The following is a draft methods paper on length-weight and length-length conversions for recreational fin fish species in Florida. The length-weight regressions have so far been updated with 2002 biological data, while the length-length regressions are for data collected from 2000-2003. This includes state collected commercial samples from the Trip Interview Program (TIP) for the length-length conversions only.

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Length and Weight Conversions for Florida's Recreationally Important Finfish Species

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Introduction

The Marine Recreational Fisheries Statistics Survey (MRFSS) is a federal survey administered by the National Marine Fisheries Service (NMFS). In Florida, MRFSS data is collected by the Florida Fish and Wildlife Conservation Commission (FWC). Fisheries dependent data, including length at the midline (ML) and whole weight, are collected from the catch of recreational anglers who voluntarily participate in MRFSS interviews. As a quality control check, estimated weights and 95% confidence intervals are calculated from species' observed length/weight relationships in the field and used to check for possible errors in MRFSS data recorded during field collection and data entry. These length/weight models are specific to the Atlantic and Gulf of Mexico coasts of Florida and are provided herein for use and comparison in stock assessments and other research in Florida and adjacent regions.

Fisheries data is often reported using length measures other than ML, and the ability to convert ML measurements to other length measurements makes the MRFSS data set compatible with other data sets and more useful for stock assessments that combine multiple data sets. In 2001, biological data from MRFSS was supplemented with a separate recreational fishery-dependent survey on Florida's west coast. In addition to midline length, up to three additional lengths were recorded for each fish encountered in recreational interviews. For each length/length combination, conversions were generated for each fish species.

Methods

Length / Weight Analysis

MRFSS samplers intercept anglers at access points in the field, including boat ramps, fishing piers, shore sites, and party and charter boat landing sites. Sites are randomly selected each month, and sites are weighted such that those with higher fishing pressures have a greater probability of selection. Three fishing modes are targeted in the survey: 1) shore fishing, 2) party and charter boat fishing and 3) private and rental boat fishing. Participation by anglers in the MRFSS survey is voluntary. State MRFSS samplers have no enforcement authority and information provided by participants is protected by the Federal Privacy Act. Therefore, deterrence from participation in the survey is kept to a minimum. A detailed description of intercept protocols can be found in MRFSS Procedures Manuals (GSMFC 2001, NOAA 1997) and on the Internet (www.st.nmfs.gov/st1/recreational/index.html).

Length and weight data were collected from fish encountered during MRFSS interviews conducted in Florida from 1998 to 2001. Fish were identified to species by trained samplers and lengths were measured to the nearest mm as a straight midline length (ML) from the tip of the snout to the center of the tail, regardless of tail shape (Figure 1). Fish weight was measured to the nearest tenth kilogram.

An exponential growth model (equation 1) was transformed to a linear regression model (equation 2) by taking the natural log of observed length and weight data (Zar 1996):

$$Y_i = aX_i^b \qquad \text{(equation 1)}$$

where y = whole weight in kg, x = body length measured at the midline in mm, and *a* and *b* are coefficients of the regression model.

The natural log-transformed linear model is:

$$\ln(Y_i) = \ln(a) + b{*}\ln(X_i) \qquad \text{(equation 2)}$$

Potential outliers were examined in SAS using diagnostic tests for influence (SAS Inst. 1989). Only high influence points believed to be due to measurement or recording error were removed from the data set before further analysis. Regression coefficients were calculated for each species for the Atlantic (east) and Gulf of Mexico (west) coasts. Comparisons were made for each species among the two coasts, and slopes and intercepts were tested for significant differences among coasts using the Bonferroni procedure ($\alpha = .05/2$). The east coast of Florida encompasses Nassau county to Dade county, and the west coast encompasses Monroe county, including the Florida Keys, north to Escambia county (Figure x). For species that were not significantly different among coasts, data were pooled to generate a single model for both coasts combined. Species that were infrequently encountered on one coast versus the other were also pooled.

Length / Length Analysis

Additional recreational intercepts were conducted on the west coast of Florida during 2001. Selection and execution of the additional intercepts followed the same protocols of regular MRFSS surveys outlined previously; however, the emphasis was on surveying anglers with harvested fish that could be examined by the interviewer. Available catch was identified to species, weighed, and measured. In addition to ML, fish were measured for: 1) total length (TL) from the tip of the snout to the longest tip of the tail in a natural and relaxed state, 2) maximum total length (maxTL) from the tip of the snout to the longest tip of the tail when compressed or "squeezed", and 3) standard length (SL) from the tip of the snout to the end of the vertebral column.

Paired data for each length / length combination grouped by species were fitted to linear regression models. Outliers were examined in SAS using diagnostic tests for influence (SAS Inst. 1989). Regression coefficients were generated for each species, along with parameters for calculating 95% confidence intervals for estimated lengths.

Results

Length / Weight Analysis

Regression coefficients (a, b) for estimating weight (Y_i) from observed length (X_i) using equation 1 are provided for each species in Table 1. To calculate the estimated whole weight in kg:

$$Y_i = a * ML^b \qquad \text{(equation 3)}$$

For example, a red snapper from the west coast of Florida that measures 400 mm ML has an estimated weight of:

$$2.352*10^{-8} * 400\ \text{mm}^{2.953} = 1.136\ \text{kg}$$

The 95% confidence interval for that same fish is 1.129 kg to 1.142 kg. To calculate the 95% confidence interval for Y_i, first calculate:

$$s_{\ln Y_i} = \sqrt{MSE\ [1/n + (\ln(X_i) - \ln(\text{mean}X))^2 / \sum x^2]}\ , \qquad \text{(equation 4)}$$

where MSE is mean square error of the regression, n is the number of paired length/weight measurements, ln(meanX) is the natural log of the mean length, and $\sum x^2$ is the sum of corrected sum of squares for lengths in the regression, $\sum [\ln X - \ln(\text{mean}X)]^2$. The 95% confidence interval equals:

$$\text{upper confidence limit} = \exp(\ln Y_i + t95\% * s_{\ln Y_i}) \text{ and} \qquad \text{(equation 5)}$$
$$\text{lower confidence limit} = \exp(\ln Y_i - t95\% * s_{\ln Y_i}), \qquad \text{(equation 6)}$$

where t95% is the table value for $t_{\alpha(2),(n-2)}$.

Values for variables in equations 4 through 6 are provided in Table 1 for each species.

Length / Length Analysis

Regression coefficients for length / length combinations are provided for estimating TL from known ML (Table 2), TL from maxTL (Table 3), ML from maxTL (Table 4), and ML from SL (Table 5). To obtain an estimated length (Y_i) from another known length (X_i):

$$Y_i = a + b\ (X_i),$$

where a is the y intercept and b is the slope. Values for a and b are provided in tables for each respective length / length conversion by species. To calculate the 95% confidence interval for estimated length, calculate:

s_{Yi} = square root (MSE [1/n + (Xi – meanX)^2/$\sum x^2$])

upper confidence limit = Y_i + t95% * s_{Yi}

lower confidence limit = Y_i - t95% * s_{Yi}

Discussion

The data in this study are based on fishery dependent samples. Fish encountered in MRFSS interviews are restricted in size by regulated size limits and angler selectivity patterns. Minimum and maximum observed lengths for each species in this study are provided in the conversion tables and these conversions should not be used for fish outside the range measured in our study. For some species, the size range measured in our study falls outside regulated size limits for recreational fisheries. This may be due to changes in size limits during the duration of this study, or in some cases, intercepted fish were not legal. The ability to collect these types of data from anglers without enforcement consequences enables assessments of angler compliance with size, bag, and season limits. Length conversion factors reported in this study are currently being used to assess angler compliance with recreational size limits and to identify areas where greater outreach and education to the angling public are needed.

Literature Cited

GSMFC (Gulf States Marine Fisheries Commission). 2001. Intercept Interviewer Procedures Manual, Marine Recreational Fisheries Statistics Survey, Gulf Coast. January, 2001. Gulf States Marine Fisheries Commission, Ocean Springs, MS. 71 pp.

NOAA (National Oceanographic and Atmospheric Administration). 1997. Marine Recreational Fisheries Statistics Survey Procedures Manual. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics and Economics Division. Silver Spring, MD. 74pp.

SAS Inst. 1989. SAS/STAT User's Guide, Version 6, Fourth Edition, Volume 2. SAS Institute, Inc., Cary, NC. 846 pp.

Zar, J.H. 1996. Biostatistical Analysis. Prentice Hall. 121pp.

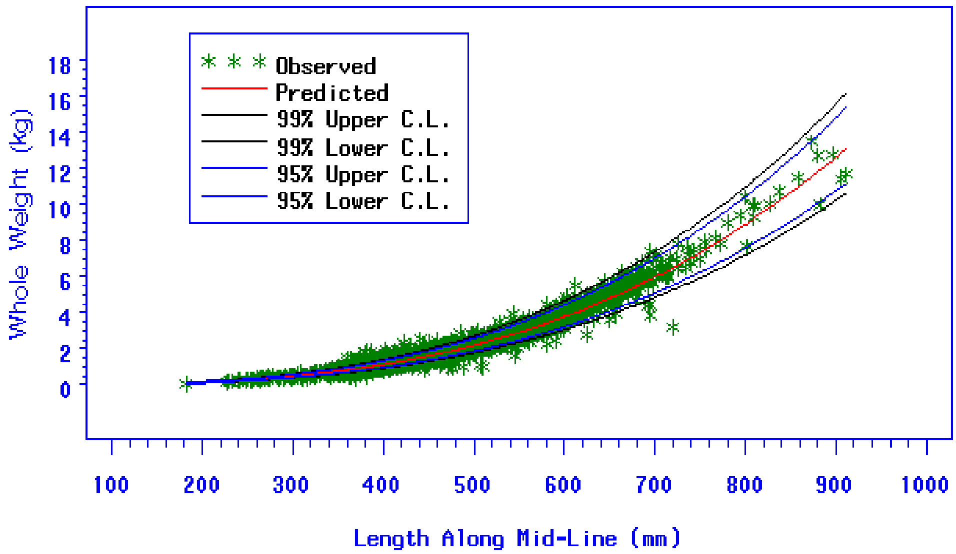
1998 to 2002 Length / weight regression coefficients for red snapper, *Lutjanus campechanus*, for Florida and east and west coasts of Florida (when significant) for estimating weight (kg) from ML (mm).

COMMON	REGION	SP_CODE	n	mean length	sum x^2	b	Yint	MSE	maxleng	minleng	maxwt	minwt	r2	t95	t99
RED SNAPPER	COASTWIDE	8835360107	18488	6.03622686	315.8284	2.97083	-17.6733	0.00673	911	183	13.5	0.1	0.957	1.960	2.576
RED SNAPPER	EFL	8835360107	421	6.255	11.506	3.014	-17.907	0.008	847	276	11.5	0.45	0.969	0.009	0.011
RED SNAPPER	WFL	8835360107	18067	6.031	283.654	2.958	-17.596	0.007	911	183	13.5	0.1	0.954	0.001	0.002

Florida MRFSS Interview Data

RED SNAPPER, sub region = 7 **(West coast)**

1998 to 2002



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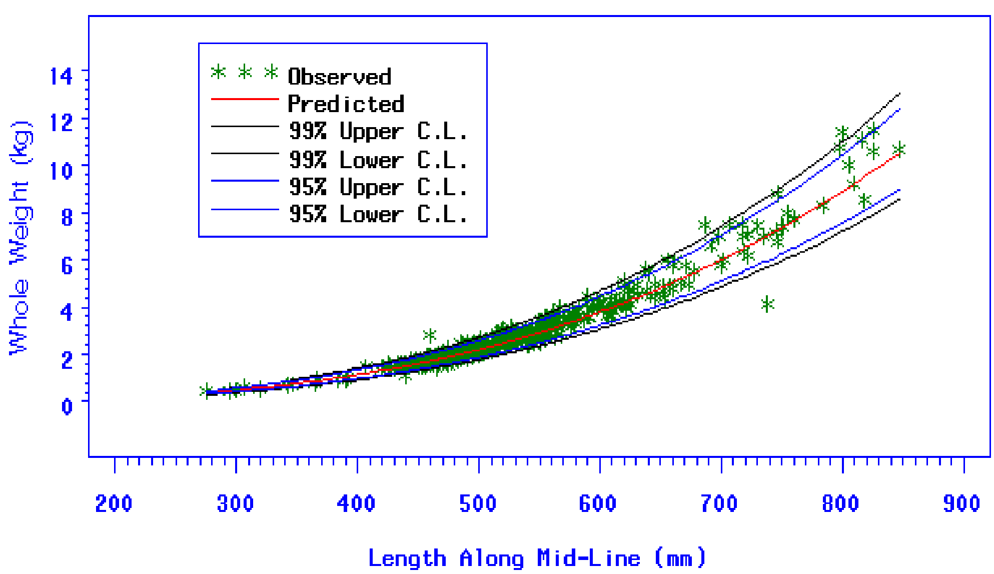
Florida MRFSS Interview Data

RED SNAPPER, sub region = 6

1998 to 2002



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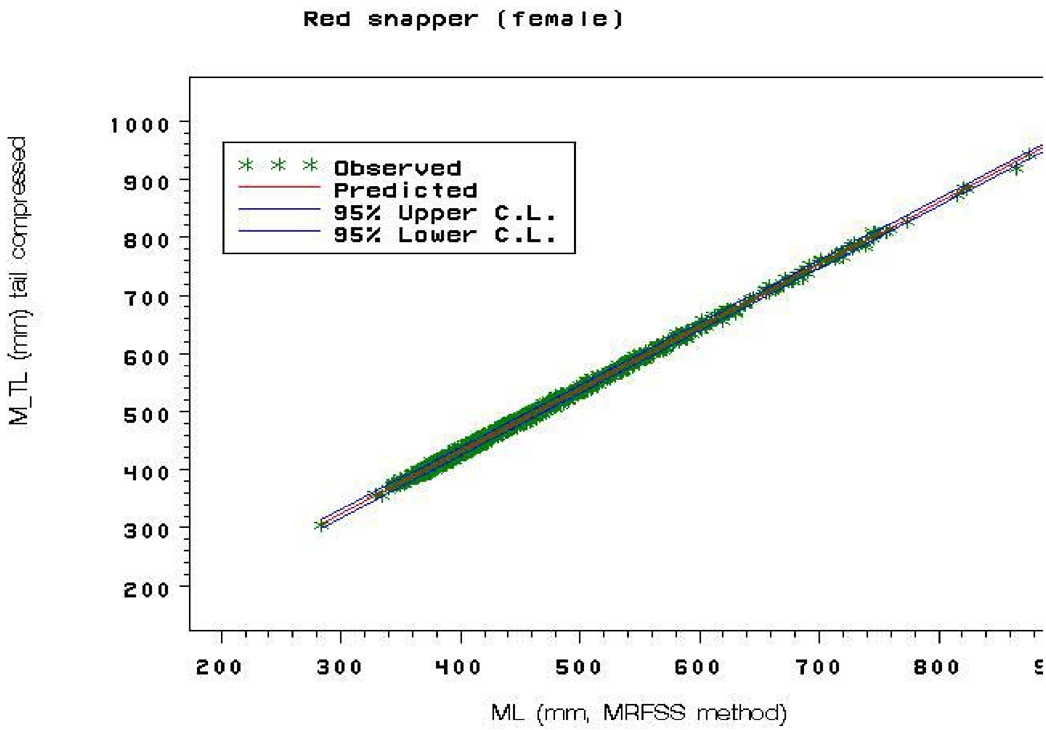
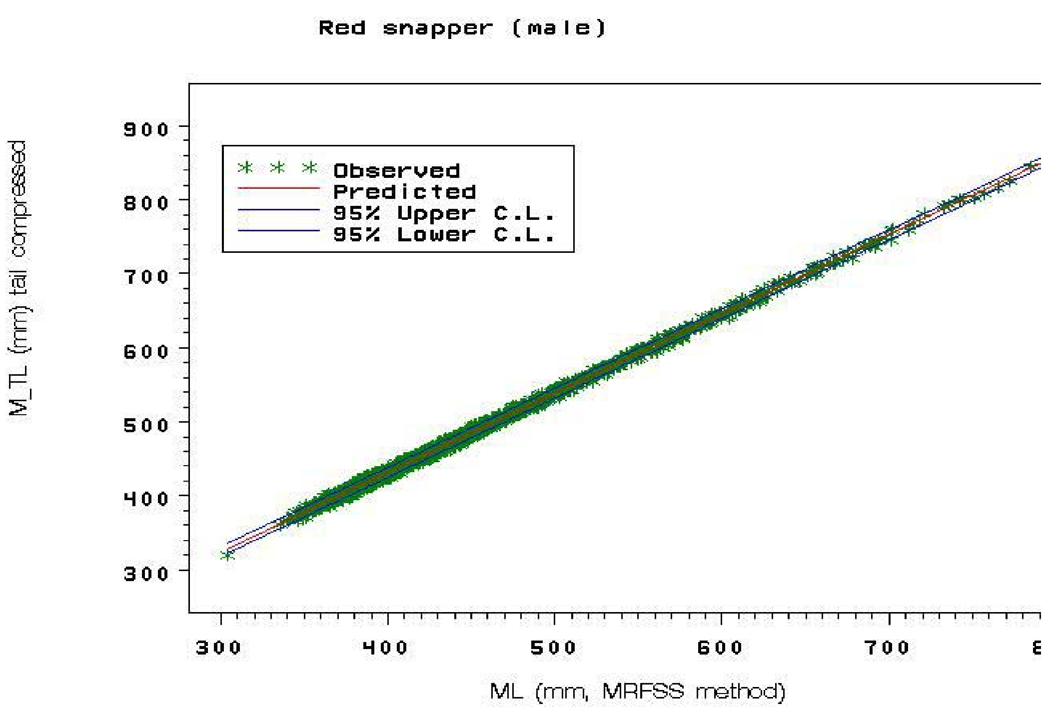
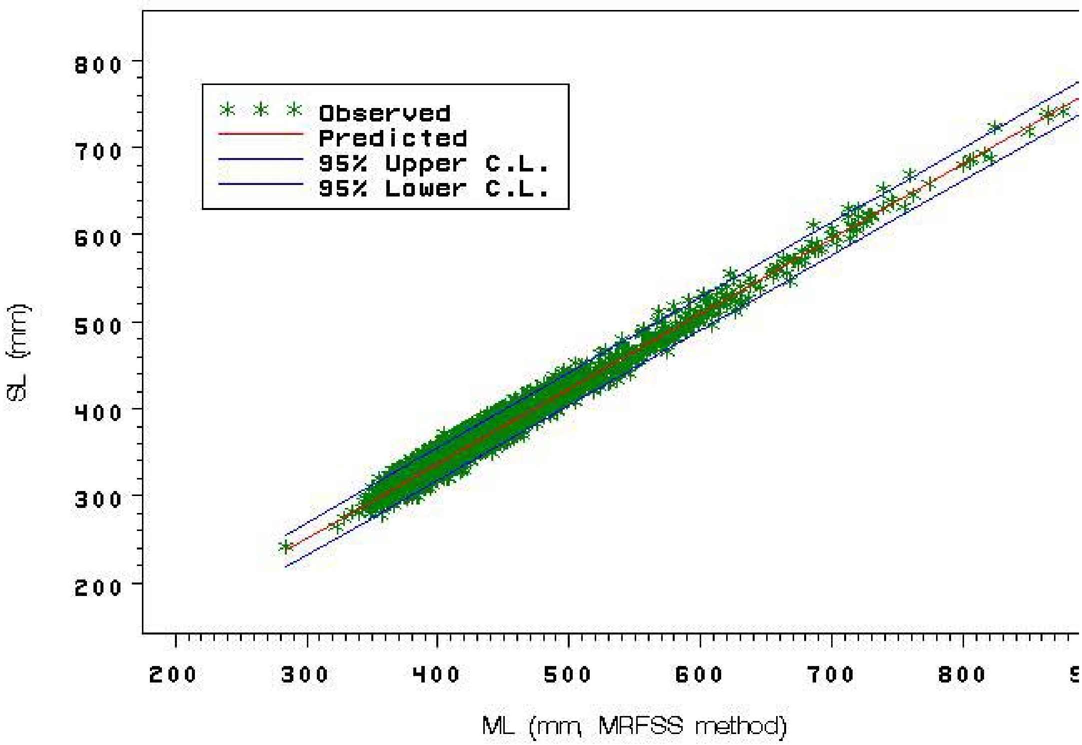
Length-length regressions for red snapper, *Lutjanus campechanus* , by sex, 2000-2003

Regression	Sex	N FL	MEAN X	MIN X	MIN Y	MAX X	MAX Y	SUM x^2	DEG F	SLOPE	Y INTER	MSE	r^2	ADJ r^2	T 95%
maxtl_fl	female	2,611	436.4182	284	304	900	958	13,494,365	2,610	1.0731	2.0882	13.1484	0.9978	0.9978	0.2047
	male	2,404	435.0566	304	320	795	847	11,736,970	2,403	1.0707	3.3410	11.6322	0.9979	0.9979	0.4431
maxtl_tl	female	2,619	460.7801	300	304	943	958	15,634,991	2,618	1.0087	5.7666	39.8929	0.9935	0.9935	0.3399
	male	2,428	459.2764	315	320	827	847	13,342,660	2,427	1.0098	5.5549	42.5011	0.9925	0.9925	0.8249
sl_fl	female	2,569	435.4364	284	242	900	770	13,653,938	2,568	0.8610	-7.5848	91.6611	0.9773	0.9773	0.5445
	male	2,423	435.3640	304	255	795	683	12,513,437	2,422	0.8488	-2.7089	90.5552	0.9763	0.9763	1.1990
tl_fl	female	2,636	436.4867	284	300	900	943	13,716,299	2,635	1.0530	0.8113	50.4799	0.9913	0.9913	0.3983
	male	2,464	436.0962	304	315	795	827	12,576,318	2,463	1.0495	2.3096	54.2053	0.9905	0.9905	0.9220

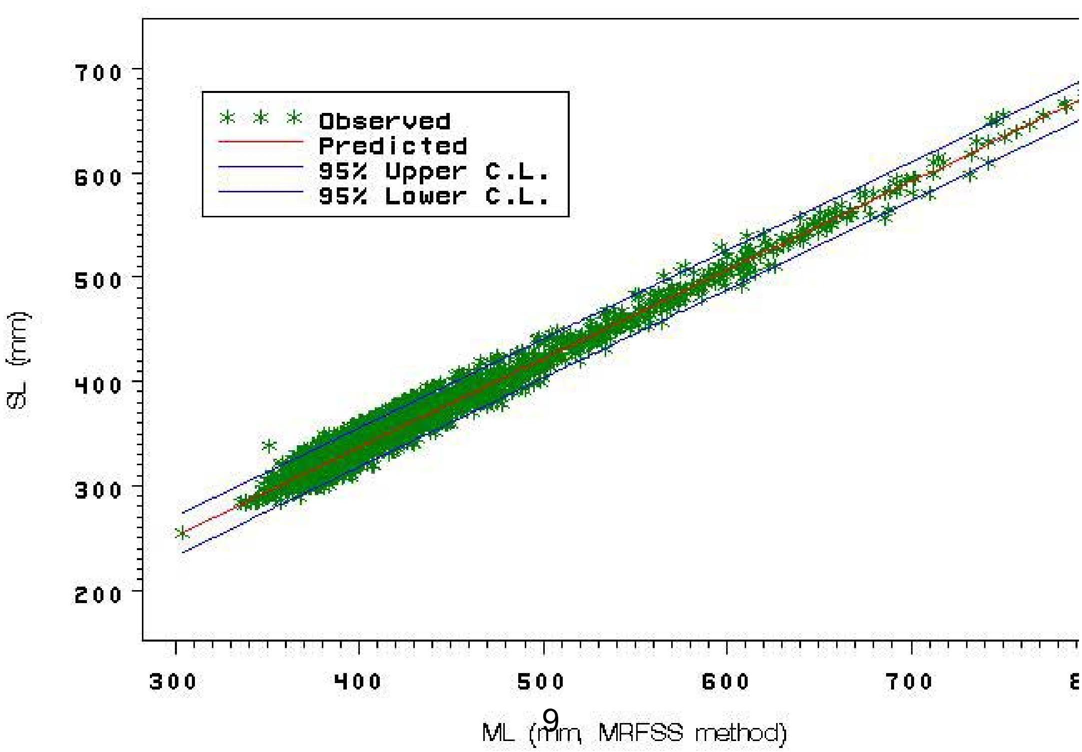

Red snapper (female)
M_TL (mm) tail compressed
1000
900
800
700
600
500
400
300
200
Observed
Predicted
95% Upper C.L.
95% Lower C.L.
200
300
400
500
600
700
800
ML (mm, MRFSS method)


Red snapper (male)
M_TL (mm) tail compressed
900
800
700
600
500
400
300
Observed
Predicted
95% Upper C.L.
95% Lower C.L.
300
400
500
600
700
ML (mm, MRFSS method)

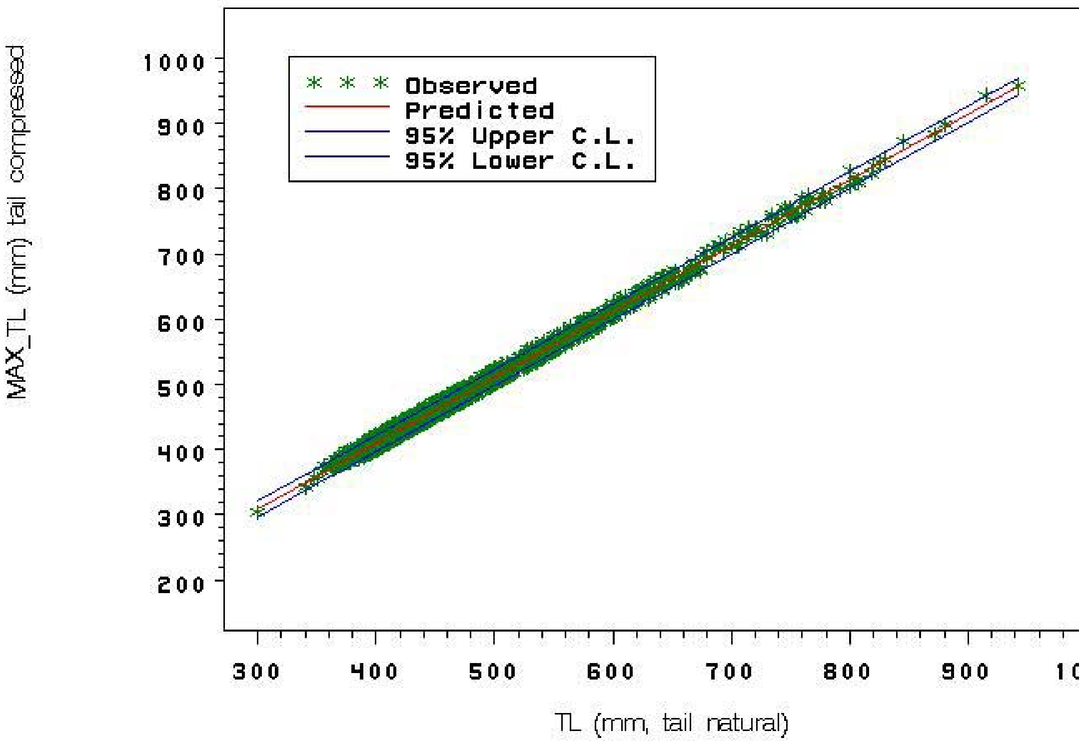
Red snapper (female)



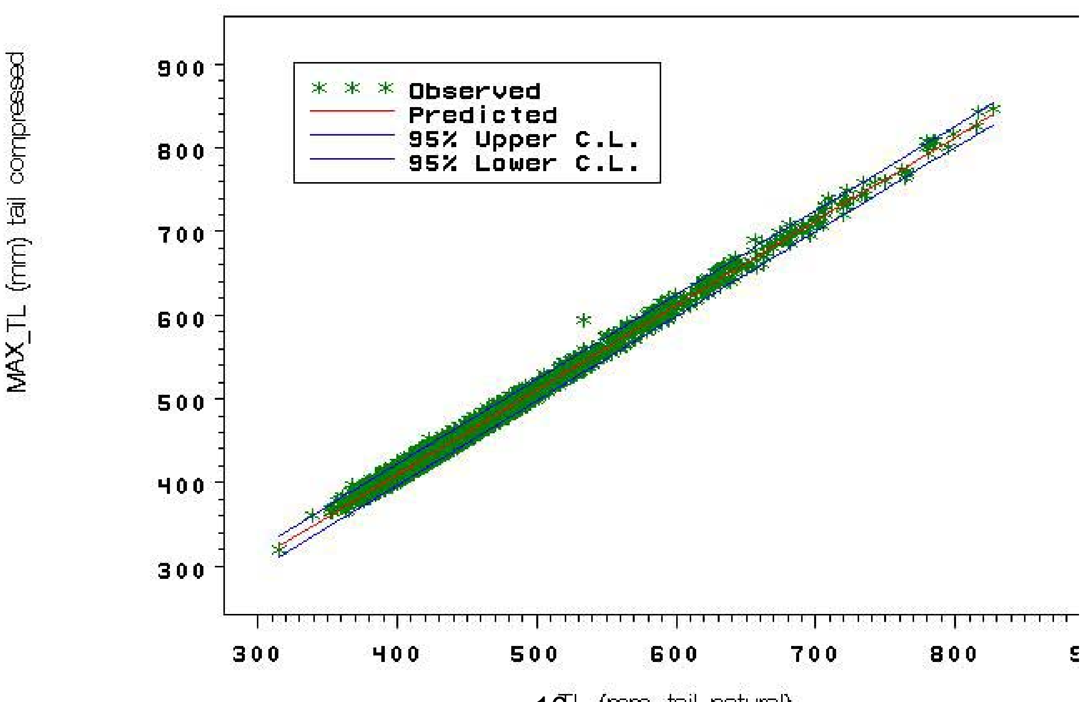
Red snapper (male)

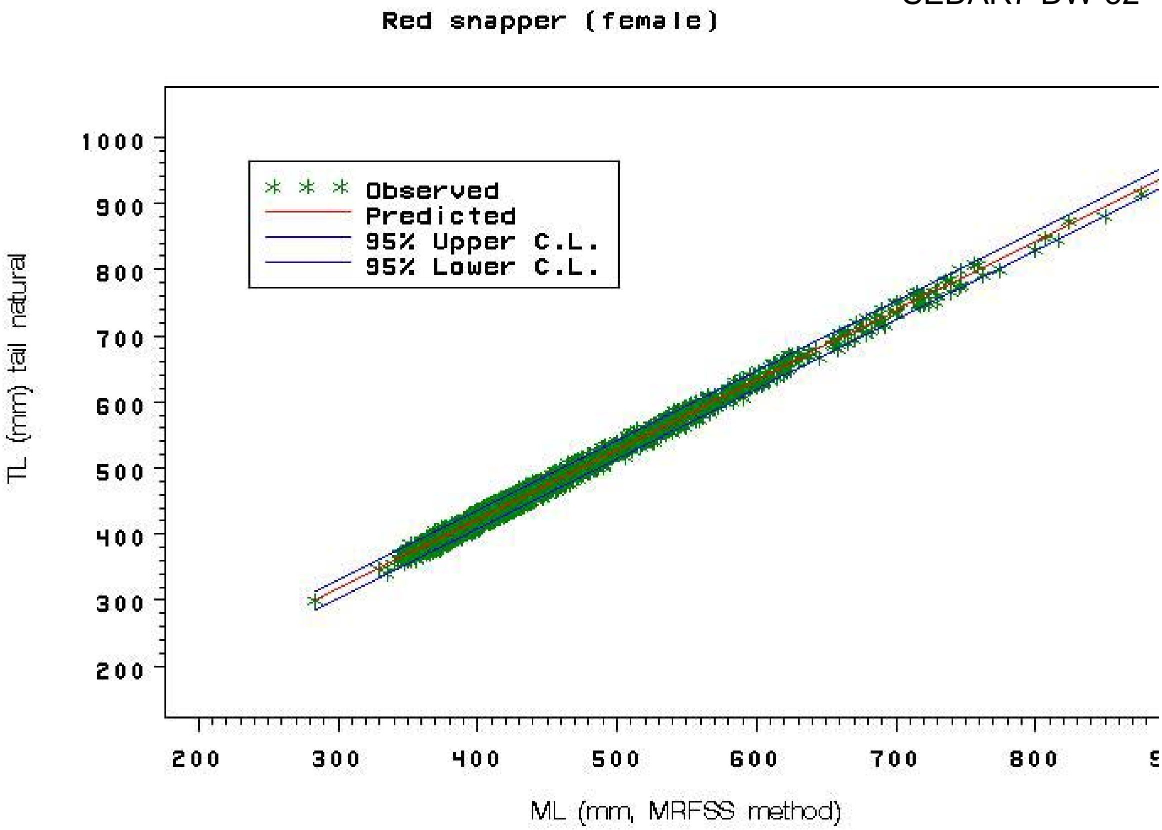


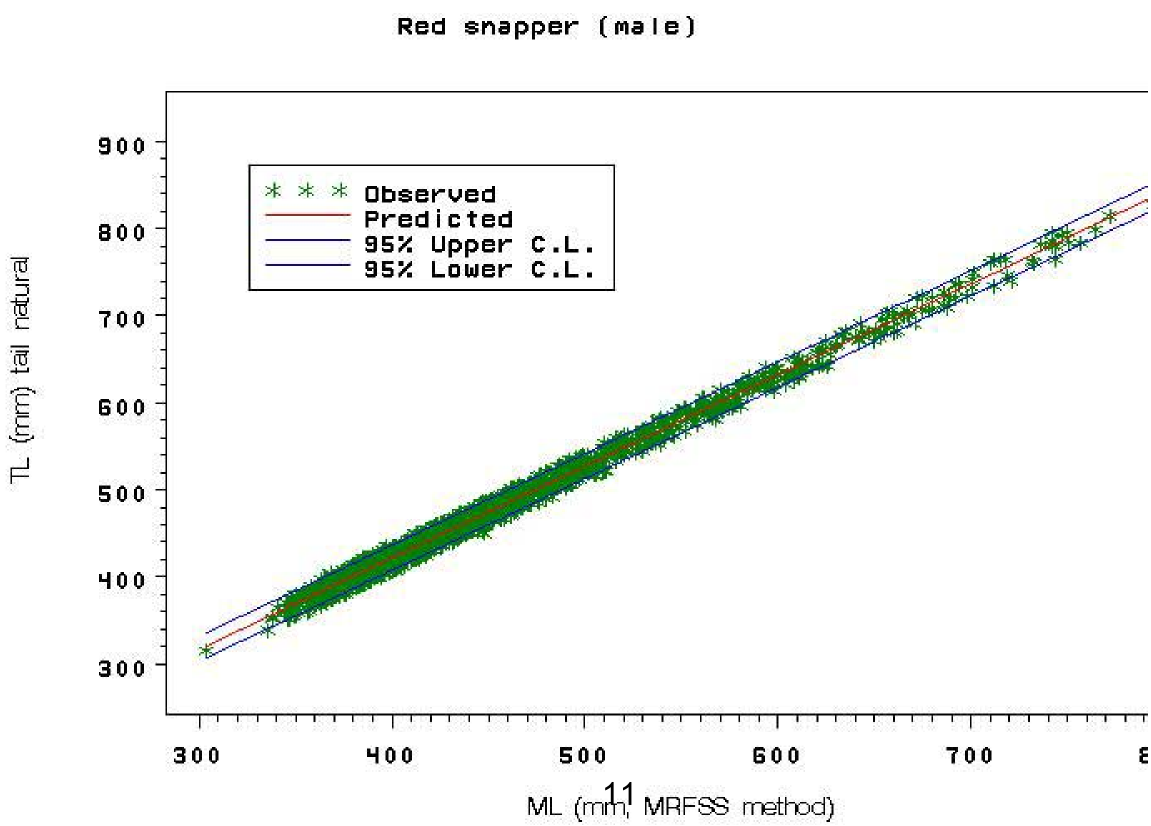
Red snapper (female)



Red snapper (male)




Red snapper (female)
Observed
Predicted
95% Upper C.L.
95% Lower C.L.
TL (mm) tail natural
ML (mm, MRFSS method)
1000
900
800
700
600
500
400
300
200
200
300
400
500
600
700
800


Red snapper (male)
Observed
Predicted
95% Upper C.L.
95% Lower C.L.
TL (mm) tail natural
ML (mm, MRFSS method)
900
800
700
600
500
400
300
300
400
500
600
700