REVISED CATCH RATE INDICES FOR RED SNAPPER (*LUTJANUS CAMPECHANUS*) LANDED DURING 1981-2003 BY THE U.S. GULF OF MEXICO RECREATIONAL FISHERY

Shannon L. Cass-Calay

NOAA Fisheries, Southeast Fisheries Science Center,
Miami Laboratory, 75 Virginia Beach Drive, Miami, FL, 33149-1099, USA

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ABSTRACT

Three delta-lognormal indices were constructed for the SEDAR red snapper assessment workshop (Miami, Florida, August 2004) according to the recommendations of the SEDAR red snapper data workshop (New Orleans, Louisiana, April 2004). The revised indices include an index for the entire Gulf of Mexico, and indices for the eastern (FL,AL,MS) and western regions (LA). All the indices were constructed using Marine Recreational Fisheries Statistics Survey (MRFSS) data. The gulfwide and eastern indices demonstrate the influence of strong year classes, and suggest higher catch rates of red snapper after 1990. The western index has no clear trend, and is more variable than the others.

INTRODUCTION

Red snapper is a valuable resource in the U.S. Gulf of Mexico. During 1998-2002, about 9 million pounds were landed annually within the U.S. Gulf of Mexico by commercial and recreational fishermen. While the value of the recreational fishery is difficult to quantify, it is estimated that Gulf wide, approximately 264,000 individual recreational trips target red snapper annually (Holiman, 1999). The commercial catch was valued at approximately $10 million annually.

Red snapper are found in the western Atlantic Ocean and Gulf of Mexico, from Massachusetts to the Bay of Campeche, but are infrequent north of Cape Hatteras, NC (Hoese and Moore, 1998). Adults are common in submarine gullies and depressions, and over coral reefs, rock outcrops and gravel bottoms. They are most commonly found at depths of 40-110 meters[1]. Typically, red snapper reach a size of approximately 1000 mm TL, and weights up to 9.2 kg (Wilson and Nieland, 2001). Although ages in excess of 50 years have been observed, the vast majority of red snapper landed in the Gulf of Mexico are less than 15 years old (Wilson and Nieland, 2001).

This document describes the construction of catch rate indices for the recreational fishery for red snapper in the U.S. Gulf of Mexico. These indices were constructed for the SEDAR red snapper assessment workshop (Miami, Florida, August 2004) according to the recommendations

[1] NOAA Fisheries, Southeast Fisheries Science Center, Panama City Laboratory.

of the SEDAR red snapper data workshop (New Orleans, Louisiana, April 2004). They are intended to be used CPUE indices during formal assessment procedures.

METHODS

Data Sources

NOAA Fisheries initiated the Marine Recreational Fisheries Statistics Survey (MRFSS) in 1979 in order to obtain standardized estimates of participation, effort, and catch by recreational fishermen in U.S. marine waters. MRFSS data is collected using two approaches: a telephone survey of households in coastal counties, and dockside interviews of fishermen (intercept survey). MRFSS intercept data was used for the construction of catch rate indices.

MRFSS intercept survey sampling coverage has varied over the time series. Initially, the survey covered shore fishing, as well as charter boat (CB), headboat (HB) and private boat (PB) fishing modes in all Gulf States. During 1982-1984, MRFSS discontinued sampling boat modes in Texas. This program was turned over to the Texas Park and Wildlife Department (TPWD) which began sampling Texas boat modes in the summer of 1983. Headboat sampling Gulf wide was transferred to the NOAA Fisheries Headboat Survey (HBS) program in 1986. TPWD continued to survey bay headboats until July, 1991. Due to the lack of TX and HB mode samples during the bulk of the time series, TX data and HB mode data were excluded from the analyses. Also, the MRFSS program no longer recommends the use of data collected during.1979 and 1980. Therefore, these data were also excluded during the construction of catch rate indices[2].

Three indices were constructed, each using MRFSS intercept data from 1981-2003. All CB and PB trips that fished in "oceanic" areas using hook and line gear were included. Shore mode and inshore fishing trips were excluded as they very seldom landed red snapper. In accordance with the recommendations of the SEDAR data workshop, the gulfwide index was constructed using the data from fishing trips off FL, AL, MS and LA, the eastern index was constructed using intercept data from trips off FL, AL and MS, and the western index was restricted to fishing trips off LA.

. Ideally, fishing trips that targeted species that seldom co-occur with red snapper should be excluded from the data sets used to construct the catch rate indices. Unfortunately, no data were available regarding depth of fishing, fine-scale fishing location, gear configuration, or other information routinely used to infer the species targeted. Therefore, lists of species associated with red snapper were developed and used to exclude fishing trips that were unlikely to catch a red snapper.

Two sets of species associates (east and west) were identified using an association statistic proposed by Heinemann[3]. The association statistic was calculated for each species (Species X) reported by >50 trips during 1981-2003 (Eq. 1).

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[2] Patty Phares. Personal communication. NOAA Fisheries, Southeast Fisheries Science Center. Miami Laboratory.
[3] Heinemann, Dennis. The Ocean Conservancy, 1725 DeSales Street, Suite 600, Washington, D.C. 20036

$$Association\ Statistic = \frac{\#Trips\ with\ \text{Red}\ Snapper\ and\ Species\ X}{\#Trips\ with\ \text{Red}\ Snapper} \Bigg/ \frac{\#Trips\ with\ Species\ X}{\#Total\ Trips} \qquad (1)$$

The association statistic does not provide an objective critical value at which to include or exclude a species. A value of 1.0 implies that a given species co-occurs with red snapper exactly as often as random chance would predict. Values >1.0 indicate that a species co-occurs more often with red snapper than expected, and values <1.0 indicate that a given species co-occurs with red snapper less often than expected. For this analysis, a species was assumed to be associated with red snapper if its association statistic was ≥ 3.0. Trips were excluded if they did not land any species associate of red snapper.

Index Development

For each index, the following factors were considered as possible influences on the proportion of trips that observed red snapper (proportion positive trips), and the catch rates on positive trips. The factor REC_SEASON (OPEN/CLOSED) is defined in Table 1.

FACTOR	INDEX	LEVELS	VALUES
YEAR	ALL	23	1981-2003
SEASON	GULFWIDE	4	WIN = (Nov-Feb) SPR = (Mar-May) SUM = (Jun-Aug) AUT = (Sep-Oct)
	EASTERN	4	WIN = (Nov-Feb) SPR = (Mar-May) SUM = (Jun-Aug) AUT = (Sep-Oct)
	WESTERN	3	WIN = (Nov-Feb) SPR = (Mar-May SUM = (Jun-Oct)
MODE	ALL	2	Charter (CB) and Private (PB)
REC_SEASON	ALL	2	Closed and Open
STATE	GULFWIDE	4	FL, AL, MS, LA
	EASTERN	3	FL, AL, MS
	WESTERN	1	LA

A delta-lognormal approach (Lo et al., 1992) was used to develop the updated standardized catch rate indices. This method combines separate generalized linear modeling (GLM) analyses of the proportion positive trips[4] (trips that observed red snapper) and the catch rate on successful trips[5] to construct a single standardized index of abundance. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS

[4] Type-3 model, error = binomial, link = logit, response variable = success (where success = 1 if red snapper catch > 0, else success = 0)
[5] Type-3 model, error = normal, link = identity, response variable = logCPUE (where catch ≠ 0).

System for Windows © 2000. SAS Institute Inc. Cary, NC, USA). For the lognormal models, the response variable, ln(CPUE), was calculated:

$$\log(CPUE) = \log\left[(A + B1 + B2) / (anglers * hours\ \ fished)\right] \quad (2)$$

where A = fish observed, B1 = dead fish not observed and B2 = fish released alive. B1 and B2 catch, as well as effort (angler hours) were corrected for non-interviewed fishermen. When necessary, catch was rounded to the nearest whole number.

A forward stepwise approach was used during the construction of each GLM. First, the model was fit using only the factor YEAR (YEAR must be included in all models to construct annual indices). These results reflect the distribution of the nominal data. Next each potential factor was added to the null model individually, and the resulting reduction (%RED) in deviance per degree of freedom (DEV/DF) was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test (PROBCHISQ≤0.05), and the reduction in deviance per degree of freedom was ≥1%. This model then became the base model, and the process was repeated, adding factors and two-way interaction terms individually until no factor or interaction met the criteria for incorporation into the final model. Higher order interaction terms were not examined.

The final delta-lognormal models were fitted using a SAS macro, GLIMMIX (glmm800MaOB.sas: Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR (e.g. YEAR*STATE). These were modeled as random effects. To facilitate visual comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

RESULTS AND DISCUSSION

Species Associated with Red Snapper

Lists of the species associates identified for the eastern and western Gulf of Mexico, and their association statistics are summarized in Tables 2 and 3. Species were assumed to be associated with red snapper if the Association Statistic was ≥3.0. Fishing trips were excluded if they did not catch red snapper, or any species associated with red snapper.

Gulfwide Index

Annual variations in the nominal CPUE (scaled to the mean) and the proportion of positive trips are summarized in Figure 1. The probable influence of a large year class is evident in 1983, but subsequently, the proportion of positive trips and nominal CPUE returned to about the 1981-1982 level during 1985-1990. Both PPT and CPUE have generally increased since 1991.

The stepwise construction of the binomial model on proportion positive trips (PPT) is summarized in Table 4. The final model was:

PPT = YEAR + STATE + MODE + REC_SEASON

Diagnostic plots were examined to evaluate the fit of the binomial model. The distribution of the chi-square residuals, by each factor, indicate an acceptable fit (Fig. 2). In general, the residuals are distributed evenly above and below zero, and show no trend in variance with year. A few outliers (n=3) are present in the data for MS charter boats during the open season (Fig. 2). However, three outlying values are unlikely to affect the fit of the binomial model.

The stepwise construction of the lognormal model (normal model on logCPUE) on catch rates during positive trips is summarized in Table 5. The final model was:

LOG(CPUE) = YEAR + STATE + MODE + YEAR*STATE

Residual plots were examined to assess the fit of the lognormal model (Fig. 3). The residuals were distributed evenly above and below zero. A QQ-plot was examined to compare the fit of the model estimates to the expected normal distribution (Fig. 4). The fit was acceptable, and all diagnostics support the use of the delta-lognormal approach.

The gulfwide index results are summarized in Figure 5 and Table 6. The standardized abundance index is quite similar to the nominal CPUE series. Both indicate an increase in the catch rates of red snapper since 1990, with the highest observed catch rates occurring in recent years (1997-2003).

Eastern Index

Annual variations in the nominal CPUE and the proportion of positive trips are summarized in Figure 6. Both time series are very similar to the gulfwide series. This is as expected as the vast majority of red snapper trips recorded in the MRFSS dataset occurred in the eastern Gulf of Mexico (~90%).

The stepwise construction of the binomial model on PPT is summarized in Table 7 and the construction of the lognormal model on catch rates is summarized in Table 8. The final models were:

PPT = YEAR + STATE + MODE + REC_SEASON + SEASON + SEASON*STATE + YEAR*SEASON

LOG(CPUE) = YEAR + STATE + MODE + SEASON + REC_SEASON + MODE*STATE + YEAR*STATE + YEAR*SEASON

Residual plots for the binomial (Fig. 7) and lognormal (Fig. 8) models indicate acceptable fits. The residuals are typically distributed evenly above and below zero, and no annual trends in variance are noted. The QQ-plot also supports an adequate fit to the expected normal distribution (Fig. 9).

The eastern index results are summarized in Figure 10 and Table 9. The standardized eastern index is quite similar to the nominal CPUE series, and the gulfwide index. Like the gulfwide results, the time series suggest increasing catch rates, with the highest observed catch rates during 1997-2003.

Western Index

The western index was constructed using only LA fishing trips due to the lack of TX data. The MRFSS program ceased data collection in TX after 1985. Texas recreational trips are recorded by the Texas Park and Wildlife Department (TPWD), but these data do not include discarded fish, and therefore, are not directly comparable to MRFSS data.

Annual variations in the nominal CPUE and the proportion of positive trips are summarized in Figure 11. Unlike the gulfwide and eastern treatments, there is no increasing trend in the proportion of positive trips or CPUE in the western gulf. Instead, both time series fluctuate. Although this behavior may accurately reflect changes in abundance, it should be noted that this index is probably less reliable due to small sample sizes. Only ~1100 LA fishing trips kept or discarded a red snapper from 1981-2003.

The stepwise construction of the binomial model on PPT is summarized in Table 10 and the construction of the lognormal model on catch rates is summarized in Table 11. The final models were:

PPT = YEAR + MODE + SEASON + REC_SEASON + YEAR*MODE

LOG(CPUE) = YEAR + REC_SEASON + MODE + YEAR*MODE

Residual plots for the binomial (Fig. 12) and lognormal (Fig. 13) models indicate acceptable fits, although the fits are not as good as the eastern and gulfwide treatments. The chi-square residuals are typically distributed evenly above and below zero, but small differences are apparent in the mean residual values of the levels within a factor (e.g. Fig. 12D). The residuals of the lognormal model (Fig. 13) and the QQ-plot (Fig. 14) suggest that the fit to the lognormal model on catch rates is adequate.

The western index results are summarized in Figure 15 and Table 12. The standardized western index is more variable than the other treatments (higher CVs; Table 12) and has no apparent annual trend. As expected, the index is similar to the nominal CPUE series (Fig. 15). The increased variability and lack of coherent pattern in the western index may be caused, in part, by the low number of fishing trips interviewed in the western gulf. To properly resolve population dynamics in the western gulf, the use of available fishery independent indices is strongly recommended.

LITERATURE CITED

Hoese, H. D., and R. H. Moore. 1998. Fishes of the Gulf of Mexico. Texas A&M Univ. Press, College Station, TX, 422 p.

Lo, N.C., L.D. Jackson, J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

Holiman, S.G. 1999. Economic summary of the Gulf of Mexico reef fish recreational fishery. SERO-ECON-00-02. NOAA Fisheries, Southeast Regional Office, St. Petersburg, FL USA.

Schirripa, M.S. and C.M. Legault. 1999. Status of the red snapper in U.S. waters of the Gulf od Mexico: updated through 1998. NOAA Fisheries, Southeast Fisheries Science Center, Miami Laboratory, SFD-99/00-75.

Wilson, C.A. and D.L. Nieland. 2001. Age and growth of red snapper, *Lutjanus campechanus,* from the northern Gulf of Mexico off Louisiana. Fish. Bull. U.S. 99:653–664.

Table 1. History of management for the Gulf of Mexico recreational sector.

Changes in recreational red snapper size limits, bag limits, and season length.

Year	Size Limit (Inches TL)	Daily Bag Limit (Number of Fish)	Rec Season Open	Rec Season Closed	Season length (days)
1984	13[1]	no bag limit[2]			365
1990	13	7			365
1994	14	7			365
1995	15	5			365
1996	15	5			365
1997	15	5	Jan. 1	Nov. 27	330
1998	15	4[3]	Jan. 1	Sept. 30	272
1999	15[4]	4	Jan. 1	Aug. 29	240
2000	16	4	Apr. 21	Oct. 31	194
2001	16	4	Apr. 21	Oct. 31	194
2002	16	4	Apr. 21	Oct. 31	194
2003	16	4	Apr. 21	Oct. 31	194

[1] for-hire boats exempted until 1987
[2] Allowed to keep 5 undersized fish per day
[3] Bag limit was 5 fish from January through April, 1998.
[4] Size limit was 18 inches from June 4 through August 29, 1999.

Table 2. Results of calculations used to identify species associated with red snapper in the eastern GOM (FL,AL,MS). Species were assumed to be associated with red snapper if the association statistic was ≥ 3.0. %CO is the percent common occurrence.

Common Name	Scientific Name	Trips with Red Snapper and Species X	Trips with Species X	Total Red Snapper Trips	Total Trips	Association Statistic	%CO
Red snapper	*Lutjanus campechanus*	9409	9409	9409	89507	9.51	1.00
Red porgy	*Pagrus pagrus*	1511	1829	9409	89507	7.86	0.83
Banded rudderfish	*Seriola zonata*	282	344	9409	89507	7.80	0.82
Vermilion snapper	*Rhomboplites aurorubens*	3222	3984	9409	89507	7.69	0.81
Whitebone porgy	*Calamus leucosteus*	208	266	9409	89507	7.44	0.78
Scamp	*Mycteroperca phenax*	723	982	9409	89507	7.00	0.74
Warsaw grouper	*Epinephelus nigritus*	126	172	9409	89507	6.97	0.73
Gray triggerfish	*Balistes capriscus*	4276	5935	9409	89507	6.85	0.72
Almaco jack	*Seriola rivoliana*	530	748	9409	89507	6.74	0.71
Snowy grouper	*Epinephelus niveatus*	73	110	9409	89507	6.31	0.66
Lesser amberjack	*Seriola fasciata*	85	134	9409	89507	6.03	0.63
Queen triggerfish	*Balistes vetula*	72	115	9409	89507	5.96	0.63
Greater amberjack	*Seriola dumerili*	2145	3772	9409	89507	5.41	0.57
Bank sea bass	*Centropristis ocyurus*	370	660	9409	89507	5.33	0.56
Tomtate	*Haemulon aurolineatum*	356	725	9409	89507	4.67	0.49
Amberjack genus	*Seriola spp.*	295	627	9409	89507	4.48	0.47
Sea bass genus	*Centropristis spp.*	58	127	9409	89507	4.34	0.46
Moray family	*Muraenidae*	23	52	9409	89507	4.21	0.44
Speckled hind	*Epinephelus drummondhayi*	39	96	9409	89507	3.86	0.41
Black snapper	*Apsilus dentatus*	20	50	9409	89507	3.81	0.40
Sharksucker	*Echeneis naucrates*	48	130	9409	89507	3.51	0.37
Atlantic spadefish	*Chaetodipterus faber*	174	494	9409	89507	3.35	0.35
Squirrelfish	*Holocentrus adscensionis*	63	180	9409	89507	3.33	0.35
Remora	*Remora remora*	119	348	9409	89507	3.25	0.34
Lane snapper	*Lutjanus synagris*	822	2505	9409	89507	3.12	0.33

Table 3. Results of calculations used to identify species associated with red snapper in the western GOM (LA). Species were assumed to be associated with red snapper if the association statistic was ≥ 3.0. %CO is the percent common occurrence.

Common Name	Scientific Name	Trips with Red Snapper and Species X	Trips with Species X	Total Red Snapper Trips	Total Trips	Association Statistic	%CO
Red snapper	*Lutjanus campechanus*	1109	1109	1109	8773	7.91	1.00
Kane snapper	*Lutjanus synagris*	185	196	1109	8773	7.47	0.94
Gag	*Mycteroperca microlepis*	102	122	1109	8773	6.61	0.84
Vermilion snapper	*Rhomboplites aurorubens*	79	99	1109	8773	6.31	0.80
Almaco jack	*Seriola rivoliana*	47	60	1109	8773	6.20	0.78
Gray triggerfish	*Balistes capriscus*	310	397	1109	8773	6.18	0.78
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	68	92	1109	8773	5.85	0.74
Greater amberjack	*Seriola dumerili*	252	341	1109	8773	5.85	0.74
Cobia	*Rachycentron canadum*	266	382	1109	8773	5.51	0.70
Great barracuda	*Sphyraena barracuda*	38	56	1109	8773	5.37	0.68
Gray snapper	*Lutjanus griseus*	188	281	1109	8773	5.29	0.67
King mackerel	*Scomberomorus cavalla*	154	289	1109	8773	4.22	0.53
Pinfish	*Lagodon rhomboides*	98	194	1109	8773	4.00	0.51
Silver seatrout	*Cynoscion nothus*	63	125	1109	8773	3.99	0.50
Blue runner	*Caranx crysos*	108	220	1109	8773	3.88	0.49
Requiem shark family	*Carcharhinidae*	23	50	1109	8773	3.64	0.46
Bluefish	*Pomatomus saltatrix*	209	458	1109	8773	3.61	0.46
Atlantic spadefish	*Chaetodipterus faber*	61	141	1109	8773	3.42	0.43
Little tunny	*Euthynnus alletteratus*	70	176	1109	8773	3.15	0.40
Blacktip shark	*Carcharhinus limbatus*	96	250	1109	8773	3.04	0.38

Table 4. A summary of formulation of the binomial model for the ***GULFWIDE INDEX***. Factors were added to the model if PROBCHISQ ≤ 0.05 and the reduction in DEV/DF (%RED) ≥ 1.0% (bold blue font).

The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	18411	24429.7	1.3269		-12214.9		
STATE	**18408**	**21189.3**	**1.1511**	**13.25**	**-10594.6**	**3240.42**	**<0.0001**
MODE	18410	22967.2	1.2475	5.98	-11483.6	1462.56	<0.0001
REC_SEASON	18410	23775.2	1.2914	2.67	-11887.6	654.54	<0.0001
SEASON	18408	24078.4	1.3080	1.42	-12039.2	351.33	<0.0001

The explanatory factors in the base model are: YEAR STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	18408	21189.3	1.1511		-10594.6		
MODE	**18407**	**19385.5**	**1.0532**	**8.51**	**-9692.8**	**1803.76**	**<0.0001**
REC_SEASON	18407	20578.1	1.1180	2.88	-10289.1	611.18	<0.0001
SEASON	18405	20696.1	1.1245	2.31	-10348.0	493.24	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	18407	19385.5	1.0532		-9692.8		
REC_SEASON	**18406**	**18652.4**	**1.0134**	**3.78**	**-9326.2**	**733.18**	**<0.0001**
SEASON	18404	18922.9	1.0282	2.37	-9461.4	462.68	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE REC_SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	18406	18652.4	1.0134		-9326.2		
SEASON	18403	18494.9	1.0050	0.83	-9247.5	157.42	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE REC_SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	18406	18652.4	1.0134		-9326.2		
MODE*STATE	18403	18531.3	1.0070	0.63	-9265.6	121.10	<0.0001
MODE*REC_SEASON	18405	18536.2	1.0071	0.62	-9268.1	116.17	<0.0001
YEAR*MODE	18384	18535.0	1.0082	0.51	-9267.5	193.79	<0.0001
STATE_CHAR*REC_SEASON	18403	18580.8	1.0097	0.37	-9290.4	71.56	<0.0001

Table 5. A summary of formulation of the lognormal model for the ***GULFWIDE INDEX***. Factors were added to the model if PROBCHISQ ≤ 0.05 and the reduction in DEV/DF (%RED) $\geq 1.0\%$ (bold blue font).

The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	10264	11492.2	1.1197		-15166.4		
STATE	**10261**	**11084.6**	**1.0803**	**3.52**	**-14980.7**	**371.43**	**<0.0001**
MODE	10263	11308.0	1.1018	1.59	-15083.3	166.21	<0.0001
SEASON	10261	11369.0	1.1080	1.04	-15111.0	110.85	<0.0001
REC_SEASON	10263	11453.7	1.1160	0.32	-15149.2	34.46	<0.0001

The explanatory factors in the base model are: YEAR STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	10261	11084.6	1.0803		-14980.7		
MODE	**10260**	**10763.2**	**1.0490**	**2.89**	**-14829.4**	**302.66**	**<0.0001**
SEASON	10258	10957.7	1.0682	1.12	-14921.5	118.44	<0.0001
REC_SEASON	10260	11031.8	1.0752	0.47	-14956.2	49.13	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	10260	10763.2	1.0490		-14829.4		
SEASON	10257	10659.1	1.0392	0.94	-14779.4	100.00	<0.0001
REC_SEASON	10259	10708.9	1.0439	0.50	-14803.3	52.10	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	10260	10763.2	1.0490		-14829.4		
YEAR*STATE	**10195**	**10297.5**	**1.0101**	**3.72**	**-14601.9**	**455.07**	**<0.0001**
YEAR*MODE	10238	10562.4	1.0317	1.66	-14732.5	193.79	<0.0001
MODE*STATE	10257	10663.0	1.0396	0.90	-14781.3	96.22	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE YEAR*STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	10195	10297.5	1.0101		-14601.9		
YEAR*MODE	10173	10174.3	1.0001	0.98	-14539.9	123.84	<0.0001
MODE*STATE	10192	10202.1	1.0010	0.90	-14554.0	95.68	<0.0001

Table 6. Relative nominal CPUE, proportion positive trips (PPT) and abundance index statistics for the ***GULFWIDE INDEX***.

YEAR	PPT	Relative Nominal CPUE	Relative Index	Lower 95% CI	Upper 95% CI	CV
1981	0.4080	0.7575	0.9236	0.4554	1.8731	0.3649
1982	0.4034	0.2657	0.4355	0.2273	0.8343	0.3338
1983	0.6750	1.3267	1.4347	0.8329	2.4715	0.2770
1984	0.5909	1.0222	0.7765	0.4119	1.4638	0.3251
1985	0.4921	1.0026	0.5216	0.2256	1.2059	0.4381
1986	0.5099	0.6242	0.5890	0.3559	0.9747	0.2559
1987	0.3792	0.4810	0.6429	0.3647	1.1333	0.2892
1988	0.3498	0.4145	0.5537	0.2971	1.0320	0.3190
1989	0.3180	0.3780	0.3936	0.1910	0.8111	0.3738
1990	0.4409	0.6167	0.5528	0.2886	1.0587	0.3337
1991	0.5289	1.3236	0.9299	0.5327	1.6232	0.2840
1992	0.5246	1.3123	1.1819	0.7405	1.8863	0.2370
1993	0.4954	1.0338	1.0794	0.6640	1.7546	0.2466
1994	0.4829	0.9787	0.8341	0.5032	1.3827	0.2568
1995	0.4667	0.7819	0.7790	0.4271	1.4208	0.3074
1996	0.4857	1.2046	1.1604	0.6926	1.9440	0.2624
1997	0.6274	1.7049	1.6552	1.0863	2.5221	0.2129
1998	0.6068	1.3237	1.5745	1.0523	2.3558	0.2035
1999	0.6396	1.4744	1.6294	1.1013	2.4108	0.1977
2000	0.6936	1.3317	1.3001	0.8783	1.9243	0.1980
2001	0.6142	1.1098	1.2213	0.8159	1.8283	0.2038
2002	0.6498	1.3700	1.3913	0.9460	2.0462	0.1947
2003	0.6371	1.1614	1.4397	0.9786	2.1179	0.1948

Table 7. A summary of formulation of the binomial model for the ***EASTERN INDEX***. Factors were added to the model if PROBCHISQ ≤ 0.05 and the reduction in DEV/DF (%RED) ≥ 1.0% (bold blue font).

The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16217	21299.6	1.3134		-10649.8		
STATE	**16215**	**17994.7**	**1.1098**	**15.51**	**-8997.4**	**3304.92**	**<0.0001**
MODE	16216	20029.3	1.2352	5.96	-10014.7	1270.31	<0.0001
REC_SEASON	16216	20660.2	1.2741	3.00	-10330.1	639.39	<0.0001
SEASON	16214	20885.2	1.2881	1.93	-10442.6	414.39	<0.0001

The explanatory factors in the base model are: YEAR STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16215	17994.7	1.1098		-8997.4		
MODE	**16214**	**16372.9**	**1.0098**	**9.01**	**-8186.5**	**1621.77**	**<0.0001**
REC_SEASON	16214	17401.1	1.0732	3.29	-8700.5	593.62	<0.0001
SEASON	16212	17410.1	1.0739	3.23	-8705.1	584.60	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16214	16372.9	1.0098		-8186.5		
REC_SEASON	**16213**	**15680.4**	**0.9672**	**4.22**	**-7840.2**	**692.51**	**<0.0001**
SEASON	16211	15825.7	0.9762	3.32	-7912.8	547.28	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE REC_SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16213	15680.4	0.9672		-7840.2		
SEASON	**16210**	**15488.1**	**0.9555**	**1.21**	**-7744.1**	**192.32**	**<0.0001**

The explanatory factors in the base model are: YEAR STATE MODE REC_SEASON SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16210	15488.1	0.9555		-7744.1		
YEAR*SEASON	**16144**	**15157.8**	**0.9389**	**1.73**	**-7578.9**	**330.35**	**<0.0001**
SEASON*STATE	16204	15265.8	0.9421	1.40	-7632.9	222.31	<0.0001
SEASON*MODE	16207	15341.0	0.9466	0.93	-7670.5	147.12	<0.0001
YEAR*MODE_CHAR	16188	15355.9	0.9486	0.72	-7677.9	132.26	<0.0001
MODE*REC_SEASON	16209	15389.0	0.9494	0.63	-7694.5	99.14	<0.0001
SEASON*REC_SEASON	16207	15394.9	0.9499	0.58	-7697.5	93.18	<0.0001
MODE*STATE	16208	15409.3	0.9507	0.50	-7704.6	78.82	<0.0001
STATE*REC_SEASON	16208	15470.2	0.9545	0.10	-7735.1	17.91	0.0001

The explanatory factors in the base model are: YEAR STATE MODE REC_SEASON SEASON YEAR*SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16144	15157.8	0.9389		-7578.9		
SEASON*STATE	**16138**	**14962.9**	**0.9272**	**1.25**	**-7481.4**	**194.91**	**<0.0001**
SEASON*MODE	16141	15027.4	0.9310	0.84	-7513.7	130.33	<0.0001
MODE*REC_SEASON	16143	15048.7	0.9322	0.71	-7524.4	109.05	<0.0001
MODE*STATE	16142	15071.9	0.9337	0.55	-7535.9	85.90	<0.0001
YEAR*MODE	16122	15054.0	0.9338	0.55	-7527.0	103.80	<0.0001
SEASON*REC_SEASON	16141	15131.7	0.9375	0.15	-7565.9	26.03	<0.0001
STATE*REC_SEASON	16142	15134.7	0.9376	0.14	-7567.3	23.07	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE REC_SEASON SEASON YEAR*SEASON SEASON*STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	16138	14962.9	0.9272		-7481.4		
MODE*STATE	16136	14862.5	0.9211	0.66	-7431.3	100.32	<0.0001
YEAR*MODE_CHAR	16116	14864.2	0.9223	0.52	-7432.1	98.64	<0.0001
MODE*REC_SEASON	16137	14891.1	0.9228	0.47	-7445.6	71.73	<0.0001
SEASON*MODE	16135	14890.7	0.9229	0.46	-7445.3	72.20	<0.0001
SEASON*REC_SEASON	16135	14936.8	0.9257	0.16	-7468.4	25.05	<0.0001
STATE*REC_SEASON	16136	14943.5	0.9261	0.12	-7471.8	19.31	<0.0001

Table 8. A summary of formulation of the lognormal model for the ***EASTERN INDEX***. Factors were added to the model if PROBCHISQ ≤ 0.05 and the reduction in DEV/DF (%RED) ≥ 1.0% (bold blue font).

The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9175	10248.5	1.1170		-13548.8		
STATE	**9173**	**9824.3**	**1.0710**	**4.12**	**-13354.3**	**388.84**	**<0.0001**
MODE	9174	10099.0	1.1008	1.45	-13481.2	135.15	<0.0001
SEASON	9172	10117.8	1.1031	1.24	-13489.7	118.08	<0.0001
REC_SEASON	9174	10216.4	1.1136	0.30	-13534.3	28.83	<0.0001

The explanatory factors in the base model are: YEAR STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9173	9824.3	1.0710		-13354.3		
MODE	**9172**	**9527.8**	**1.0388**	**3.01**	**-13213.4**	**281.89**	<0.0001
SEASON	9170	9690.5	1.0568	1.33	-13291.3	126.12	<0.0001
REC_SEASON	9172	9779.0	1.0662	0.45	-13333.1	42.54	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9172	9527.8	1.0388		-13213.4		
SEASON	**9169**	**9415.6**	**1.0269**	**1.15**	**-13158.9**	**108.94**	**<0.0001**
REC_SEASON	9171	9481.0	1.0338	0.48	-13190.8	45.25	<0.0001

The explanatory factors in the base model are: YEAR STATE MODE SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9169	9415.6	1.0269		-13158.9		
REC_SEASON	**9168**	**9290.1**	**1.0133**	**1.32**	**-13097.2**	**123.43**	**<0.0001**

The explanatory factors in the base model are: YEAR STATE MODE SEASON REC_SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9168	9290.1	1.0133		-13097.2		
YEAR*STATE	**9125**	**8987.6**	**0.9849**	**2.80**	**-12945.0**	**304.49**	**<0.0001**
YEAR*SEASON	9103	9062.7	0.9956	1.75	-12983.2	227.92	<0.0001
YEAR*MODE	9146	9112.6	0.9964	1.67	-13008.5	177.39	<0.0001
MODE*STATE	9166	9175.3	1.0010	1.21	-13040.0	114.38	<0.0001
MODE*REC_SEASON	9167	9253.2	1.0094	0.39	-13078.9	36.59	<0.0001
STATE*REC_SEASON	9166	9257.9	1.0100	0.32	-13081.3	31.89	<0.0001
SEASON*MODE	9165	9258.3	1.0102	0.31	-13081.4	31.52	<0.0001
SEASON*STATE	9162	9260.6	1.0108	0.25	-13082.6	29.24	<0.0001
SEASON*REC_SEASON	9165	9278.5	1.0124	0.09	-13091.5	11.47	0.0094

The explanatory factors in the base model are: YEAR STATE MODE SEASON REC_SEASON YEAR*STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9125	8987.6	0.9849		-12945.0		
YEAR*SEASON	**9060**	**8765.5**	**0.9675**	**1.77**	**-12829.9**	**230.11**	**<0.0001**
MODE*STATE	9123	8874.1	0.9727	1.24	-12886.5	116.86	<0.0001
YEAR*MODE	9103	8880.2	0.9755	0.96	-12889.7	110.53	<0.0001
MODE*REC_SEASON	9124	8951.0	0.9810	0.40	-12926.2	37.52	<0.0001
SEASON*MODE	9122	8955.1	0.9817	0.33	-12928.3	33.31	<0.0001
SEASON*STATE	9119	8961.6	0.9827	0.22	-12931.6	26.66	0.0002
STATE*REC_SEASON	9123	8976.8	0.9840	0.10	-12939.5	11.00	0.0041
SEASON*REC_SEASON	9122	8978.0	0.9842	0.07	-12940.1	9.76	0.0207

The explanatory factors in the base model are: YEAR STATE MODE SEASON REC_SEASON YEAR*STATE YEAR*SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9060	8765.5	0.9675		-12829.9		
MODE*STATE	**9058**	**8653.8**	**0.9554**	**1.25**	**-12770.9**	**118.00**	**<0.0001**
YEAR*MODE	9038	8665.7	0.9588	0.90	-12777.2	105.37	<0.0001
MODE*REC_SEASON	9059	8725.6	0.9632	0.44	-12808.9	42.00	<0.0001
SEASON*MODE	9057	8729.6	0.9638	0.38	-12811.0	37.80	<0.0001
SEASON*STATE	9054	8741.8	0.9655	0.20	-12817.4	24.95	0.0003
STATE*REC_SEASON	9058	8752.7	0.9663	0.12	-12823.2	13.50	0.0012
SEASON*REC_SEASON	9057	8758.7	0.9671	0.04	-12826.3	7.11	0.0685

The explanatory factors in the base model are: YEAR STATE MODE SEASON REC_SEASON YEAR*STATE YEAR*SEASON MODE*STATE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	9058	8653.8	0.9554		-12770.9		
YEAR*MODE	9036	8572.9	0.9487	0.69	-12727.7	86.39	<0.0001
MODE*REC_SEASON	9057	8605.0	0.9501	0.55	-12744.9	51.95	<0.0001
SEASON*MODE	9055	8612.5	0.9511	0.44	-12748.9	43.95	<0.0001
SEASON*STATE	9052	8630.9	0.9535	0.20	-12758.7	24.33	0.0005
SEASON*REC_SEASON	9055	8645.6	0.9548	0.06	-12766.5	8.71	0.0333
STATE*REC_SEASON	9056	8647.3	0.9549	0.05	-12767.5	6.87	0.0323

Table 9. Relative nominal CPUE, proportion positive trips (PPT) and abundance index statistics for the ***EASTERN INDEX***.

YEAR	PPT	Relative Nominal CPUE	Relative Index	Lower 95% CI	Upper 95% CI	CV
1981	0.3167	0.4480	0.7599	0.3263	1.7699	0.4423
1982	0.3605	0.2132	0.3896	0.1778	0.8535	0.4077
1983	0.5496	1.2944	1.4442	0.6995	2.9820	0.3748
1984	0.4286	0.8932	0.4630	0.1737	1.2341	0.5212
1985	0.5510	1.2077	0.5452	0.2339	1.2704	0.4427
1986	0.4884	0.6470	0.6091	0.3381	1.0972	0.3008
1987	0.3808	0.5007	0.7308	0.3946	1.3537	0.3157
1988	0.3562	0.3489	0.4361	0.2174	0.8749	0.3590
1989	0.3168	0.3808	0.3623	0.1604	0.8183	0.4249
1990	0.4427	0.6233	0.5005	0.2423	1.0340	0.3751
1991	0.5437	1.3181	0.8036	0.4362	1.4806	0.3128
1992	0.5317	1.3227	1.0573	0.6206	1.8016	0.2712
1993	0.4904	1.0189	0.9665	0.5600	1.6680	0.2780
1994	0.4683	0.9709	0.7795	0.4416	1.3761	0.2900
1995	0.4553	0.6970	0.6058	0.3063	1.1979	0.3511
1996	0.4700	1.1982	1.0858	0.6216	1.8968	0.2844
1997	0.6469	1.8126	1.6585	1.0222	2.6908	0.2456
1998	0.6184	1.3726	1.6949	1.0641	2.6996	0.2359
1999	0.6556	1.5357	1.7688	1.1145	2.8073	0.2341
2000	0.7089	1.3839	1.5439	0.9685	2.4610	0.2363
2001	0.6348	1.1627	1.5618	0.9777	2.4950	0.2375
2002	0.6712	1.4627	1.7516	1.1076	2.7701	0.2322
2003	0.6449	1.1868	1.4812	0.9339	2.3492	0.2337

Table 10. A summary of formulation of the binomial model for the ***WESTERN INDEX***. Factors were added to the model if PROBCHISQ ≤ 0.05 and the reduction in DEV/DF (%RED) ≥ 1.0% (bold blue font).

The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2171	2876.2	1.3248		-1438.1		
MODE	**2170**	**2753.2**	**1.2688**	**4.23**	**-1376.6**	**122.98**	**<0.0001**
SEASON	2169	2793.3	1.2878	2.79	-1396.7	82.91	<0.0001
REC_SEASON	2170	2827.2	1.3028	1.66	-1413.6	49.04	<0.0001

The explanatory factors in the base model are: YEAR MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2170	2753.2	1.2688		-1376.6		
SEASON	**2168**	**2674.2**	**1.2335**	**2.78**	**-1337.1**	**79.03**	**<0.0001**
REC_SEASON	2169	2693.2	1.2417	2.14	-1346.6	60.04	<0.0001

The explanatory factors in the base model are: YEAR MODE SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2168	2674.2	1.2335		-1337.1		
REC_SEASON	**2167**	**2567.0**	**1.1846**	**3.97**	**-1283.5**	**107.25**	**<0.0001**

The explanatory factors in the base model are: YEAR MODE SEASON REC_SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2167	2567.0	1.1846		-1283.5		
YEAR*MODE	**2145**	**2466.5**	**1.1499**	**2.93**	**-1233.3**	**100.46**	**<0.0001**
MODE*REC_SEASON	2166	2526.9	1.1666	1.51	-1263.5	40.04	<0.0001
SEASON*REC_SEASON	2165	2559.3	1.1821	0.21	-1279.6	7.68	0.0215
SEASON*MODE	2165	2563.3	1.1840	0.05	-1281.6	3.71	0.1566

The explanatory factors in the base model are: YEAR MODE SEASON REC_SEASON YEAR*MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	2145	2466.5	1.1499		-1233.3		
MODE*REC_SEASON (*)	2144	2433.7	1.1351	1.28	-1216.8	32.82	<0.0001
SEASON*REC_SEASON	2143	2461.1	1.1484	0.13	-1230.5	5.44	0.0659
SEASON*MODE	2143	2461.8	1.1488	0.10	-1230.9	4.66	0.0974

(*) This interaction term not included because it caused a fixed factor (MODE) to become insignificant in type III analysis.

Table 11. A summary of formulation of the lognormal model for the ***WESTERN INDEX***. Factors were added to the model if PROBCHISQ ≤ 0.05 and the reduction in DEV/DF (%RED) ≥ 1.0% (bold blue font).

The explanatory factors in the base model are: YEAR

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	1066	1091.4	1.0238		-1546.4		
REC_SEASON	**1065**	**1065.7**	**1.0006**	**2.27**	**-1533.4**	**25.97**	**<0.0001**
MODE	1065	1067.3	1.0021	2.12	-1534.2	24.35	<0.0001
SEASON	1064	1088.2	1.0228	0.10	-1544.8	3.17	0.2051

The explanatory factors in the base model are: YEAR REC_SEASON

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	1065	1065.7	1.0006		-1533.4		
MODE	**1064**	**1045.0**	**0.9822**	**1.84**	**-1522.8**	**21.27**	**<0.0001**
SEASON	1063	1064.7	1.0016	-0.10	-1532.9	1.01	0.6023

The explanatory factors in the base model are: YEAR REC_SEASON MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	1064	1045.0	0.9822		-1522.8		
SEASON	1062	1044.7	0.9837	-0.16	-1522.6	0.34	0.8448

The explanatory factors in the base model are: YEAR REC_SEASON MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	1064	1045.0	0.9822		-1522.8		
YEAR*MODE	**1042**	**983.5**	**0.9439**	**3.90**	**-1489.8**	**66.06**	**<0.0001**
MODE*REC_SEASON	1063	1031.7	0.9706	1.18	-1515.8	13.98	0.0002

The explanatory factors in the base model are: YEAR REC_SEASON MODE YEAR*MODE

FACTOR	DEGF	DEVIANCE	DEV/DF	%REDUCTION	LOGLIKE	CHISQ	PROBCHISQ
BASE	1042	983.5	0.9439		-1489.8		
MODE*REC_SEASON	1041	976.5	0.9381	0.62	-1485.9	7.81	0.0052

Table 12. Relative nominal CPUE, proportion positive trips (PPT) and abundance index statistics for the ***WESTERN INDEX***.

YEAR	PPT	Relative Nominal CPUE	Relative Index	Lower 95% CI	Upper 95% CI	CV
1981	0.6111	1.7390	1.4401	0.6126	3.3854	0.4476
1982	0.5152	0.4842	0.4413	0.1604	1.2146	0.5404
1983	0.7852	1.6305	1.3754	0.6575	2.8772	0.3819
1984	0.7672	1.3987	1.0478	0.4806	2.2842	0.4049
1985	0.2955	0.3831	0.3694	0.0959	1.4231	0.7588
1986	0.5894	0.6503	0.6297	0.2675	1.4822	0.4484
1987	0.3671	0.4056	0.3234	0.0947	1.1045	0.6767
1988	0.2909	1.2331	0.9014	0.2798	2.9034	0.6386
1989	0.3247	0.4374	0.5657	0.1907	1.6782	0.5864
1990	0.4362	0.7211	0.7482	0.2900	1.9305	0.5018
1991	0.4607	1.6248	1.1325	0.4089	3.1367	0.5443
1992	0.4834	1.5080	1.4224	0.5824	3.4737	0.4696
1993	0.5301	1.3695	1.3581	0.5435	3.3934	0.4830
1994	0.5862	1.2458	1.4016	0.6183	3.1773	0.4269
1995	0.5286	1.4961	1.5654	0.6151	3.9843	0.4938
1996	0.6207	1.5187	1.6933	0.7042	4.0720	0.4607
1997	0.4953	1.1774	1.2737	0.5434	2.9858	0.4460
1998	0.4643	0.8756	1.2218	0.4913	3.0385	0.4802
1999	0.4237	0.7874	0.7626	0.2941	1.9768	0.5046
2000	0.4737	0.7094	0.7430	0.3105	1.7778	0.4578
2001	0.2529	0.2238	0.2447	0.0726	0.8247	0.6682
2002	0.4211	0.4575	0.7772	0.3462	1.7448	0.4215
2003	0.5138	0.9231	1.5611	0.7197	3.3860	0.4021

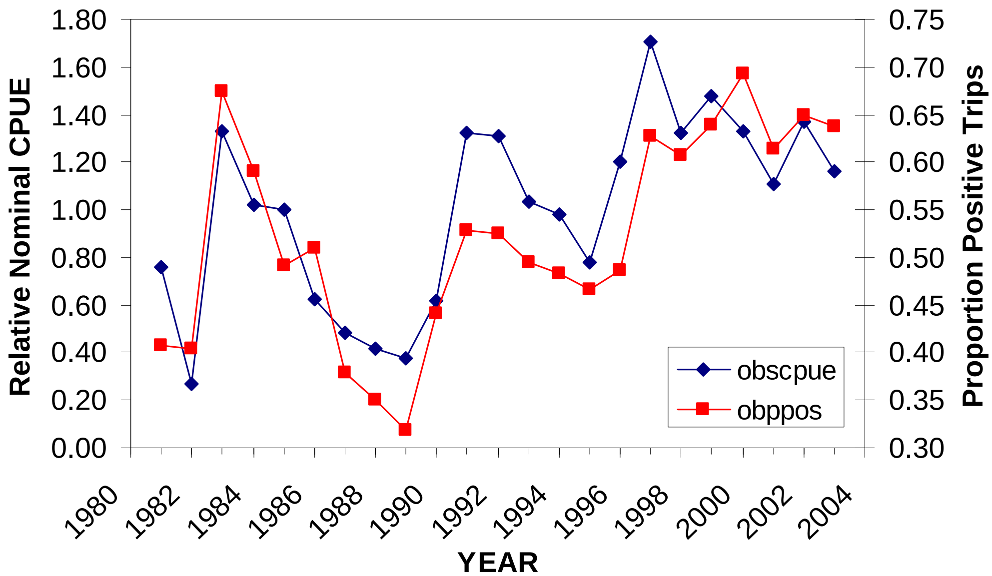

Figure 1. The annual trends in relative nominal CPUE and proportion positive trips (**Gulfwide**).

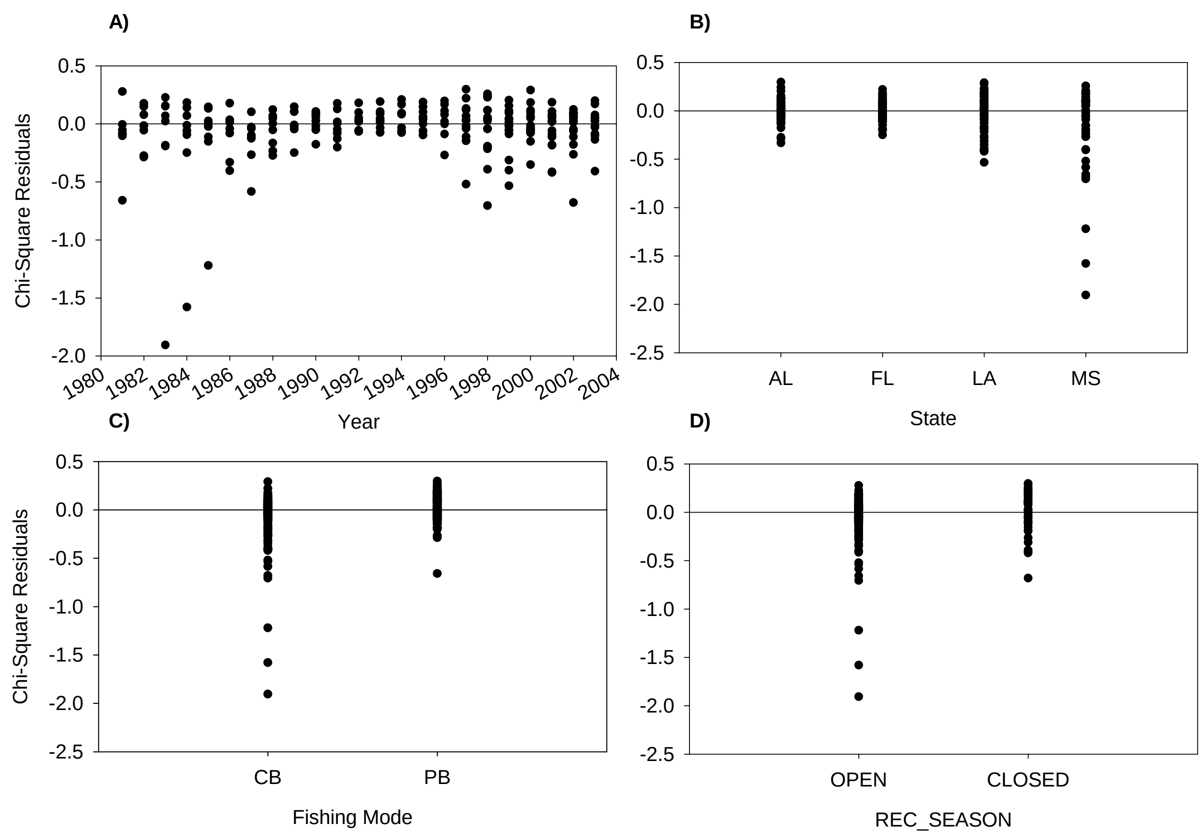

Figure 2. Chi-square residuals from the binomial model on proportion positive trips by factors year (A), state (B), mode (C) and rec_season (D) (**Gulfwide**).

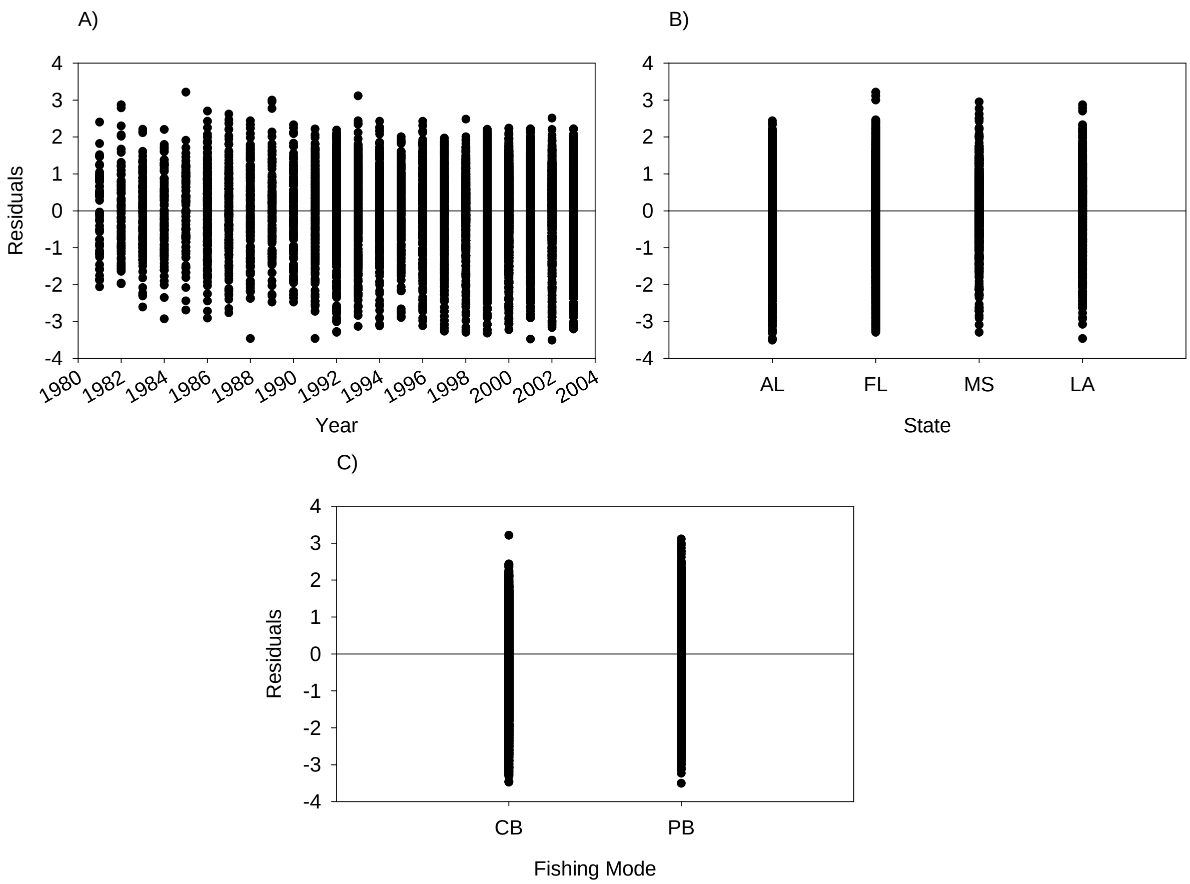

Figure 3. Residuals from the lognormal model on CPUE on positive trips by factors year (A), state (B) and mode (C) (**Gulfwide**).

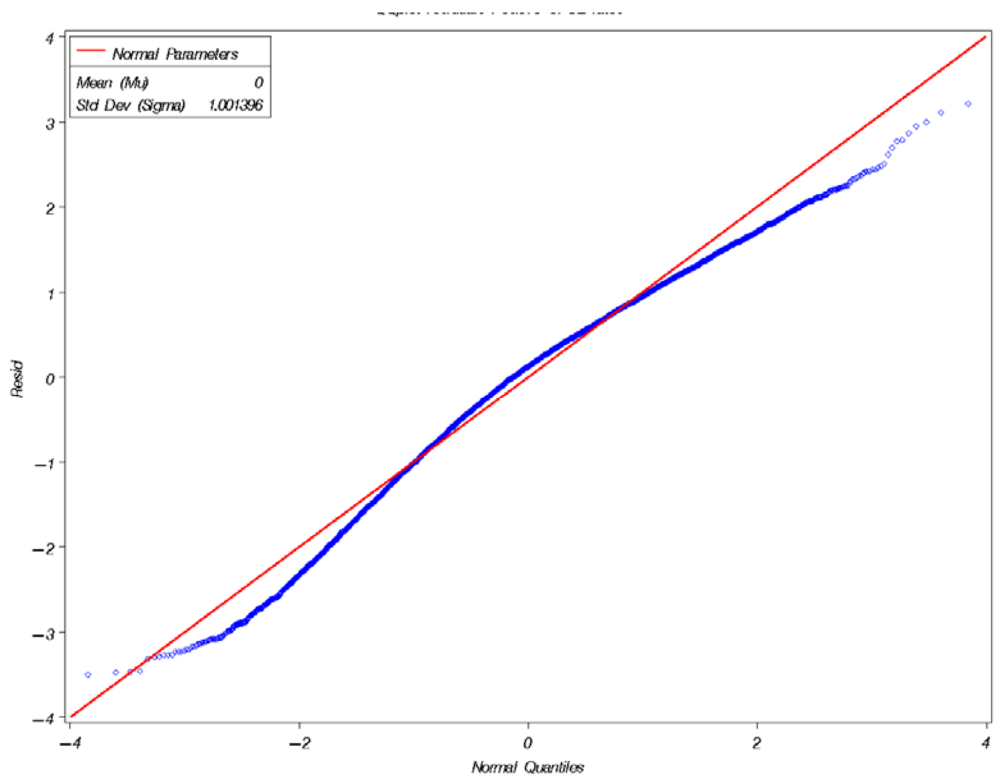

Figure 4. QQ-plot summarizing the fit of the lognormal model (normal model on log(CPUE)). The solid red line is the expected fit (Gulfwide).

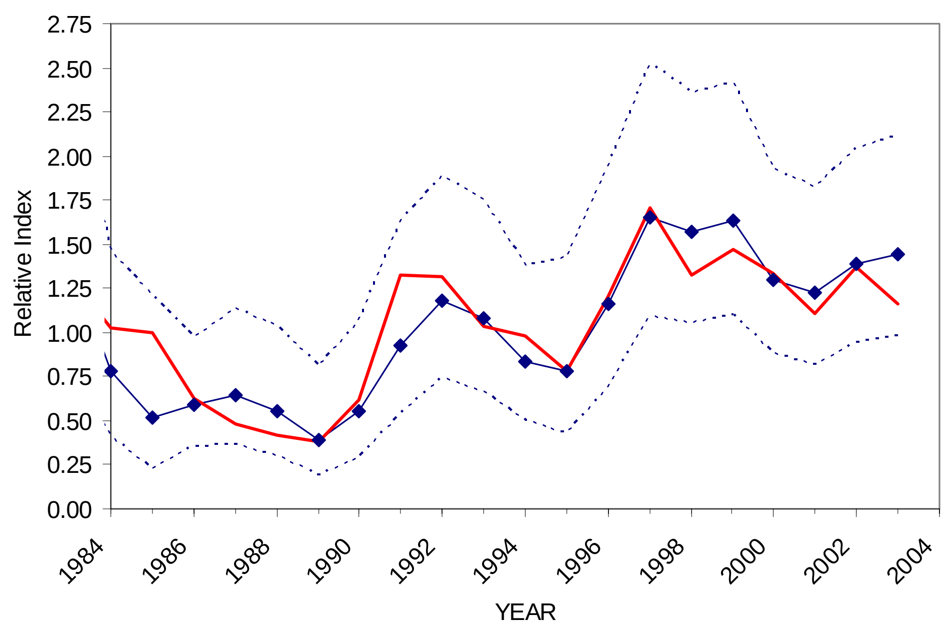

Figure 5. The annual trends in the relative index (blue with circles) and the relative nominal CPUE (red). The 95% CIs are indicated with dotted lines **(Gulfwide)**.

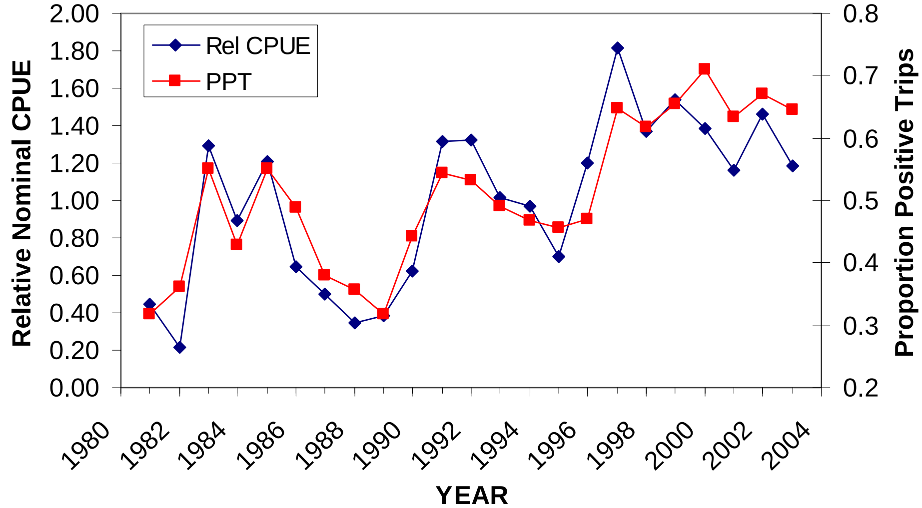

Figure 6. The annual trends in relative nominal CPUE and proportion positive trips (**Eastern**).

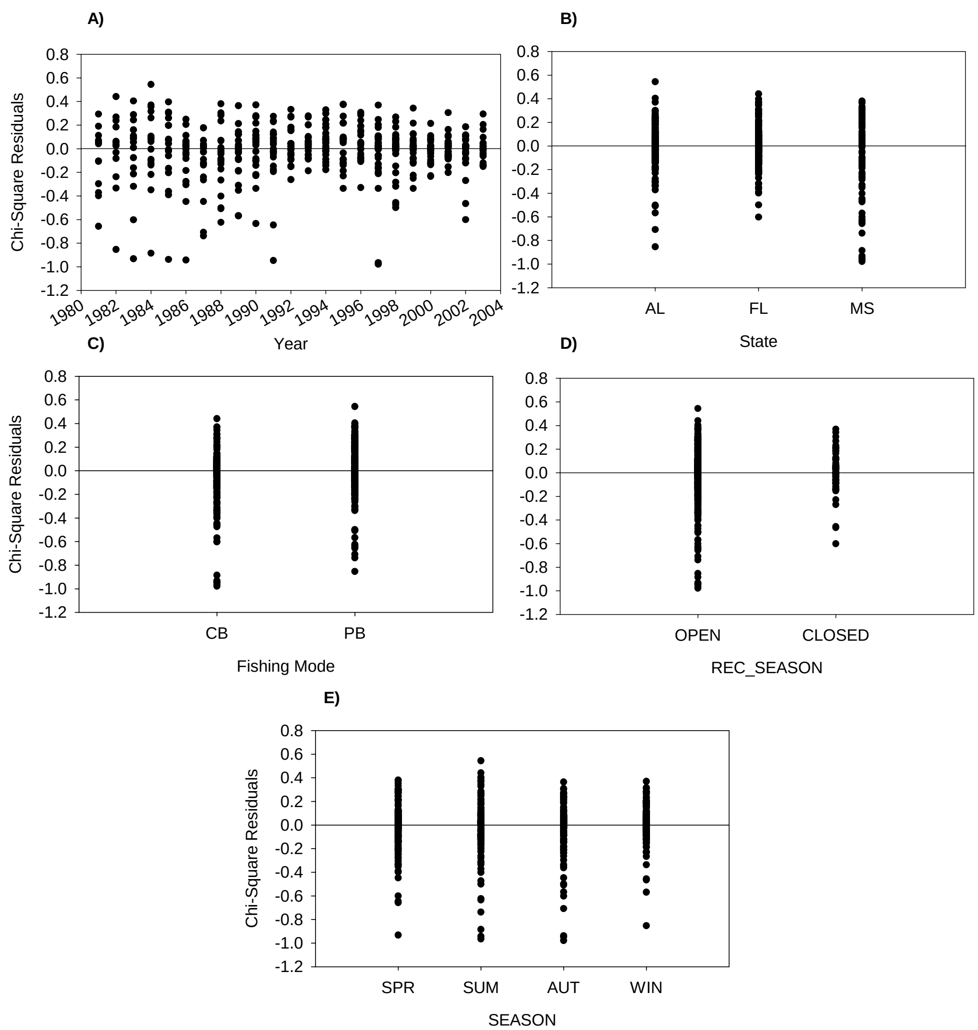

Figure 7. Chi-square residuals from the binomial model on proportion positive trips by factors year (A), state (B), mode (C) rec_season (D) and season (E) (**Eastern**).

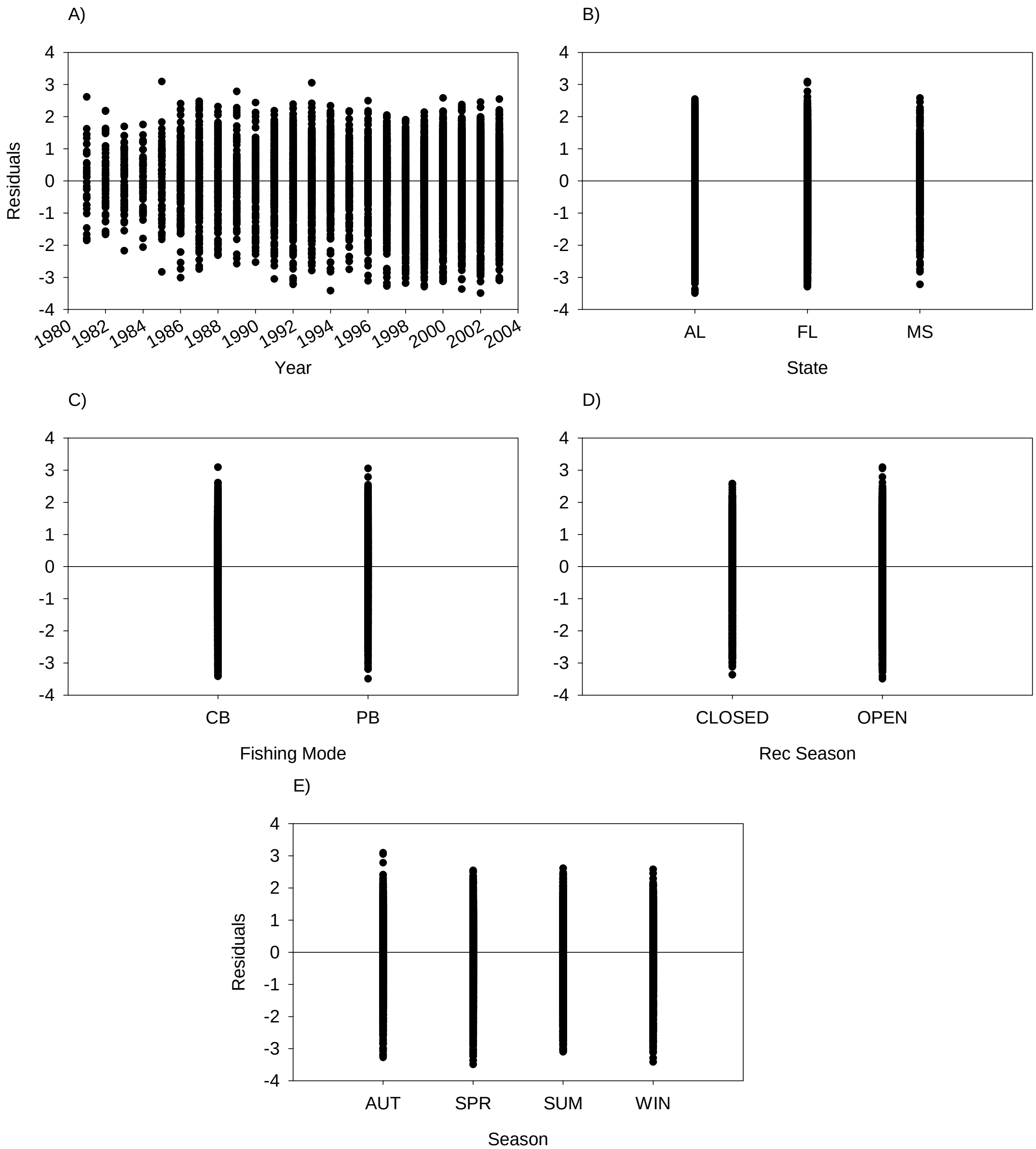

Figure 8. Residuals from the lognormal model on CPUE on positive trips by factors year (A), state (B) and mode (C) rec_season (D) and season (E) (**Eastern**).

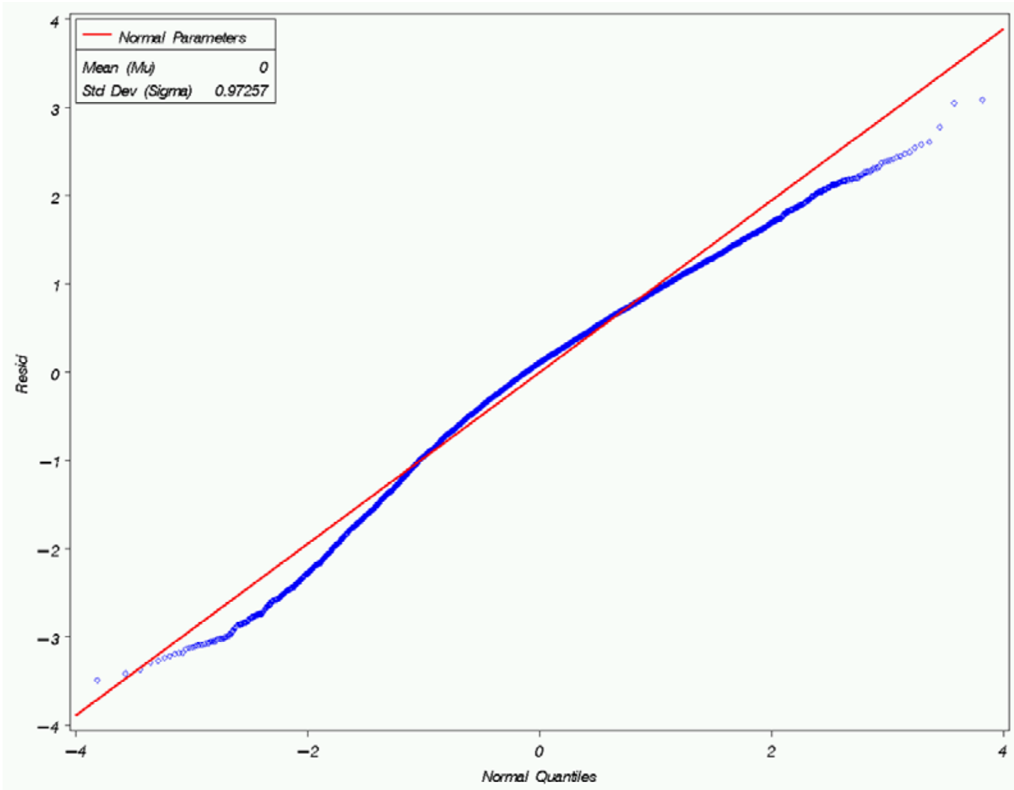

Figure 9. QQ-plot summarizing the fit of the lognormal model (normal model on log(CPUE)). The solid red line is the expected fit (**Eastern**).

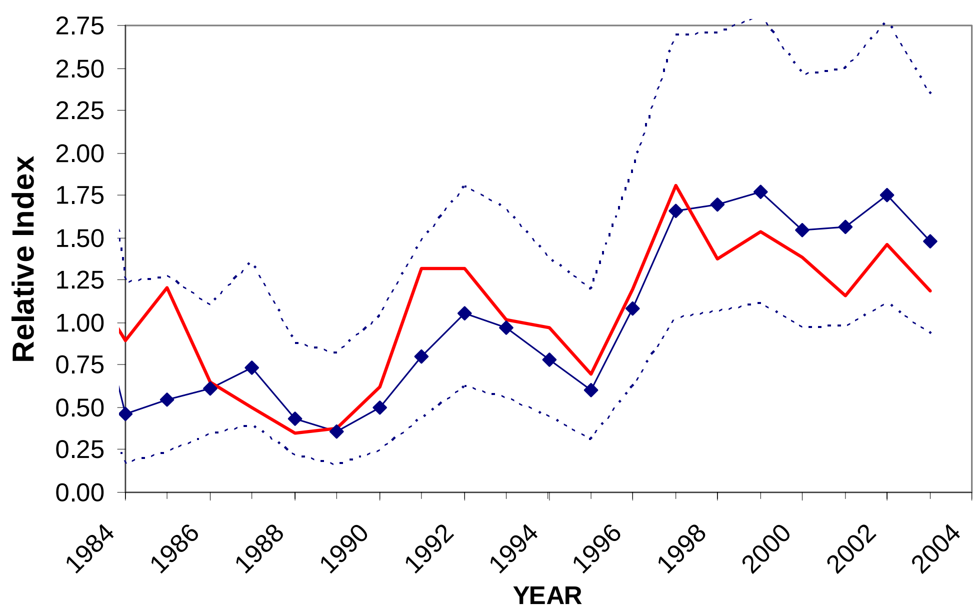

Figure 10. The annual trends in the relative index (blue with circles) and the relative nominal CPUE (red). The 95% CIs are indicated with dotted lines (**Eastern**).

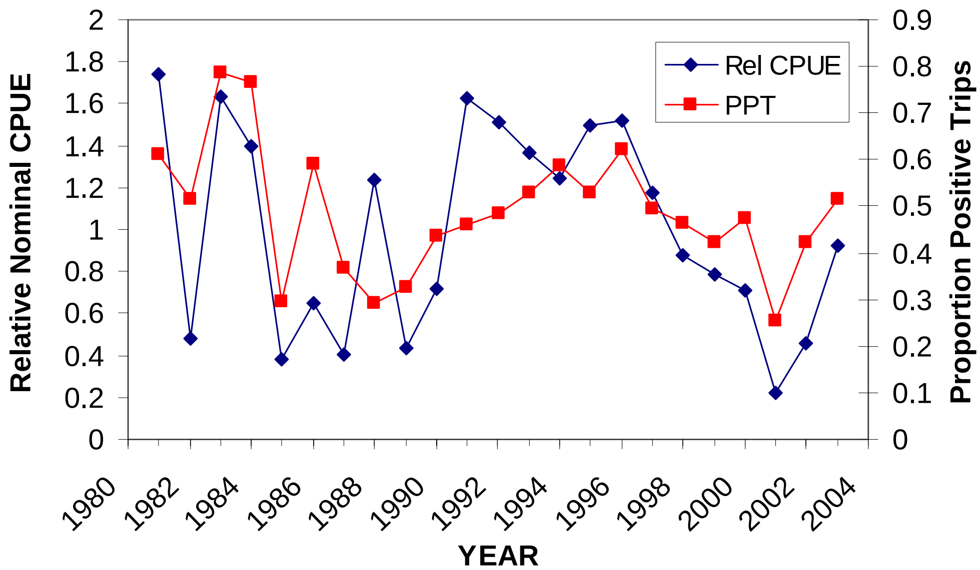

Figure 11. The annual trends in relative nominal CPUE and proportion positive trips (**Western**).

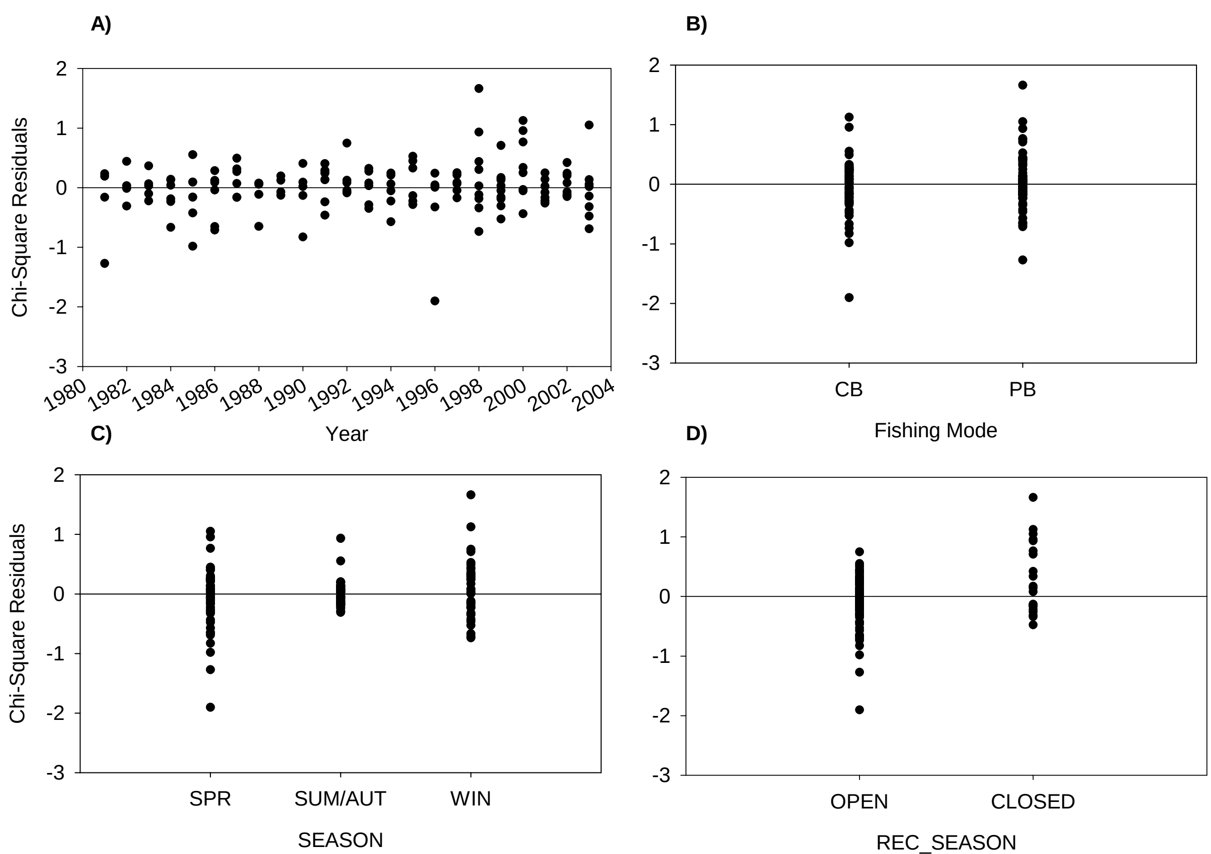

Figure 12. Chi-square residuals from the binomial model on proportion positive trips by factors year (A),mode (B), season (C) and rec_season (D) (**Western**).

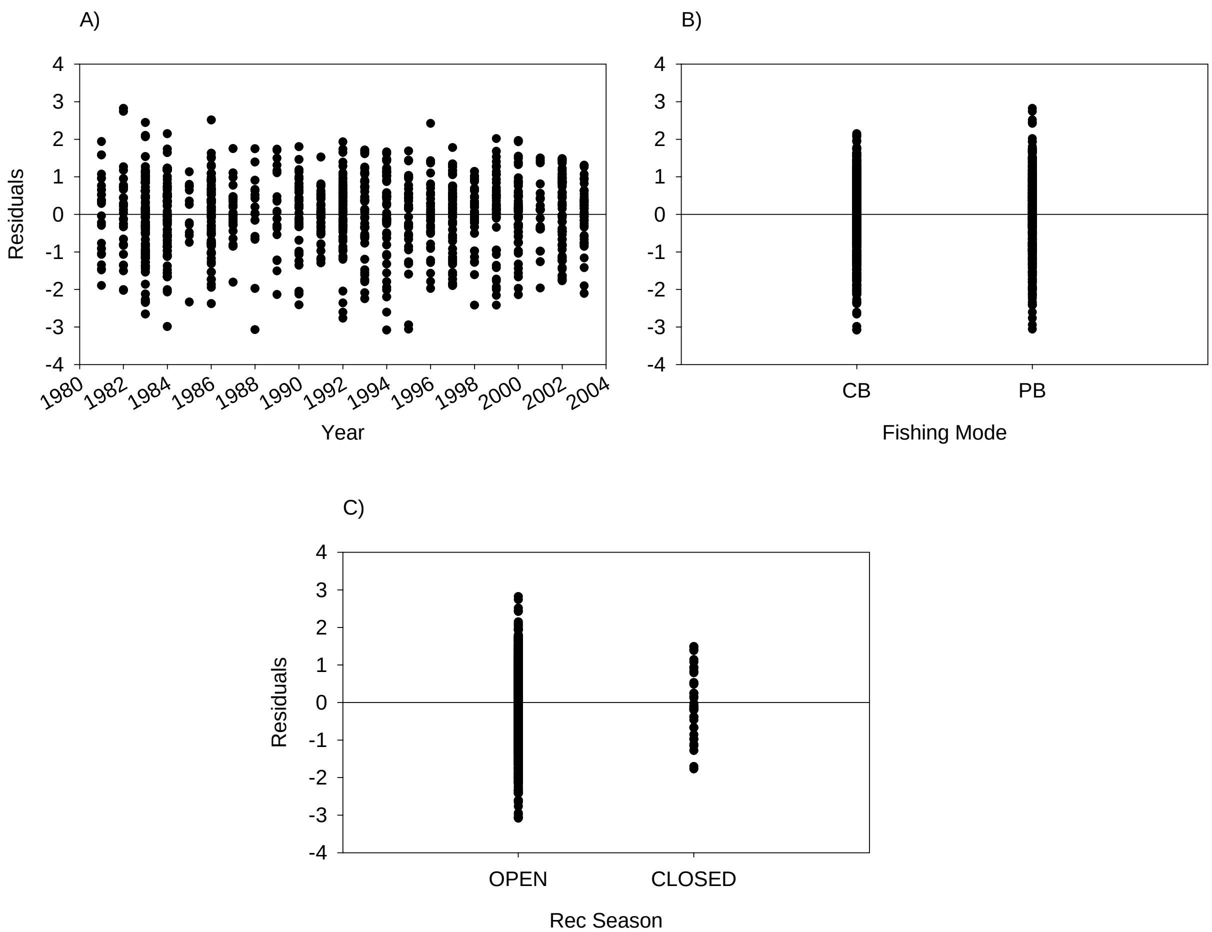

Figure 13. Residuals from the lognormal model on CPUE on positive trips by factors year (A), mode (B) and rec season (C) (**Western**).

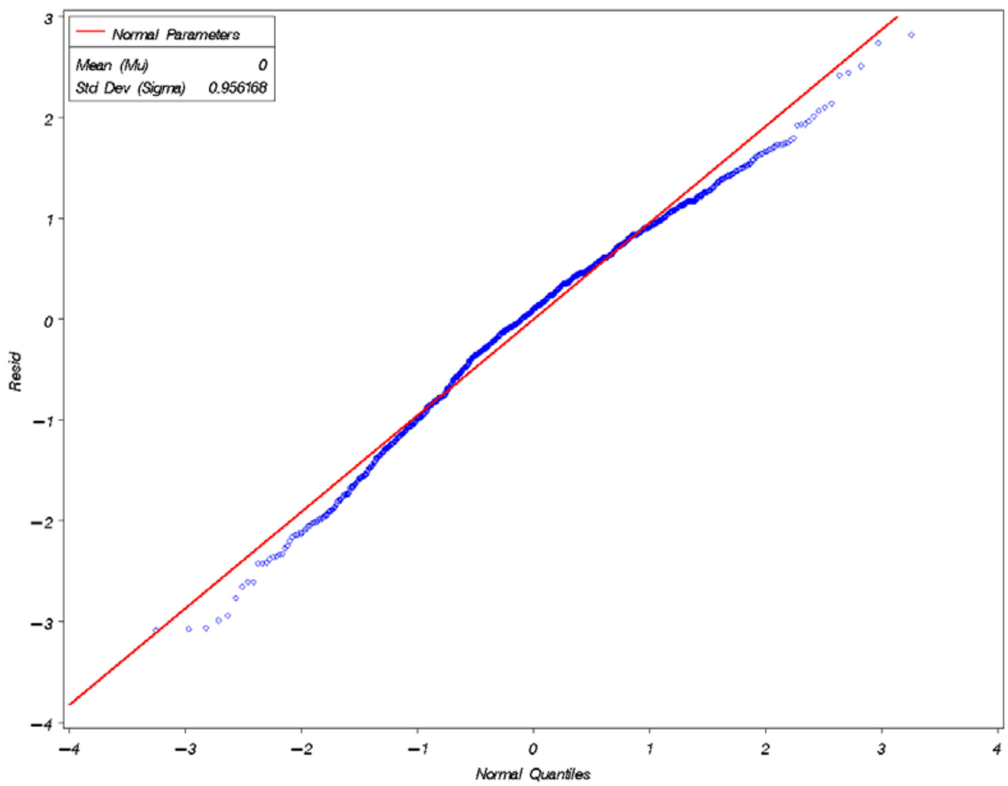

Figure 14. QQ-plot summarizing the fit of the lognormal model (normal model on log(CPUE)). The solid red line is the expected fit (**Western**).

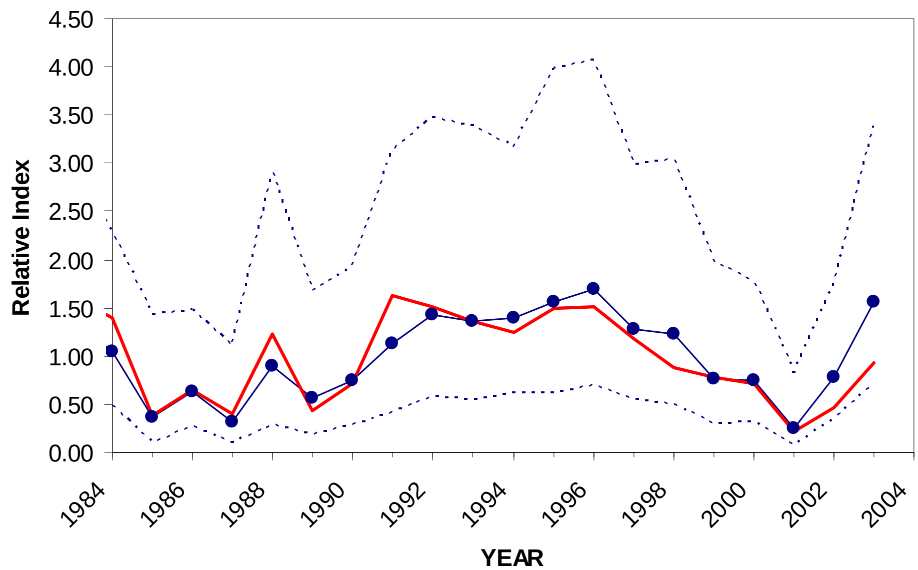

Figure 15. The annual trends in the relative index (blue with circles) and the relative nominal CPUE (red). The 95% CIs are indicated with dotted lines (**Western**).