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Determination of Conversion Factors for Vessel Comparison Studies

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ABSTRACT

NOAA's Northeast Fisheries Science Center has conducted groundfish surveys on the Northeast Continental Shelf of the United States in autumn since 1963. These surveys are used compute relative abundance indices of fish and selected invertebrates. Since the inception of the survey program, the R/V *Albatross IV* has been the primary vessel conducting the work, except periodically when the R/V *Delaware II* has been utilized because the R/V *Albatross IV* was not available. When the R/V *Delaware II* was used, differences in vessel characteristics necessitate the development of conversion coefficients to adjust catch rates using the R/V *Albatross* as the standard.

A series of vessel calibration studies between the R/Vs *Albatross IV* and *Delaware II* employing a paired tow design were initiated in 1981. In 1997, the R/V *Delaware II* underwent a major refit. Accordingly, for these two research vessels, there are two variations in the experimental time series that require consideration in development of calibration coefficients. We explored the use of a ratio estimator for the development of a vessel conversion coefficient and compared these with a general linear model (GLM) approach used by Byrne and Forrester (1991).

INTRODUCTION

For many decades the Federal Government has conducted groundfish surveys out of Woods Hole, MA. With the arrival of the newly built research vessel R/V *Albatross IV* in 1963, the Bureau of Commercial Fisheries (now National Marine Fisheries Service) began a time series that serves as the basis for some of the longest time series of standardized fishery-independent indices of relative abundance in the world. In addition to tracking abundance of mature animals, research surveys provide indices of juvenile abundance, which can indicate strong year classes before fish are vulnerable to commercial or recreational fisheries. Research surveys indicate the status of a stock over its entire range, not just in small areas of commercial or recreational concentration. Surveys also provide data on growth, maturity, predation, and mortality of a stock as well as trophic dynamics of fish communities (Azarovitz 1981).

The R/V *Albatross IV*'s autumn bottom trawl survey was conducted using a #36 Yankee net with a sixty-foot (18.3 m) headrope and eighty-foot (24.4 m) footrope. The sweep was comprised of sixteen-inch (40.6 cm) rollers that allow the gear to be fished on most bottom types. The net and fishing operation remained almost the same since the start of the autumn survey in 1963 (Azarovitz 1981). When changes were made, comparative tows were performed to quantify the changes in the catchability of the gear. Once determined, a conversion coefficient was applied to the data so that any differences in the catchability of the gear could be compared to future catches (Fogarty 1997).

Conversion coefficients between the R/V's *Albatross IV* and *Delaware II* were developed by Byrne and Forrester (1991) using a general linear model (GLM) approach. When the R/V *Delaware II* was used for surveys, these estimates were used to transform catch data. In 1997 the R/V *Delaware II* underwent a major refit. This refit included changing the winches from slower direct drive to faster free spooling winches. After the refit, the previous conversion factors were still employed to transform the data. However, the GLM approach does not allow the consideration of tows with zero catch, thus those data were lost. An alternative approach using ratio estimators, which use a ratio of the sum of the paired data, allows the comparison of all catch data between the two vessels.

Because the GLM method does not permit the inclusion of paired tows where one of the tows has zero catch, we compared the use of the GLM and ratio estimator methods for deriving the conversion factors. Additionally we examined the conversion factors before and after the refit of the R/V *Delaware II* in 1997.

MATERIALS & METHODS

The R/V's *Albatross IV* and *Delaware II* fished alongside each other five times since the R/V Delaware II was refurbished in 1997 (Table 1, Figure 1). During these cruises, the R/V *Delaware II* accompanied the R/V *Albatross IV* while the R/V *Albatross IV* was engaged in its standard bottom trawl survey. Three paired comparison cruises from the 1980s were used to compare the GLM and ratio estimators for developing conversion factors. One 1998 cruise and four cruises from the 2000s were utilized to construct the ratio estimator model to estimate conversion coefficients.

The conversion coefficient (α) was calculated as:

$$\hat{\alpha} = \frac{\sum_{i=1}^{n} wV2_i V1_i}{\sum_{i=1}^{n} wV1_i^2}$$

where w is a weighting coefficient that depends on the relationship between the variance of V2 (Vessel 2) and V1(Vessel 1); the variance is defined as:

$$\text{var}\left(\hat{\alpha}\right) = \frac{\frac{1}{n-1}\sum_{i=1}^{n} w\left(V2_i - \hat{\alpha}V1_i\right)^2}{\sum_{i=1}^{n} wV1_i^2}$$

If the variance of V2 and V1 is proportional, the weighting coefficient is V1-1 and the estimator for the conversion coefficient is:

$$\hat{\alpha} = \frac{\sum_{i=1}^{n} V2_i}{\sum_{i=1}^{n} V1_i}$$

We used the proportional variance estimator in our analyses where “V2” is the variance of the R/V *Albatross IV* and “V1” is the variance of the R/V *Delaware II*.

Conversion coefficients were developed for winter skate (*Leucoraja ocellata*) , silver hake (*Merluccius bilinearis*), Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), white hake (*Urophycis tenuis*), red hake (*Urophycis chuss*), American plaice (*Hippoglossoides platessoides*), fourspot flounder (*Hippoglossina oblonga*), yellowtail flounder (*Limanda ferruginea*), witch flounder (*Glyptocephalus cynoglossus*), windowpane flounder (*Scophthalmus aquosus*), redfish (*Sebastes fasciatus*), and ocean pout (*Zoarces americanus*).

RESULTS

When we examined the conversion factors derived from both the GLM and ratio estimator models using the 1980s data, with the exception of haddock, there appears to be good correlation between the two methods for determining vessel conversion coefficients (Figure 2).

Ratio conversion coefficients calculated for catches before and after the R/V *Delaware*’s 1997 refit suggest that the vessel effect was reduced after the vessel was modified. Twelve of the 14 species’ coefficients calculated from the 1980s data showed a difference, while only 4 of the 14 species show a difference after the refit (Figure 3).The species that showed a difference included cod, haddock, pollock and redfish (Figure 4). For these four species, the post-fit conversion factors should be applied to the R/V *Delaware II* data when the R/V *Delaware II* was used in place of the R/V *Albatross IV* for the standardized groundfish surveys (Table 2).

DISCUSSION

Differences in catch efficiencies between the R/V *Albatross IV* and R/V *Delaware II* were reduced after the refit of the R/V *Delaware II*. It was unanticipated that the refit would reduce the difference in the catchability between the two vessels or, in other words, reduce the catchability of the R/V *Delaware II*. After the R/V *Delaware II* was modified, the winches were replaced with faster winches. We hypothesize that because the winches were faster, the amount of time the net spent on the bottom was reduced. The winch speed was designed to match the speed of the winches on the R/V *Albatross IV* which appears to have equalized the catchability between the two vessels.

The ratio conversion coefficients were calculated for fourteen species. The next step will be to apply it to the other principal groundfish species to determine if conversion coefficients are required.

ACKNOWLEDGEMENTS

This work would not be possible without the efforts of numerous members of the Northeast Fisheries Science Center, particularly the Resource Survey Branch, who participated in these cruises and helped collect this data. A special thanks is due to Kathy Mays of the Northeast Fisheries Science Center who spent considerable time helping to develop the proper scripts to pull the data from the survey database.

LITERATURE CITED

Azarovitz TR. 1981. A brief historical review of the Woods Hole Laboratory trawl survey time series. Can Spec Pub Fish Aq Sci. 58:62-67.

Byrne CJ, Forrester JRS. 1991. Relative Fishing Power of NOAA R/V's Albatross IV and Delaware II. In: Report of the Twelfth Northeast Regional Stock Assessment Workshop. US. Dept. Commer., NOAA, Northeast Fisheries Science Center Ref. Doc. 91-03, 187 p.

Fogarty M.J. 1997. Standardizing fishing power in research vessel surveys. In: Proceedings of the Workshop on Maintaining Current & Future Fisheries Resource Survey Capabilities. Special Report No. 63 of the Atlantic States Marine Fisheries Commission, p 54-63.

Table 1. Cruise information for paired fishing power cruises between the R/V's *Albatross IV* and *Delaware II* since 1982. When the start date for the *Albatross IV* precedes the *Delaware II* it is because the comparative work did not occur during all four legs of a survey.

CRUISE NUMBER	VESSEL NAME	START DATE	END PATE	SURVEY	NUMBER OF PAIRS	GEAR TYPE
198206	Albatross IV	9/13/1982	11/12/1982	FALL	144	Yankee 36
198207	Delaware II	10/4/1982	10/29/1982			
198306	Albatross IV	9/12/1983	11/10/1983	FALL	113	Yankee 36
198307	Delaware II	10/4/1983	10/26/1983			
198803	Albatross IV	9/12/1988	10/28/1988	FALL	227	Yankee 36
198804	Delaware II	9/19/1988	10/28/1988			
199802	Albatross IV	3/2/1998	4/20/1998	SPRING	44	Yankee 36
199807	Delaware II	3/30/1998	4/10/1998			
200002	Albatross IV	3/16/2000	5/3/2000	SPRING	125	Yankee 36
200003	Delaware II	3/20/2000	4/14/2000			
200102	Albatross IV	2/26/2001	4/30/2001	SPRING	69	Yankee 36
200104	Delaware II	3/26/2001	4/20/2001			
200202	Albatross IV	3/4/2002	4/26/2002	SPRING	131	Yankee 36
200203	Delaware II	4/3/2002	4/26/2002			
200209	Albatross IV	9/3/2002	10/25/2002	FALL	51	Yankee 36
200211	Delaware II	10/16/2002	10/25/2002			

Table 2. A list of the species analyzed, the ratio estimates (conversion factors), the standard error of the estimates, and 90% confidence limits.

SPECIES	RATIO ESTIMATE	STANDARD ERROR	90% CONFIDENCE INTERVALS	
Winter Skate	0.93	0.06	0.831	1.029
Silver Hake	1.02	0.07	0.9045	1.1355
Cod	0.82	0.06	0.721	0.919
Haddock	0.83	0.06	0.731	0.929
Pollock	0.69	0.05	0.6075	0.7725
White Hake	1.04	0.07	0.9245	1.1555
Red Hake	0.91	0.06	0.811	1.009
American Plaice	1.01	0.07	0.8945	1.1255
Fourspot Flounder	1.04	0.07	0.9245	1.1555
Yellowtail Flounder	1.07	0.07	0.9545	1.1855
Witch Flounder	1.00	0.07	0.8845	1.1155
Windowpane Flounder	0.95	0.07	0.8345	1.0655
Redfish	0.87	0.06	0.771	0.969
Ocean Pout	0.98	0.07	0.8645	1.0955

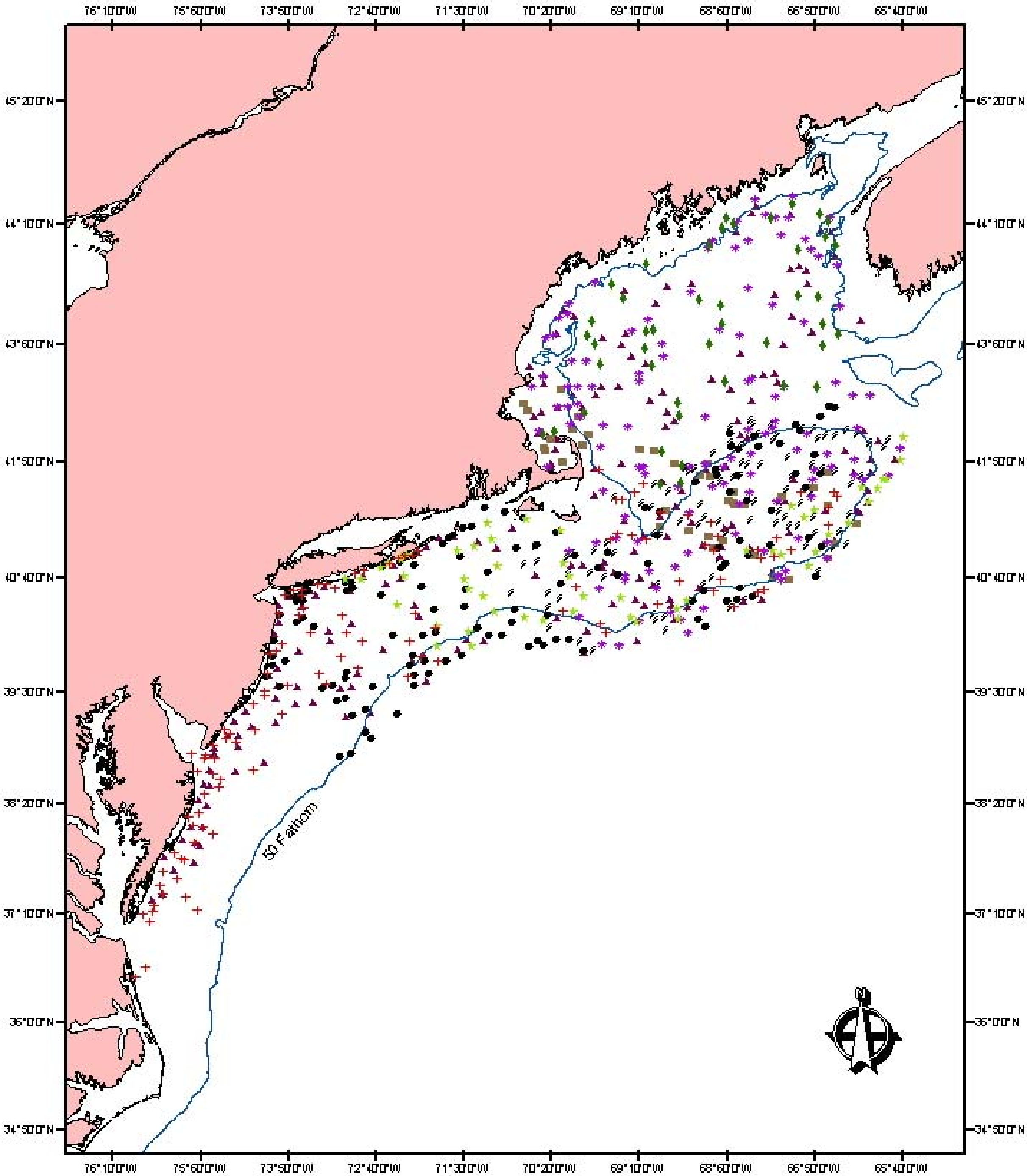


Figure 1. Station locations for paired comparisons (listed in Table 1). Different colors signify different cruises.

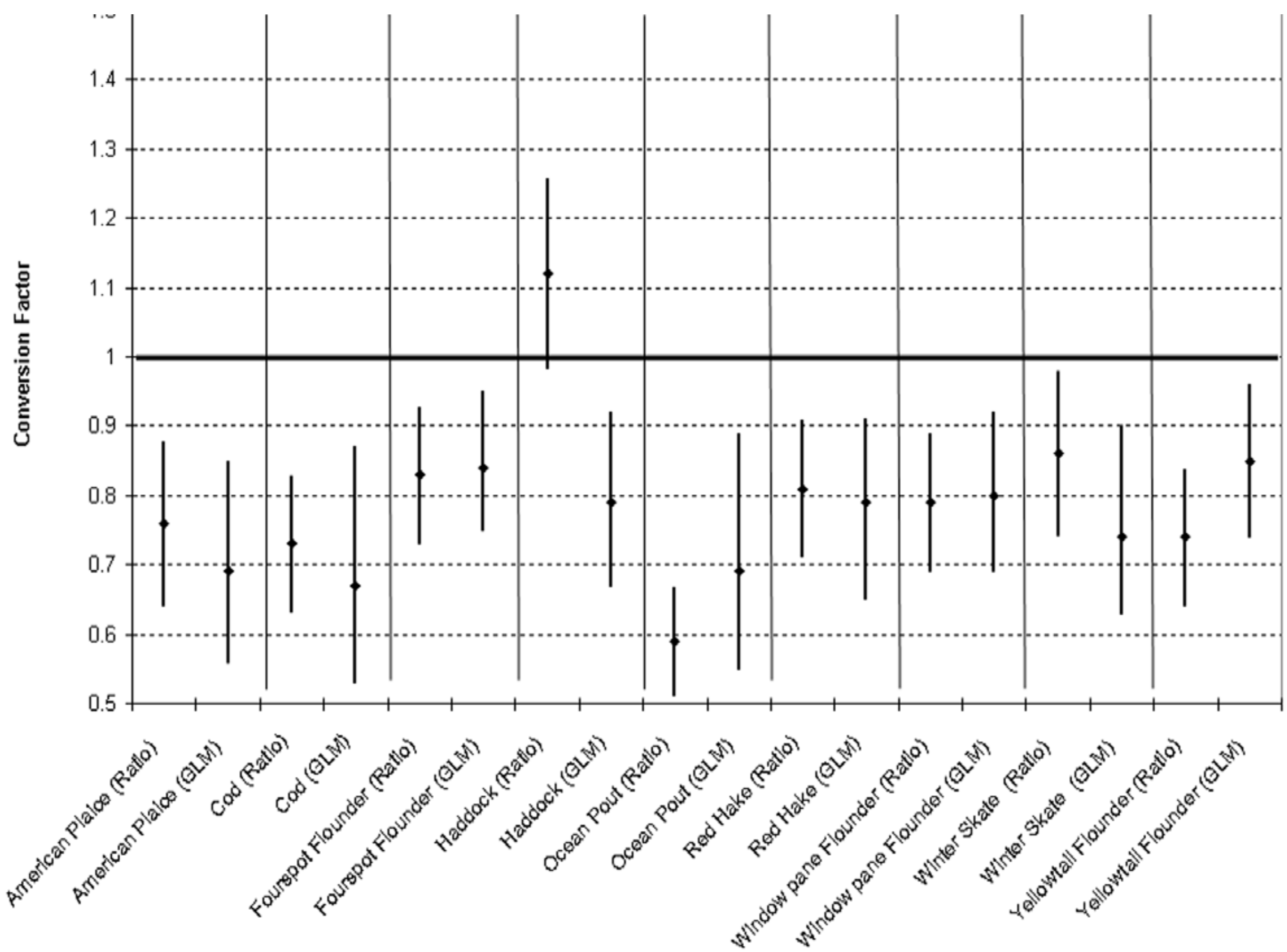


Figure 2. Confidence intervals (95%) for "GLM" conversion factors versus the "ratio" conversion factors for the 1980s data only. Species which did not have a conversion factor in one of the data sets were omitted. When the error bar falls above or below "1", the catch weights between the two vessels are significantly different. When the bars fall below "1", it indicates that the R/V *Delaware* caught significantly more of that species.

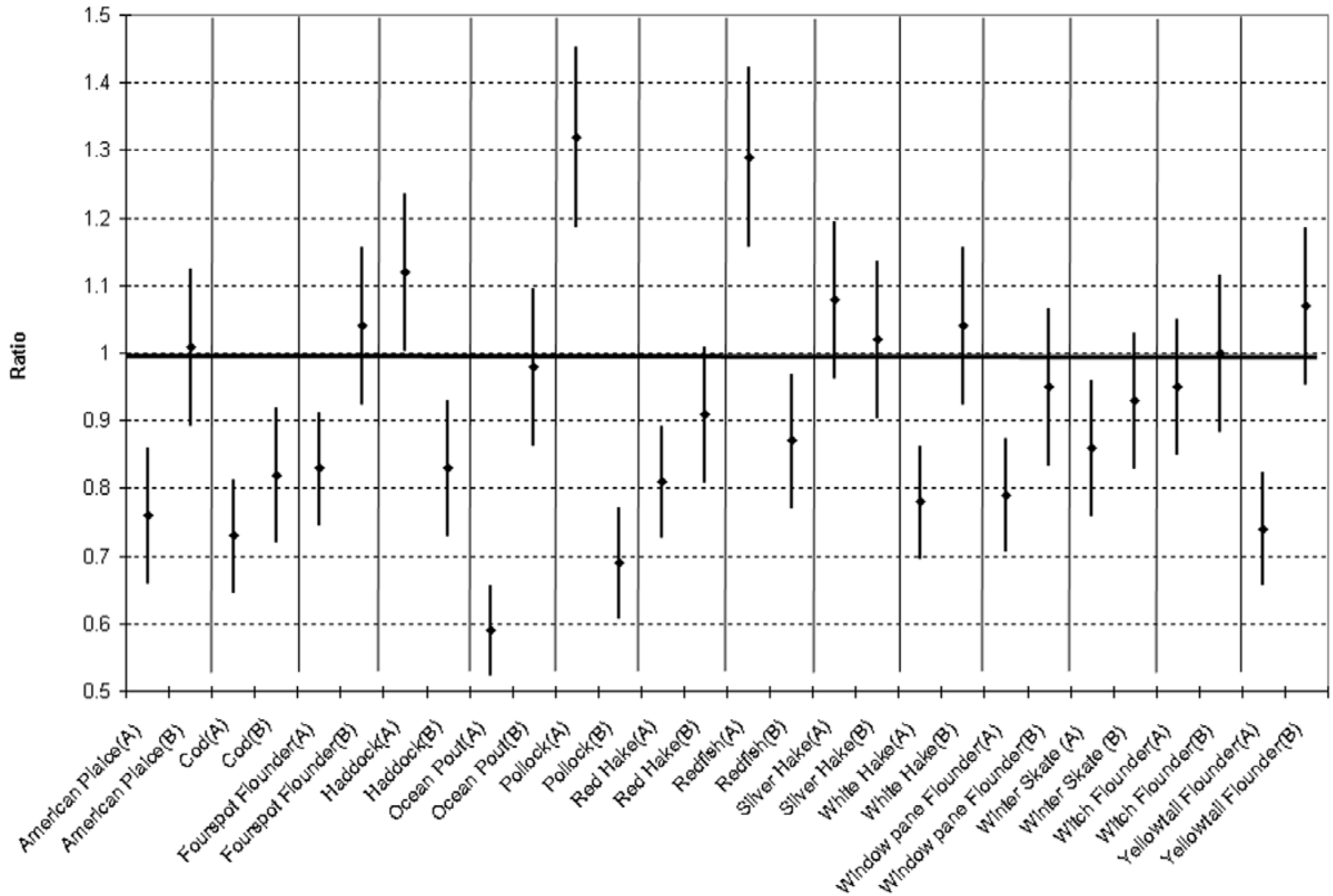


Figure 3. A comparison of the ratio conversion factors derived from the 1980's data (A) and the data following the refit of the R/V *Delaware II* (B). When the error bar falls above or below "1", the catch weights between the two vessels are significantly different. When the bars fall below "1", it indicates that the R/V *Delaware* caught significantly more of that species. Bars represent the 90% confidence intervals.

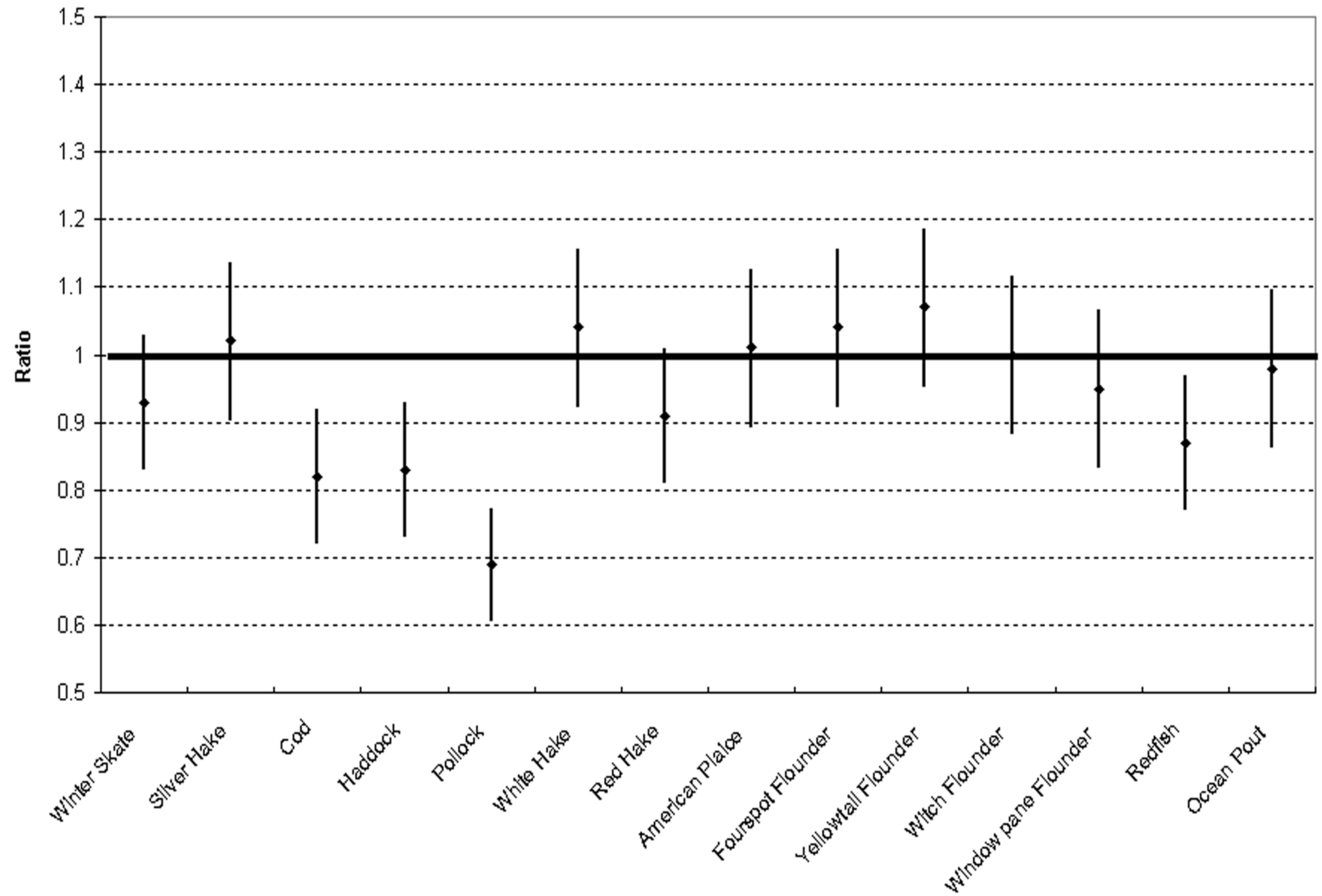


Figure 4. Plot of the ratio between the sum of the R/V *Albatross IV* divided by the sum of the R/V *Delaware II* and the 90% confidence intervals. When the error bar falls above or below “1”, the catch weights between the two vessels are significantly different. When the bars fall below “1”, it indicates that the R/V *Delaware* caught significantly more of that species.

APPENDIX A

Winter skate [cruise = Pooled data]

```
Dep Var: WINTERSK_ALB   N: 482   Multiple R: 0.728   Squared multiple R: 0.530

Adjusted squared multiple R: 0.529   Standard error of estimate: 40.948

Effect      Coefficient    Std Error     Std Coef  Tolerance     t   P(2 Tail)

CONSTANT          4.502        1.934        0.000        .       2.328     0.020
WINTERSK_DEL      0.614        0.026        0.728     1.000    23.276     0.000

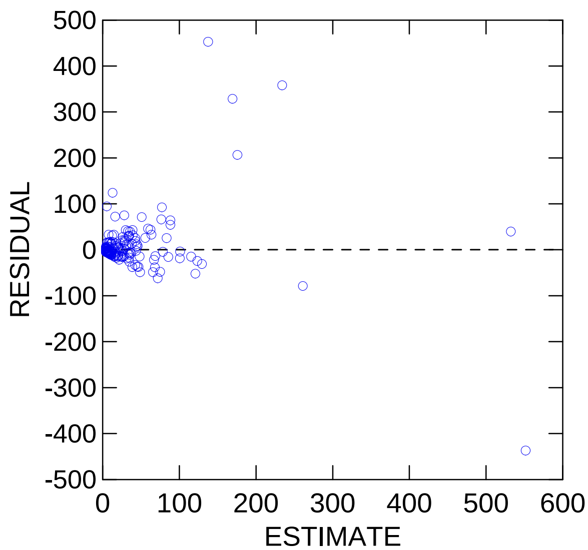
Analysis of Variance
Source              Sum-of-Squares   df  Mean-Square     F-ratio       P

Regression             908363.493     1   908363.493     541.750       0.000
Residual               804825.997   480     1676.721

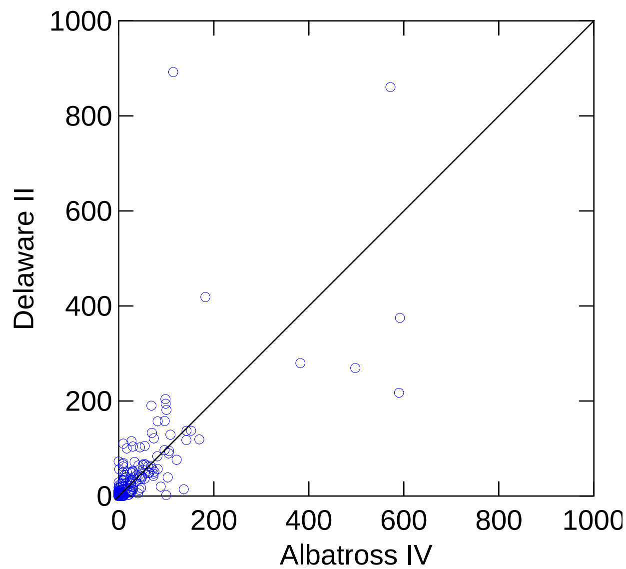
-------------------------------------------------------------------------------
Case            83 is an outlier        (Studentized Residual =        5.259)
Case           198 has large leverage   (Leverage =                    0.318)
Case           198 is an outlier        (Studentized Residual =      -15.989)
Case           198 has large influence  (Cook distance =              38.888)
Case           207 is an outlier        (Studentized Residual =       12.938)
Case           212 has large leverage   (Leverage =                    0.295)
Case           216 is an outlier        (Studentized Residual =        8.753)
Case           224 has large leverage   (Leverage =                    0.054)
Case           224 is an outlier        (Studentized Residual =        9.839)
Case           257 has large leverage   (Leverage =                    0.068)

Durbin-Watson D Statistic          1.866
First Order Autocorrelation        0.067
```

Plot of Residuals against Predicted Values



Winter skate weights (kg)



Silver Hake [cruise = Pooled data]

Dep Var: SH_ALB   N: 482   Multiple R: 0.343   Squared multiple R: 0.118

Adjusted squared multiple R: 0.116   Standard error of estimate: 22.614

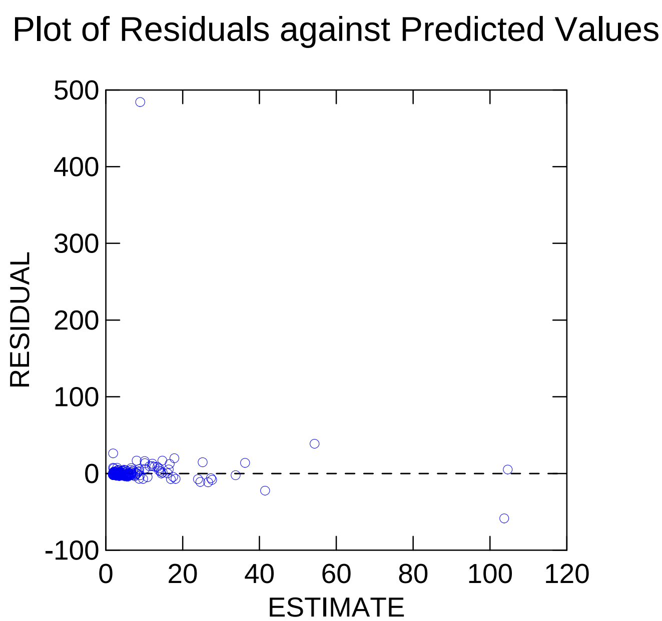
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1.921	1.073	0.000	.	1.791	0.074
SH_DEL	0.613	0.077	0.343	1.000	8.012	0.000

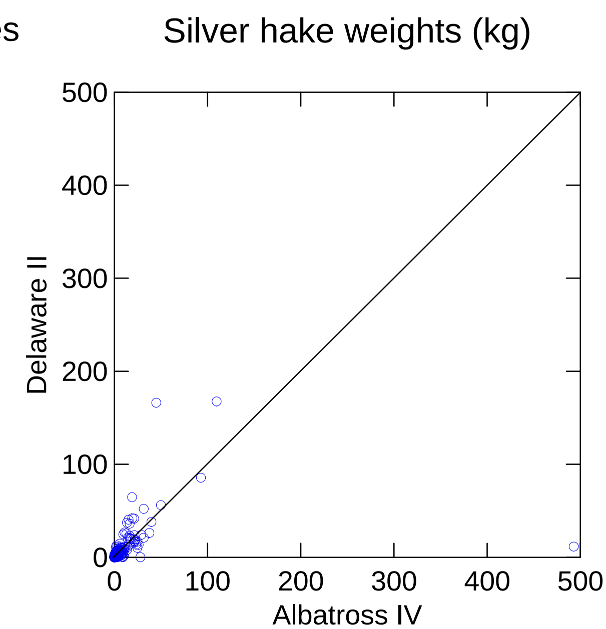
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	32832.852	1	32832.852	64.200	0.000
Residual	245479.063	480	511.415		

Case	95	is an outlier	(Studentized Residual =	103.250)
Case	229	has large leverage	(Leverage =	0.044)
Case	232	has large leverage	(Leverage =	0.303)
Case	248	has large leverage	(Leverage =	0.309)
Case	344	has large leverage	(Leverage =	0.078)

Durbin-Watson D Statistic 2.011
First Order Autocorrelation -0.006





Atlantic Cod [cruise = Pooled data]

Dep Var: COD_ALB N: 482 Multiple R: 0.634 Squared multiple R: 0.401

Adjusted squared multiple R: 0.400 Standard error of estimate: 9.876

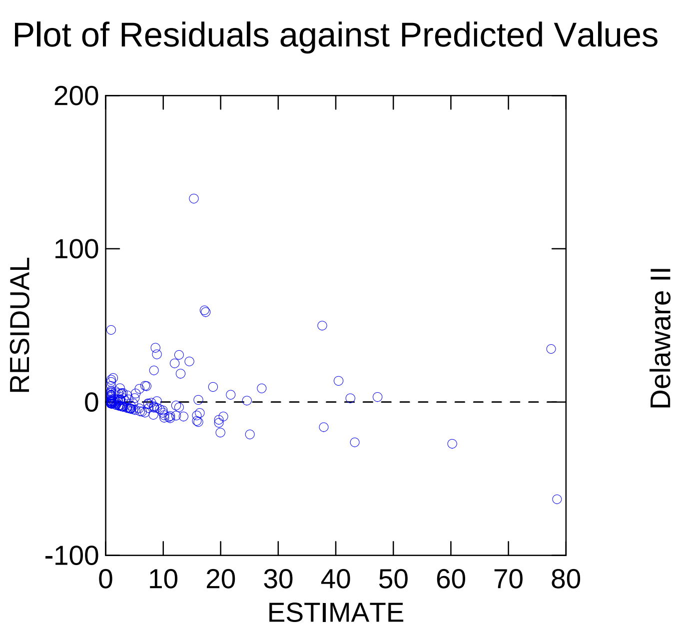
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.969	0.470	0.000	.	2.063	0.040
COD_DEL	0.513	0.029	0.634	1.000	17.943	0.000

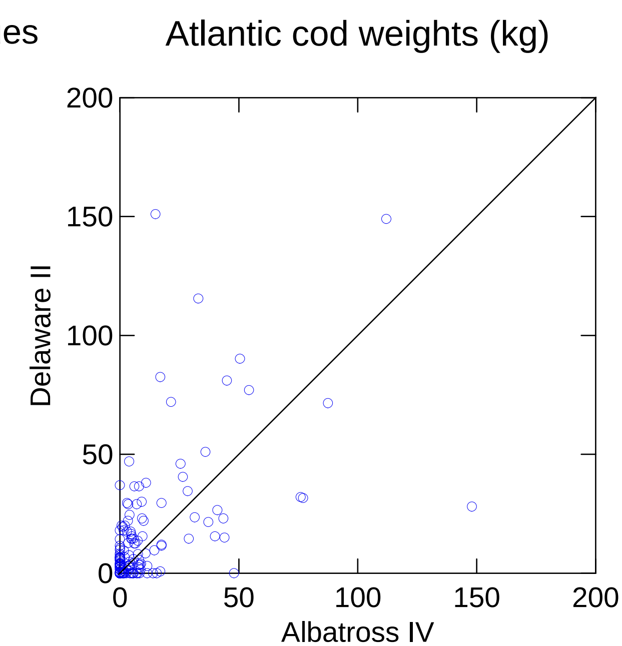
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	31398.690	1	31398.690	321.946	0.000
Residual	46813.349	480	97.528		

Case	98 is an outlier	(Studentized Residual =	6.186)
Case	186 has large leverage	(Leverage =	0.053)
Case	222 has large leverage	(Leverage =	0.046)
Case	223 has large leverage	(Leverage =	0.040)
Case	236 has large leverage	(Leverage =	0.182)
Case	236 is an outlier	(Studentized Residual =	-7.502)
Case	318 has large leverage	(Leverage =	0.040)
Case	318 is an outlier	(Studentized Residual =	5.292)
Case	329 is an outlier	(Studentized Residual =	4.880)
Case	342 has large leverage	(Leverage =	0.177)
Case	359 has large leverage	(Leverage =	0.063)
Case	361 has large leverage	(Leverage =	0.051)
Case	362 is an outlier	(Studentized Residual =	17.078)
Case	383 is an outlier	(Studentized Residual =	6.324)
Case	393 has large leverage	(Leverage =	0.105)

Durbin-Watson D Statistic 1.923
First Order Autocorrelation 0.037





Haddock [cruise = Pooled data]

Dep Var: HADDOCK_ALB   N: 482   Multiple R: 0.646   Squared multiple R: 0.417

Adjusted squared multiple R: 0.416   Standard error of estimate: 11.751

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.619	0.550	0.000	.	1.126	0.261
HADDOCK_DEL	0.869	0.047	0.646	1.000	18.545	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	47488.890	1	47488.890	343.901	0.000
Residual	66282.680	480	138.089		

```
Case     236 has large leverage   (Leverage =                  0.189)
Case     325 has large leverage   (Leverage =                  0.088)
Case     325 is an outlier        (Studentized Residual =     -4.370)
Case     329 is an outlier        (Studentized Residual =     11.928)
Case     340 is an outlier        (Studentized Residual =     27.927)
Case     342 has large leverage   (Leverage =                  0.056)
Case     382 has large leverage   (Leverage =                  0.177)
Case     383 has large leverage   (Leverage =                  0.069)
Case     389 is an outlier        (Studentized Residual =      4.106)
Case     393 has large leverage   (Leverage =                  0.214)
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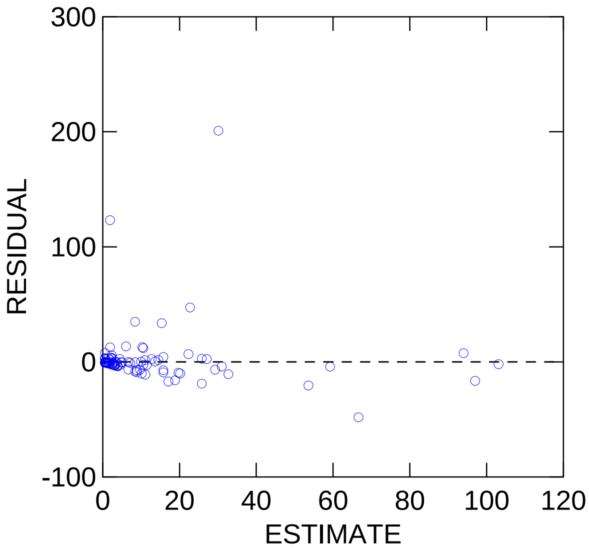
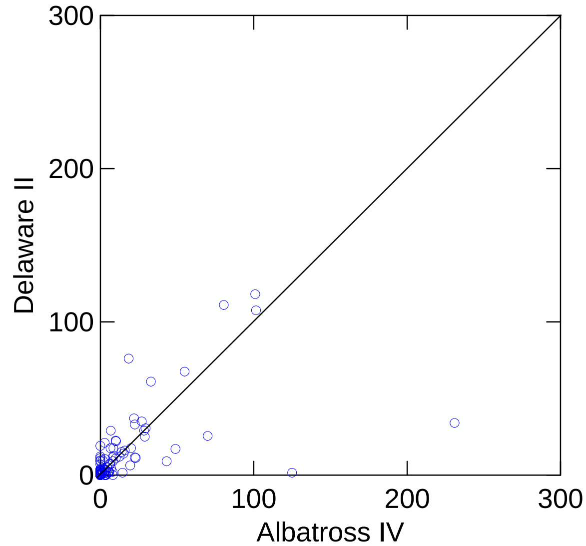
Durbin-Watson D Statistic   1.996
First Order Autocorrelation   0.002

Plot of Residuals against Predicted Values



Haddock weights (kg)



White Hake [cruise = Pooled data]

Dep Var: W_HAKE_ALB   N: 482   Multiple R: 0.693   Squared multiple R: 0.480

Adjusted squared multiple R: 0.479   Standard error of estimate: 4.411

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.621	0.209	0.000	.	2.970	0.003
W_HAKE_DEL	0.518	0.025	0.693	1.000	21.036	0.000

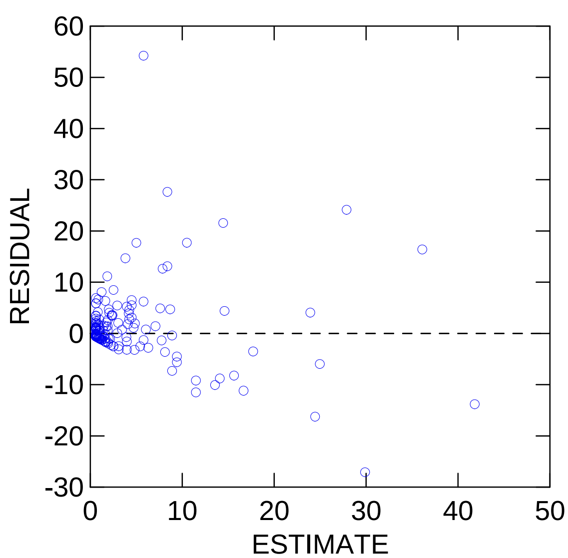
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	8608.851	1	8608.851	442.493	0.000
Residual	9338.566	480	19.455		

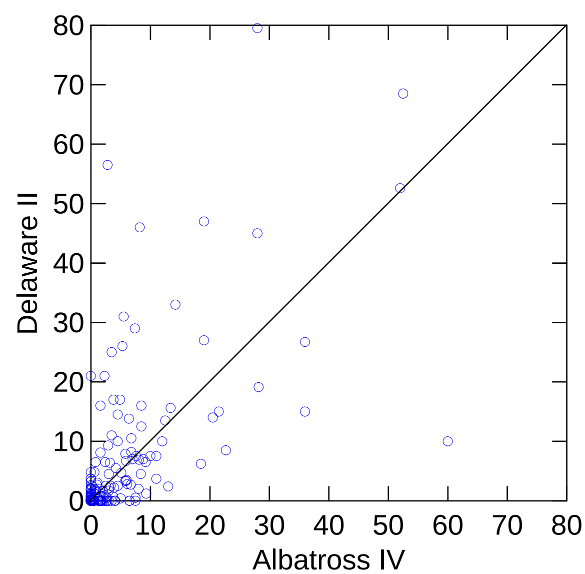
Case	232 has large leverage	(Leverage =	0.064)
Case	233 has large leverage	(Leverage =	0.188)
Case	235 has large leverage	(Leverage =	0.059)
Case	243 is an outlier	(Studentized Residual =	4.096)
Case	252 has large leverage	(Leverage =	0.139)
Case	252 is an outlier	(Studentized Residual =	4.065)
Case	368 is an outlier	(Studentized Residual =	5.060)
Case	371 is an outlier	(Studentized Residual =	6.549)
Case	372 has large leverage	(Leverage =	0.081)
Case	372 is an outlier	(Studentized Residual =	5.901)
Case	392 has large leverage	(Leverage =	0.061)
Case	397 is an outlier	(Studentized Residual =	14.868)
Case	398 has large leverage	(Leverage =	0.094)
Case	398 is an outlier	(Studentized Residual =	-6.746)
Case	405 is an outlier	(Studentized Residual =	4.078)

Durbin-Watson D Statistic   1.994
First Order Autocorrelation   0.003

Plot of Residuals against Predicted Values



White hake weights (kg)



Red Hake [cruise = Pooled data]

Dep Var: RED_HAKE_ALB N: 482 Multiple R: 0.743 Squared multiple R: 0.552

Adjusted squared multiple R: 0.551 Standard error of estimate: 6.582

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.561	0.312	0.000	.	1.800	0.073
RED_HAKE_DEL	0.705	0.029	0.743	1.000	24.322	0.000

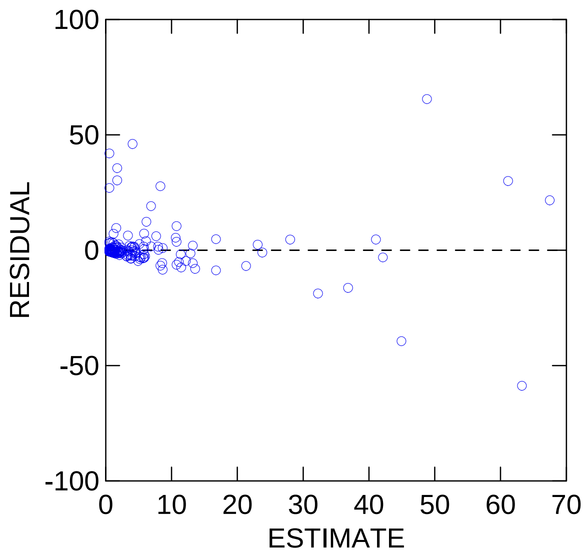
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	25627.542	1	25627.542	591.546	0.000
Residual	20795.050	480	43.323		

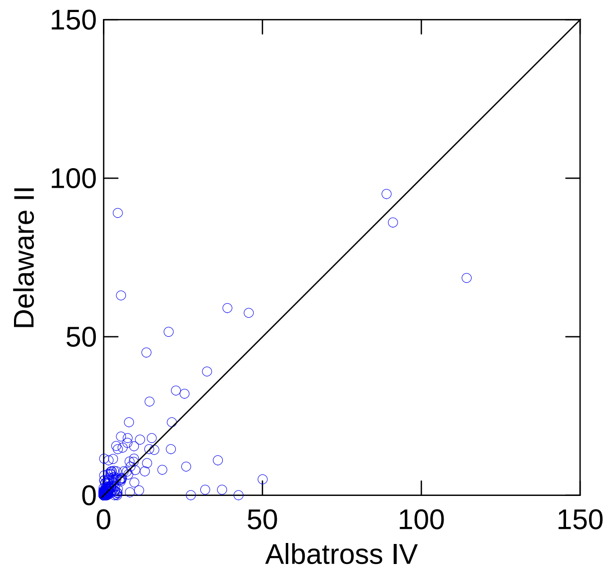
```
Case           26 has large leverage   (Leverage =                    0.060)
Case           27 has large leverage   (Leverage =                    0.048)
Case           45 has large leverage   (Leverage =                    0.146)
Case           45 is an outlier        (Studentized Residual =      -10.750)
Case           86 is an outlier        (Studentized Residual =        5.572)
Case           95 is an outlier        (Studentized Residual =        7.378)
Case          145 has large leverage   (Leverage =                    0.085)
Case          145 is an outlier        (Studentized Residual =       11.807)
Case          155 has large leverage   (Leverage =                    0.166)
Case          157 has large leverage   (Leverage =                    0.136)
Case          157 is an outlier        (Studentized Residual =        5.016)
Case          258 is an outlier        (Studentized Residual =        6.661)
Case          259 is an outlier        (Studentized Residual =        4.167)
Case          287 is an outlier        (Studentized Residual =        4.699)
Case          341 has large leverage   (Leverage =                    0.072)
Case          341 is an outlier        (Studentized Residual =       -6.482)
Case          346 is an outlier        (Studentized Residual =        4.290)
Case          347 has large leverage   (Leverage =                    0.063)
```

Durbin-Watson D Statistic 1.839
First Order Autocorrelation 0.080

Plot of Residuals against Predicted Values



Red hake weights (kg)



American Plaice [cruise = Pooled data]

Dep Var: A_PLAICE_ALB   N: 482   Multiple R: 0.914   Squared multiple R: 0.836

Adjusted squared multiple R: 0.835   Standard error of estimate: 1.373

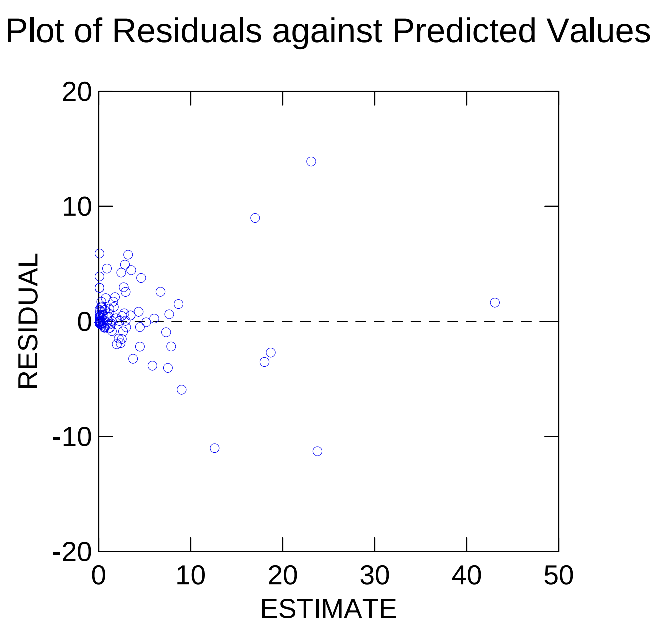
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.102	0.064	0.000	.	1.600	0.110
A_PLAICE_DEL	0.677	0.014	0.914	1.000	49.408	0.000

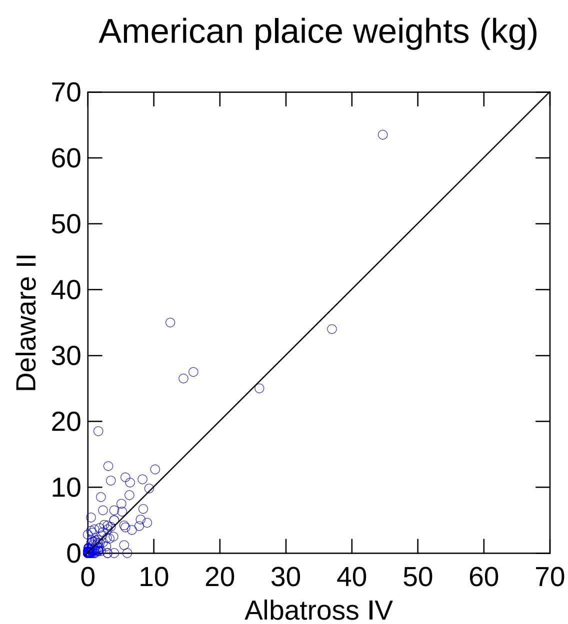
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4602.279	1	4602.279	2441.151	0.000
Residual	904.940	480	1.885		

```
Case           86 is an outlier        (Studentized Residual =        4.381)
Case           88 has large leverage   (Leverage =                    0.391)
Case           97 is an outlier        (Studentized Residual =       -8.786)
Case          229 has large leverage   (Leverage =                    0.117)
Case          229 is an outlier        (Studentized Residual =       -9.536)
Case          233 has large leverage   (Leverage =                    0.072)
Case          235 has large leverage   (Leverage =                    0.067)
Case          248 is an outlier        (Studentized Residual =        4.296)
Case          360 is an outlier        (Studentized Residual =       -4.445)
Case          361 has large leverage   (Leverage =                    0.111)
Case          361 is an outlier        (Studentized Residual =       12.285)
Case          481 has large leverage   (Leverage =                    0.059)
Case          481 is an outlier        (Studentized Residual =        7.078)
```

Durbin-Watson D Statistic   2.125
First Order Autocorrelation   -0.063





Fourspot Flounder [cruise = Pooled data]

Dep Var: FOURSPOT_ALB   N: 482   Multiple R: 0.932   Squared multiple R: 0.868

Adjusted squared multiple R: 0.868   Standard error of estimate: 0.861

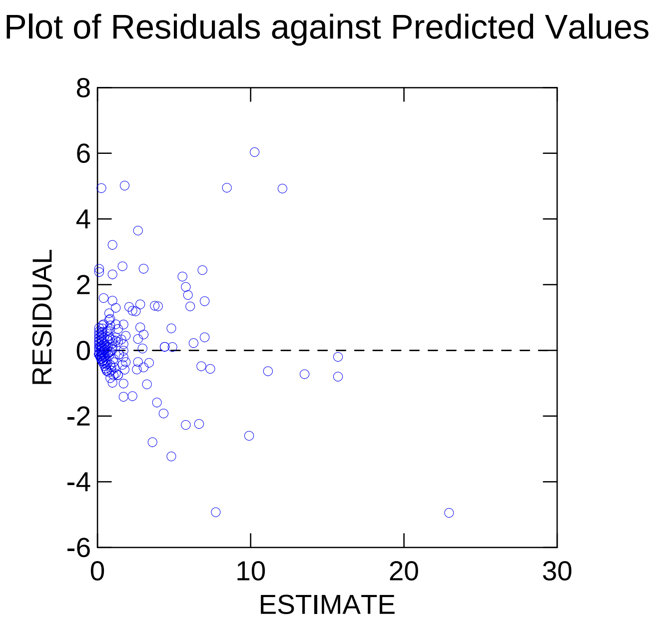
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.120	0.041	0.000	.	2.893	0.004
FOURSPOT_DEL	0.725	0.013	0.932	1.000	56.206	0.000

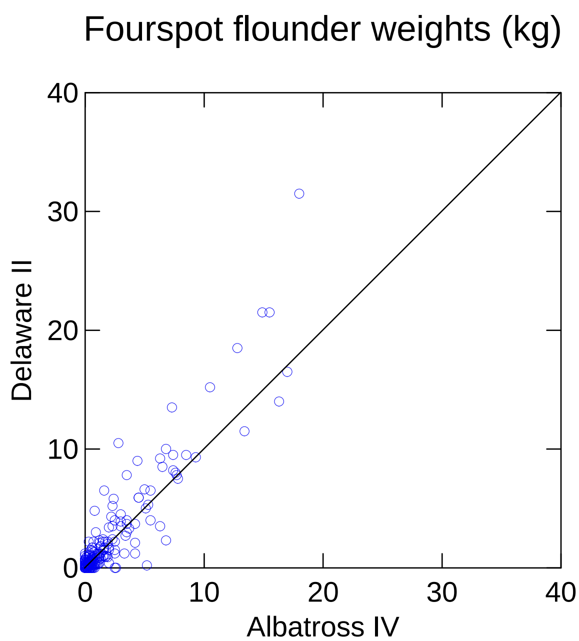
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2343.690	1	2343.690	3159.156	0.000
Residual	356.099	480	0.742		

Case	26	has large leverage	(Leverage =	0.037)
Case	53	has large leverage	(Leverage =	0.096)
Case	56	is an outlier	(Studentized Residual =	6.039)
Case	103	has large leverage	(Leverage =	0.056)
Case	103	is an outlier	(Studentized Residual =	6.099)
Case	145	has large leverage	(Leverage =	0.040)
Case	145	is an outlier	(Studentized Residual =	7.555)
Case	149	has large leverage	(Leverage =	0.096)
Case	155	has large leverage	(Leverage =	0.210)
Case	155	is an outlier	(Studentized Residual =	-6.757)
Case	157	has large leverage	(Leverage =	0.070)
Case	167	is an outlier	(Studentized Residual =	4.315)
Case	287	is an outlier	(Studentized Residual =	5.937)
Case	301	has large leverage	(Leverage =	0.047)
Case	305	is an outlier	(Studentized Residual =	-5.994)
Case	478	is an outlier	(Studentized Residual =	6.031)

Durbin-Watson D Statistic   2.127
First Order Autocorrelation   -0.064





Yellowtail Flounder [cruise = Pooled data]

Dep Var: YT_ALB   N: 482   Multiple R: 0.941   Squared multiple R: 0.886

Adjusted squared multiple R: 0.886   Standard error of estimate: 1.887

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.146	0.088	0.000	.	1.655	0.099
YT_DEL	0.658	0.011	0.941	1.000	61.078	0.000

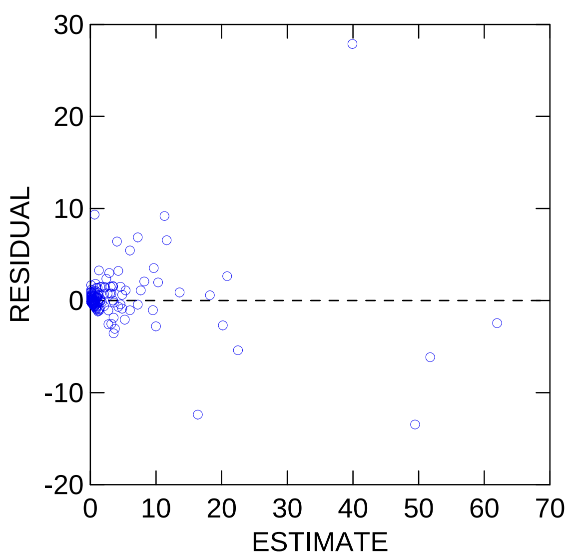
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	13279.336	1	13279.336	3730.523	0.000
Residual	1708.629	480	3.560		

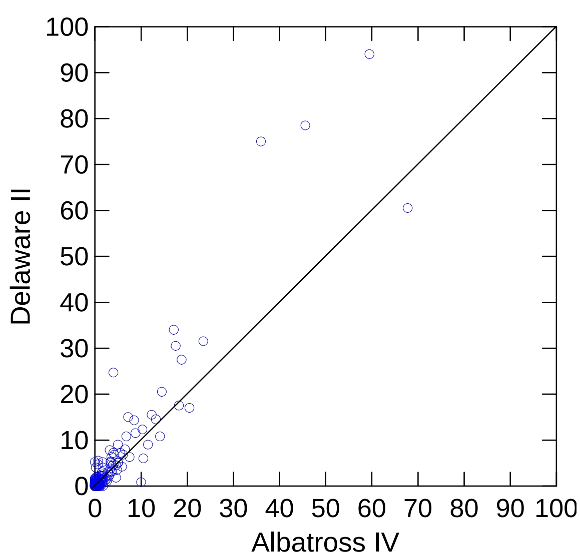
Case	21 has large leverage	(Leverage =	0.114)
Case	21 is an outlier	(Studentized Residual =	22.472)
Case	30 has large leverage	(Leverage =	0.279)
Case	31 has large leverage	(Leverage =	0.177)
Case	31 is an outlier	(Studentized Residual =	-8.421)
Case	92 is an outlier	(Studentized Residual =	-6.950)
Case	149 has large leverage	(Leverage =	0.194)
Case	151 is an outlier	(Studentized Residual =	5.007)
Case	174 is an outlier	(Studentized Residual =	5.075)

Durbin-Watson D Statistic   1.948
First Order Autocorrelation   0.023

Plot of Residuals against Predicted Values



Yellowtail flounder weights (kg)



Winter Flounder [cruise = Pooled data]

Dep Var: WINTER_F_ALB   N: 482   Multiple R: 0.816   Squared multiple R: 0.666

Adjusted squared multiple R: 0.666   Standard error of estimate: 2.643

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.284	0.126	0.000	.	2.257	0.024
WINTER_F_DEL	0.777	0.025	0.816	1.000	30.956	0.000

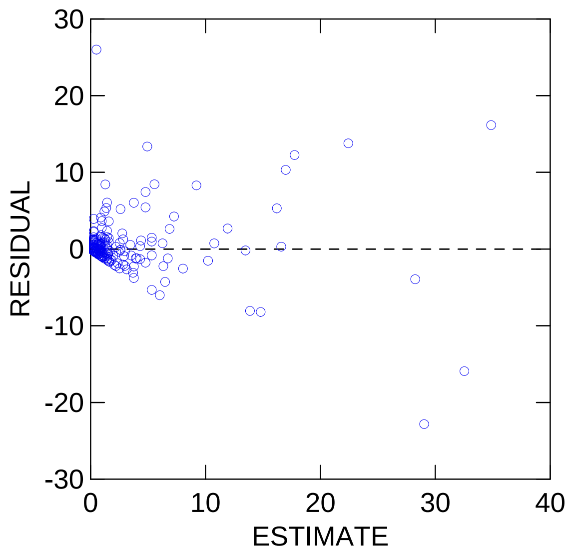
Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	6691.408	1	6691.408	958.245	0.000
Residual	3351.831	480	6.983		

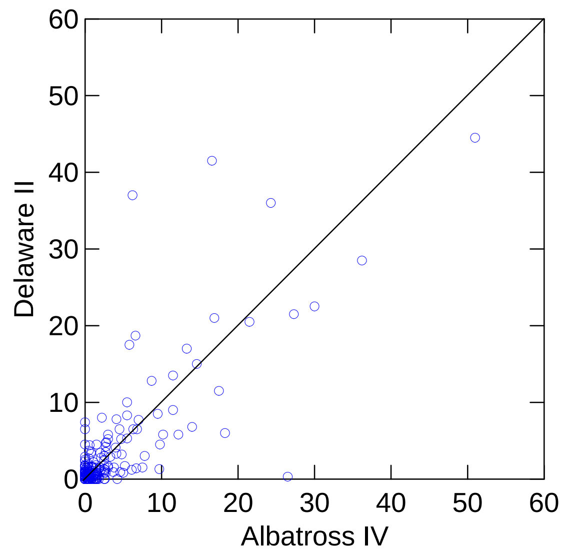
Case	81	has large leverage	(Leverage =	0.038)
Case	81	is an outlier	(Studentized Residual =	4.042)
Case	91	is an outlier	(Studentized Residual =	5.199)
Case	143	is an outlier	(Studentized Residual =	11.007)
Case	210	has large leverage	(Leverage =	0.068)
Case	210	is an outlier	(Studentized Residual =	5.565)
Case	239	has large leverage	(Leverage =	0.110)
Case	332	has large leverage	(Leverage =	0.147)
Case	332	is an outlier	(Studentized Residual =	-6.830)
Case	382	has large leverage	(Leverage =	0.042)
Case	382	is an outlier	(Studentized Residual =	4.839)
Case	383	has large leverage	(Leverage =	0.169)
Case	383	is an outlier	(Studentized Residual =	7.031)
Case	469	has large leverage	(Leverage =	0.116)
Case	469	is an outlier	(Studentized Residual =	-10.115)

Durbin-Watson D Statistic	1.893
First Order Autocorrelation	0.054

Plot of Residuals against Predicted Values



Winter flounder weights (kg)



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The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "conducting ecosystem-based research and assessments of living marine resources, with a focus on the Northeast Shelf, to promote the recovery and long-term sustainability of these resources and to generate social and economic opportunities and benefits from their use." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Currently, there are three such media:

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