Estimated conversion factors for calibrating MRFSS charterboat landings and effort estimates from the Southeastern US (North Carolina to Florida-east coast) in 1981-2003 with For-Hire Survey estimates with application to King Mackerel landings

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INTRODUCTION (text taken from Diaz and Phares, 2004 and modified for Atlantic Coast)
The Marine Recreational Fishery Statistics Survey (MRFSS) was established to create a reliable data base for estimating catch and effort by the marine recreational fishery (http://www.st.nmfs.gov/st1/recreational/survey/overview.html). In the traditional MRFSS methodology, data are collected by a telephone survey of households in coastal counties and by interviewing anglers at fishing access sites. MRFSS acknowledged that the estimation of effort for the charterboat sector is difficult due to the low incidence of this type of fishing trips by households contacted in the telephone survey. To reduce the effect of small sample sizes on charterboat effort estimation, data from a 5 year period are combined for estimates using the traditional MRFSS method. Pooling data across years provides a larger data set to produce more reliable estimates of effort. However, this approach tends to mask trends in the fishery, annual weather patterns, etc. To improve the effort estimation procedure for the charterboat mode, MRFSS started testing a new survey protocol named For Hire Survey (FHS) in 1995 (http://www.st.nmfs.gov/st1/recreational/pubs/charter_method.pdf). To implement the new FHS, charterboat directories were created by NMFS and participating state agencies and are maintained by the NMFS' Contractor. Approximately 10% of the charterboats in the directory are randomly contacted by phone and asked relevant information regarding their fishing activities (e.g., number of trips and anglers, area of fishing, etc.). MRFSS concluded that the FHS produced significantly 'more efficient, precise, and credible charter angler effort estimates than the traditional MRFSS method'. The FHS was officially adopted as the new charterboat method in the Gulf of Mexico in 2000 and expanded to the Atlantic Coast in 2004. This document provides conversion factors to adjust effort estimates obtained by MRFSS until 2004 along the Atlantic Coast to the FHS effort levels 2004-2007. The adjusted effort levels were applied to landings' CPUEs to produce adjusted historical king mackerel landings from the Southeastern US.

METHODS
From 2004 to 2007, the NMFS estimated charterboat effort using both the MRFSS (old) and FHS (new) protocols. Thus, differences in effort estimates for each stratum between both methodologies can be directly compared only for that period of time. Each stratum is defined by a unique combination of state, year, wave, and fishing-area, where wave corresponds to bimonthly periods starting in January. The MRFSS defined fishing areas for most states as: a) Inshore waters, b) < 3 miles, and c) > 3 miles. For the period 1986-2003, charterboat effort was estimated using only the MRFSS protocol. To calibrate MRFSS charterboat effort estimates (1986-2003) to FHS levels, conversion factors (ratios) between FHS and MRFSS charterboat effort were estimated using 2003-2007 data and applied to the 1986-2003 MRFSS effort estimates. To estimate the conversion factors, a ratio of FHS/MRFSS effort estimates was calculated for each stratum using only the estimates from the period 2003-2007. A generalized linear model (GLM procedure, SAS Inst.) was used to identify significant factors and to estimate predicted ratios. The factors included in the model were year, wave, fishing area, state and the interaction terms. In the event that a factor was found non-significant ($Pr > 0.05$), it was removed and the regression re-run until all (highest order) model terms were significant (Hocking 1976, Draper and Smith 1981). The predicted ratios are used as the conversion factors.

From 1981 to 1985, MRFSS considered charterboat and headboat as part of single mode. Thus, the conversion factors estimated with 2004-2007 charterboat data (used to calibrate 1986-2003 charterboat effort estimates) can not be used to calibrate the 1981-1985 estimates. To calibrate the

1981-1985 combined charterboat and headboat effort estimates, conversion factors will be estimated using 1986-1990 effort estimates instead of 2004-2007 to minimize possible effects of changes in the fishery over time. To do so, headboat (NMFS Headboat Survey) and original (MRFSS) charterboat effort estimates were combined (summed) into one estimate for each year and wave.

RESULTS OF GLM PROCEDURE

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 106
RATIO outliers removed (ratio > 50): NC 2 Inland
09:42 Wednesday, February 13, 2008

The GLM Procedure

Class Level Information

Class	Levels	Values
srg	3	EF NC NN
areaf	2	I O
wave	6	1 2 3 4 5 6

Number of Observations Read 247
Number of Observations Used 247

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	669.248957	83.656120	8.56	<.0001
Error	238	2326.541118	9.775383		
Corrected Total	246	2995.790076			

R-Square	Coeff Var	Root MSE	ratio Mean
0.223396	155.5523	3.126561	2.009974

Source	DF	Type I SS	Mean Square	F Value	Pr > F
srg	2	192.7821297	96.3910649	9.86	<.0001
areaf	1	315.9997273	315.9997273	32.33	<.0001
wave	5	160.4671003	32.0934201	3.28	0.0069

Source	DF	Type III SS	Mean Square	F Value	Pr > F
srg	2	187.8216618	93.9108309	9.61	<.0001
areaf	1	319.8680944	319.8680944	32.72	<.0001
wave	5	160.4671003	32.0934201	3.28	0.0069

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 108
RATIO outliers removed (ratio > 50): NC 2 Inland
09:42 Wednesday, February 13, 2008

The GLM Procedure
Least Squares Means

srg	ratio LSMEAN	Standard Error	Pr > |t|
EF	1.60680634	0.34285212	<.0001
NC	3.99821318	0.46608702	<.0001
NN	2.09140432	0.34299411	<.0001

areaf	ratio LSMEAN	Standard Error	Pr > |t|
I	3.77103722	0.36446772	<.0001
O	1.35991201	0.27032873	<.0001

wave	ratio LSMEAN	Standard Error	Pr > |t|
1	2.49149503	0.86496570	0.0043
2	2.95833242	0.45120221	<.0001
3	3.56495573	0.44793923	<.0001
4	3.23644347	0.45903199	<.0001
5	1.55090958	0.46247577	0.0009
6	1.59071145	0.54220571	0.0037

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 109
RATIO outliers removed (ratio > 50): NC 2 Inland
SRG: EFL, NC or NN (SC & GA) in South Atlantic sub-region
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---------- srg=EF areaf=I ----------

The GLM Procedure

Class Level Information

Class	Levels	Values
wave	6	1 2 3 4 5 6

Number of Observations Read 29
Number of Observations Used 29

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	25.21843903	5.04368781	1.89	0.1344
Error	23	61.23693961	2.66247564		
Corrected Total	28	86.45537864			

R-Square	Coeff Var	Root MSE	ratio Mean
0.291693	75.46190	1.631709	2.162296

Source	DF	Type I SS	Mean Square	F Value	Pr > F
wave	5	25.21843903	5.04368781	1.89	0.1344

Source	DF	Type III SS	Mean Square	F Value	Pr > F
wave	5	25.21843903	5.04368781	1.89	0.1344

---------- srg=EF areaf=I ----------

The GLM Procedure
Least Squares Means

wave	ratio LSMEAN	Standard Error	Pr > |t|
1	2.05063839	0.72972264	0.0099
2	3.35726007	0.72972264	0.0001
3	1.91921572	0.72972264	0.0150
4	3.30164110	0.72972264	0.0002
5	0.88738129	0.72972264	0.2363
6	1.28147361	0.81585471	0.1299

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 112
RATIO outliers removed (ratio > 50): NC 2 Inland
SRG: EFL, NC or NN (SC & GA) in South Atlantic sub-region
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---------- srg=EF areaf=O ----------

The GLM Procedure

Class Level Information

Class	Levels	Values
wave	6	1 2 3 4 5 6

Number of Observations Read 58
Number of Observations Used 58

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	2.06962571	0.41392514	2.67	0.0322
Error	52	8.07368787	0.15526323		
Corrected Total	57	10.14331358			

R-Square	Coeff Var	Root MSE	ratio Mean
0.204038	50.73194	0.394035	0.776699

Source	DF	Type I SS	Mean Square	F Value	Pr > F
wave	5	2.06962571	0.41392514	2.67	0.0322

Source	DF	Type III SS	Mean Square	F Value	Pr > F
wave	5	2.06962571	0.41392514	2.67	0.0322

---------- srg=EF areaf=O ----------

The GLM Procedure
Least Squares Means

wave	ratio LSMEAN	Standard Error	Pr > |t|
1	0.67113964	0.12460467	<.0001
2	0.97987451	0.12460467	<.0001
3	0.80452634	0.12460467	<.0001
4	1.03616265	0.12460467	<.0001
5	0.51998484	0.12460467	0.0001
6	0.61645857	0.13931225	<.0001

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 115
RATIO outliers removed (ratio > 50): NC 2 Inland
SRG: EFL, NC or NN (SC & GA) in South Atlantic sub-region
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---------- srg=NC areaf=I ----------

The GLM Procedure

Class Level Information

Class	Levels	Values
wave	5	2 3 4 5 6

Number of Observations Read 16
Number of Observations Used 16

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	326.5374247	81.6343562	1.51	0.2665
Error	11	595.8705864	54.1700533		
Corrected Total	15	922.4080111			

R-Square	Coeff Var	Root MSE	ratio Mean
0.354005	83.53192	7.360031	8.811040

Source	DF	Type I SS	Mean Square	F Value	Pr > F
wave	4	326.5374247	81.6343562	1.51	0.2665

Source	DF	Type III SS	Mean Square	F Value	Pr > F
wave	4	326.5374247	81.6343562	1.51	0.2665

---------- srg=NC areaf=I ----------

The GLM Procedure
Least Squares Means

wave	ratio LSMEAN	Standard Error	Pr > |t|
2	12.1818928	3.6800154	0.0070
3	13.2911500	3.6800154	0.0041
4	7.9664955	4.2493158	0.0876
5	0.9725798	4.2493158	0.8232
6	6.1336209	5.2043277	0.2634

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 118
RATIO outliers removed (ratio > 50): NC 2 Inland
SRG: EFL, NC or NN (SC & GA) in South Atlantic sub-region
09:42 Wednesday, February 13, 2008

---------- srg=NC areaf=O ----------

The GLM Procedure

Class Level Information

Class	Levels	Values
wave	5	2 3 4 5 6

Number of Observations Read 36
Number of Observations Used 36

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	7.19241242	1.79810310	1.11	0.3689
Error	31	50.15932600	1.61804277		
Corrected Total	35	57.35173842			

R-Square	Coeff Var	Root MSE	ratio Mean
0.125409	94.82254	1.272023	1.341478

Source	DF	Type I SS	Mean Square	F Value	Pr > F
wave	4	7.19241242	1.79810310	1.11	0.3689

Source	DF	Type III SS	Mean Square	F Value	Pr > F
wave	4	7.19241242	1.79810310	1.11	0.3689

The GLM Procedure
Least Squares Means

wave	ratio LSMEAN	Standard Error	Pr > |t|
2	1.66033523	0.44972808	0.0009
3	1.94662655	0.44972808	0.0001
4	1.11552626	0.48077954	0.0271
5	1.07519281	0.48077954	0.0327
6	0.68374440	0.51930126	0.1976

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 121
RATIO outliers removed (ratio > 50): NC 2 Inland
SRG: EFL, NC or NN (SC & GA) in South Atlantic sub-region
09:42 Wednesday, February 13, 2008

---------- srg=NN areaf=I ----------

The GLM Procedure

Class Level Information

Class	Levels	Values
wave	5	2 3 4 5 6

Number of Observations Read 38
Number of Observations Used 38

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	81.4833292	20.3708323	1.05	0.3974
Error	33	641.2270269	19.4311220		
Corrected Total	37	722.7103562			

R-Square	Coeff Var	Root MSE	ratio Mean
0.112747	181.0380	4.408075	2.434890

Source	DF	Type I SS	Mean Square	F Value	Pr > F
wave	4	81.48332923	20.37083231	1.05	0.3974

Source	DF	Type III SS	Mean Square	F Value	Pr > F
wave	4	81.48332923	20.37083231	1.05	0.3974

The GLM Procedure
Least Squares Means

wave	ratio LSMEAN	Standard Error	Pr > |t|
2	2.08319997	1.55848973	0.1905
3	4.88059879	1.55848973	0.0036
4	2.88675805	1.55848973	0.0729
5	1.25184640	1.55848973	0.4276
6	0.61776336	1.79958894	0.7336

Proc GLM for Ratio = FHS-eft/RDD-Rd4 with 2007 added 124
RATIO outliers removed (ratio > 50): NC 2 Inland
SRG: EFL, NC or NN (SC & GA) in South Atlantic sub-region
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---------- srg=NN areaf=O ----------

The GLM Procedure

Class Level Information

Class	Levels	Values
wave	5	2 3 4 5 6

Number of Observations Read 70
Number of Observations Used 70

The GLM Procedure

Dependent Variable: ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	42.1071513	10.5267878	2.39	0.0598
Error	65	286.3977031	4.4061185		
Corrected Total	69	328.5048544			

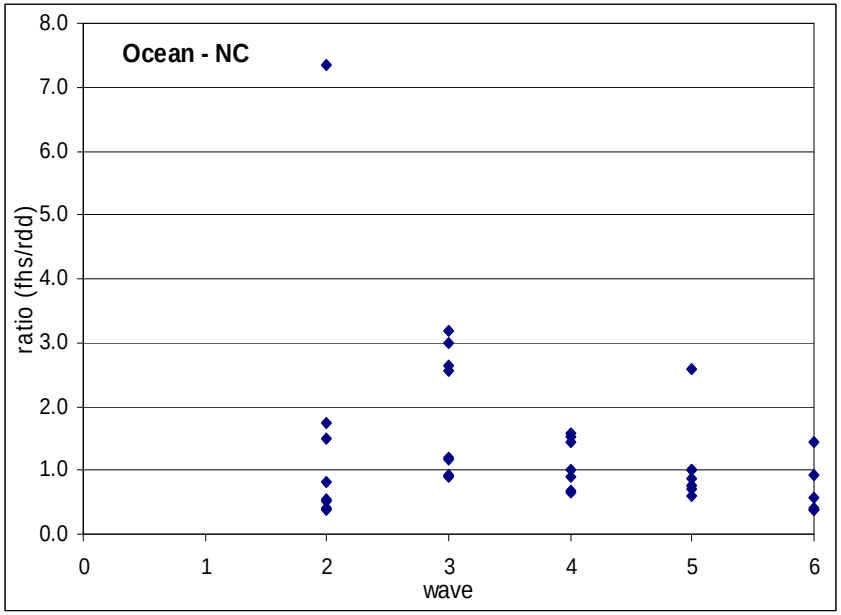
R-Square	Coeff Var	Root MSE	ratio Mean
0.128178	137.4348	2.099076	1.527324

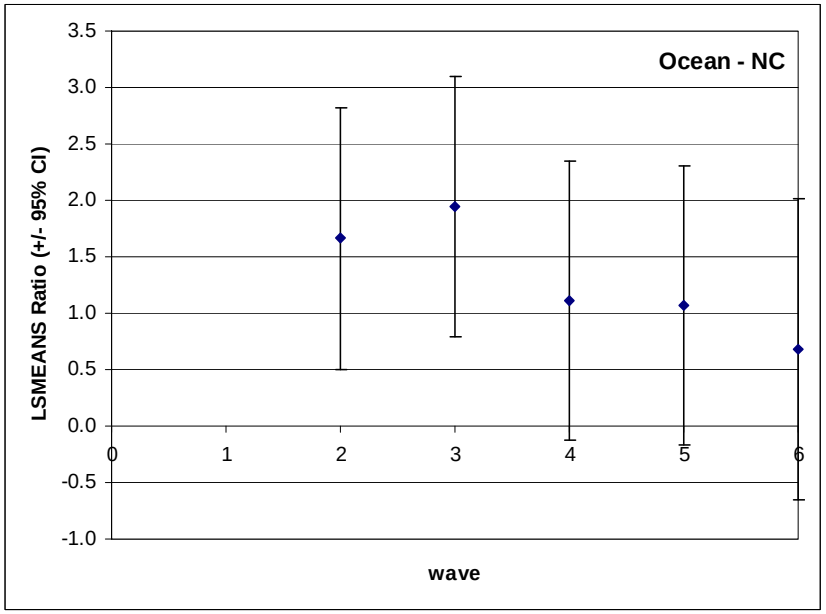
Source	DF	Type I SS	Mean Square	F Value	Pr > F
wave	4	42.10715132	10.52678783	2.39	0.0598

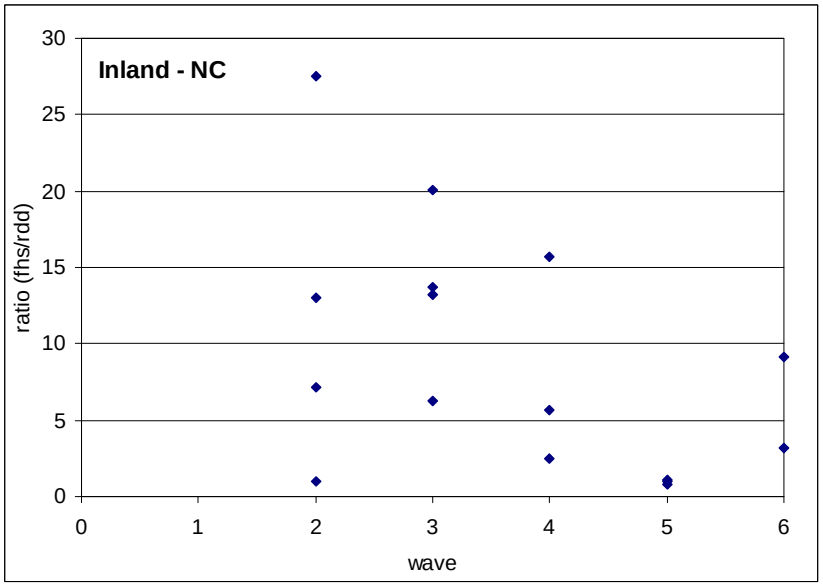
Source	DF	Type III SS	Mean Square	F Value	Pr > F
wave	4	42.10715132	10.52678783	2.39	0.0598

The GLM Procedure
Least Squares Means

wave	ratio LSMEAN	Standard Error	Pr > |t|
2	1.01839621	0.54197900	0.0647
3	1.70809906	0.52476891	0.0018
4	2.81179835	0.52476891	<.0001
5	0.94018586	0.54197900	0.0875
6	0.65195213	0.74213531	0.3829


Ocean - NC
ratio (fhs/rdd)
wave
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1
2
3
4
5
6


Ocean - NC
LSMEANS Ratio (+/- 95% CI)
wave
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
1
2
3
4
5
6


Inland - NC
ratio (fhs/rdd)
wave
30
25
20
15
10
5
0
0
1
2
3
4
5
6

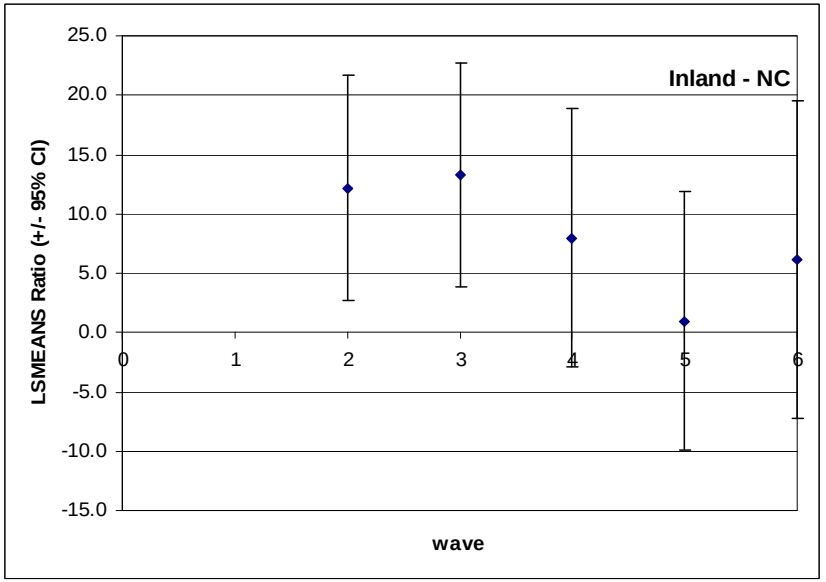

Inland - NC
LSMEANS Ratio (+/- 95% CI)
wave
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
0
1
2
3
4
5
6

Figure 1a. North Carolina Charter boat effort ratios observed (left column) in ocean waters (top) and inland waters (bottom) and estimated mean ratios from GLM model (ocean - top, right; inland - bottom, right).

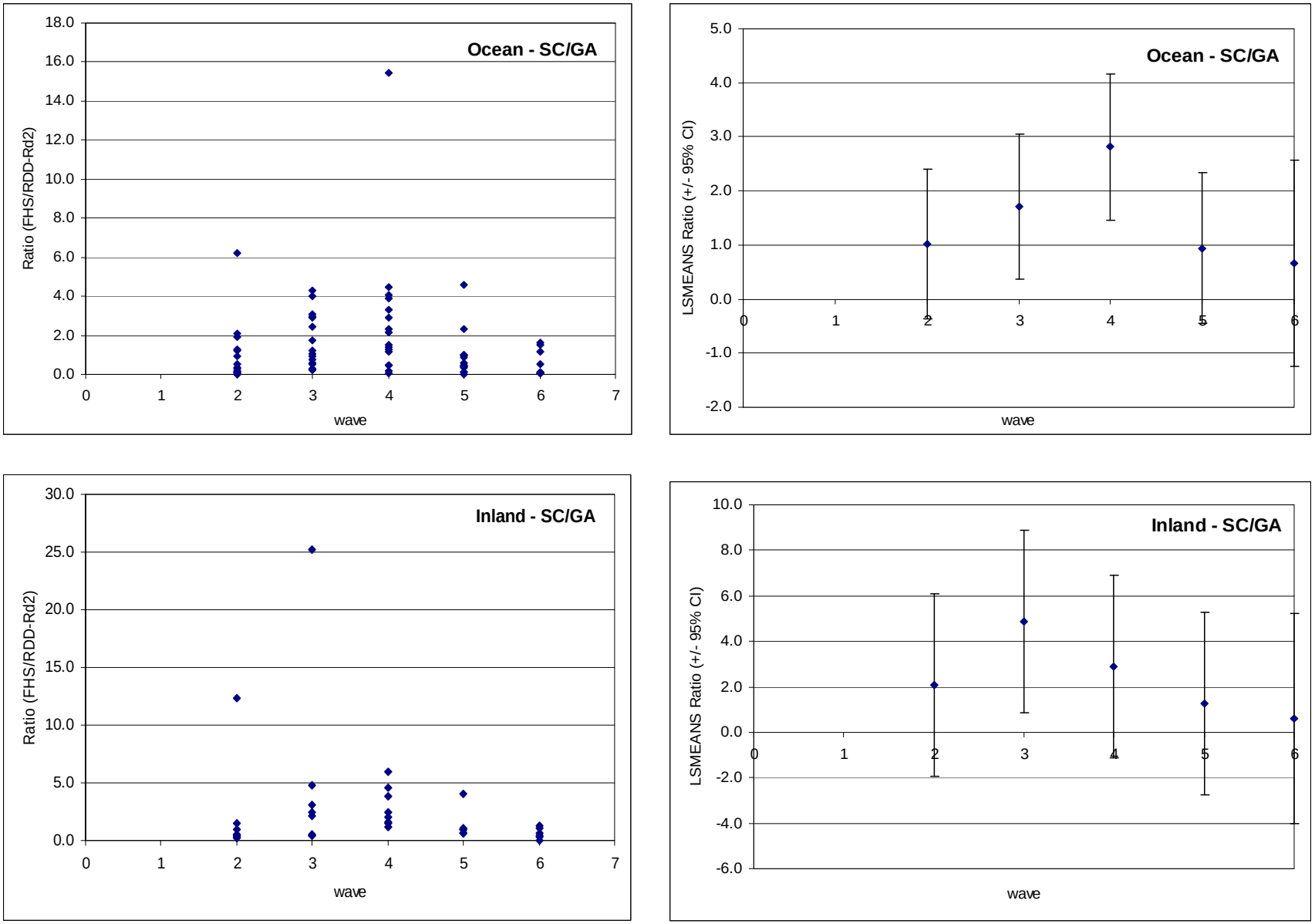


Figure 1b. SC and GA pooled Charter boat effort ratios observed (left column) in ocean waters (top) and inland waters (bottom) and estimated mean ratios from GLM model (ocean - top, right; inland - bottom, right).

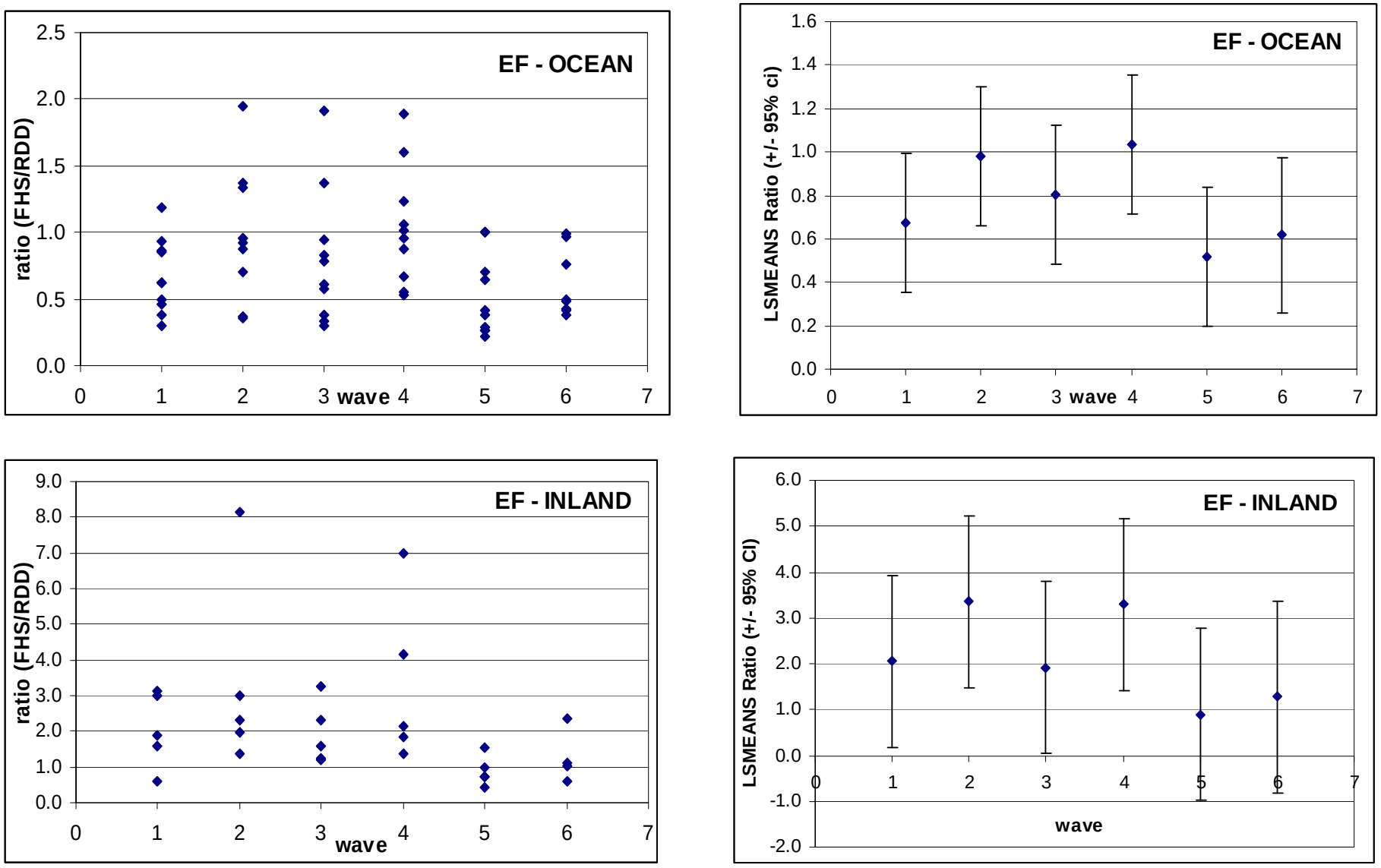
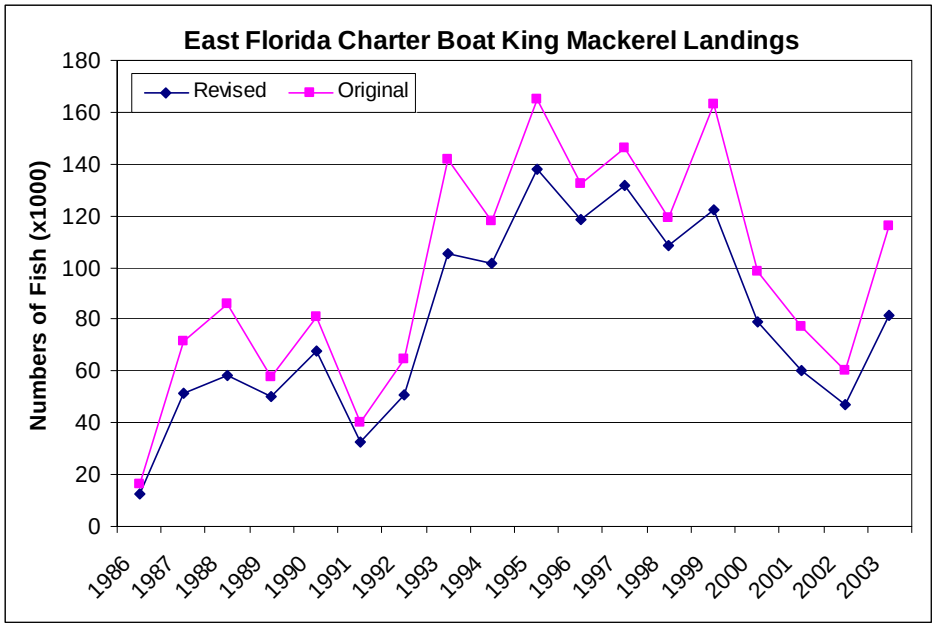
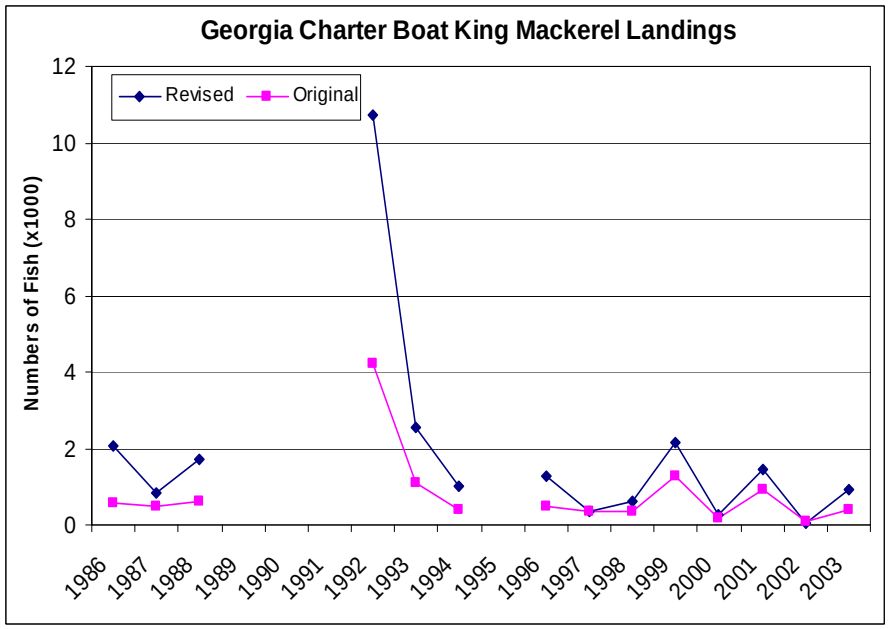
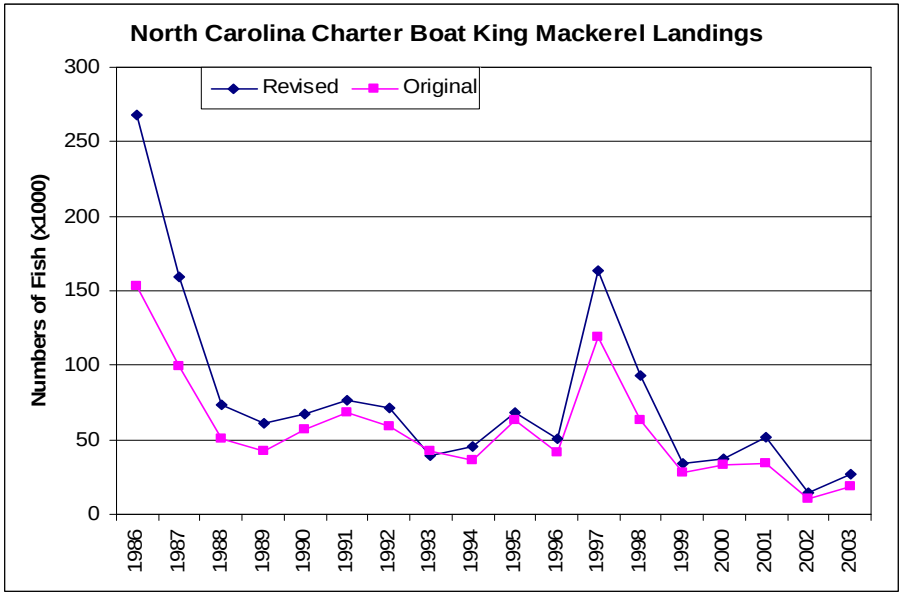


Figure 1c. East Florida only Charter boat effort ratios observed (left column) in ocean waters (top) and inland waters (bottom) and estimated mean ratios from GLM model (ocean - top, right; inland - bottom, right).


East Florida Charter Boat King Mackerel Landings
Revised
Original
Numbers of Fish (x1000)
0
20
40
60
80
100
120
140
160
180
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003


Georgia Charter Boat King Mackerel Landings
Revised
Original
Numbers of Fish (x1000)
0
2
4
6
8
10
12
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003


North Carolina Charter Boat King Mackerel Landings
Revised
Original
Numbers of Fish (x1000)
0
50
100
150
200
250
300
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003

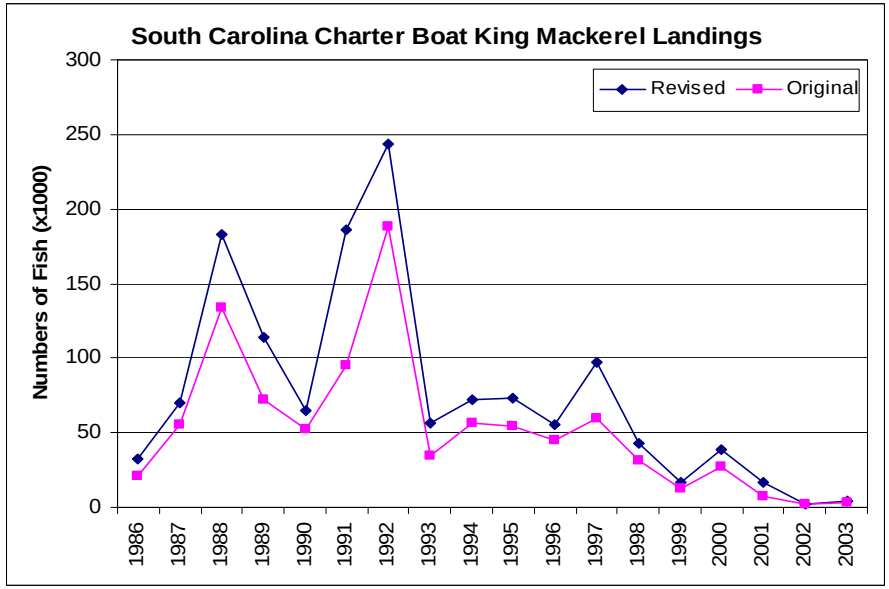

South Carolina Charter Boat King Mackerel Landings
Revised
Original
Numbers of Fish (x1000)
0
50
100
150
200
250
300
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003

Figure 2. King mackerel harvest (landings, Type A+B1) in numbers of fish. Original are estimates from round-4 (3 years pooled data) of Coastal Household Telephone Survey and Revised are produced using GLM model ratios (from CHTS:FHS model) and unpooled estimates.

Table 1. Annual charter boat king mackerel harvest (Type A+B1, numbers of fish) by state.

REVISED HARVEST ESTIMATES
(from FHS-GLM RD4 EFFORT CONVERSION)

YEAR	EFL	GA	NC	SC
1986	12,276	2,066	268,203	32,240
1987	51,290	837	159,590	69,849
1988	58,054	1,724	73,334	182,531
1989	50,219		60,931	114,235
1990	67,479		66,795	65,235
1991	32,757		76,818	185,990
1992	50,637	10,727	71,062	243,805
1993	105,332	2,552	39,636	56,524
1994	101,696	1,013	45,444	71,997
1995	138,015		68,358	73,096
1996	118,526	1,257	51,120	55,912
1997	131,834	367	163,837	97,574
1998	108,705	606	92,991	42,885
1999	122,241	2,145	34,033	16,943
2000	78,863	251	37,531	38,907
2001	60,330	1,444	51,835	17,044
2002	47,010	47	14,724	2,453
2003	81,800	933	26,648	3,918

ORIGINAL HARVEST ESTIMATES
(from RDD RD4 CHTS - POOLED DATA)

	EFL	GA	NC	SC
1986	16,087	563	152,905	21,390
1987	71,745	463	98,842	55,409
1988	86,189	613	50,818	134,176
1989	57,726		42,433	72,577
1990	81,161		56,395	52,615
1991	39,930		68,267	94,626
1992	64,400	4,215	59,138	187,811
1993	141,788	1,101	42,691	34,986
1994	118,169	405	36,274	56,467
1995	164,982		63,497	53,853
1996	132,248	489	41,535	45,170
1997	146,054	351	119,077	59,618
1998	118,866	341	62,901	31,399
1999	163,106	1,261	27,648	12,460
2000	98,390	157	32,879	26,958
2001	76,895	928	33,930	7,755
2002	60,264	72	10,370	2,139
2003	116,183	402	18,762	3,048