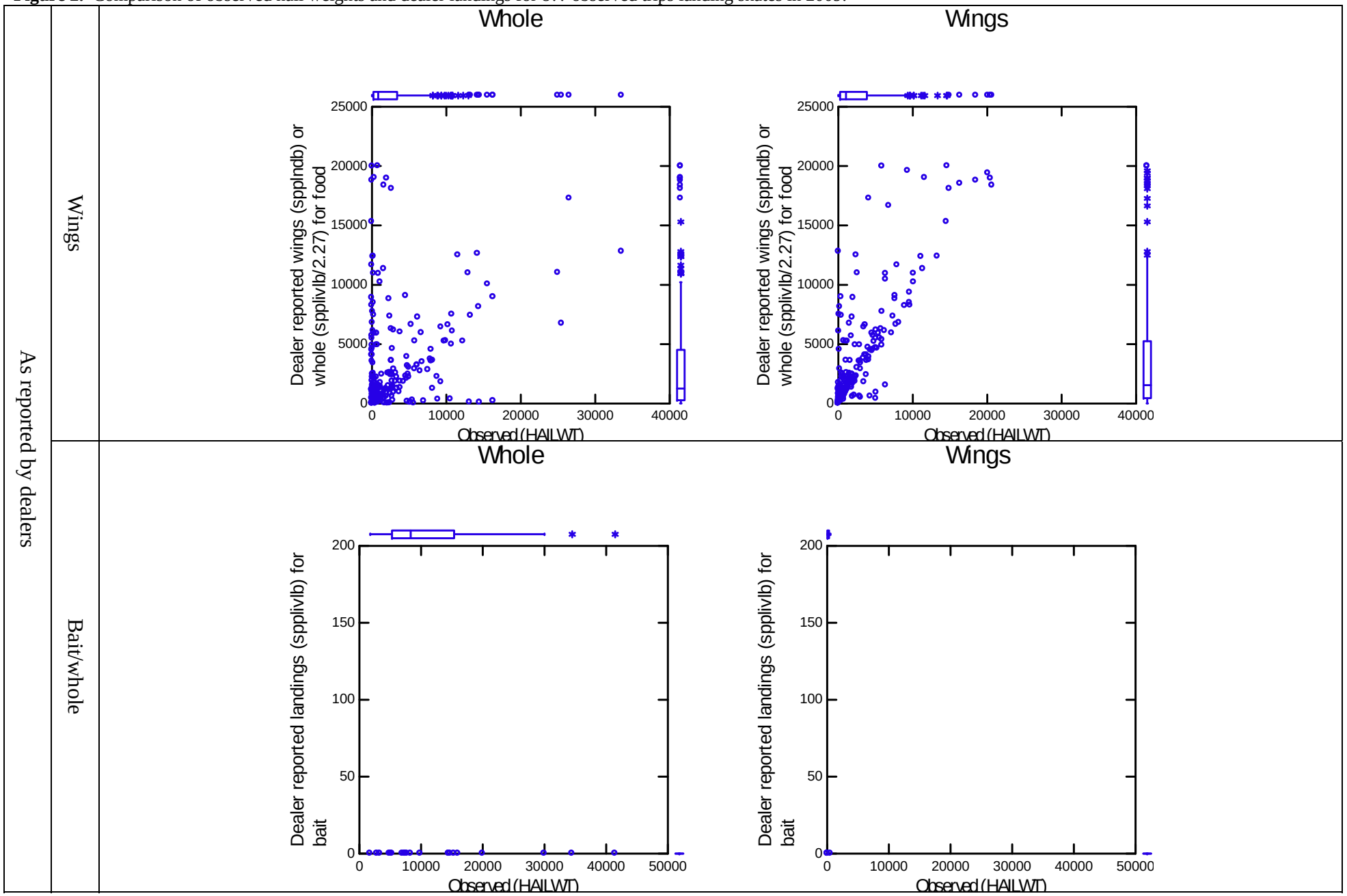
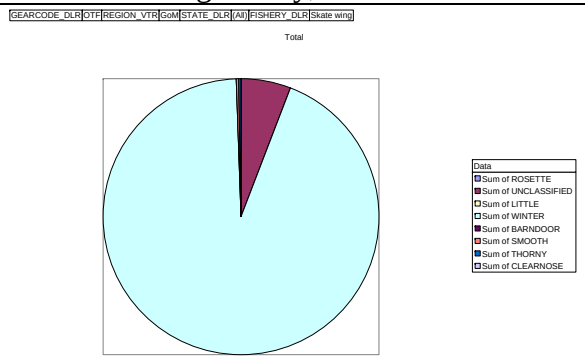
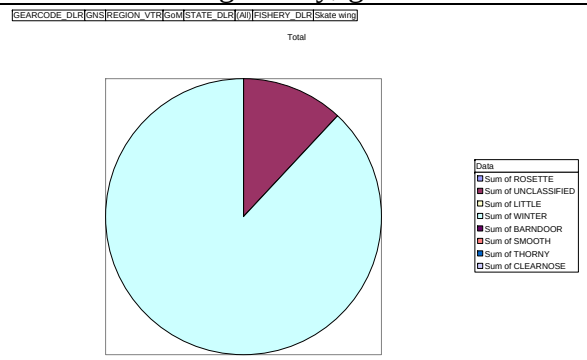
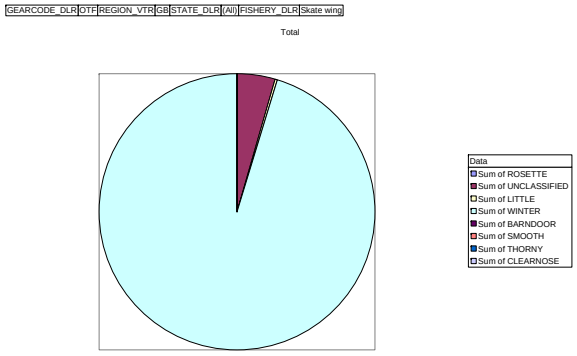
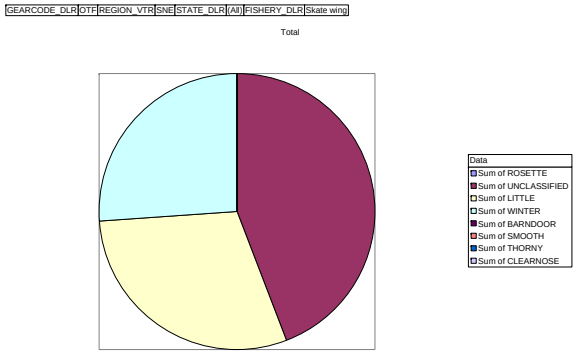
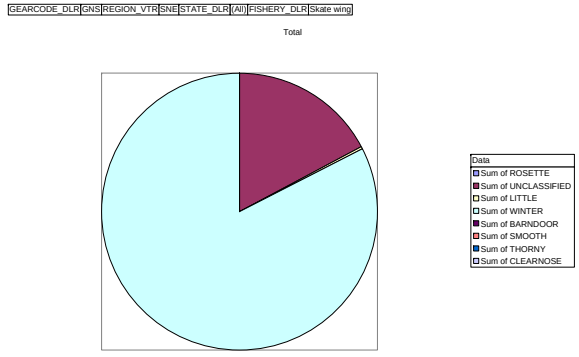
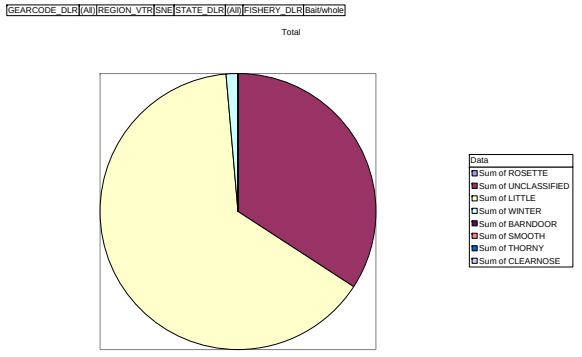


Figure 3. Proportion of observed hail weight by species, classified by dealer landings type, VTR gear code, and region (defined by statistical area).

	Wing fishery, fish trawl	Wing fishery, gillnet	Whole/bait fishery
Gulf of Maine			No observed trips
Georges Bank		No observed trips	No observed trips
Southern New England			

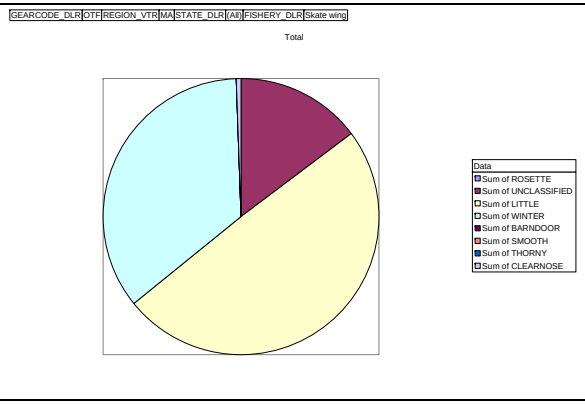
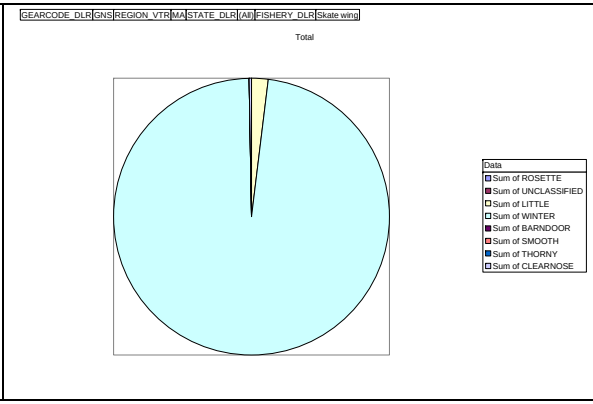
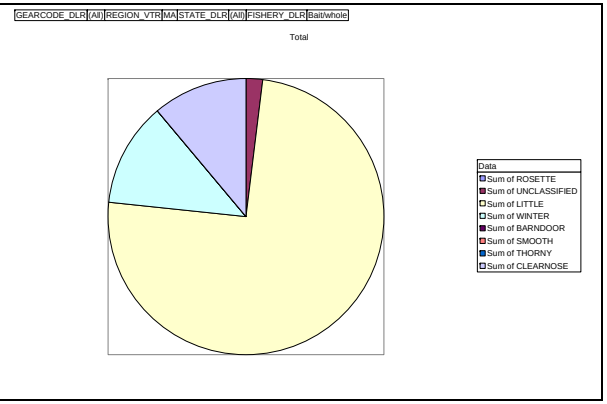
Mid-Atlantic			

Table 5. Skate trip diagnostics and effects of a 2,100 skate wing possession limit on 2009 trips landings skate wings according to dealer reports.

			Trip affected by measures?			Percent
Trip type	Dependency	Data	N	Y	Grand Total	
Day	Low	Trips	4,717	223	4,940	4.5%
		Daily fishing cost	$676	$381	$663	
		Sum of Total skate landings, live weight	2,934,336	1,745,219	4,679,554	37.3%
		Sum of Adj. skate landings	2,934,336	1,063,041	3,997,377	60.9%
		Sum of Skate discard mortality	0	229,398	229,398	13.1%
		Sum of Skate price	$0.17	$0.15	$0.16	
		Sum of Orig. revenue/DA	$3,719	$4,847	$3,783	
	Medium	Trips	147	264	411	64.2%
		Daily fishing cost	$465	$426	$440	
		Sum of Total skate landings, live weight	224,203	3,608,967	3,833,170	94.2%
		Sum of Adj. skate landings	224,203	1,258,488	1,482,691	34.9%
		Sum of Skate discard mortality	0	330,648	330,648	9.2%
		Sum of Skate price	$0.19	$0.14	$0.15	
		Sum of Orig. revenue/DA	$3,808	$5,188	$4,809	
	High	Trips	7	54	61	88.5%
		Daily fishing cost	$376	$393	$391	
		Sum of Total skate landings, live weight	19,136	870,935	890,072	97.9%
		Sum of Adj. skate landings	19,136	257,418	276,554	29.6%
		Sum of Skate discard mortality	0	29,175	29,175	3.3%
		Sum of Skate price	$0.26	$0.19	$0.19	
		Sum of Orig. revenue/DA	$2,583	$8,169	$7,455	
	#N/A	Trips	52		52	0.0%
		Daily fishing cost	$487		$487	
		Sum of Total skate landings, live weight	679		679	0.0%
		Sum of Adj. skate landings	679		679	
		Sum of Skate discard mortality	0		0	
		Sum of Skate price	$0.23		$0.23	
		Sum of Orig. revenue/DA	$2,939		$2,939	
Day Trips			4,923	541	5,464	9.9%
Day Daily fishing cost			$667	$404	$641	
Day Sum of Total skate landings, live weight			3,178,354	6,225,121	9,403,475	66.2%
Day Sum of Adj. skate landings			3,178,354	2,578,947	5,757,301	41.4%
Day Sum of Skate discard mortality			0	589,221	589,221	9.5%
Day Sum of Skate price			$0.17	$0.15	$0.16	
Day Sum of Orig. revenue/DA			$3,711	$5,289	$3,894	
Trip	Low	Trips	1,629	566	2,195	25.8%
		Daily fishing cost	$997	$1,201	$1,050	
		Sum of Total skate landings, live weight	1,853,130	8,310,331	10,163,461	81.8%
		Sum of Adj. skate landings	1,853,130	2,698,122	4,551,252	32.5%
		Sum of Skate discard mortality	0	1,552,935	1,552,935	18.7%
		Sum of Skate price	$0.22	$0.22	$0.22	
		Sum of Orig. revenue/DA	$3,541	$3,831	$3,653	
	Medium	Trips	94	156	250	62.4%
		Daily fishing cost	$386	$449	$425	
		Sum of Total skate landings, live weight	186,478	2,949,046	3,135,524	94.1%
		Sum of Adj. skate landings	186,478	743,652	930,130	25.2%
		Sum of Skate discard mortality	0	212,029	212,029	7.2%
		Sum of Skate price	$0.20	$0.18	$0.18	
		Sum of Orig. revenue/DA	$2,117	$3,547	$3,001	
	High	Trips	3	17	20	85.0%
		Daily fishing cost	$382	$428	$421	
		Sum of Total skate landings, live weight	10,674	246,019	256,693	95.8%
		Sum of Adj. skate landings	10,674	81,039	91,713	32.9%
		Sum of Skate discard mortality	0	26,005	26,005	10.6%
		Sum of Skate price	$0.20	$0.30	$0.30	
		Sum of Orig. revenue/DA	$3,480	$4,340	$4,222	
	#N/A	Trips	4		4	0.0%
		Daily fishing cost	$901		$901	
		Sum of Total skate landings, live weight	141		141	0.0%
		Sum of Adj. skate landings	141		141	
		Sum of Skate discard mortality	0		0	
		Sum of Skate price	$0.18		$0.18	
		Sum of Orig. revenue/DA	$5,094		$5,094	
Trip Trips			1,730	739	2,469	29.9%
Trip Daily fishing cost			$963	$1,025	$981	
Trip Sum of Total skate landings, live weight			2,050,423	11,505,396	13,555,819	84.9%
Trip Sum of Adj. skate landings			2,050,423	3,522,813	5,573,236	30.6%
Trip Sum of Skate discard mortality			0	1,790,969	1,790,969	15.6%
Trip Sum of Skate price			$0.22	$0.21	$0.21	
Trip Sum of Orig. revenue/DA			$3,506	$3,816	$3,629	
Total Trips			6,653	1,280	7,933	16.1%
Total Daily fishing cost			$744	$762	$747	
Total Sum of Total skate landings, live weight			5,228,776	17,730,517	22,959,293	77.2%
Total Sum of Adj. skate landings			5,228,776	6,101,760	11,330,536	34.4%
Total Sum of Skate discard mortality			0	2,380,190	2,380,190	13.4%
Total Sum of Skate price			$0.19	$0.19	$0.19	
Total Sum of Orig. revenue/DA			$3,564	$3,923	$3,685	

Table 6. Skate trip diagnostics and effects of a 1,900 skate wing possession limit on 2009 trips landings skate wings according to dealer reports.

			Trip affected by measures?			Percent
Trip type	Dependency	Data	N	Y	Grand Total	
Day	Low	Trips	4,686	254	4,940	5.1%
		Daily fishing cost	$678	$381	$663	
		Sum of Total skate landings, live weight	2,792,119	1,887,435	4,679,554	40.3%
		Sum of Adj. skate landings	2,792,119	1,095,502	3,887,621	58.0%
		Sum of Skate discard mortality	0	268,916	268,916	14.2%
		Sum of Skate price	$0.17	$0.15	$0.16	
		Sum of Orig. revenue/DA	$3,715	$4,773	$3,783	
	Medium	Trips	138	273	411	66.4%
		Daily fishing cost	$472	$423	$440	
		Sum of Total skate landings, live weight	183,302	3,649,868	3,833,170	95.2%
		Sum of Adj. skate landings	183,302	1,177,449	1,360,751	32.3%
		Sum of Skate discard mortality	0	357,922	357,922	9.8%
		Sum of Skate price	$0.19	$0.14	$0.15	
		Sum of Orig. revenue/DA	$3,691	$5,198	$4,809	
	High	Trips	7	54	61	88.5%
		Daily fishing cost	$376	$393	$391	
		Sum of Total skate landings, live weight	19,136	870,935	890,072	97.9%
		Sum of Adj. skate landings	19,136	232,902	252,038	26.7%
		Sum of Skate discard mortality	0	31,445	31,445	3.6%
		Sum of Skate price	$0.26	$0.19	$0.19	
		Sum of Orig. revenue/DA	$2,583	$8,169	$7,455	
	#N/A	Trips	52		52	0.0%
		Daily fishing cost	$487		$487	
		Sum of Total skate landings, live weight	679		679	0.0%
		Sum of Adj. skate landings	679		679	
		Sum of Skate discard mortality	0		0	
		Sum of Skate price	$0.23		$0.23	
		Sum of Orig. revenue/DA	$2,939		$2,939	
Day Trips			4,883	581	5,464	10.6%
Day Daily fishing cost			$670	$402	$641	
Day Sum of Total skate landings, live weight			2,995,236	6,408,239	9,403,475	68.1%
Day Sum of Adj. skate landings			2,995,236	2,505,853	5,501,089	39.1%
Day Sum of Skate discard mortality			0	658,283	658,283	10.3%
Day Sum of Skate price			$0.17	$0.15	$0.16	
Day Sum of Orig. revenue/DA			$3,705	$5,234	$3,894	
Trip	Low	Trips	1,594	601	2,195	27.4%
		Daily fishing cost	$996	$1,193	$1,050	
		Sum of Total skate landings, live weight	1,692,610	8,470,850	10,163,461	83.3%
		Sum of Adj. skate landings	1,692,610	2,592,113	4,284,723	30.6%
		Sum of Skate discard mortality	0	1,632,925	1,632,925	19.3%
		Sum of Skate price	$0.22	$0.22	$0.22	
		Sum of Orig. revenue/DA	$3,541	$3,818	$3,653	
	Medium	Trips	90	160	250	64.0%
		Daily fishing cost	$385	$448	$425	
		Sum of Total skate landings, live weight	168,216	2,967,308	3,135,524	94.6%
		Sum of Adj. skate landings	168,216	690,080	858,296	23.3%
		Sum of Skate discard mortality	0	227,119	227,119	7.7%
		Sum of Skate price	$0.21	$0.18	$0.18	
		Sum of Orig. revenue/DA	$2,080	$3,541	$3,001	
	High	Trips	2	18	20	90.0%
		Daily fishing cost	$388	$425	$421	
		Sum of Total skate landings, live weight	6,315	250,378	256,693	97.5%
		Sum of Adj. skate landings	6,315	77,634	83,949	31.0%
		Sum of Skate discard mortality	0	27,844	27,844	11.1%
		Sum of Skate price	$0.17	$0.30	$0.30	
		Sum of Orig. revenue/DA	$3,180	$4,331	$4,222	
	#N/A	Trips	4		4	0.0%
		Daily fishing cost	$901		$901	
		Sum of Total skate landings, live weight	141		141	0.0%
		Sum of Adj. skate landings	141		141	
		Sum of Skate discard mortality	0		0	
		Sum of Skate price	$0.18		$0.18	
		Sum of Orig. revenue/DA	$5,094		$5,094	
Trip Trips			1,690	779	2,469	31.6%
Trip Daily fishing cost			$962	$1,022	$981	
Trip Sum of Total skate landings, live weight			1,867,282	11,688,536	13,555,819	86.2%
Trip Sum of Adj. skate landings			1,867,282	3,359,827	5,227,109	28.7%
Trip Sum of Skate discard mortality			0	1,887,887	1,887,887	16.2%
Trip Sum of Skate price			$0.22	$0.21	$0.21	
Trip Sum of Orig. revenue/DA			$3,505	$3,805	$3,629	
Total Trips			6,573	1,360	7,933	17.1%
Total Daily fishing cost			$745	$757	$747	
Total Sum of Total skate landings, live weight			4,862,519	18,096,775	22,959,293	78.8%
Total Sum of Adj. skate landings			4,862,519	5,865,680	10,728,199	32.4%
Total Sum of Skate discard mortality			0	2,546,171	2,546,171	14.1%
Total Sum of Skate price			$0.19	$0.19	$0.19	
Total Sum of Orig. revenue/DA			$3,562	$3,911	$3,685	

Table 7. Affected number of vessels and trips landing skates with total revenue at various skate wing possession limit options, based on 2009 landing characteristics reported by dealers.

Skate wing possession limit option	Percent morality reduction	Additional discard rate	Number of vessels	Trips	Gross annual revenue	Net revenue	Gross annual revenue from skate wings
1,900	36.0%	8.8%	178	1,360	$32,585,318	$22,612,527	$ 2,056,247
2,100	34.5%	8.3%	170	1,280	$33,227,513	$23,048,981	$ 2,172,052
2,300	33.1%	7.7%	162	1,193	$33,800,923	$23,438,953	$ 2,280,484
2,500	31.7%	7.2%	154	1,120	$34,313,990	$23,787,679	$ 2,381,632
3,000	28.7%	6.2%	136	975	$35,446,095	$24,563,876	$ 2,611,567
3,500	25.9%	5.3%	127	869	$36,383,409	$25,208,733	$ 2,812,694
4,000	23.4%	4.6%	117	769	$37,128,576	$25,720,990	$ 2,987,174
6,000	15.6%	2.7%	80	477	$39,155,529	$27,096,392	$ 3,510,972
10,000	7.5%	1.1%	42	179	$40,915,839	$28,293,371	$ 4,028,170
All skate trips			465	7,933	$41,894,159	$28,981,639	$ 4,355,029

Figure 4. Effect of a 2,100 lb. skate wing possession limit on landings of trips using gillnets to land skates in MA.

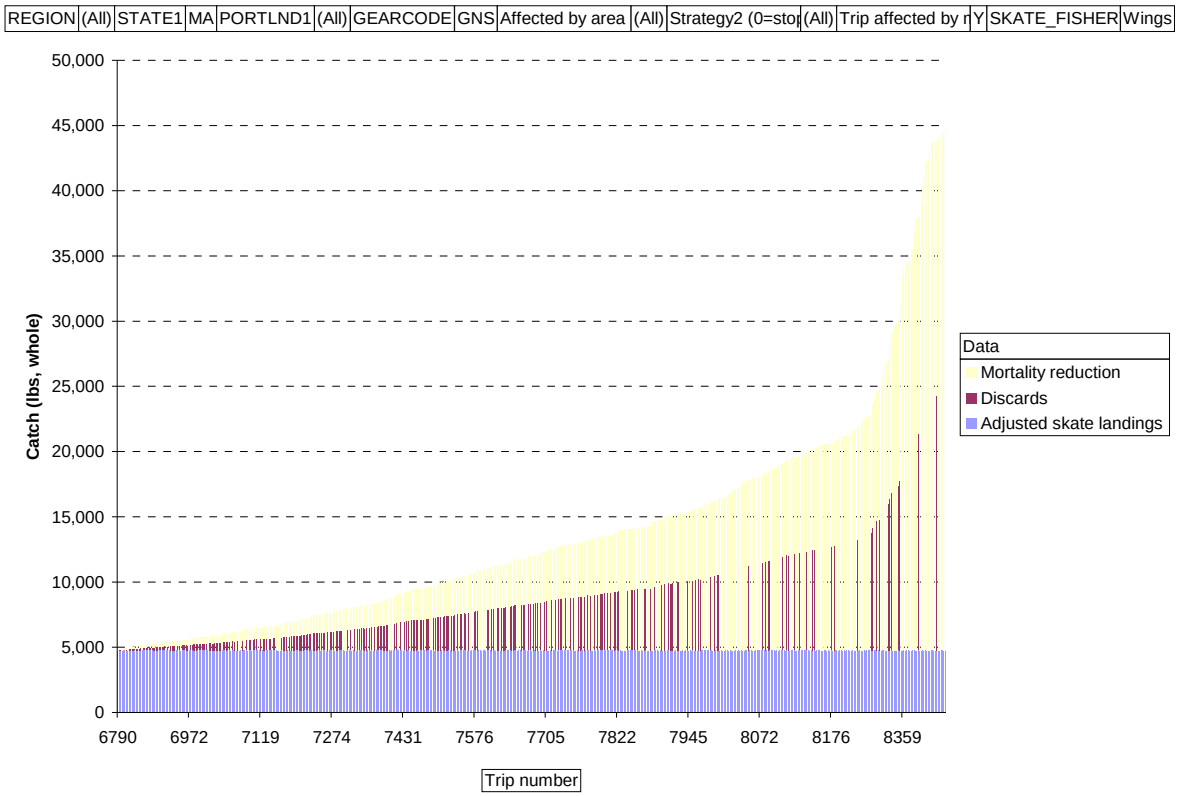


Figure 5. Effect of a 2,100 lb. skate wing possession limit on landings of trips using trawls to land skates in MA.

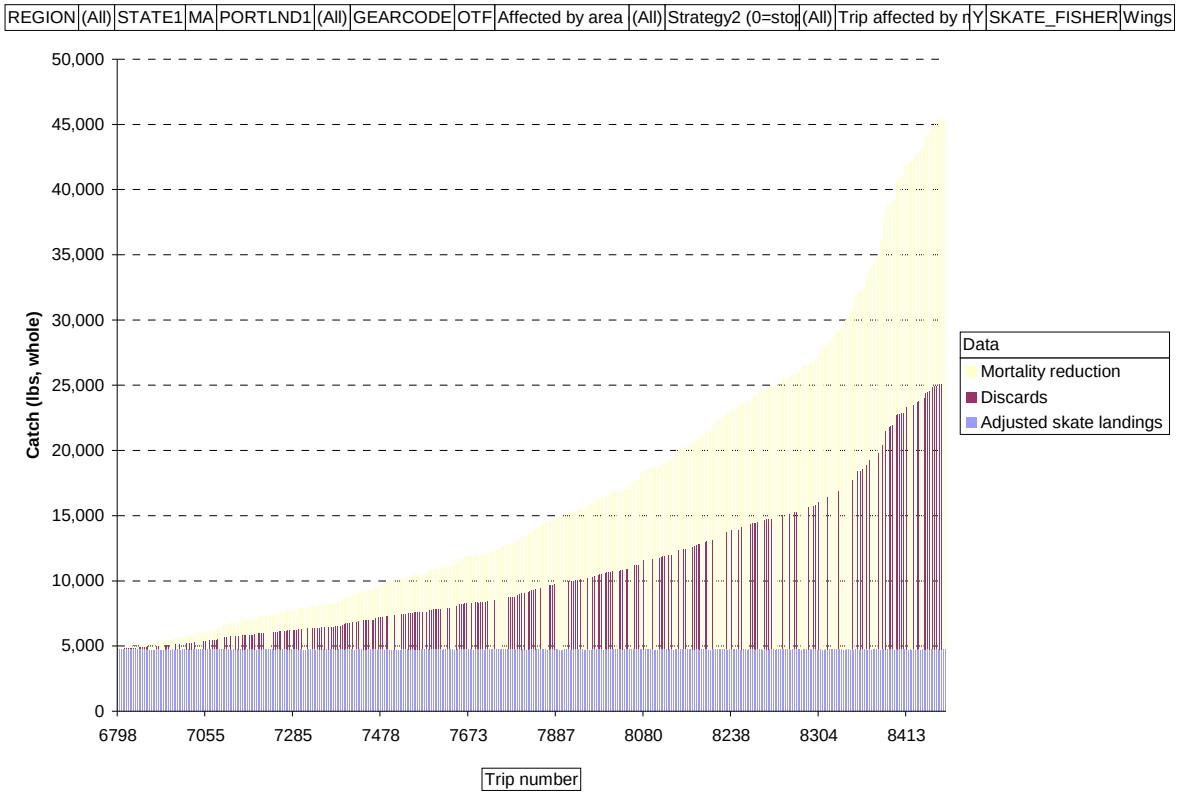
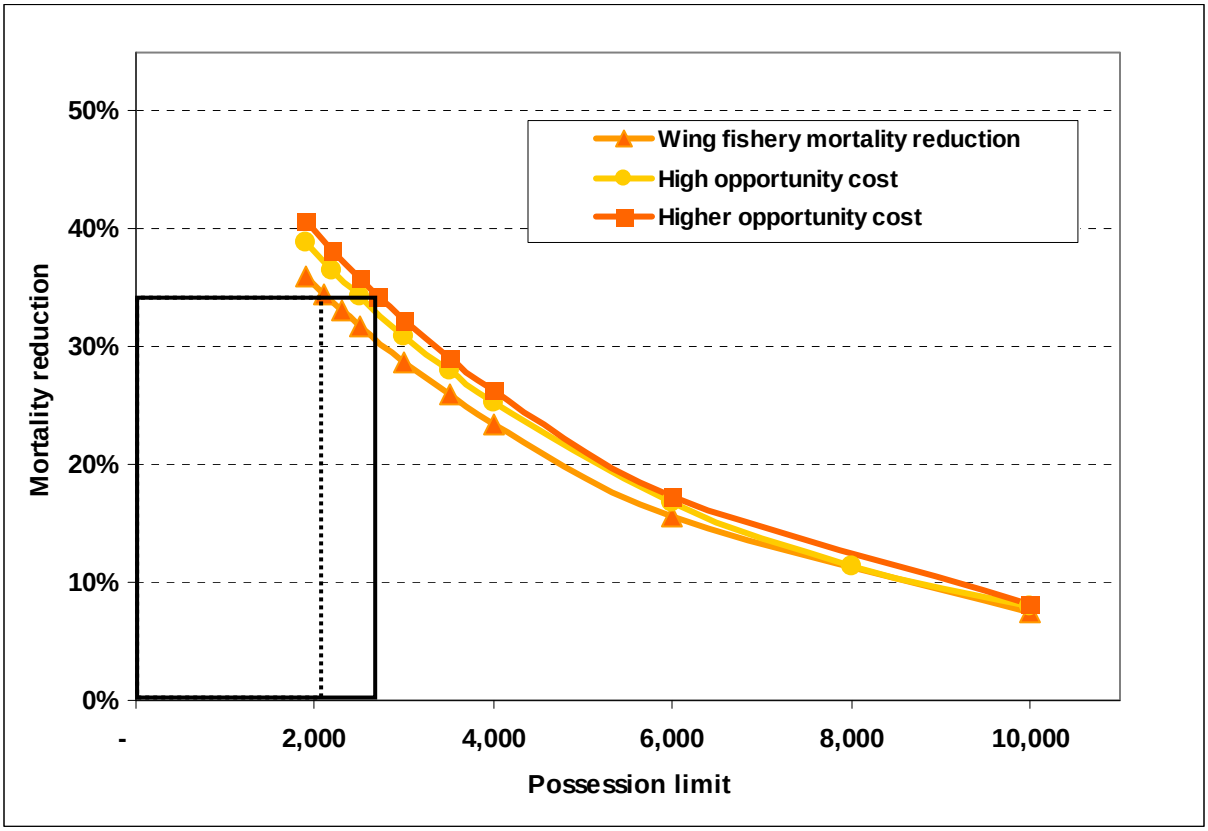


Figure 6. Estimated effect of skate wing possession limit options on skate mortality and discards, 2009 dealer landings.

Expected mortality reduction



Expected discards as a percent of 2009 skate landings