Length-weight relationships, location and depth distributions for select Gulf of Mexico reef fish species

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2016

SEDAR58-RD20

30 January 2018

NOAA Technical Memorandum NMFS-SEFSC-693

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By

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August 2016

NOTICE

This report should be cited as follows:
Pulver, J.R., and A. Whatley. 2016. Length-weight relationships, location, and depth distributions for select Gulf of Mexico reef fish species. NOAA Technical Memorandum NMFS-SEFSC-693, 100 p.

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Introduction

The NMFS Galveston Reef Fish Observer Program began mandatory coverage of the Gulf of Mexico commercial reef fish fishery in July 2006. Since that time the program has recorded catch data from vessels using multiple gear types (vertical line, bottom longline, spearfishing, and buoy fishing) across broad spatial and temporal scales (Scott-Denton et al., 2011; Scott-Denton and Williams, 2013). While at-sea, fishery observers record characteristics of individual captured fish such as length, weight, discard disposition, location, and other environmental factors (NMFS, 2016). Length and weight data obtained from at-sea fishery observer programs are often useful because they include information about species not landed, e.g. non-target species, or for size ranges of target species typically discarded at-sea. Length-weight regression models are used extensively to estimate weight from length because of the technical difficulties in obtaining accurate weights while in the field. The purpose of this document is to provide length-weight relationships, location, and depth distributions for target and non-target reef fish species using data collected by the Galveston Reef Fish Observer Program from July 2006 through December 2015.

Methods

The reef fish database contained catch information for 1,062,857 individual captures of fish by all gear types representing 336 different taxonomic categories. Only taxonomic categories at the species level, e.g. not genus or family level, which had ≥ 5 paired length-weight observations were included in this study. Total, fork, or standard lengths were recorded to the nearest mm and weights were primarily obtained using 10-kg model 235-6S Salter[1] scales (accuracy ± 0.05 kg),

[1] Mention of trade names or commercial companies is for identification purposes only and does not imply endorsement by the National Marine Fisheries Service, NOAA.

but throughout the history of the program various brands of digital scales (accuracy ± 0.01 kg) have also been used to obtain weights. Length-weight regression models were fit to species using the most common pairing observed between length measurement type and weight type (whole or gutted), e.g. fork and whole. Log-transformed length and weight data were fit using ordinary least squares with the following equation where ln = natural log, W = weight (kg), L=length (mm), a = y-intercept, and b = slope:

(1) $$\ln W = \ln a + b \ln L$$

For each species, the predicted fit from the resulting linear regression equations were plotted with 95% confidence intervals against a scatterplot of the observed data. Model fit information given in the results includes the number of observations used to fit the model, the adjusted R^2 coefficient of determination, and residual standard error (RSE). To predict weight from length using the model, the following equation is given for each species as:

(2) $$Weight = \exp(Ln\ a) * Length^b$$

Also included is the most common final disposition (kept, discarded alive, discarded dead, used for bait, or unknown) for each species recorded by the program. The number of all captures observed in each statistical zone (Figure 1) for each species category was tabulated and included as a bar chart. Finally, a histogram of capture depths was generated with an estimated kernel density probability estimate included for each species. All analyses in this study were performed using R statistical software (version 3.3.0; R Development Core Team, 2016)

Results/Discussion

Significant (p-value < 0.05) length-weight regression models were fit using 641,251 captures for 90 unique species (Table 1). Three species, red grouper (*Epinephelus morio*), vermilion snapper (*Rhomboplites aurorubens*), and red snapper (*Lutjanus campechanus*) represented the majority (> 75%) of the paired length-weight observations available. The average number of paired observations used to fit each model was 7,125 and ranged from a minimum of five observations for red hogfish (*Decodon puellaris*) to a maximum of 254,416 for red grouper. The most common (65%) paired measurements used to fit a model were fork lengths to predict whole weight. Lengths used to fit the models ranged from a minimum of 83 mm standard length for bank seabass (*Centropristis ocyurus*) to a maximum of 1683 mm total length for silky sharks (*Carcharhinus falciformis*). The mutton snapper (*Lutjanus analis*) regression model had the lowest RSE (< 0.09) of any species in this study with only five models having a RSE > 0.4.

The average adjusted R^2 was 0.79 (0.22 S.D.) and ranged from a low of 0.05 to the highest value of 0.99 for dolphin (*Coryphaena hippurus*). The majority (60) of the species length-weight regression models had an adjusted $R^2 > 0.8$. The seven species that had > 10,000 paired observations all had excellent fits with an adjusted $R^2 > 0.85$. Only 11 length-weight regression models had an adjusted $R^2 < 0.5$ with the lowest value (0.05) observed for tattler (*Serranus phoebe*); however, only 89 tattler paired measurements were available over a small length (123–206 mm) and weight (0.03–0.25 kg) range. Generally, species with smaller mean lengths accounted for the smaller adjusted R^2 observed (Figure 2). The smaller adjusted R^2 observed were possibly due to increased variance at lighter weights caused by the resolution of the Salter scales (accuracy ± 0.05 kg).

Despite the difficulties in obtaining accurate weights in the at-sea environment, the Galveston Reef Fish Observer Program has collected high quality length and weight data for a large number of commercially important fish species in the Gulf of Mexico. These length-weight and additional data should be useful to other researchers wishing to explore temporal or spatial variations in the reef fish fishery to derive conclusions benefitting the long-term management of the fishery.

References

NMFS. 2016. Characterization of the U.S. Gulf of Mexico and southeastern Atlantic otter trawl and bottom reef fish fisheries. Observer Training Manual. NMFS, Southeast Fisheries Science Center, Galveston Laboratory, Galveston, Texas. Available at http://www.galvestonlab.sefsc.noaa.gov/forms/observer/obs_training_manual_12_2015.pdf

R Development Core Team. 2016. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0.

Scott-Denton, E., Cryer, P.F., Gocke, J.P., Harrelson, M.R., Kinsella, D.J., Pulver, J.R., Smith, R.C., and Williams, J.A., 2011. Descriptions of the U.S. Gulf of Mexico reef fish bottom longline and vertical line fisheries based on observer data. Mar. Fish. Rev. 73(2): 1-26.

Scott-Denton, E., and Williams, J.A., 2013. Observer Coverage of the 2010-2011 Gulf of Mexico Reef Fish. NOAA Technical Memorandum. NMFS-SEFSC-646, 65 pp.

Table 1. Regression model information for the 90 reef fish species including the number of observations (N), minimum length in mm (Min) and maximum length in mm (Max), mean length in mm, length standard deviation (S.D.), y-intercept (Ln *a*), slope (*b*), standard error of the slope (SE *b*), residual standard error (RSE), adjusted R^2, R^2, and overall regression model significance (*p*-value).

Common Name	**Scientific Name**	**N**	**Min (mm)**	**Max (mm)**	**Mean (mm)**	**S.D.**	**Ln a**	***b***	**SE *b***	**RSE**	**Adjusted R^2**	**R^2**	***p*-value**
Grouper, Black	*Mycteroperca bonaci*	182	633	1,410	964.8	168.2	-18.3	3.04	0.06	0.14	0.93	0.93	<0.01
Gag	*Mycteroperca microlepis*	13,669	236	1,399	675.5	144.2	-17.9	2.96	0.01	0.13	0.96	0.96	<0.01
Grouper, Yellowfin	*Mycteroperca venenosa*	6	425	858	646.3	173.4	-18.1	3.01	0.21	0.13	0.98	0.98	<0.01
Grouper, Yellowmouth	*Mycteroperca interstitialis*	21	398	668	567.8	76.9	-16.5	2.74	0.26	0.17	0.85	0.86	<0.01
Scamp	*Mycteroperca phenax*	6,385	221	951	554.9	103.9	-17.1	2.80	0.01	0.18	0.90	0.90	<0.01
Grouper, Red	*Epinephelus morio*	254,416	199	924	475.2	95.5	-18.8	3.13	0.00	0.13	0.96	0.96	<0.01
Grouper, Snowy	*Epinephelus niveatus*	3,600	284	1,233	637.5	124.2	-18.2	3.01	0.01	0.13	0.95	0.95	<0.01
Grouper, Yellowedge	*Epinephelus flavolimbatus*	18,986	284	1,153	652.7	115.9	-18.1	2.99	0.00	0.12	0.95	0.95	<0.01
Grouper, Marbled	*Epinephelus inermis*	16	519	877	677.6	111.6	-19.7	3.27	0.24	0.15	0.92	0.93	<0.01
Hind, Speckled	*Epinephelus drummondhayi*	1,077	241	1,092	528.9	148.0	-18.5	3.11	0.02	0.16	0.97	0.97	<0.01
Graysby	*Cephalopholis cruentata*	53	178	518	273.4	52.7	-13.4	2.21	0.24	0.31	0.62	0.62	<0.01
Hind, Red	*Epinephelus guttatus*	17	231	546	384.6	83.0	-16.7	2.78	0.29	0.26	0.85	0.86	<0.01
Hind, Rock	*Epinephelus adscensionis*	88	229	426	355.3	42.4	-19.1	3.20	0.16	0.19	0.82	0.82	<0.01
Perch, Sand	*Diplectrum formosum*	364	126	320	212.3	28.4	-10.1	1.56	0.13	0.34	0.27	0.27	<0.01
Seabass, Black	*Centropristis striata*	642	134	457	266.2	51.1	-14.4	2.42	0.07	0.34	0.66	0.66	<0.01
Seabass, Rock	*Centropristis philadelphica*	247	106	318	201.1	38.2	-15.2	2.53	0.18	0.56	0.44	0.44	<0.01
Seabass, Bank	*Centropristis ocyurus*	175	83	470	205.7	46.8	-9.2	1.45	0.11	0.32	0.48	0.48	<0.01
Tattler	*Serranus phoebe*	89	123	206	174.6	14.1	-10.0	1.47	0.60	0.47	0.05	0.06	0.02
Bass, Longtail	*Hemanthias leptus*	84	248	555	411.0	65.3	-15.5	2.55	0.10	0.16	0.88	0.88	<0.01
Flag, Spanish	*Gonioplectrus hispanus*	18	216	278	246.1	21.4	-13.0	2.14	0.66	0.24	0.36	0.40	<0.01
Creole-Fish	*Paranthias furcifer*	639	215	403	296.2	35.3	-11.9	1.93	0.09	0.27	0.41	0.41	<0.01
Snapper, Red	*Lutjanus campechanus*	110,897	172	990	460.4	112.4	-17.7	2.96	0.00	0.14	0.96	0.96	<0.01

(Table 1, continued)

Common Name	**Scientific Name**	**N**	**Min (mm)**	**Max (mm)**	**Mean (mm)**	**S.D.**	**Ln a**	***b***	**SE *b***	**RSE**	**Adjusted R^2**	**R^2**	***p*-value**
Snapper, Lane	*Lutjanus synagris*	2,330	162	513	322.0	47.7	-16.8	2.80	0.03	0.25	0.74	0.74	<0.01
Snapper, Mutton	*Lutjanus analis*	2,502	378	864	598.0	88.7	-17.7	2.96	0.01	0.09	0.96	0.96	<0.01
Snapper, Gray	*Lutjanus griseus*	4,001	219	714	426.2	76.1	-17.5	2.92	0.01	0.16	0.92	0.92	<0.01
Snapper, Cubera	*Lutjanus cyanopterus*	7	597	1,037	805.3	160.0	-16.5	2.78	0.17	0.09	0.98	0.98	<0.01
Snapper, Silk	*Lutjanus vivanus*	785	220	810	440.4	72.3	-18.6	3.11	0.02	0.11	0.95	0.95	<0.01
Snapper, Vermilion	*Rhomboplites aurorubens*	117,080	106	624	291.0	51.0	-17.8	2.98	0.00	0.21	0.85	0.85	<0.01
Wenchman	*Pristipomoides aquilonaris*	146	155	365	218.1	24.5	-15.2	2.51	0.30	0.39	0.32	0.33	<0.01
Snapper, Queen	*Etelis Oculatus*	328	200	912	549.9	119.2	-16.1	2.69	0.04	0.17	0.94	0.93	<0.01
Snapper, Yellowtail	*Ocyurus chrysurus*	7,740	168	512	300.0	42.7	-17.6	2.95	0.01	0.18	0.84	0.84	<0.01
Tilefish	*Lopholatilus chamaeleonticeps*	11,304	316	1,023	631.8	123.0	-20.2	3.29	0.01	0.15	0.95	0.94	<0.01
Tilefish, Blueline	*Caulolatilus microps*	6,558	319	810	553.6	63.2	-18.8	3.09	0.01	0.10	0.92	0.92	<0.01
Tilefish, Goldface	*Caulolatilus chrysops*	70	243	602	448.8	75.6	-19.8	3.27	0.15	0.23	0.87	0.88	<0.01
Tilefish, Sand	*Malacanthus plumieri*	144	313	632	504.4	61.2	-19.6	3.15	0.10	0.16	0.87	0.87	<0.01
Grunt, White	*Haemulon plumieri*	2,463	162	743	283.6	41.9	-18.3	3.09	0.03	0.22	0.78	0.78	<0.01
Tomtate	*Haemulon aurolineatum*	1,306	121	427	205.2	25.0	-17.2	2.86	0.10	0.43	0.38	0.38	<0.01
Porgy, Red	*Pagrus pagrus*	35,784	114	651	287.3	47.7	-17.0	2.88	0.01	0.19	0.86	0.86	<0.01
Porgy, Knobbed	*Calamus nodosus*	1,135	205	548	307.6	35.4	-16.4	2.79	0.04	0.15	0.81	0.81	<0.01
Porgy, Saucereye	*Calamus calamus*	414	189	549	300.0	36.6	-16.2	2.75	0.06	0.14	0.86	0.86	<0.01
Porgy, Jolthead	*Calamus bajonado*	1,097	192	700	422.9	111.2	-17.2	2.93	0.02	0.15	0.97	0.97	<0.01
Porgy, Littlehead	*Calamus proridens*	490	191	410	290.6	38.9	-17.2	2.92	0.07	0.22	0.76	0.76	<0.01
Sheepshead	*Archosargus probatocephalus*	238	277	562	399.8	57.4	-19.7	3.36	0.08	0.17	0.89	0.89	<0.01
Porgy, Whitebone	*Calamus leucosteus*	123	200	578	311.0	58.2	-17.6	2.97	0.16	0.31	0.73	0.74	<0.01
Rudderfish, Banded	*Seriola zonata*	1,657	241	752	427.4	70.8	-16.3	2.72	0.02	0.15	0.91	0.91	<0.01
Amberjack, Lesser	*Seriola fasciata*	286	186	950	409.9	105.6	-15.7	2.63	0.04	0.17	0.93	0.93	<0.01
Amberjack, Greater	*Seriola dumerili*	2,323	222	1,600	787.4	287.4	-16.0	2.69	0.01	0.16	0.98	0.98	<0.01

(Table 1, continued)

Common Name	Scientific Name	N	Min (mm)	Max (mm)	Mean (mm)	S.D.	Ln a	*b*	SE *b*	RSE	Adjusted R^2	R^2	*p*-value
Jack, Almaco	*Seriola rivoliana*	2,058	165	1,302	516.9	170.5	-16.2	2.73	0.01	0.16	0.97	0.97	<0.01
Runner, Blue	*Caranx crysos*	1,165	157	532	329.6	53.0	-17.3	2.90	0.03	0.19	0.87	0.87	<0.01
Jack, Common Crevalle	*Caranx hippos*	81	242	957	594.7	226.0	-15.2	2.59	0.04	0.15	0.98	0.98	<0.01
Rainbow Runner	*Elagatis bipinnulata*	26	272	663	465.2	108.6	-16.2	2.69	0.16	0.20	0.91	0.92	<0.01
Pompano, Florida	*Trachinotus carolinus*	111	300	426	357.8	30.4	-20.3	3.45	0.15	0.13	0.84	0.84	<0.01
Barrelfish	*Hyperoglyphe perciferomis*	256	277	815	630.0	99.1	-17.0	2.87	0.03	0.09	0.97	0.97	<0.01
Dolphin	*Coryphaena hippurus*	329	292	1,227	573.5	289.2	-17.0	2.74	0.02	0.13	0.99	0.99	<0.01
Bluefish	*Pomatomus saltatrix*	224	266	803	418.6	64.4	-18.1	2.99	0.06	0.13	0.92	0.92	<0.01
Cobia, Ling	*Rachycentron canadum*	165	400	1,330	824.1	173.3	-20.1	3.26	0.06	0.15	0.96	0.96	<0.01
Tuna, Blackfin	*Thunnus atlanticus*	255	499	890	724.5	71.9	-16.6	2.83	0.06	0.09	0.91	0.91	<0.01
Bonito	*Euthynnus alletteratus*	821	277	837	643.3	91.2	-17.0	2.84	0.03	0.12	0.94	0.94	<0.01
Mackerel, Spanish	*Scomberomorus maculatus*	62	337	678	512.3	80.0	-18.9	3.04	0.13	0.16	0.90	0.91	<0.01
Mackerel, King	*Scomberomorus cavalla*	2,585	476	1,309	813.8	114.0	-18.6	2.98	0.02	0.11	0.93	0.93	<0.01
Mackerel, Cero	*Scomberomorus regalis*	24	337	710	463.1	85.9	-20.1	3.25	0.31	0.26	0.83	0.83	<0.01
Wahoo	*Acanthocybium solandri*	24	925	1,591	1278.4	188.2	-21.2	3.32	0.33	0.24	0.82	0.83	<0.01
Barracuda, Great	*Sphyraena barracuda*	350	346	1,478	907.2	164.9	-18.4	2.94	0.05	0.20	0.90	0.90	<0.01
Triggerfish, Gray	*Balistes capriscus*	3,211	178	694	379.0	64.3	-16.8	2.85	0.02	0.17	0.88	0.88	<0.01
Sharksucker	*Echeneis naucrates*	896	257	984	704.6	95.2	-16.3	2.53	0.04	0.21	0.80	0.80	<0.01
Drum, Red	*Sciaenops ocellatus*	100	538	1,143	795.6	133.2	-19.2	3.14	0.09	0.15	0.93	0.93	<0.01
Bigeye	*Priacanthus arenatus*	90	191	572	336.2	60.0	-16.2	2.68	0.12	0.19	0.85	0.86	<0.01
Bigeye, Short	*Pristigenys alta*	124	181	326	259.7	24.4	-16.2	2.75	0.22	0.25	0.55	0.55	<0.01
Squirrelfish	*Holocentrus adscensionis*	237	178	386	281.4	28.5	-11.3	1.86	0.18	0.30	0.30	0.30	<0.01
Scorpionfish, Spinycheek	*Neomerinthe hemingwayi*	346	216	602	426.8	47.6	-18.0	2.97	0.10	0.21	0.74	0.74	<0.01
Rosefish, Blackbelly	*Helicolenus dactylopterus*	34	261	492	374.9	57.8	-14.8	2.46	0.20	0.18	0.82	0.82	<0.01
Lionfish, Red	*Pterois volitans*	71	169	407	295.0	59.3	-16.5	2.71	0.16	0.29	0.81	0.81	<0.01

(Table 1, continued)

Common Name	Scientific Name	N	Min (mm)	Max (mm)	Mean (mm)	S.D.	Ln a	*b*	SE *b*	RSE	Adjusted R^2	R^2	*p*-value
Hogfish	*Lachnolaimus maximus*	723	234	733	392.0	65.6	-14.5	2.44	0.05	0.20	0.78	0.78	<0.01
Hogfish, Red	*Decodon puellaris*	5	219	406	277.2	73.9	-18.3	3.06	0.36	0.17	0.95	0.96	<0.01
Toadfish, Leopard	*Opsanus pardus*	564	193	583	340.6	51.3	-14.5	2.45	0.09	0.32	0.57	0.57	<0.01
Lizardfish, Inshore	*Synodus foetens*	256	235	475	348.5	42.5	-17.1	2.72	0.15	0.30	0.55	0.55	<0.01
Snakefish	*Trachinocephalus myops*	230	184	403	249.0	41.2	-8.5	1.21	0.20	0.47	0.14	0.14	<0.01
Sand Diver	*Synodus intermedius*	650	210	471	328.2	50.6	-15.7	2.51	0.09	0.34	0.57	0.57	<0.01
Shark, Bonnethead	*Sphyrna tiburo*	12	621	1,010	850.0	100.7	-12.9	2.06	0.47	0.20	0.62	0.66	<0.01
Shark, Bigeye Sixgill	*Hexanchus vitulus*	134	474	1,251	796.4	156.8	-15.8	2.48	0.13	0.31	0.73	0.73	<0.01
Shark, Sevengill	*Heptranchias perlo*	62	701	1,074	887.6	98.5	-18.8	2.89	0.21	0.18	0.76	0.76	<0.01
Dogfish, Chain	*Scyliorhinus retifer*	46	345	557	476.0	53.1	-9.4	1.45	0.56	0.44	0.11	0.13	0.01
Dogfish, Roughskin	*Cirrhigaleus asper*	20	421	1,113	834.7	185.6	-19.1	3.02	0.15	0.17	0.96	0.96	<0.01
Dogfish, Cuban	*Squalus cubensis*	2,981	269	1,136	538.3	82.7	-17.6	2.77	0.03	0.23	0.74	0.74	<0.01
Dogfish, Shortspine	*Squalus mitsukurii*	106	433	814	707.1	57.5	-18.9	2.98	0.11	0.10	0.89	0.89	<0.01
Shark, Smooth Dogfish	*Mustelus canis*	1,929	460	1,460	1023.2	183.4	-21.6	3.33	0.02	0.21	0.90	0.90	<0.01
Shark, Atlantic Sharpnose	*Rhizoprionodon terraenovae*	6,540	269	1,300	814.5	99.9	-18.7	2.91	0.02	0.19	0.79	0.79	<0.01
Shark, Blacknose	*Carcharhinus acronotus*	1,045	552	1,294	864.9	149.2	-19.0	3.00	0.03	0.19	0.88	0.88	<0.01
Shark, Finetooth	*Carcharhinus isodon*	10	661	1,167	902.5	155.2	-14.5	2.33	0.64	0.34	0.57	0.62	0.01
Shark, Silky	*Carcharhinus falciformis*	311	652	1,683	934.2	147.3	-19.0	2.98	0.07	0.18	0.86	0.86	<0.01

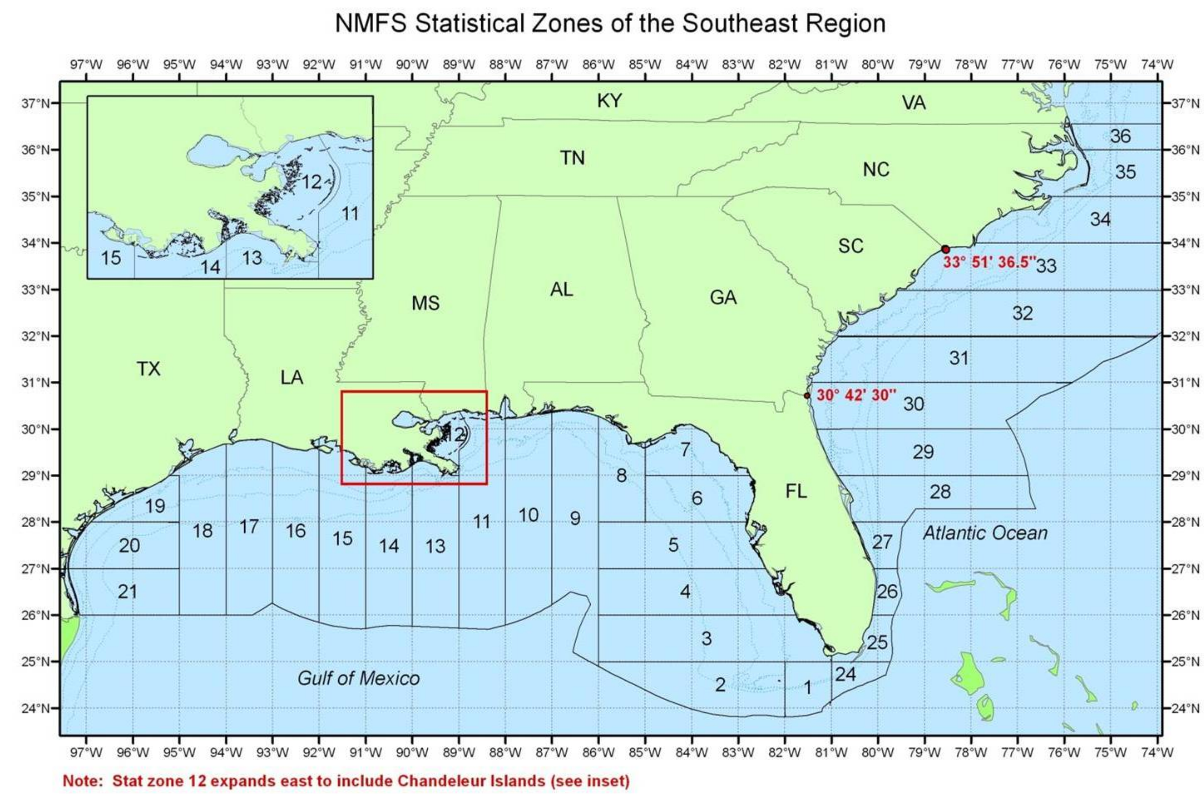


Figure 1. NMFS statistical zones used by the observer program for the Gulf of Mexico and South Atlantic.

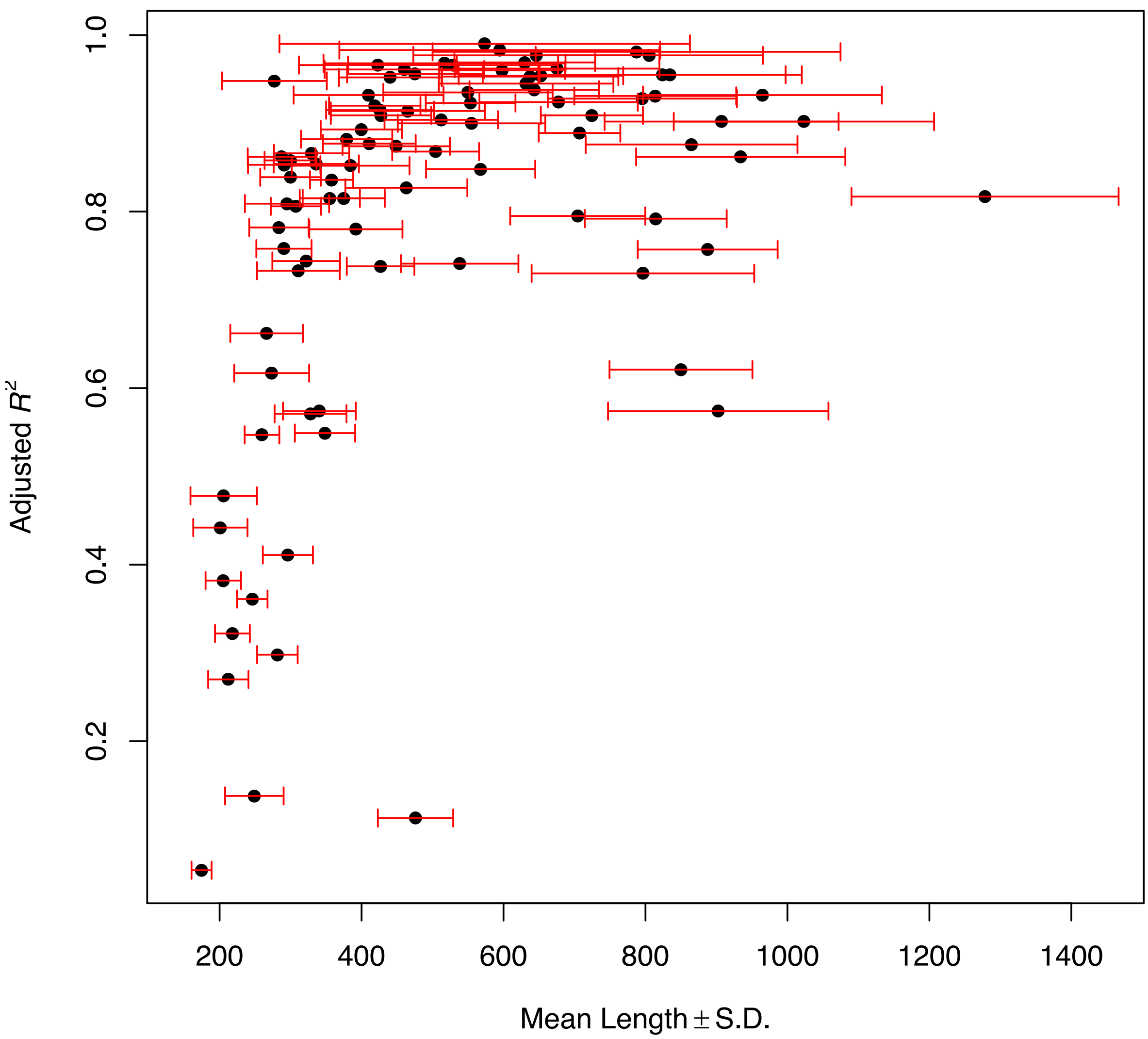


Figure 2. Mean lengths (± S.D.) for 90 reef fish species compared to its corresponding adjusted R^2 given by the length-weight regression model.

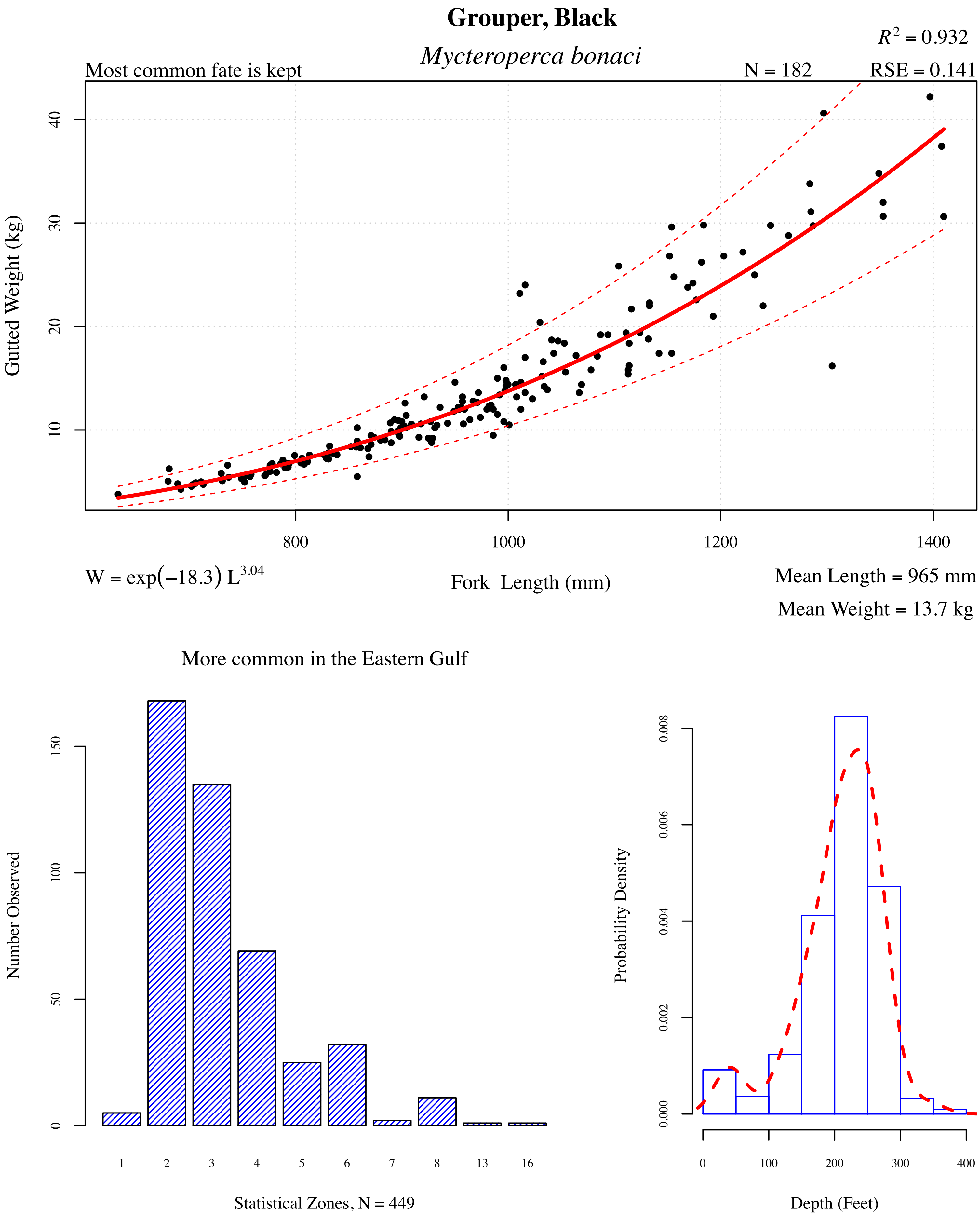


Figure 3 . Regression model, location, and depth information for grouper, black (*Mycteroperca bonaci*).

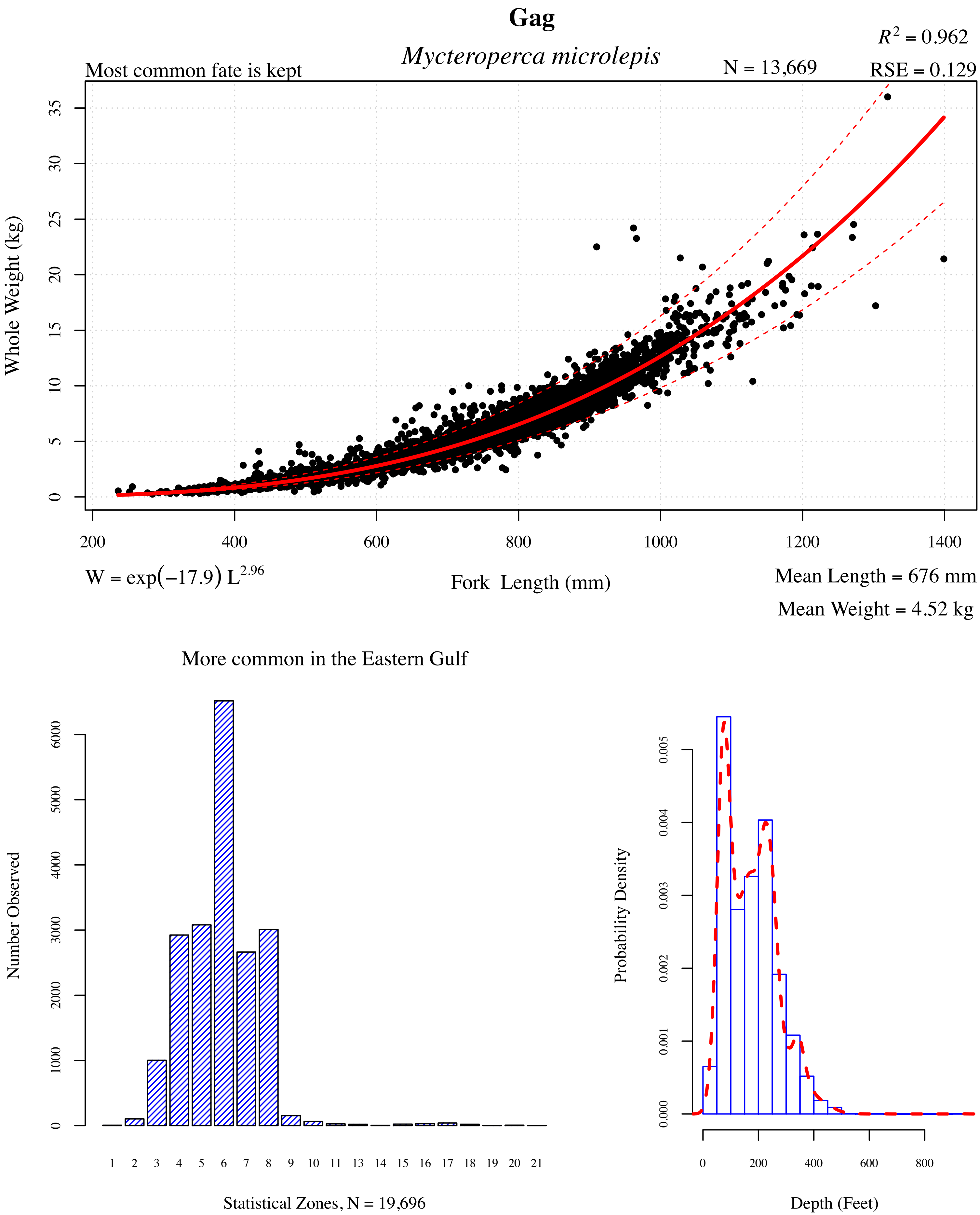


Figure 4 . Regression model, location, and depth information for gag (*Mycteroperca microlepis*).

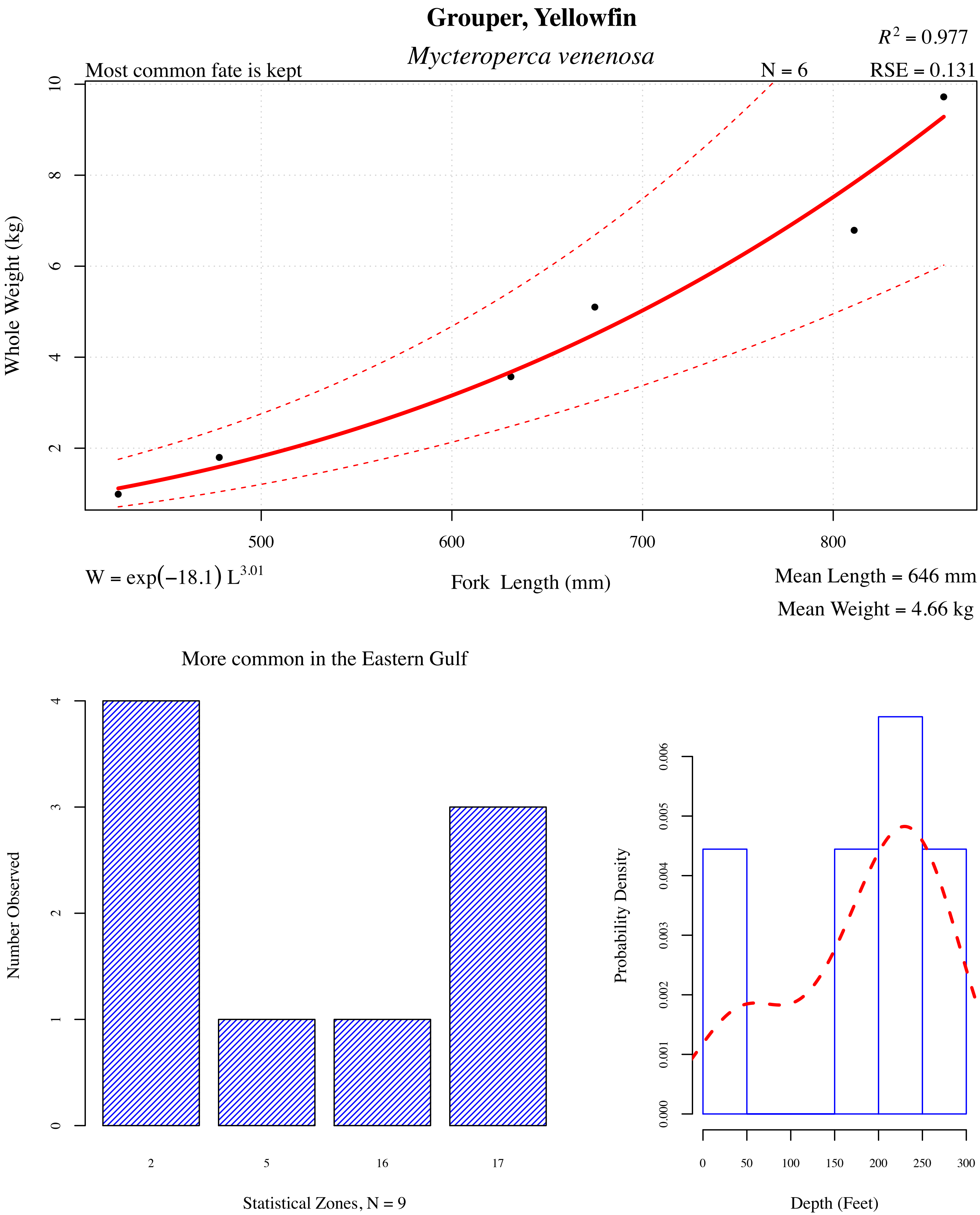


Figure 5 . Regression model, location, and depth information for grouper, yellowfin (*Mycteroperca venenosa*).

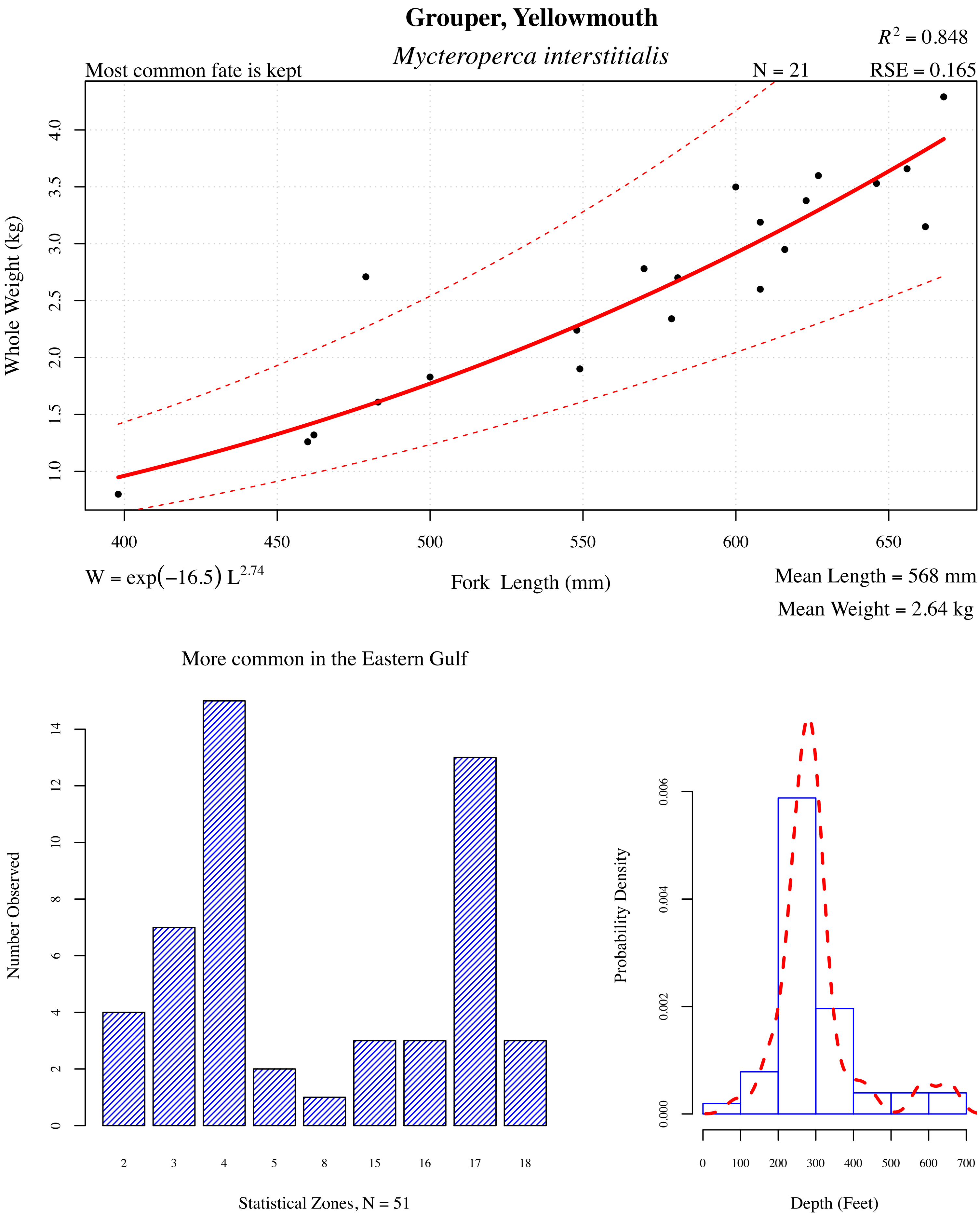


Figure 6 . Regression model, location, and depth information for grouper, yellowmouth (*Mycteroperca interstitialis*).

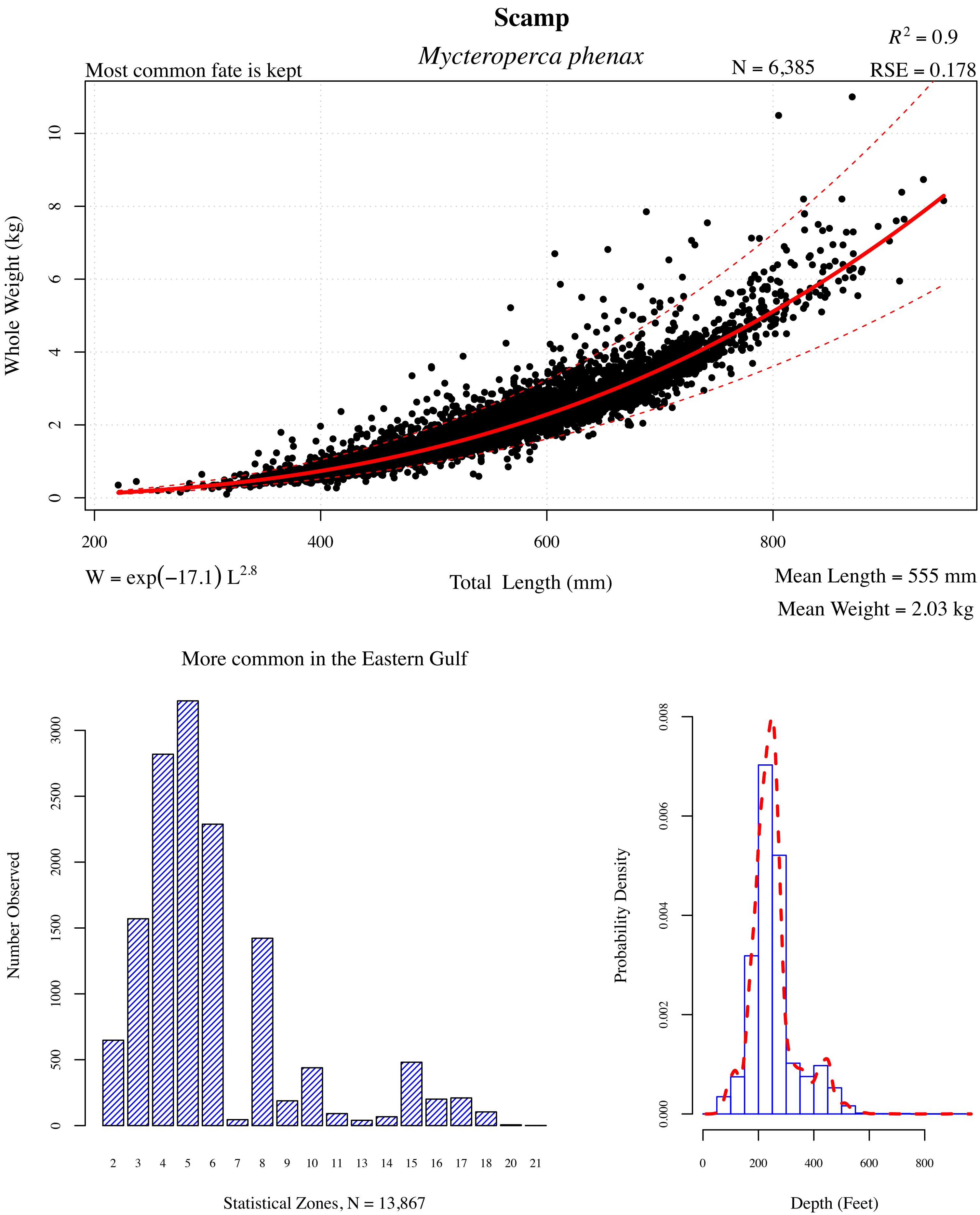
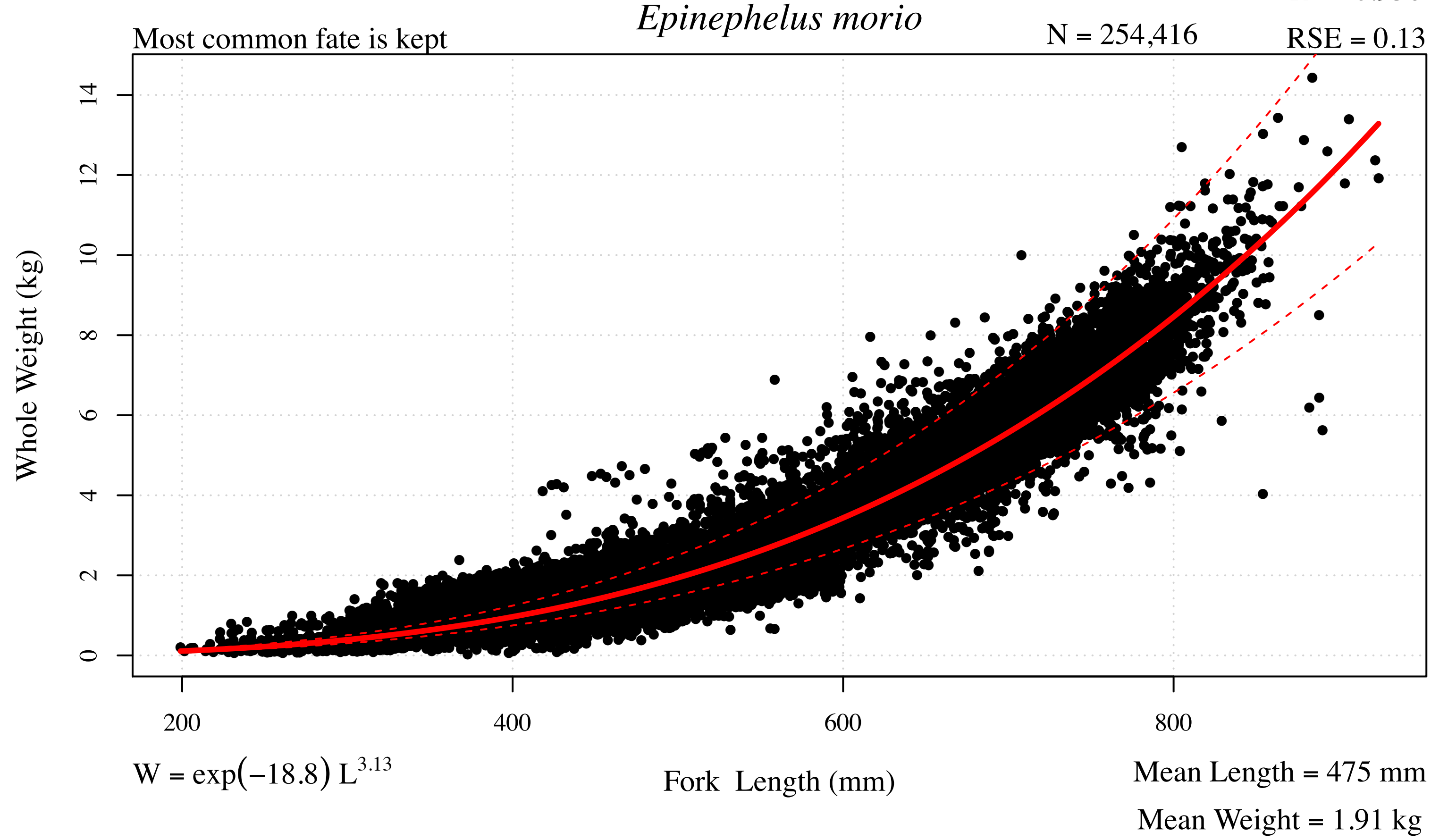


Figure 7 . Regression model, location, and depth information for scamp (*Mycteroperca phenax*).

Grouper, Red

Epinephelus morio



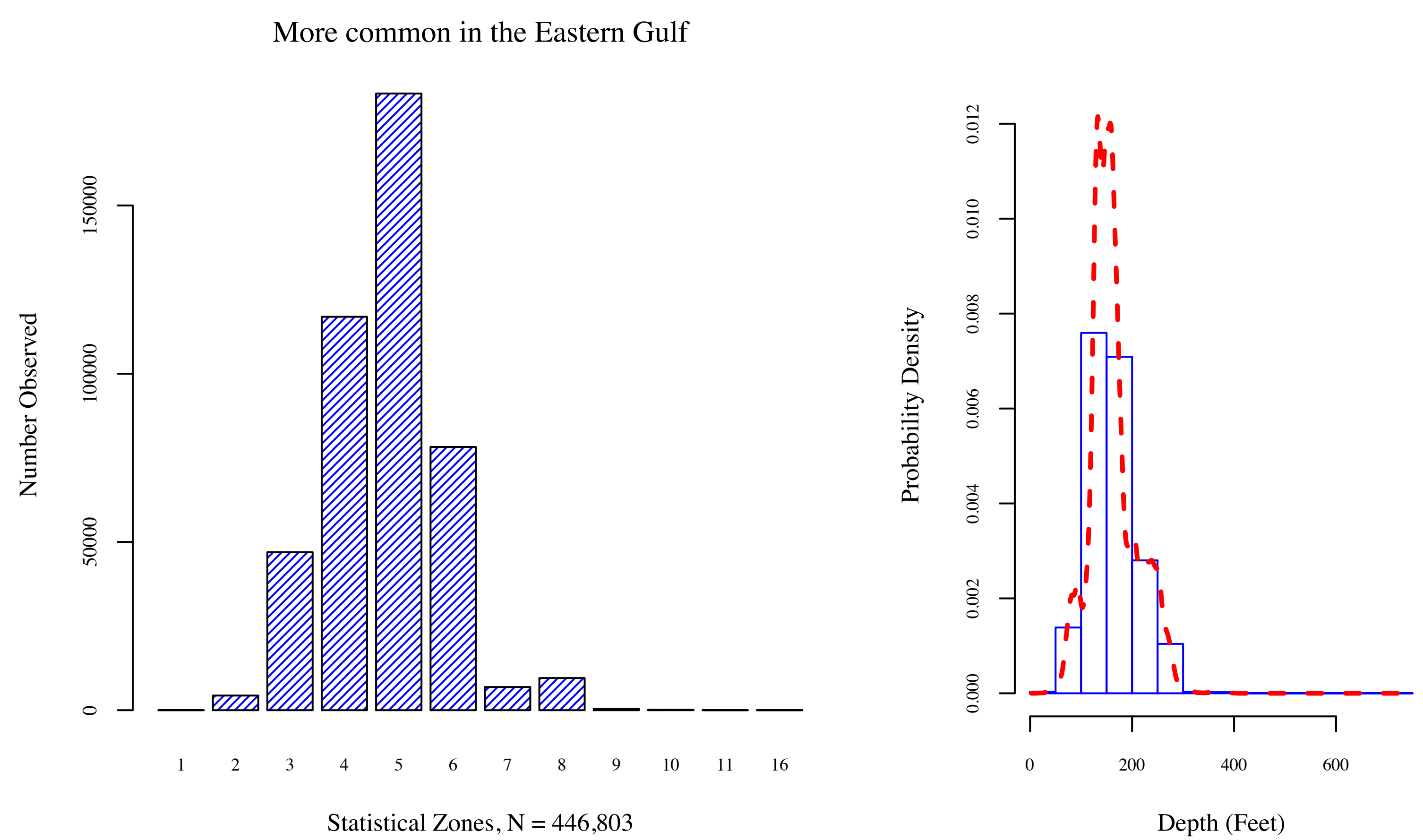


Figure 8 . Regression model, location, and depth information for grouper, red (*Epinephelus morio*).

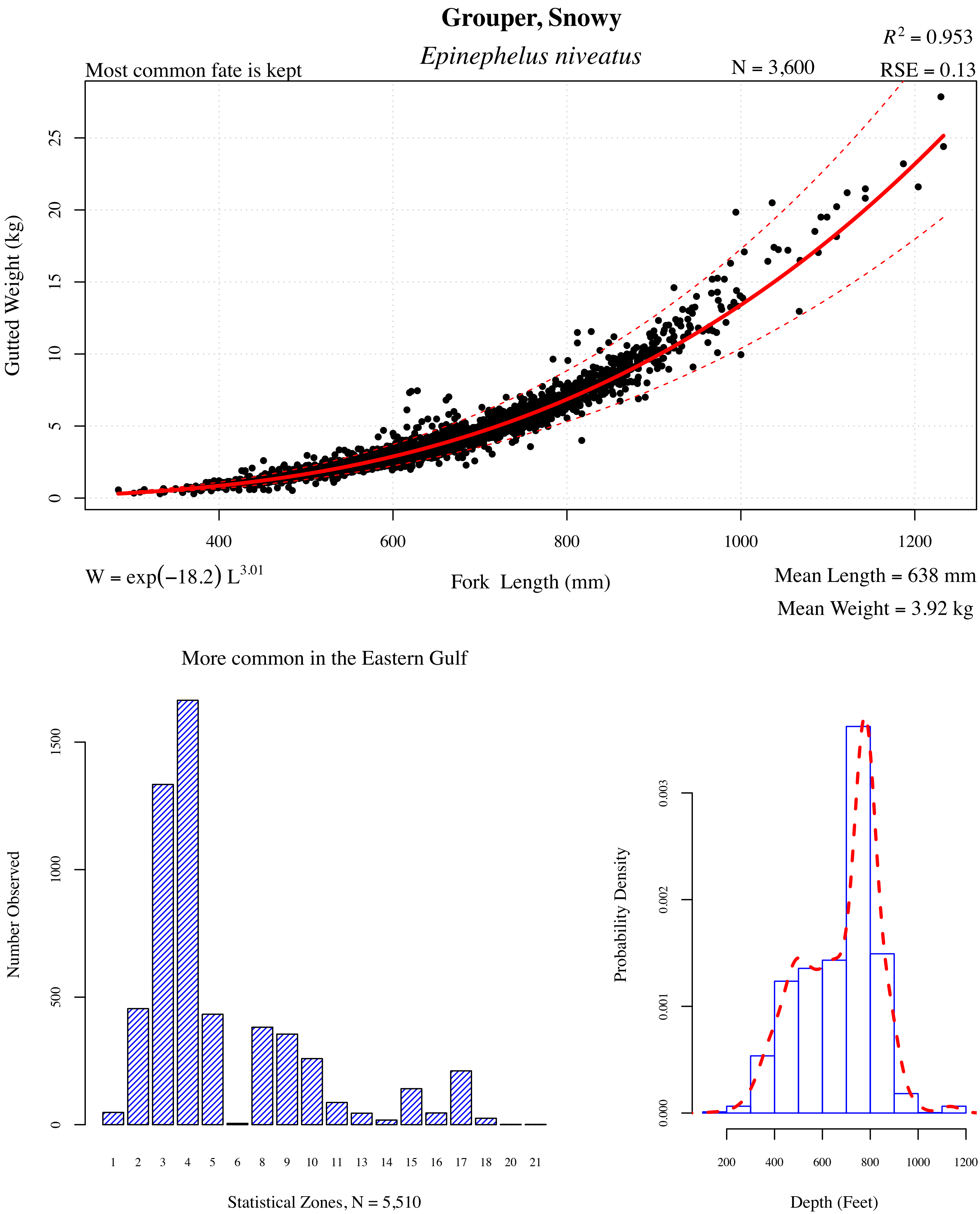


Figure 9 . Regression model, location, and depth information for grouper, snowy (*Epinephelus niveatus*).

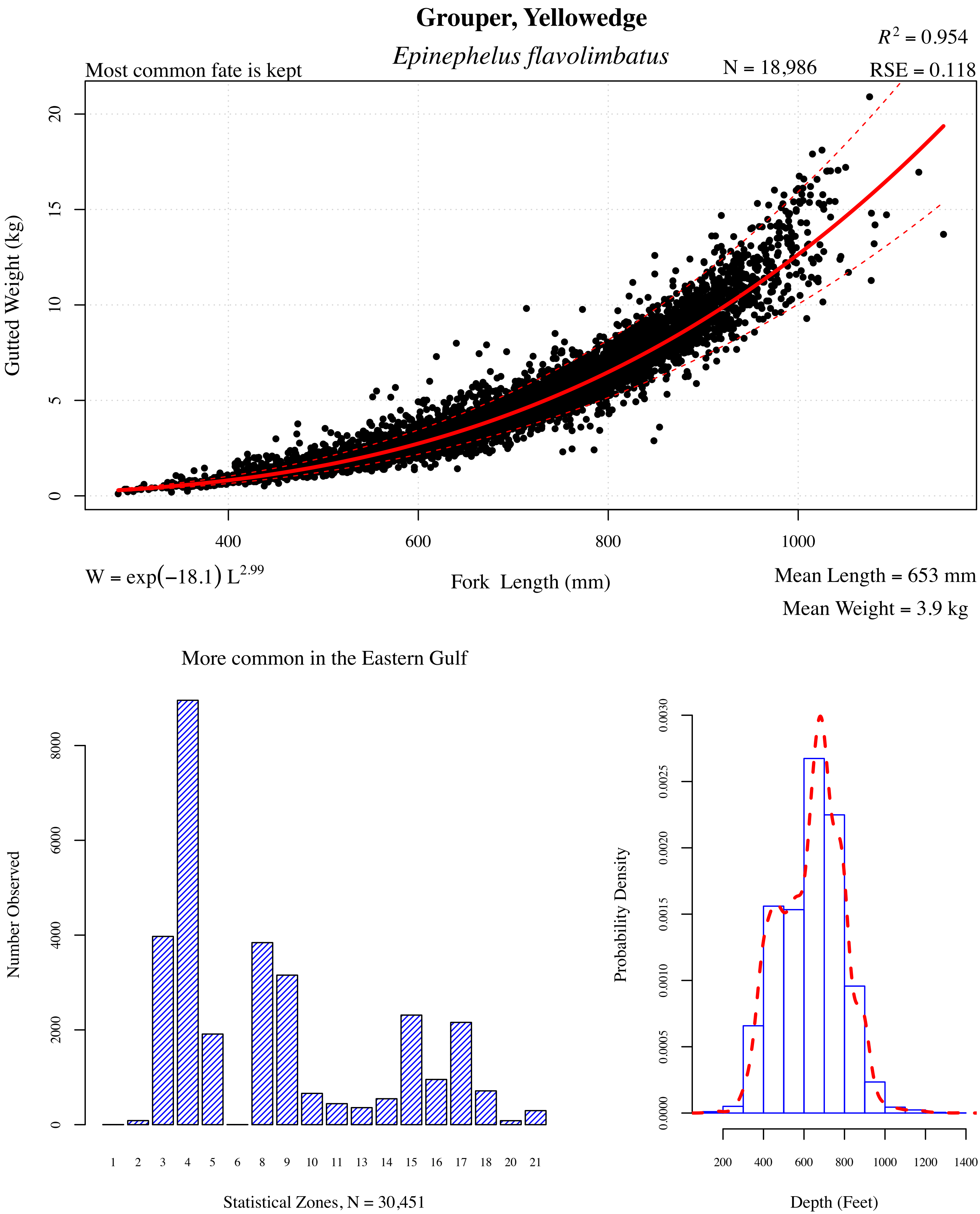


Figure 10 . Regression model, location, and depth information for grouper, yellowedge (*Epinephelus flavolimbatus*).

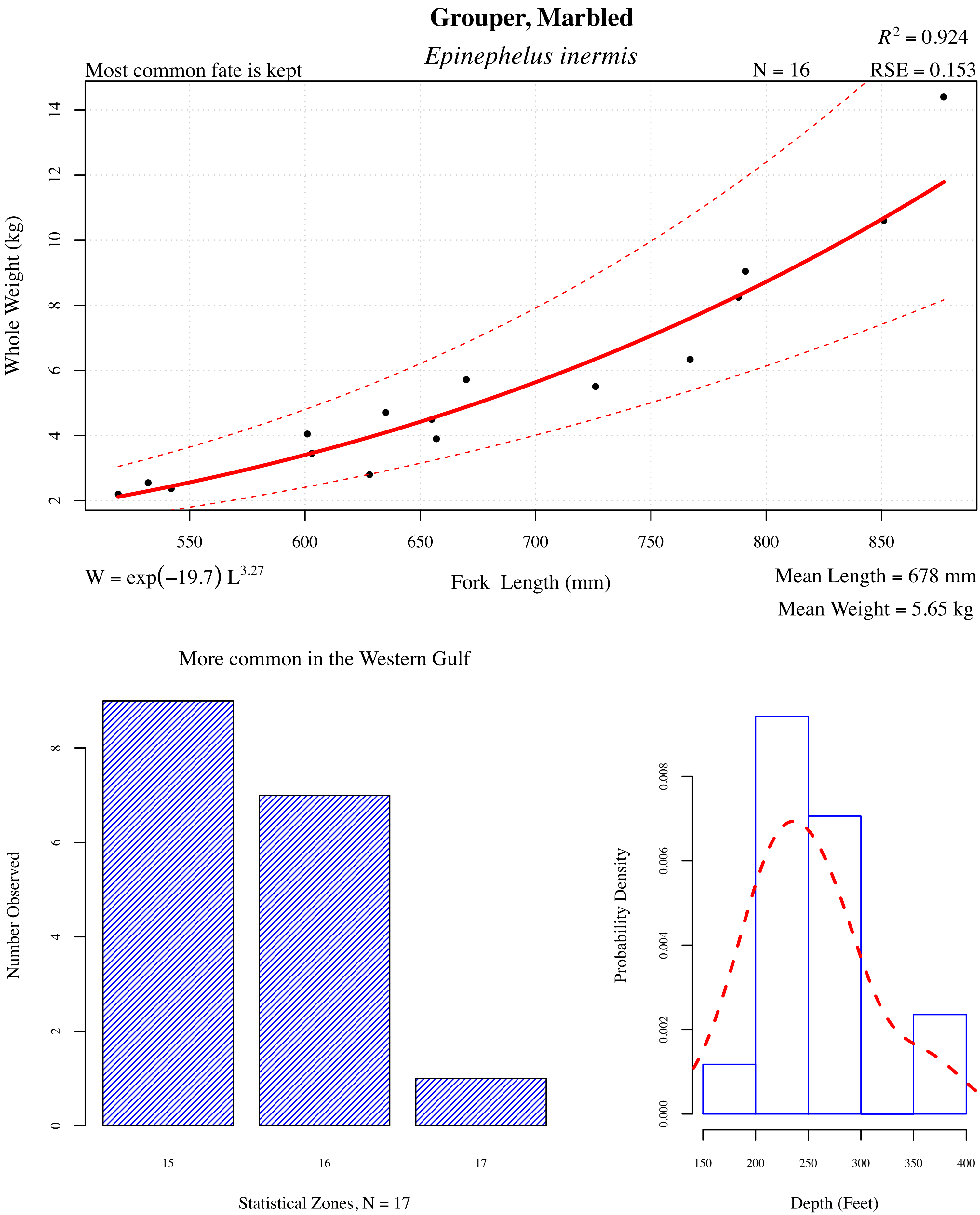


Figure 11 . Regression model, location, and depth information for grouper, marbled (*Epinephelus inermis*).

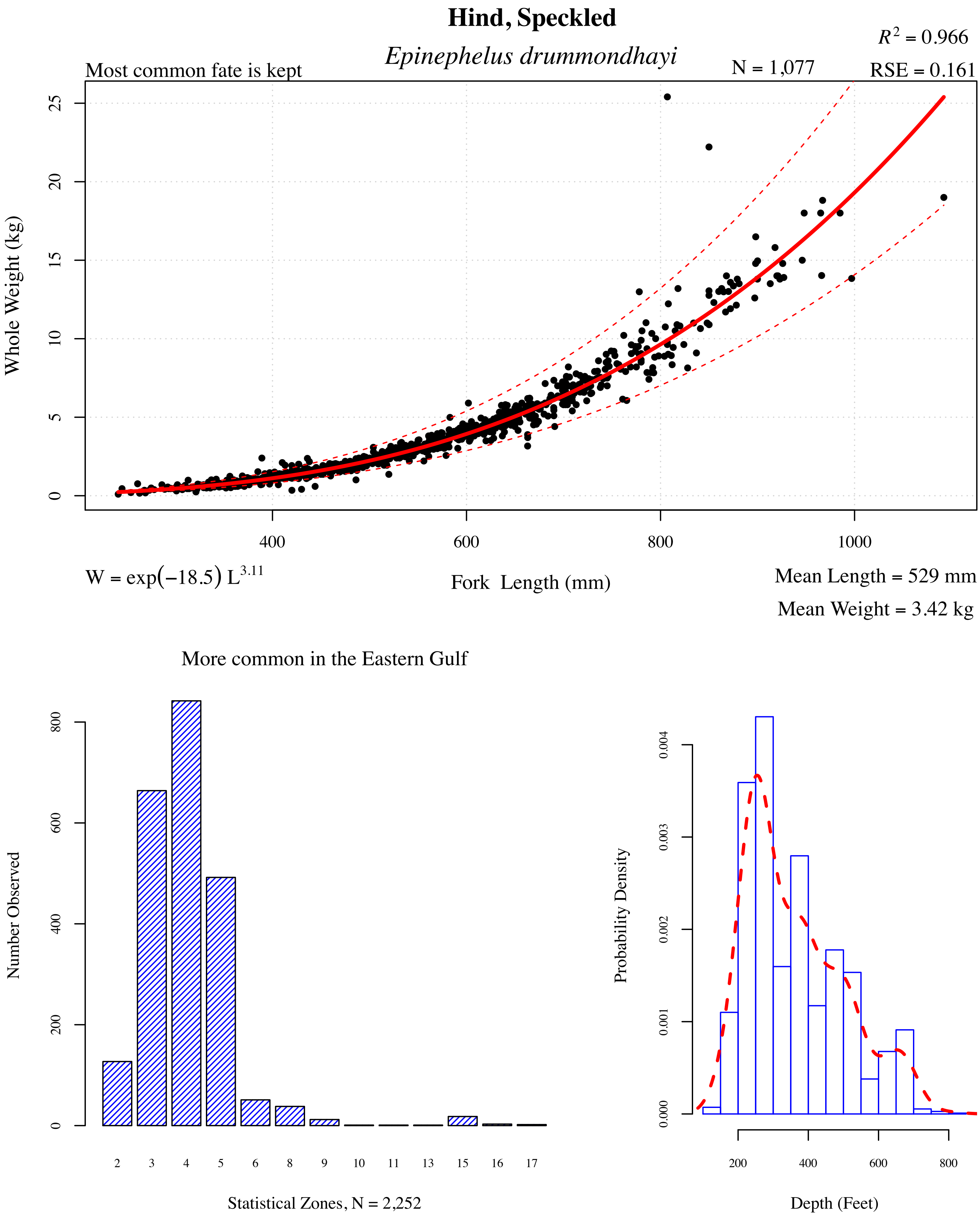


Figure 12 . Regression model, location, and depth information for hind, speckled (*Epinephelus drummondhayi*).

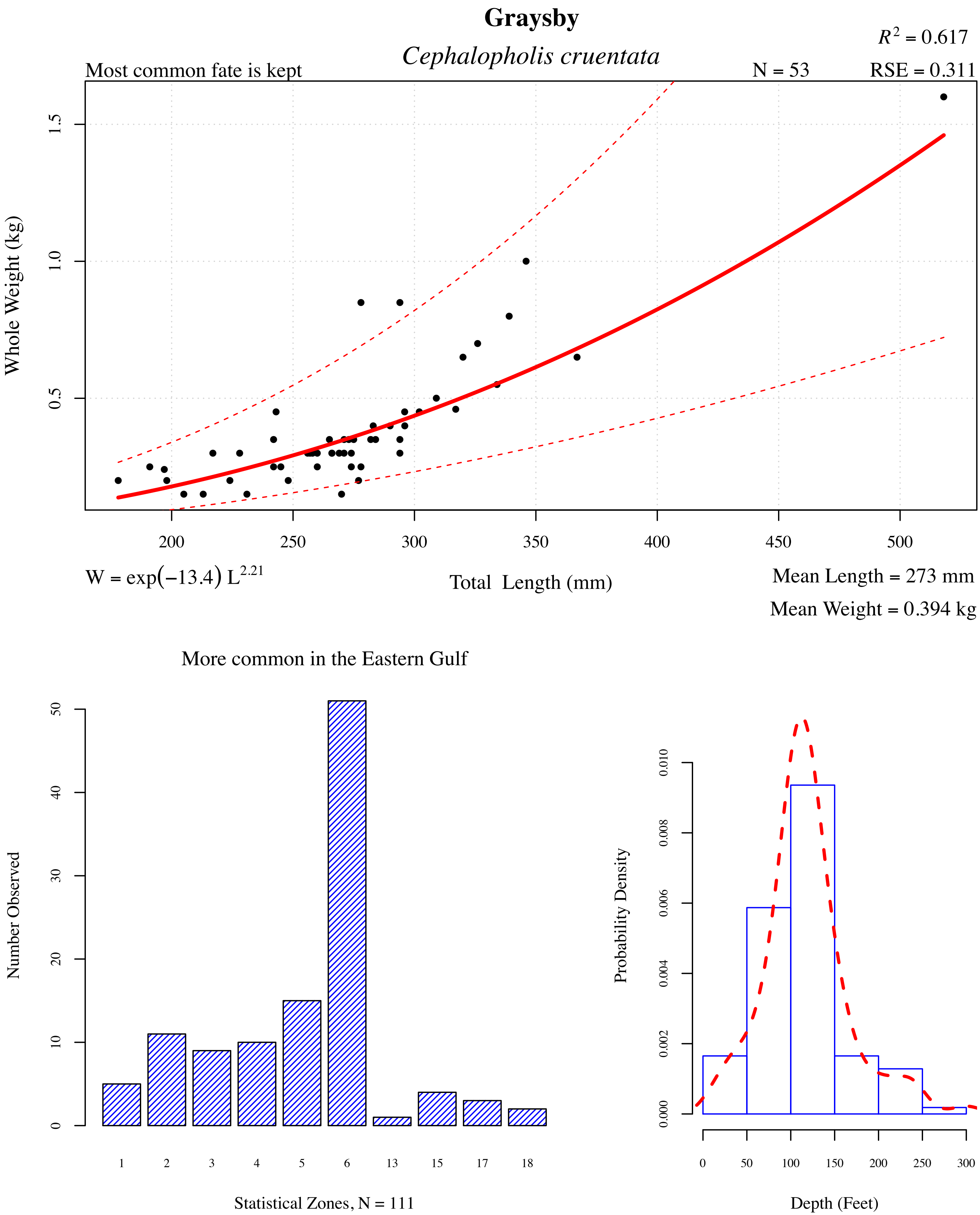


Figure 13 . Regression model, location, and depth information for graysby (*Cephalopholis cruentata*).

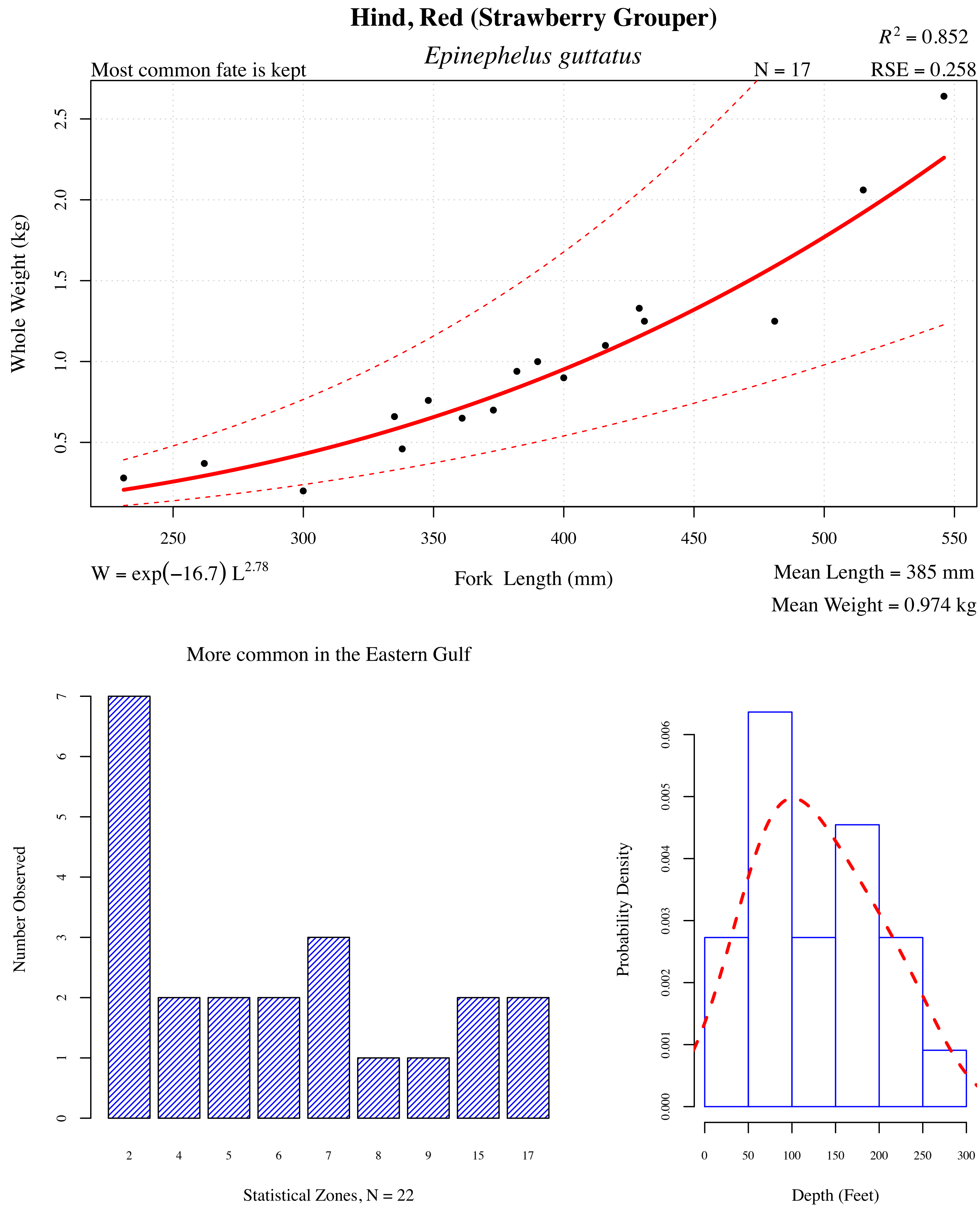


Figure 14 . Regression model, location, and depth information for hind, red (strawberry grouper) (*Epinephelus guttatus*).

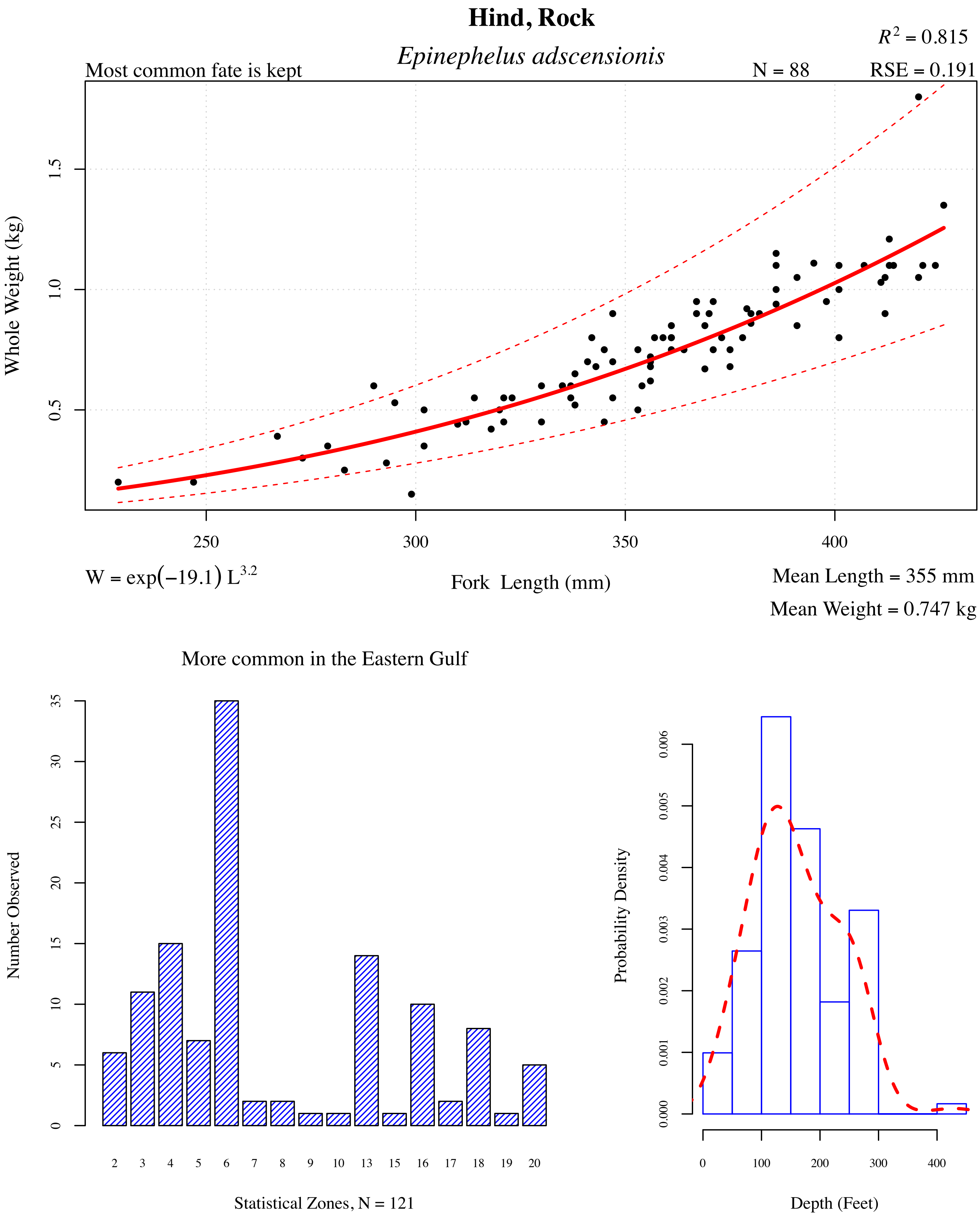


Figure 15 . Regression model, location, and depth information for hind, rock (*Epinephelus adscensionis*).

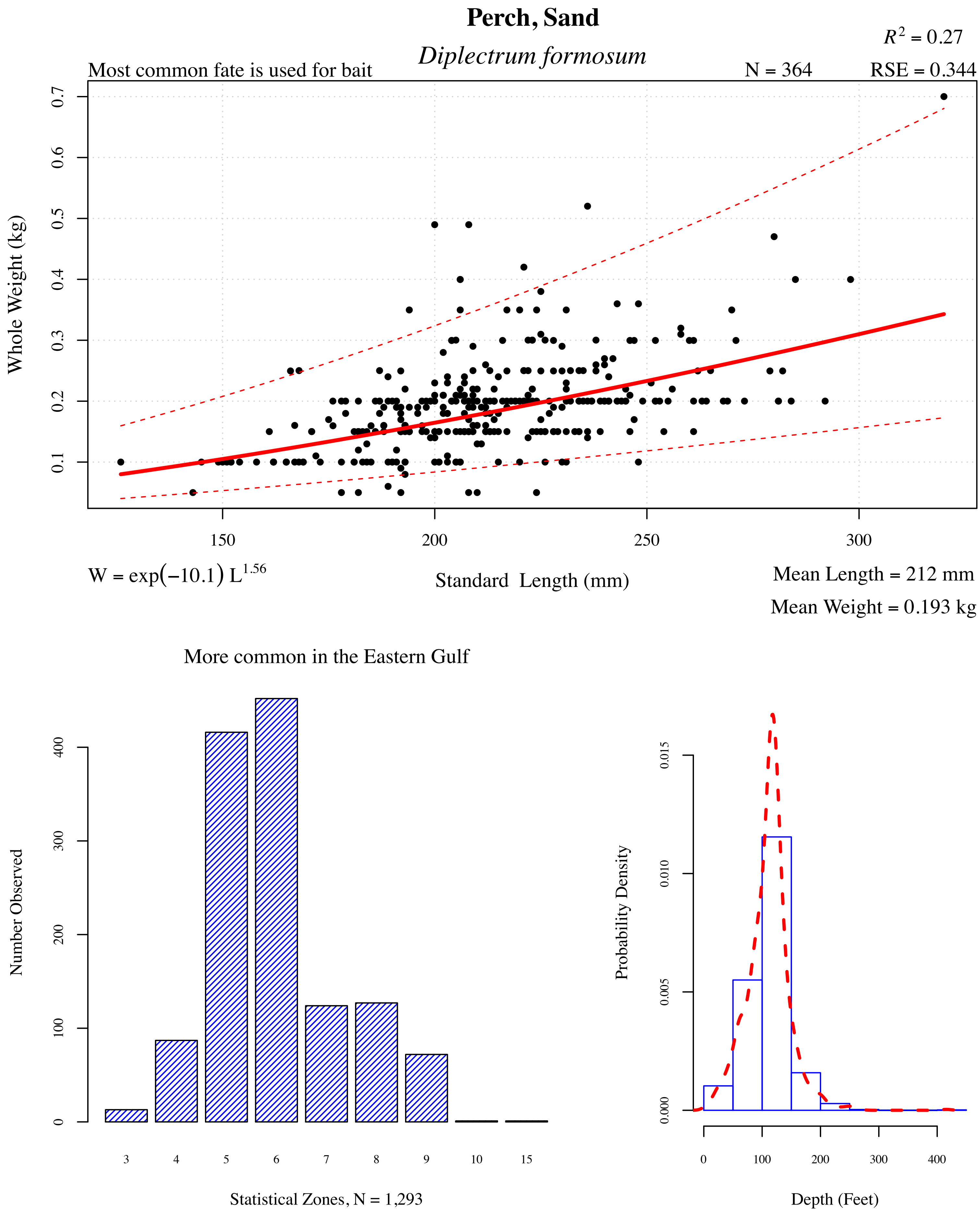
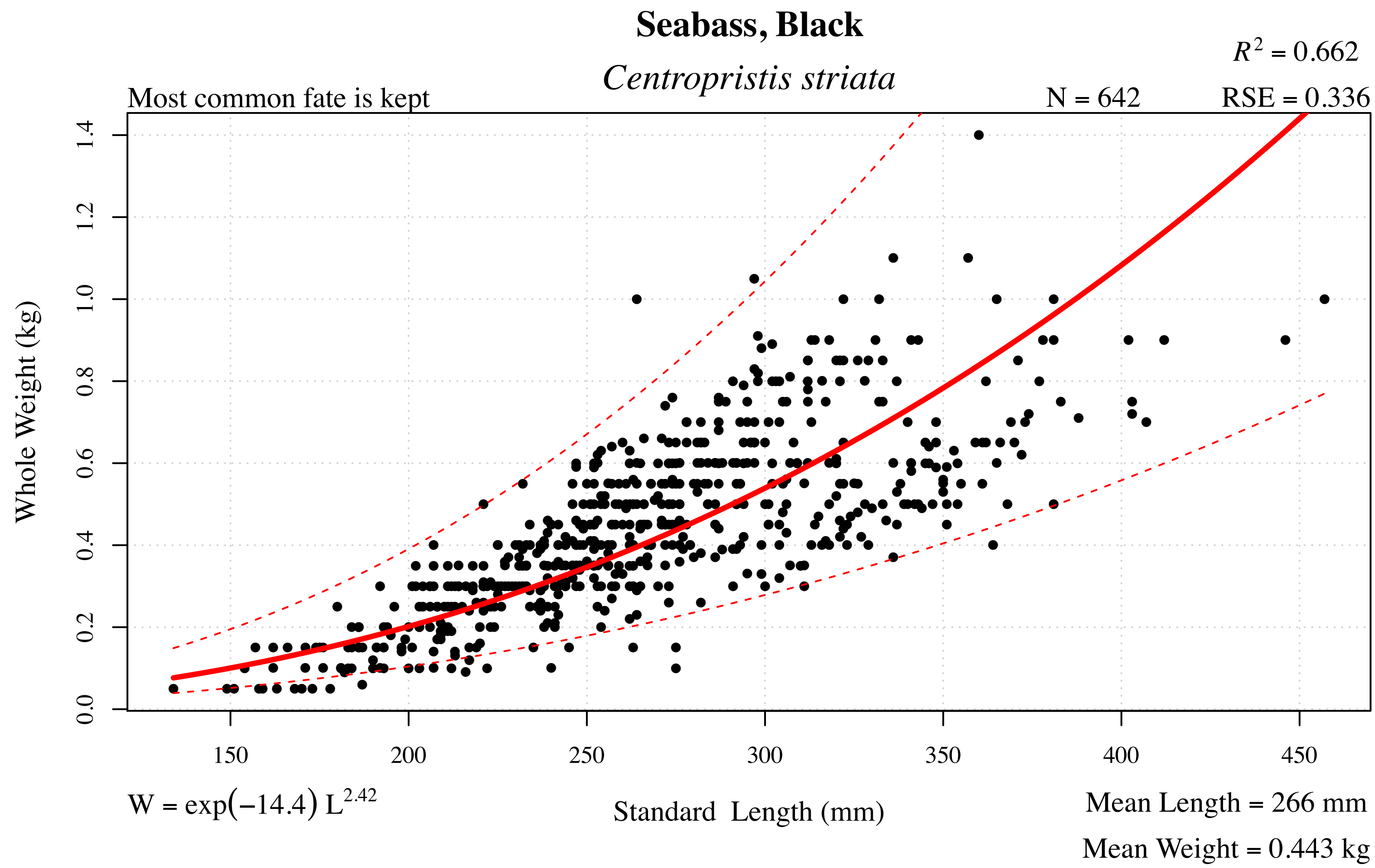
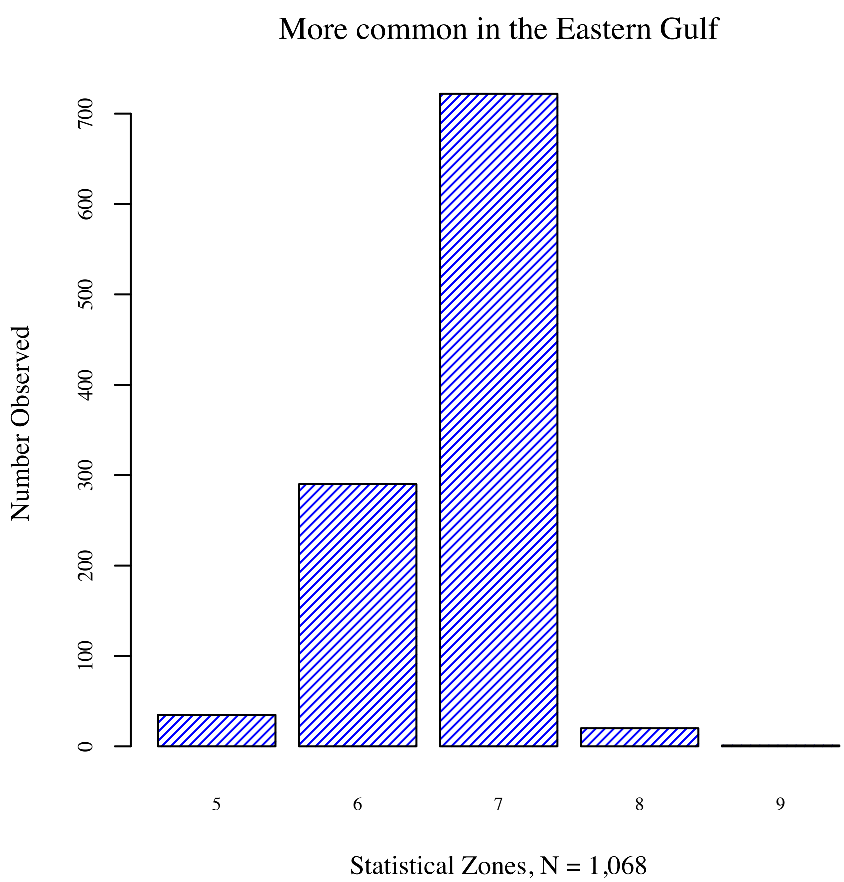


Figure 16 . Regression model, location, and depth information for perch, sand (*Diplectrum formosum*).





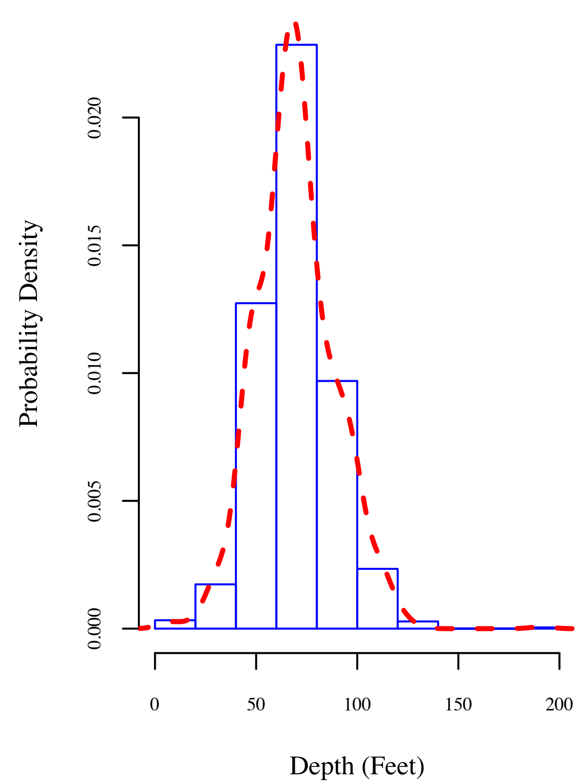


Figure 17 . Regression model, location, and depth information for seabass, black (*Centropristis striata*).

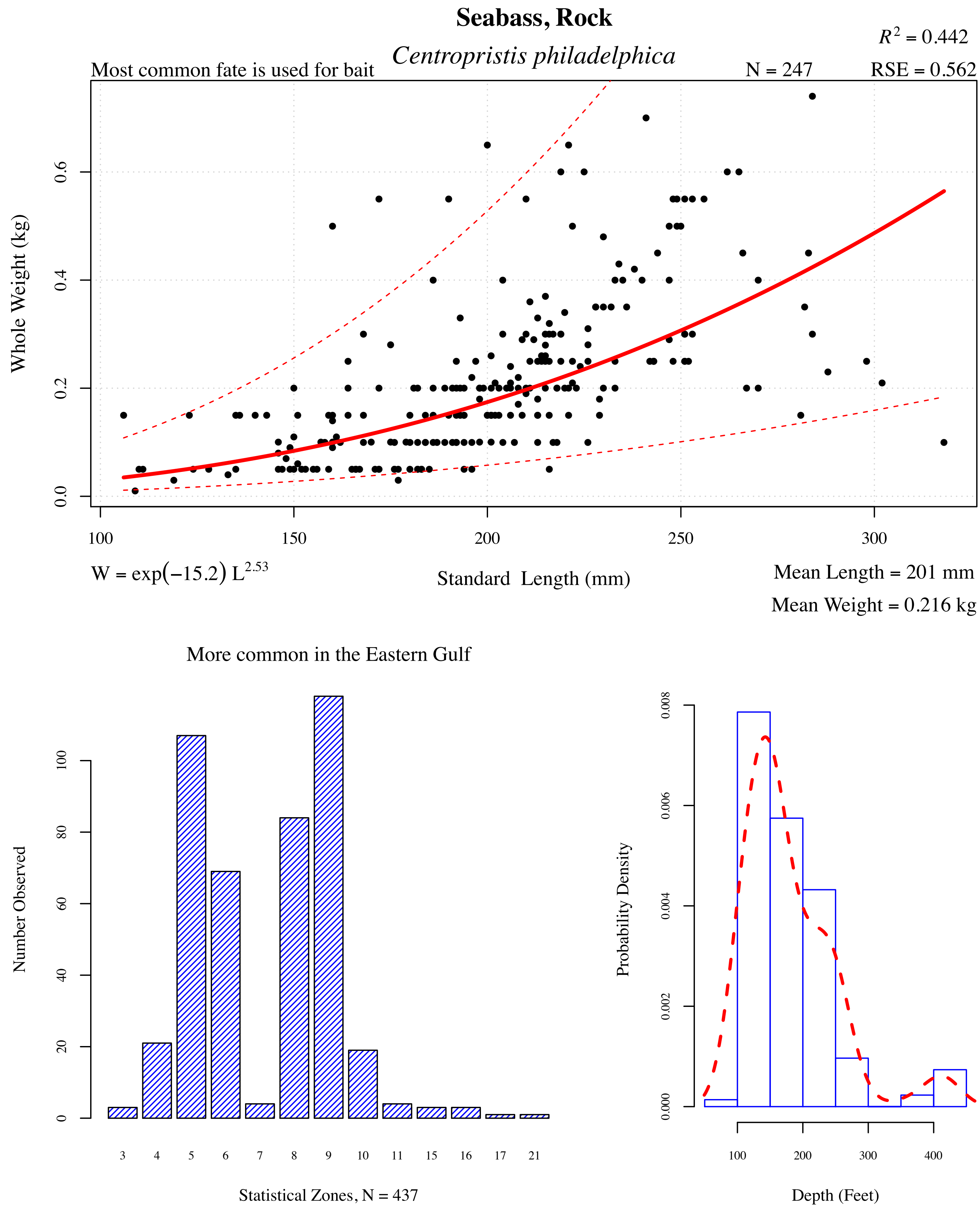


Figure 18 . Regression model, location, and depth information for seabass, rock (*Centropristis philadelphica*).

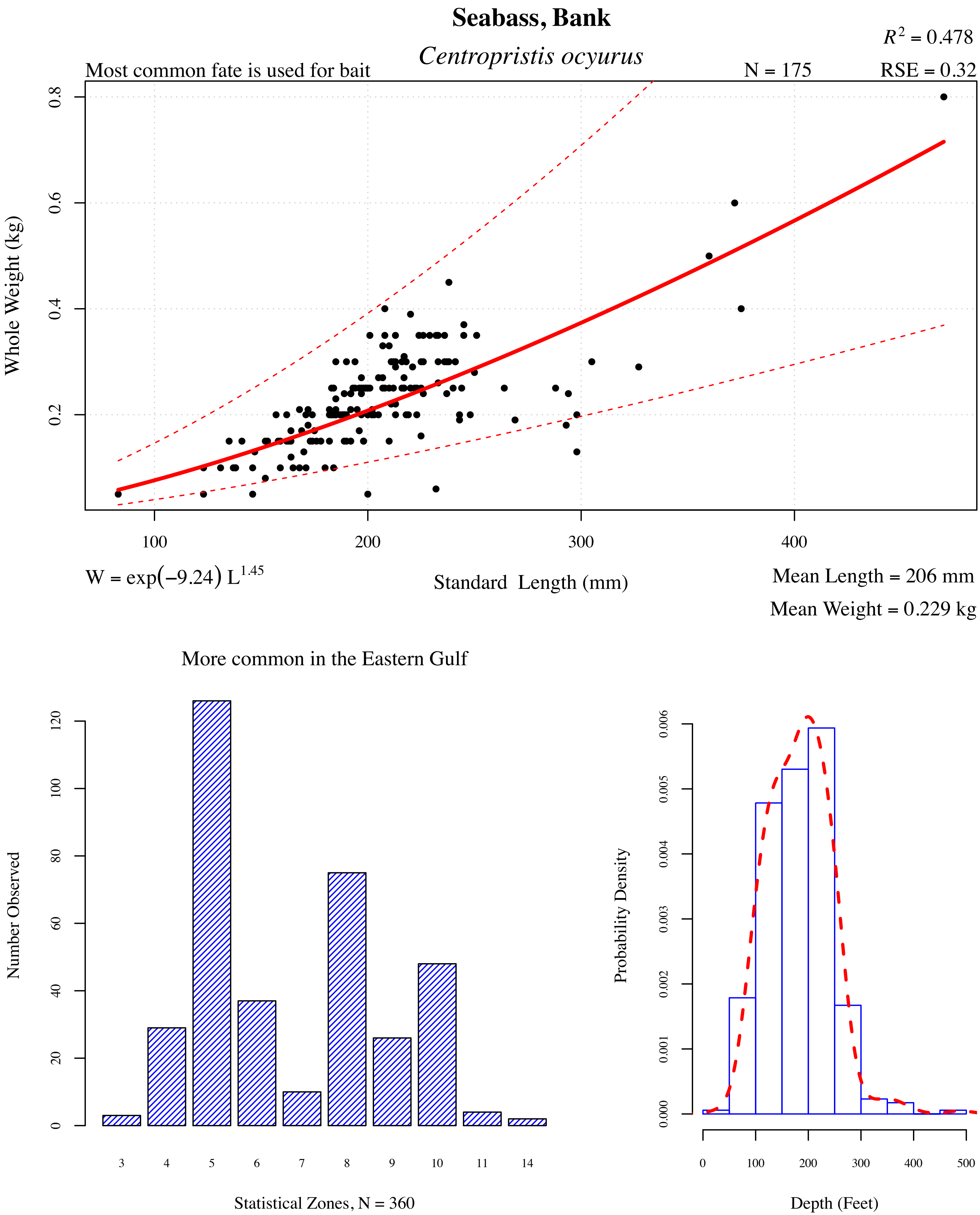


Figure 19 . Regression model, location, and depth information for seabass, bank (*Centropristis ocyurus*).

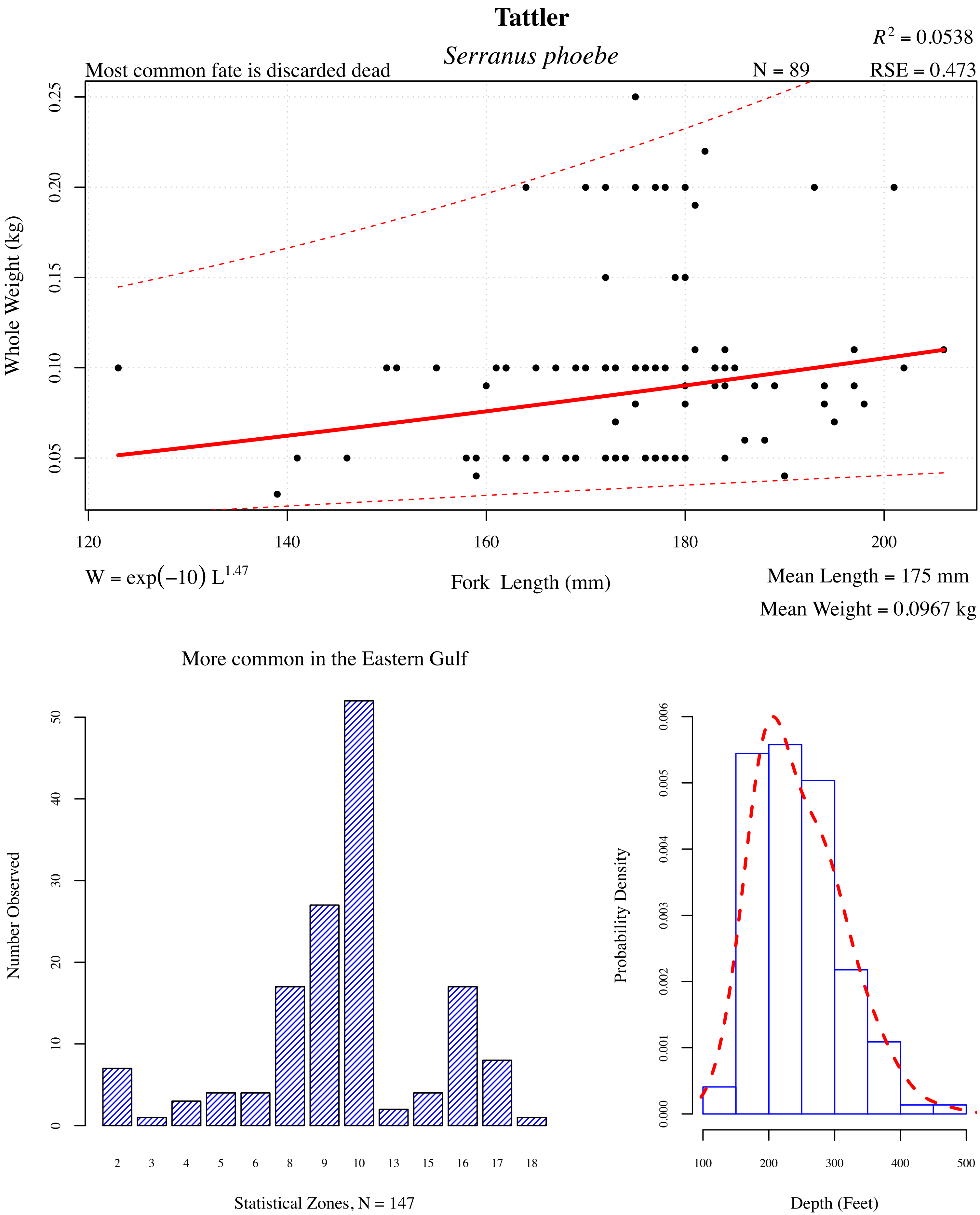
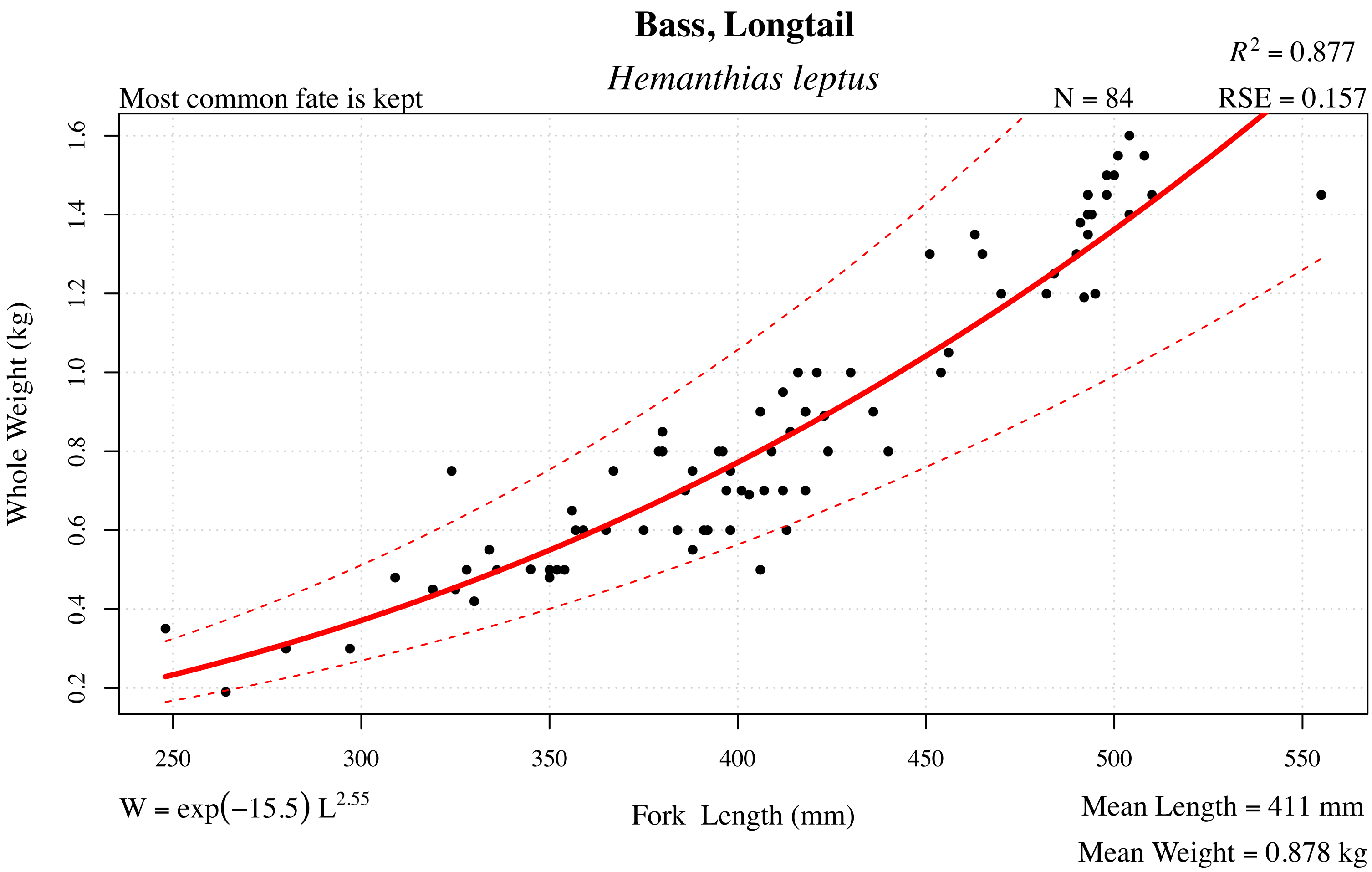
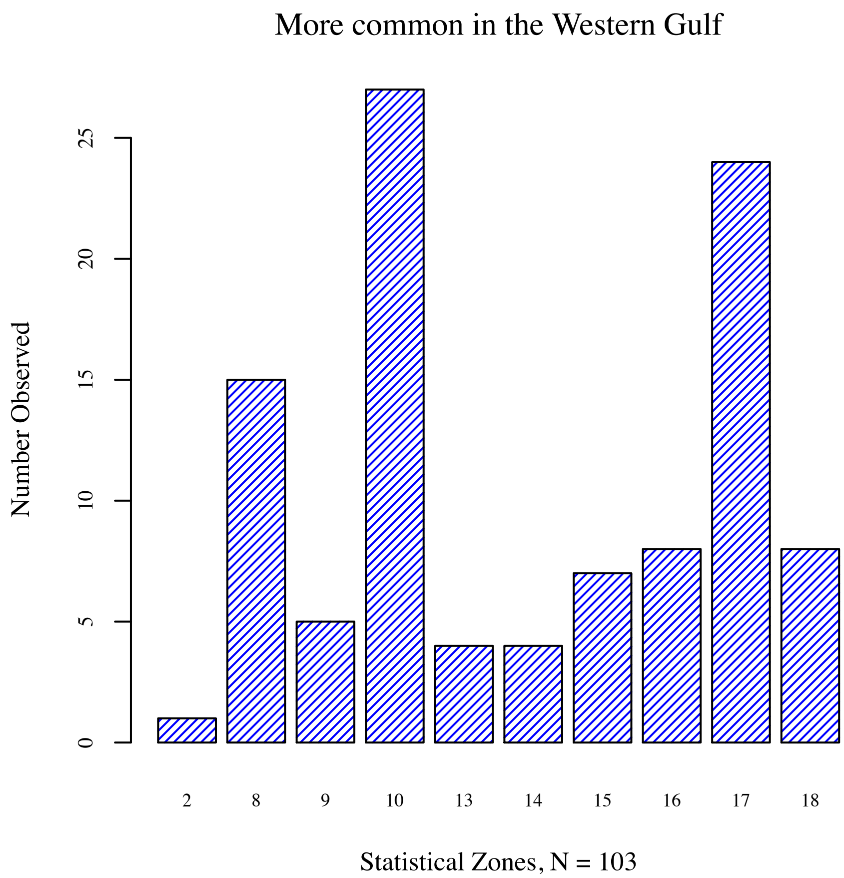


Figure 20 . Regression model, location, and depth information for tattler (*Serranus phoebe*).





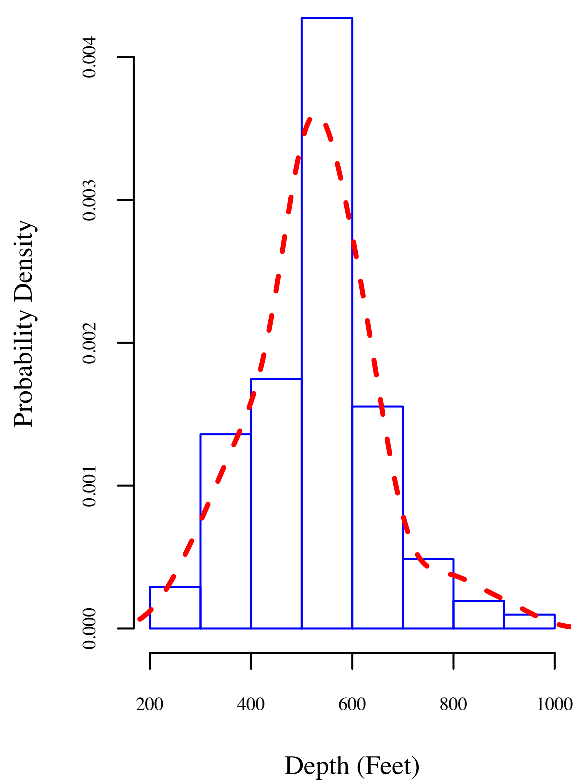


Figure 21 . Regression model, location, and depth information for bass, longtail (*Hemanthias leptus*).

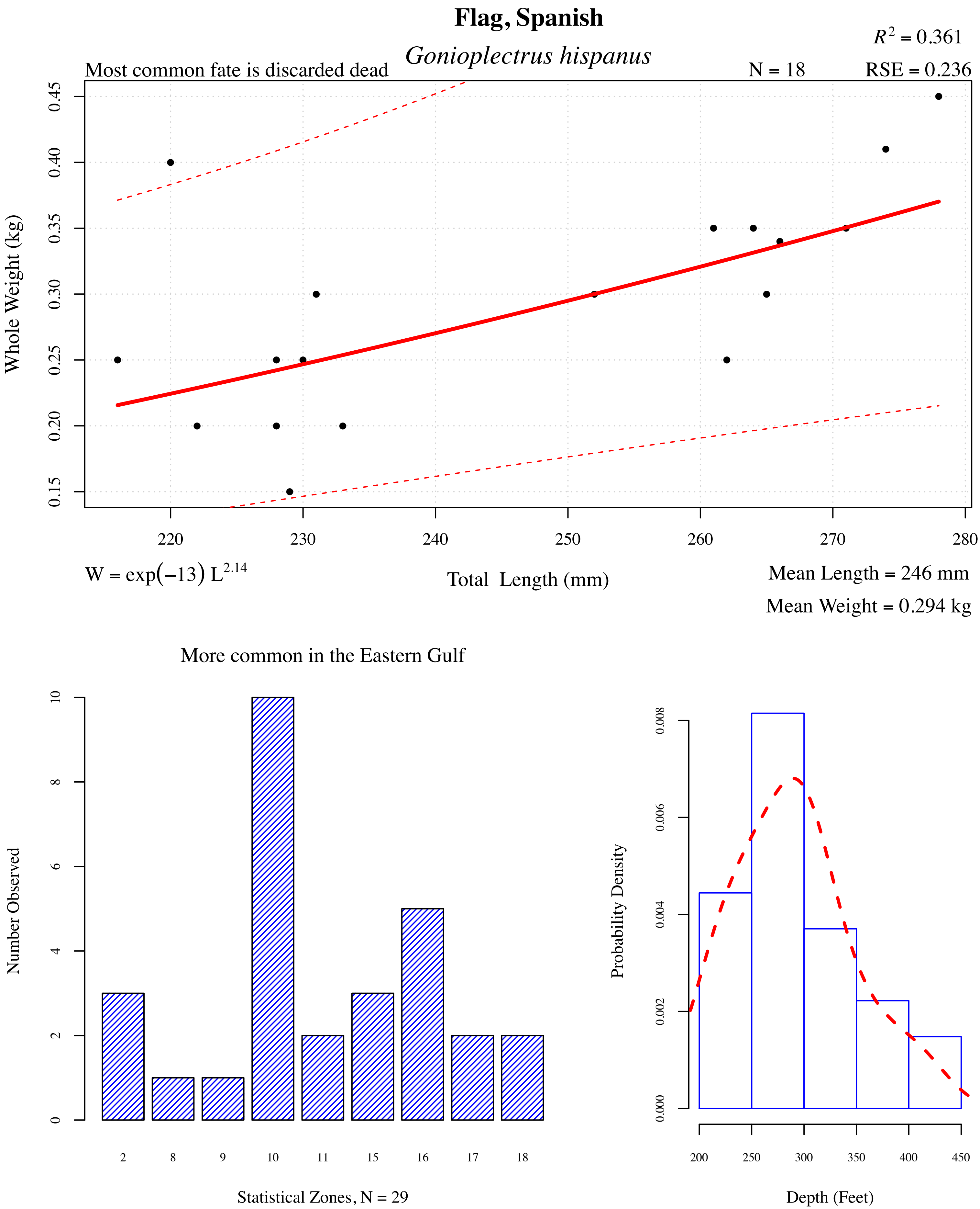


Figure 22 . Regression model, location, and depth information for flag, spanish (*Gonioplectrus hispanus*).

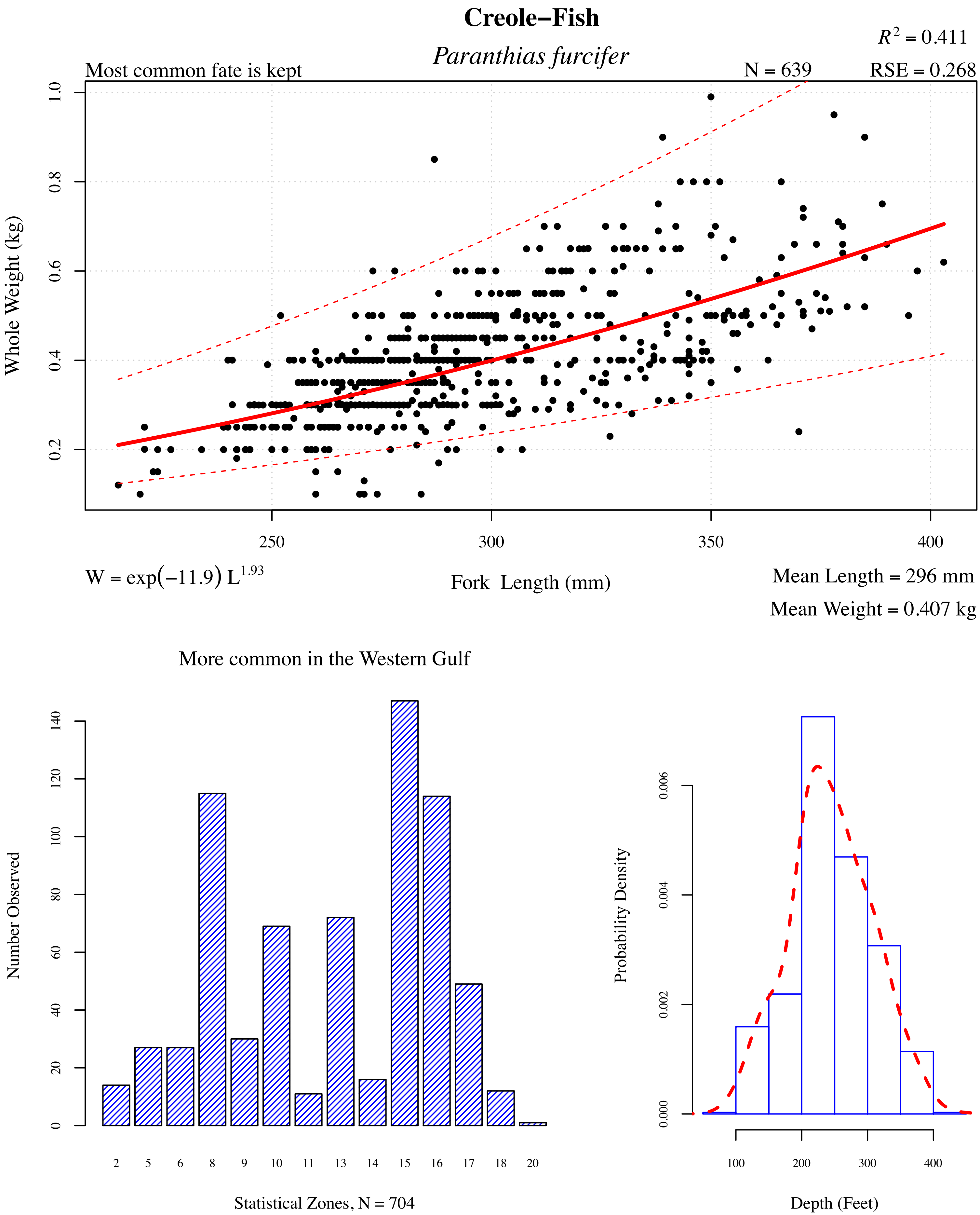


Figure 23 . Regression model, location, and depth information for creole−fish (*Paranthias furcifer*).

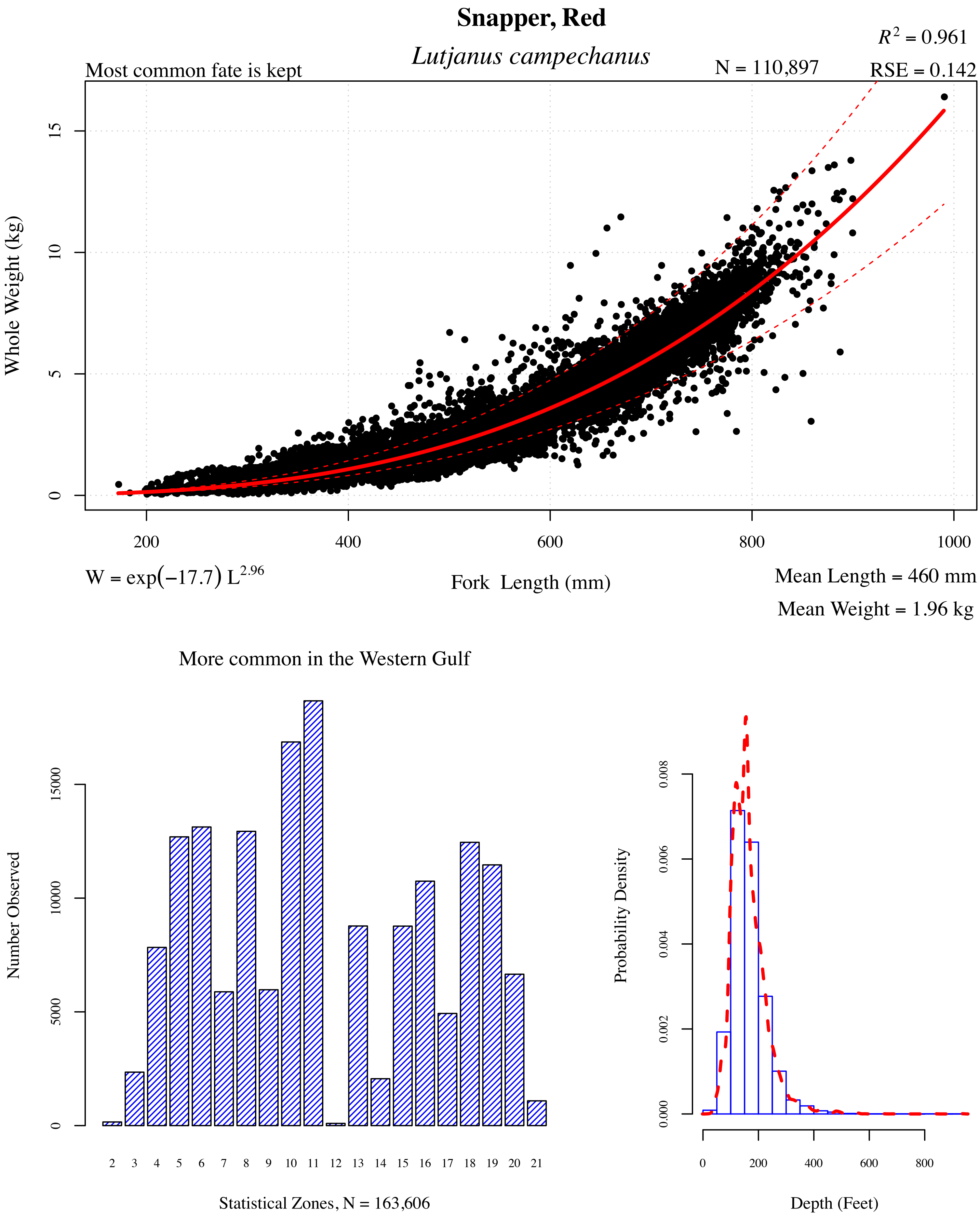


Figure 24 . Regression model, location, and depth information for snapper, red (*Lutjanus campechanus*).

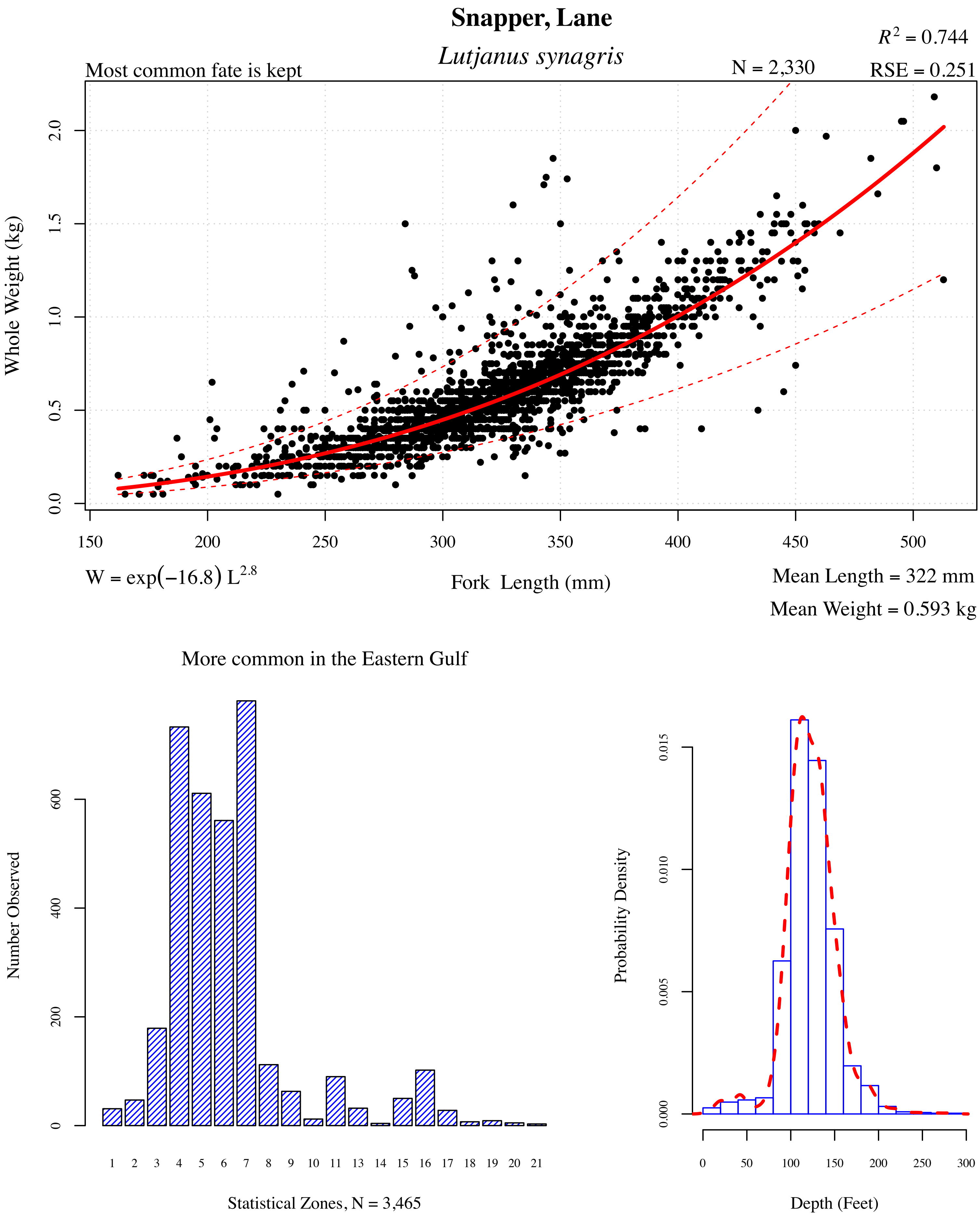


Figure 25 . Regression model, location, and depth information for snapper, lane (*Lutjanus synagris*).

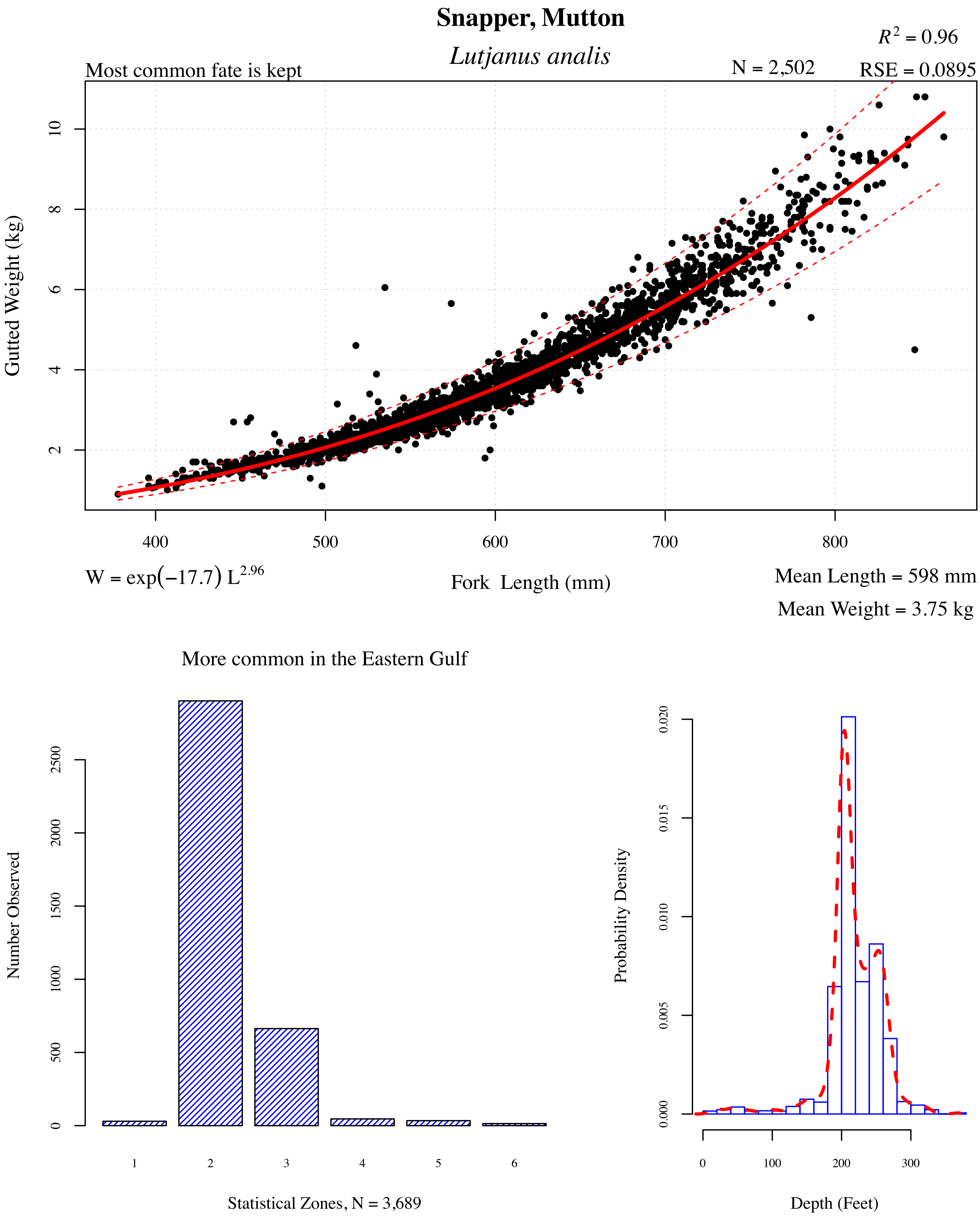


Figure 26 . Regression model, location, and depth information for snapper, mutton (*Lutjanus analis*).

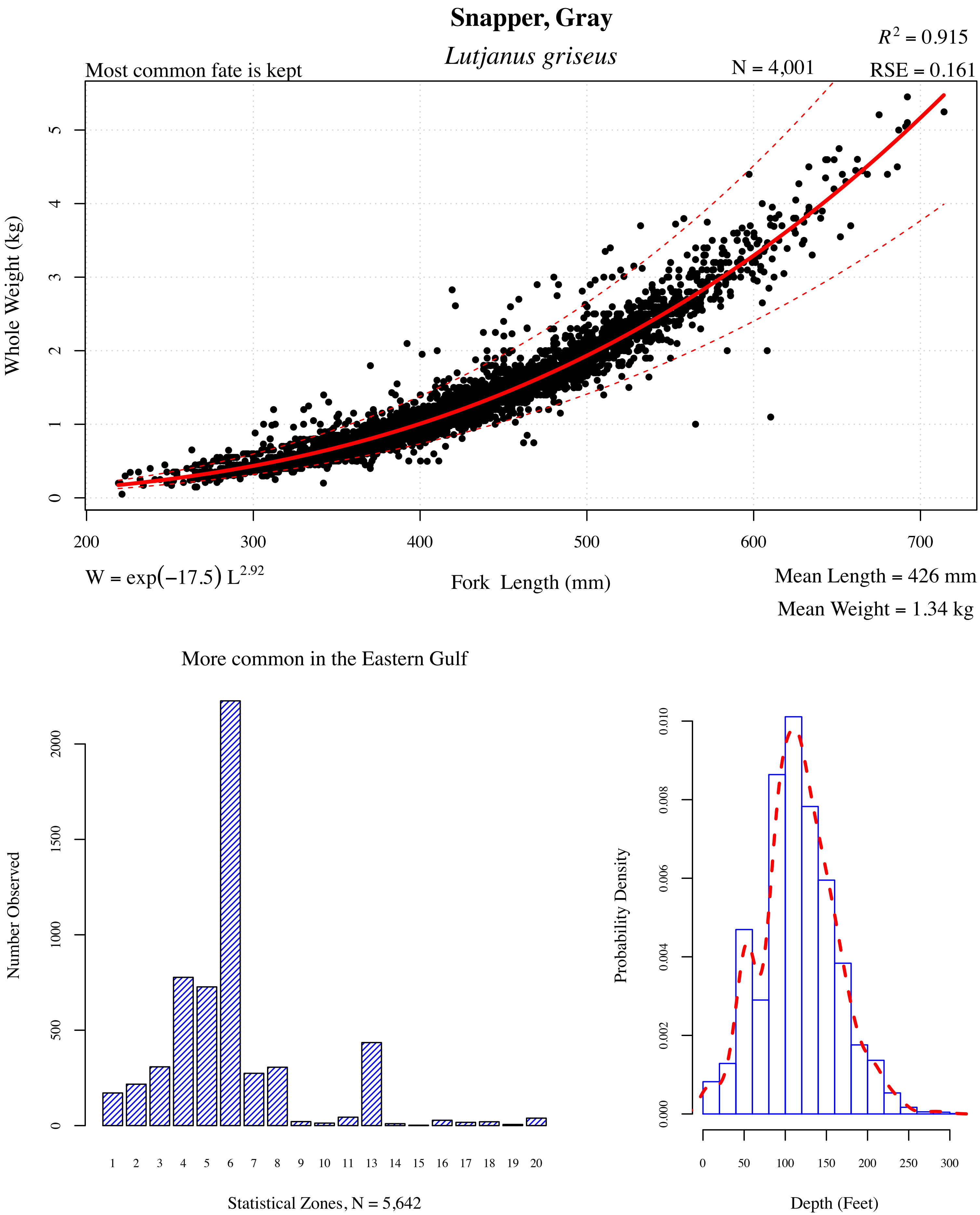
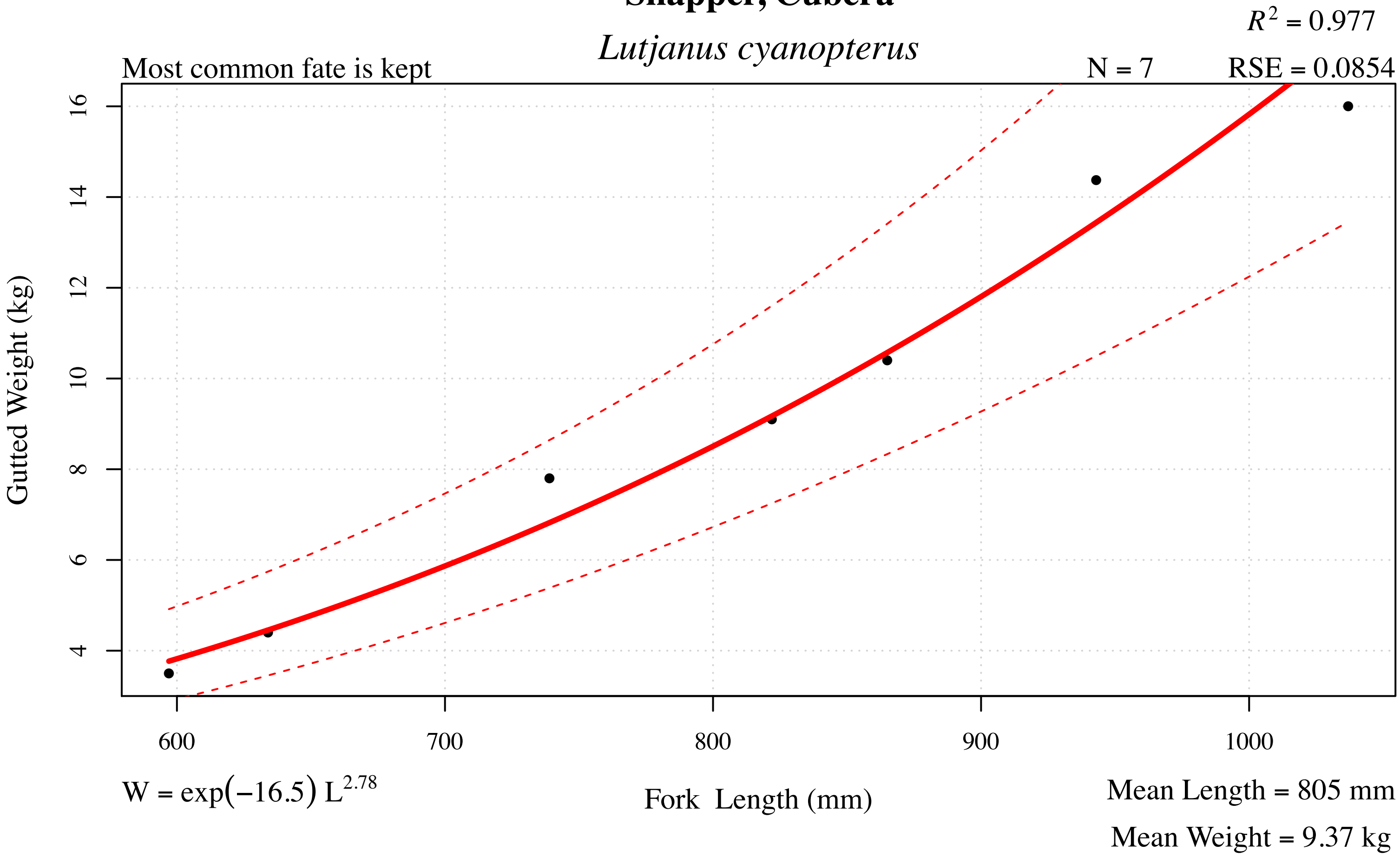
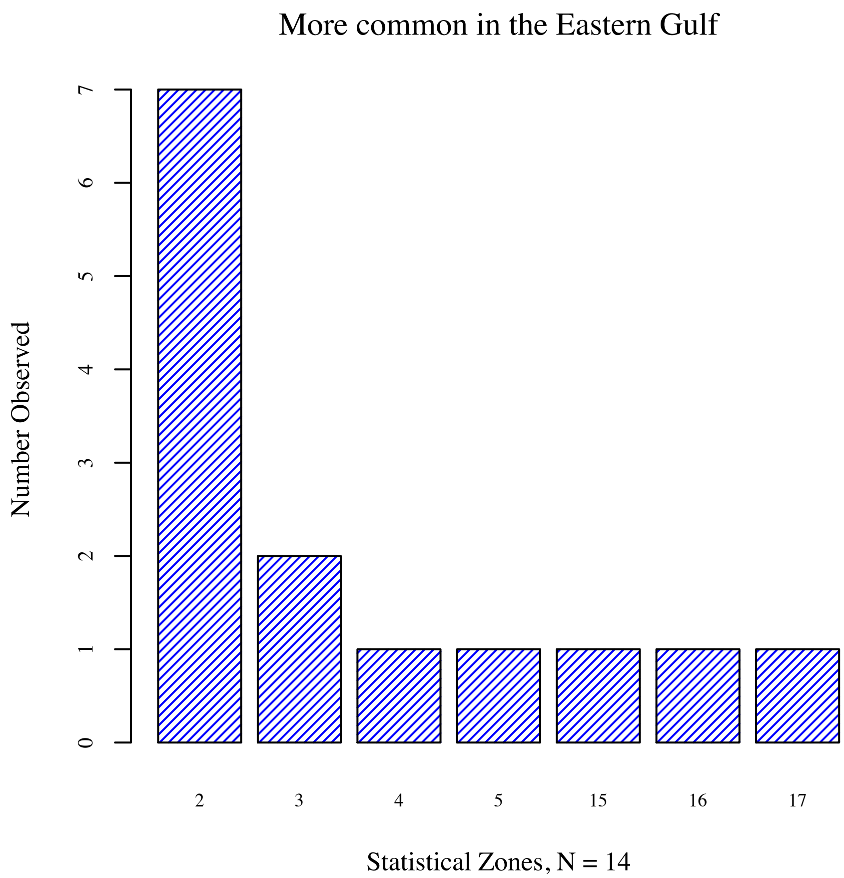


Figure 27 . Regression model, location, and depth information for snapper, gray (*Lutjanus griseus*).

Snapper, Cubera

Lutjanus cyanopterus





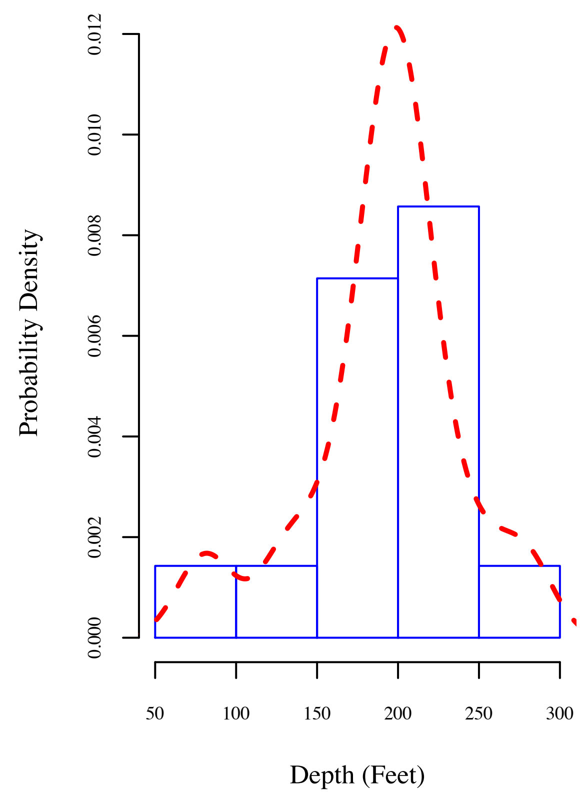
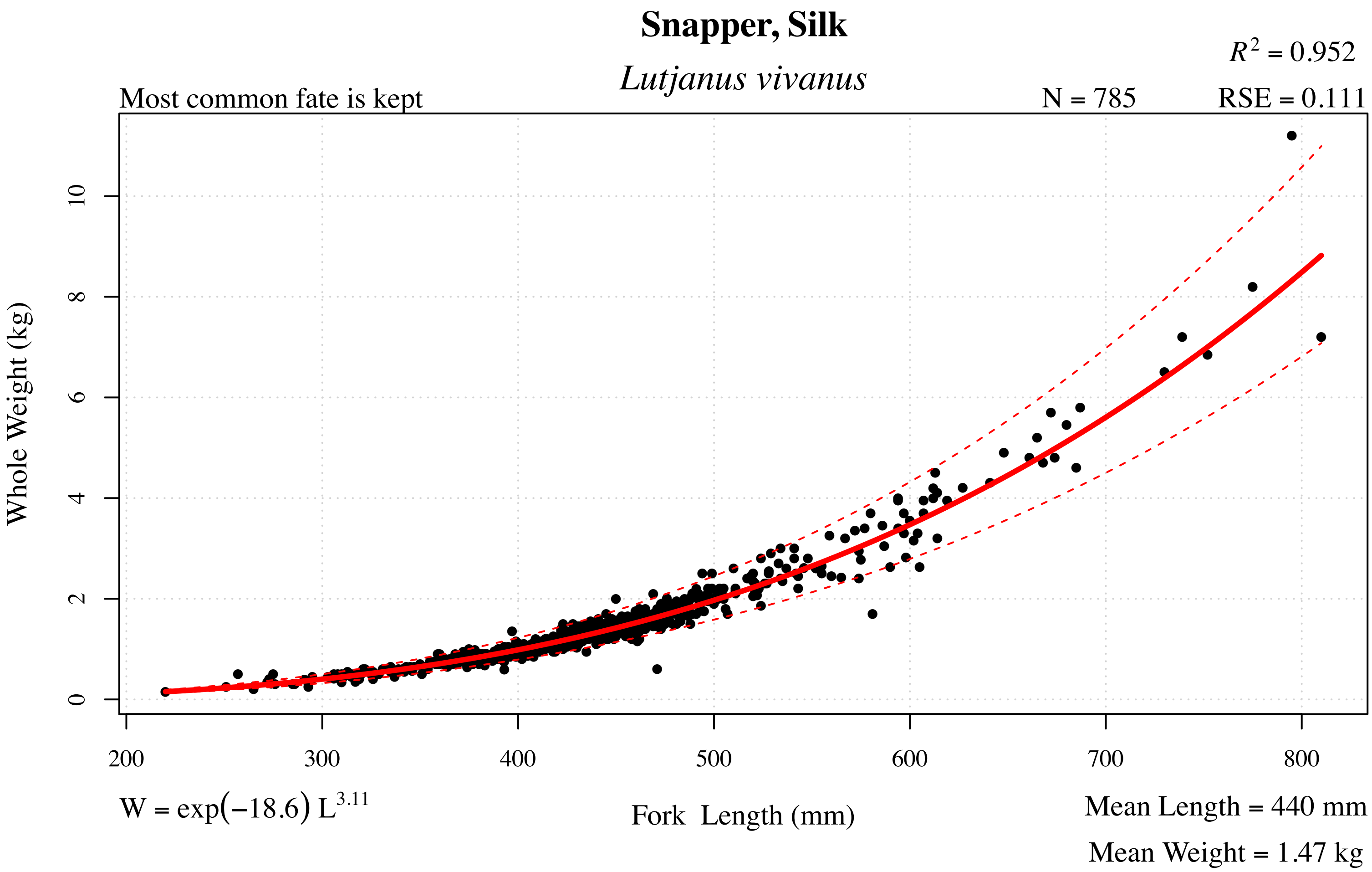
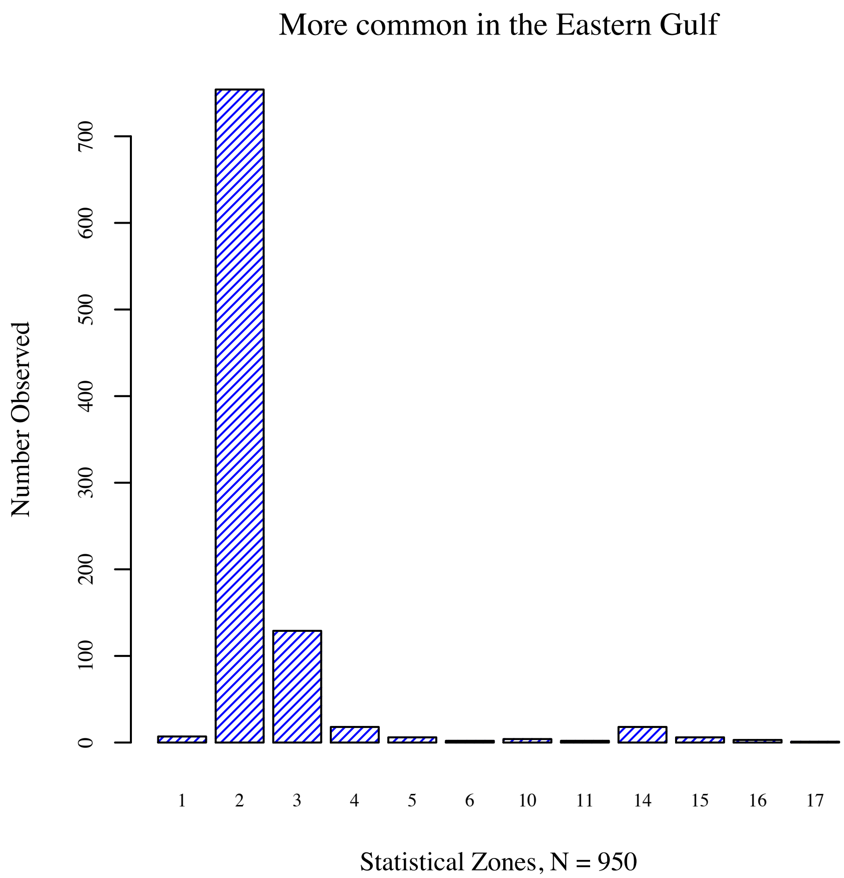


Figure 28 . Regression model, location, and depth information for snapper, cubera (*Lutjanus cyanopterus*).





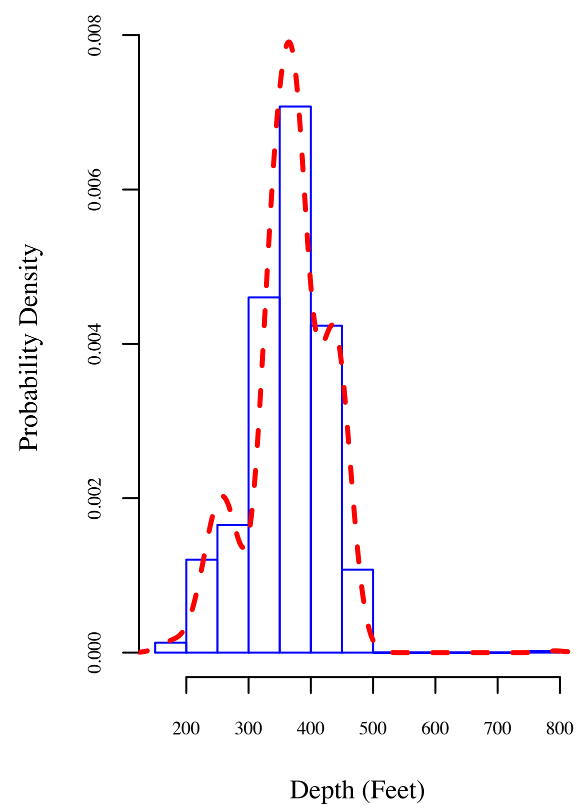


Figure 29 . Regression model, location, and depth information for snapper, silk (*Lutjanus vivanus*).

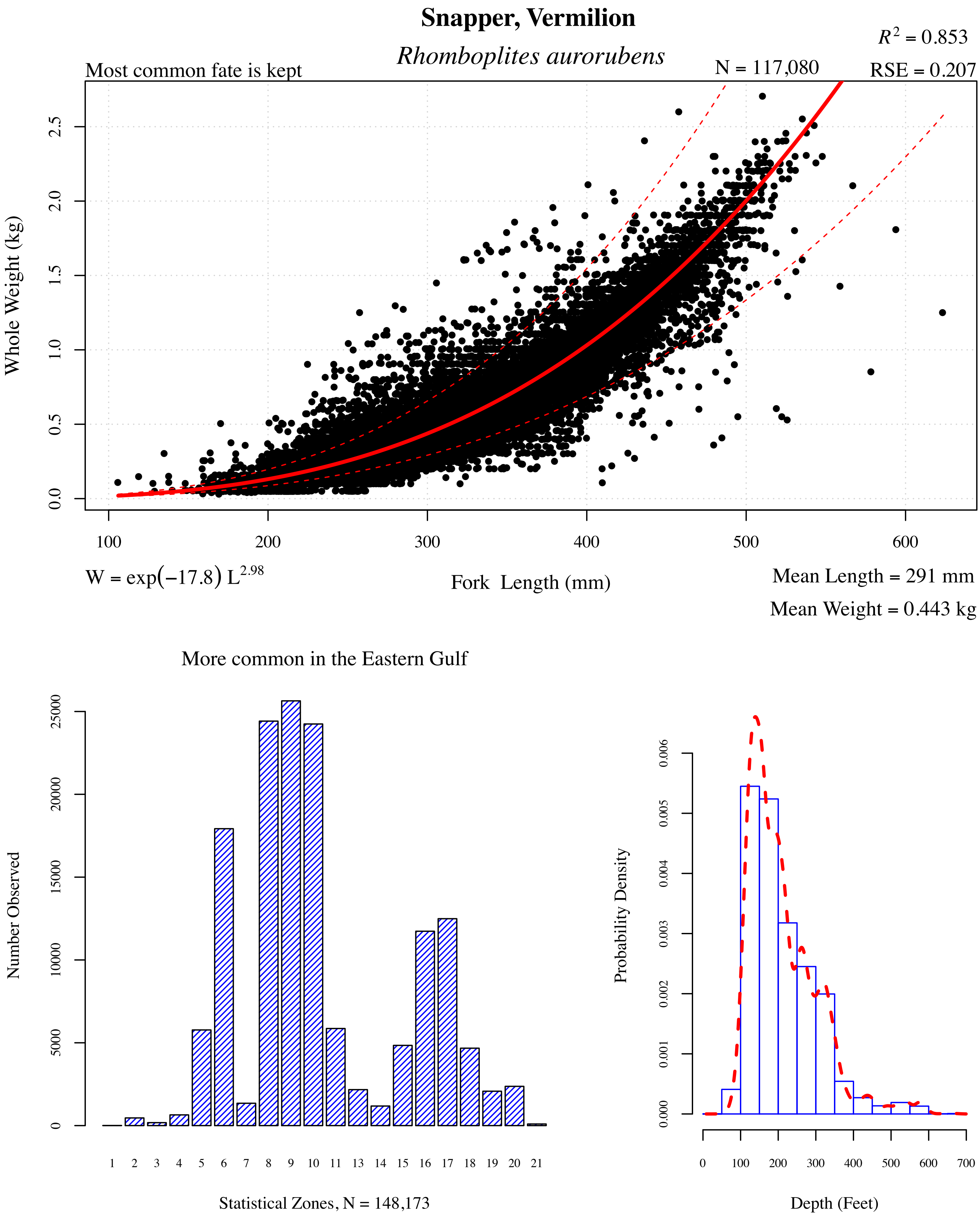


Figure 30 . Regression model, location, and depth information for snapper, vermilion (*Rhomboplites aurorubens*).

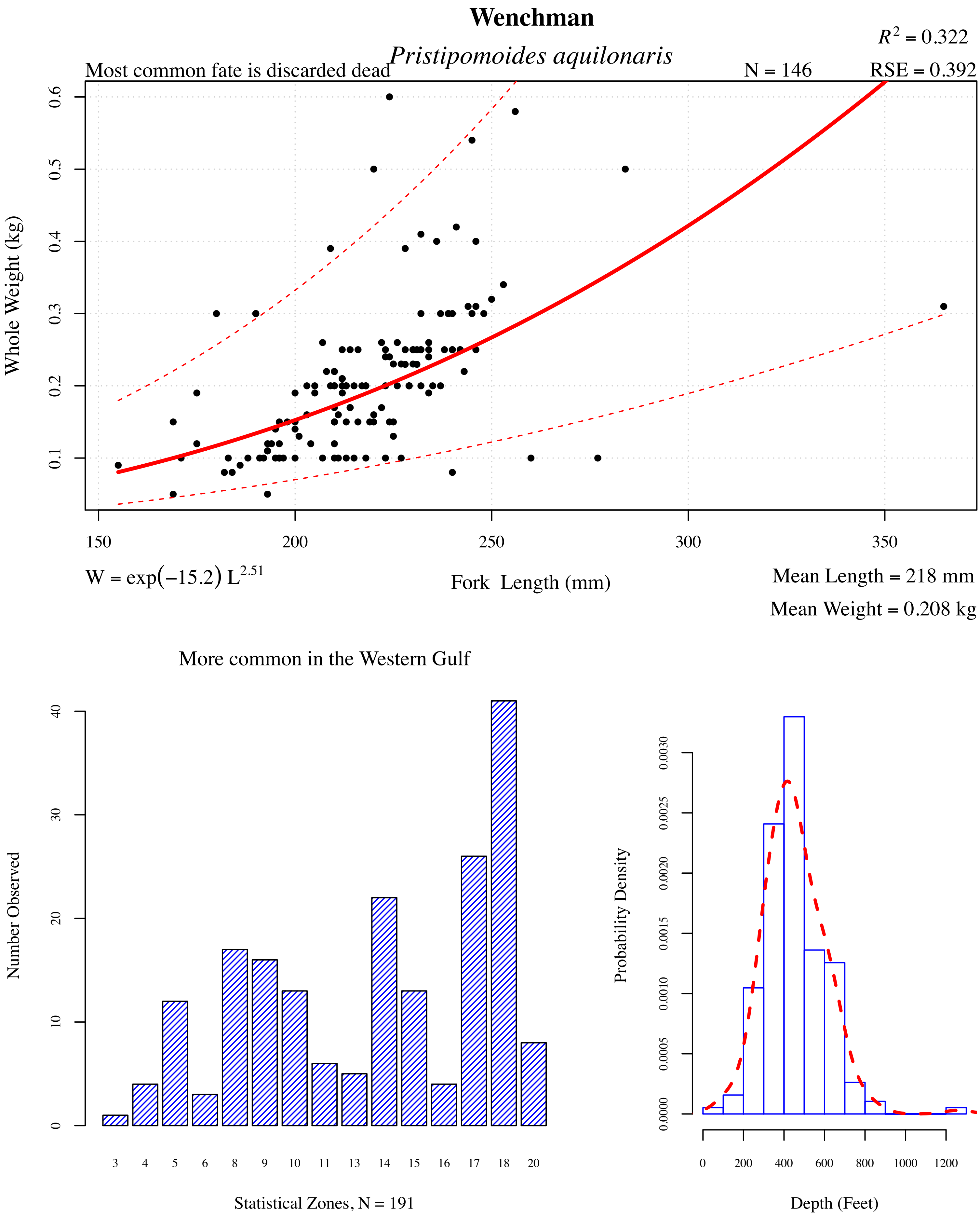


Figure 31 . Regression model, location, and depth information for wenchman (*Pristipomoides aquilonaris*).

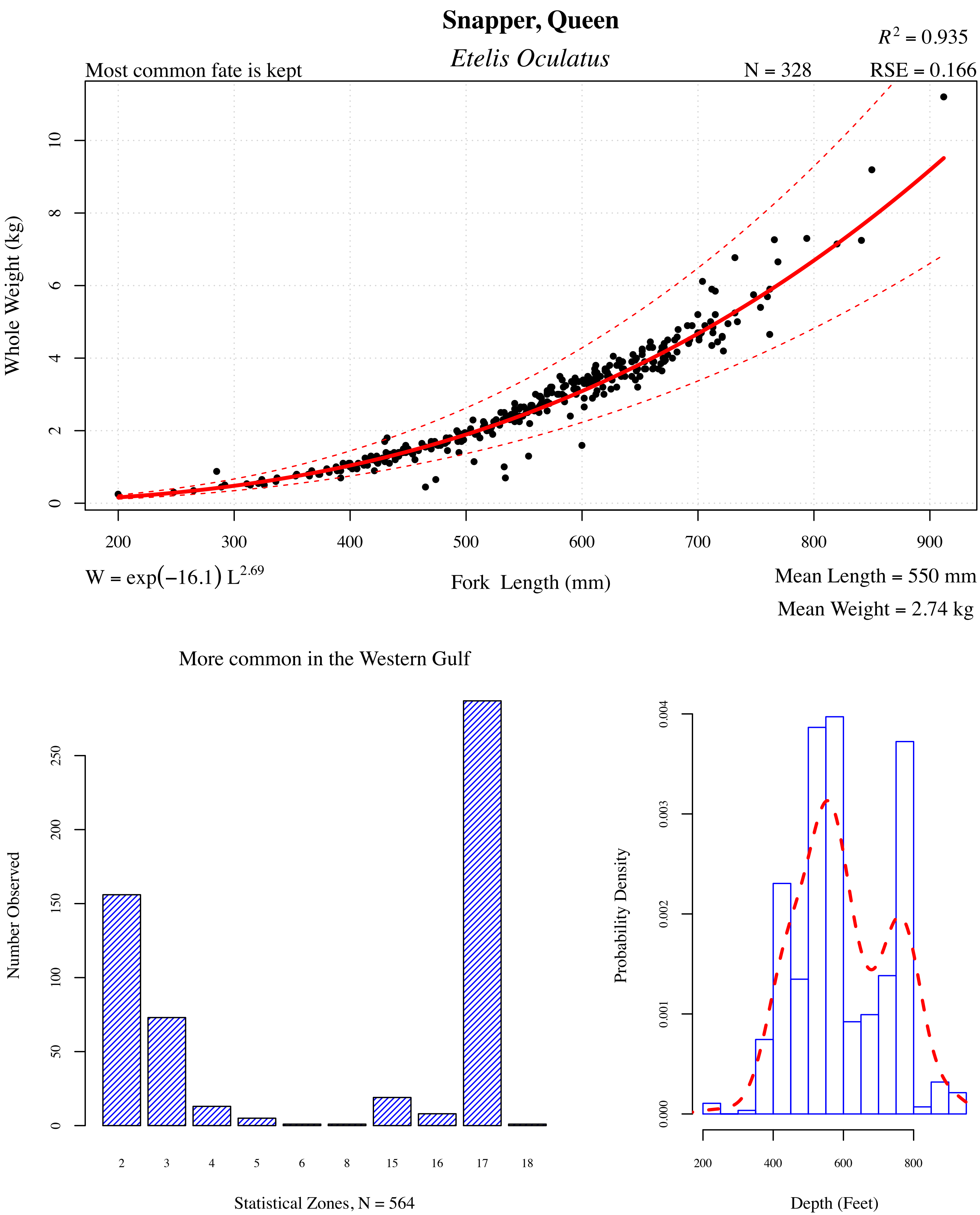


Figure 32 . Regression model, location, and depth information for snapper, queen (*Etelis Oculatus*).

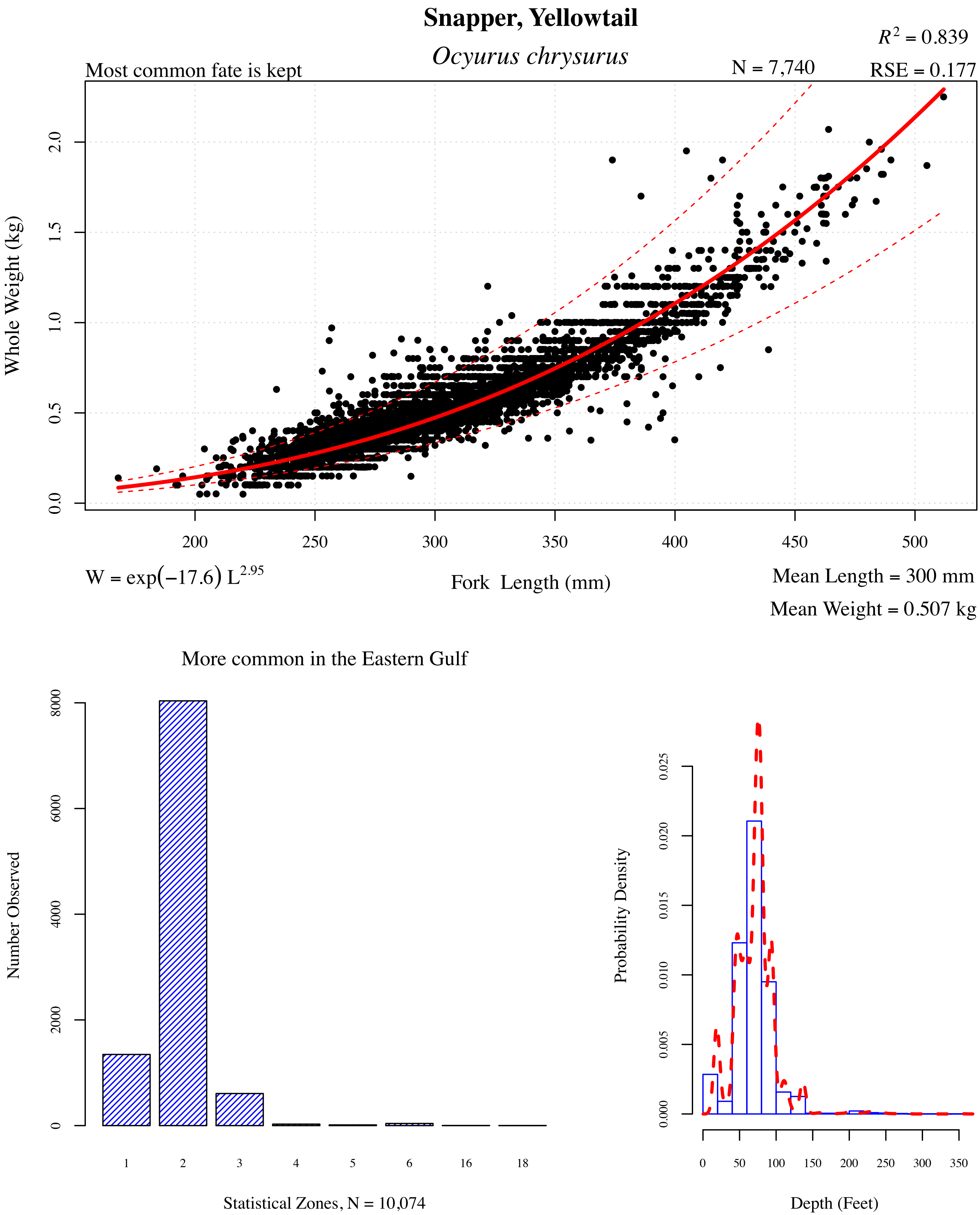


Figure 33 . Regression model, location, and depth information for snapper, yellowtail (*Ocyurus chrysurus*).

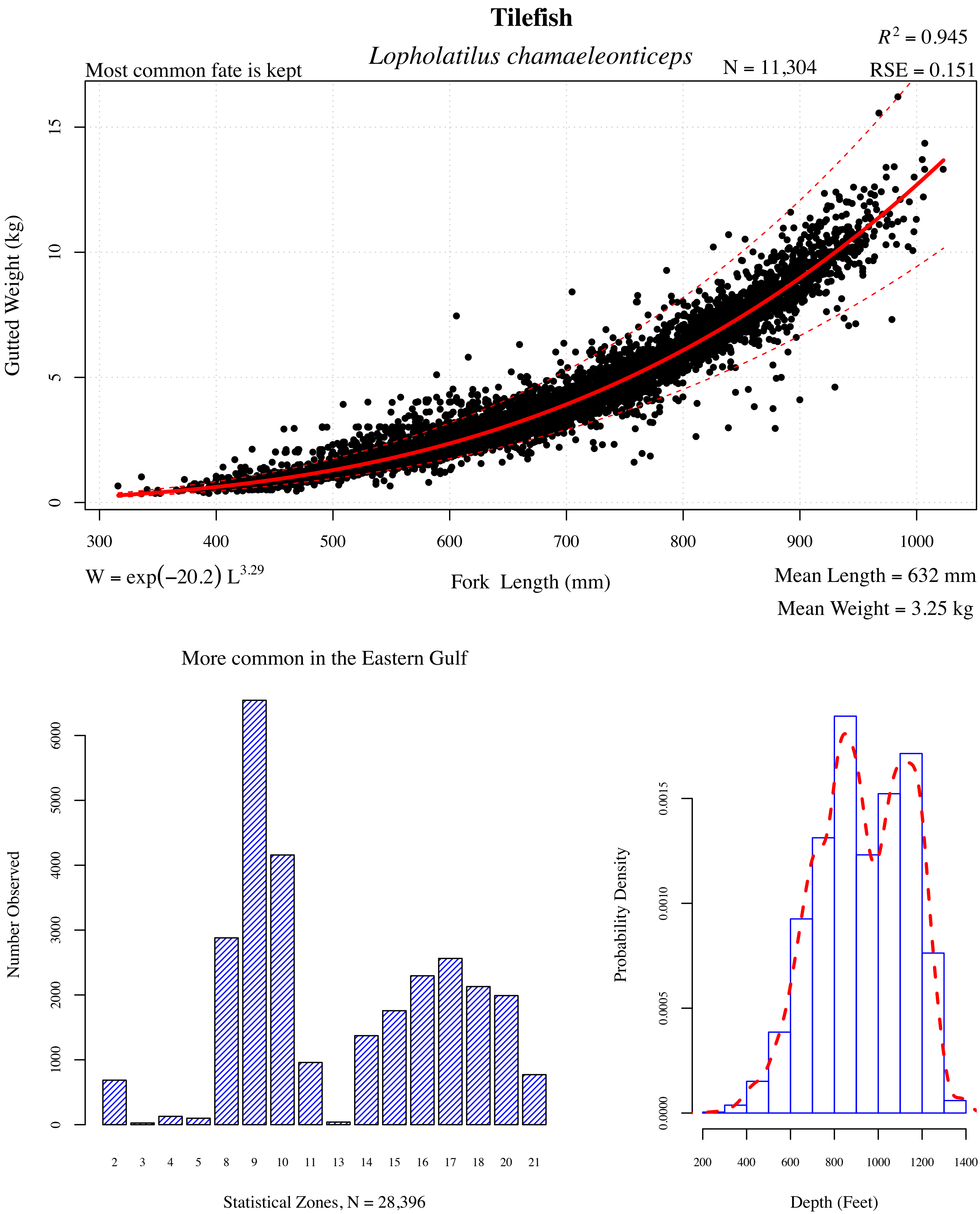


Figure 34 . Regression model, location, and depth information for tilefish (*Lopholatilus chamaeleonticeps*).

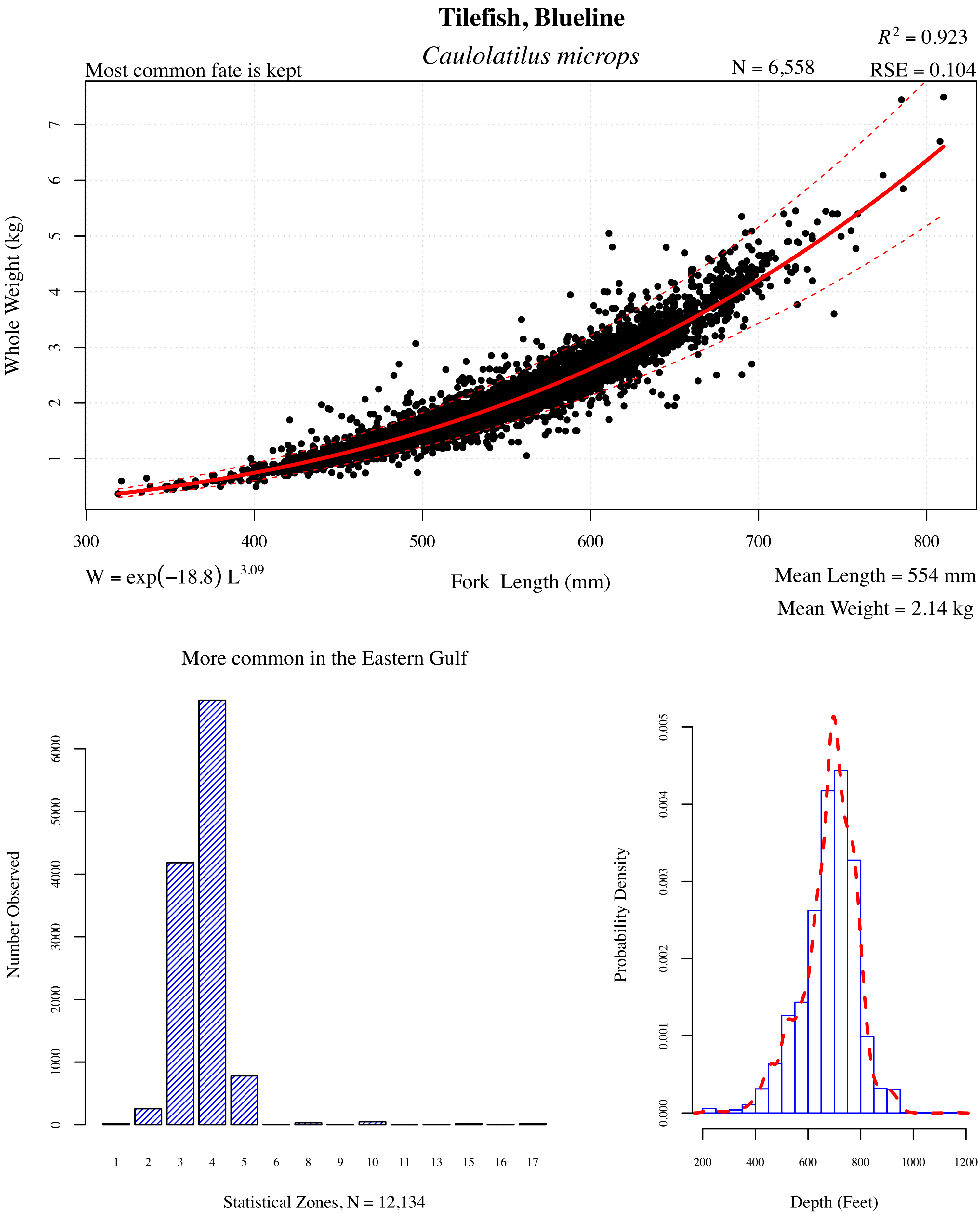
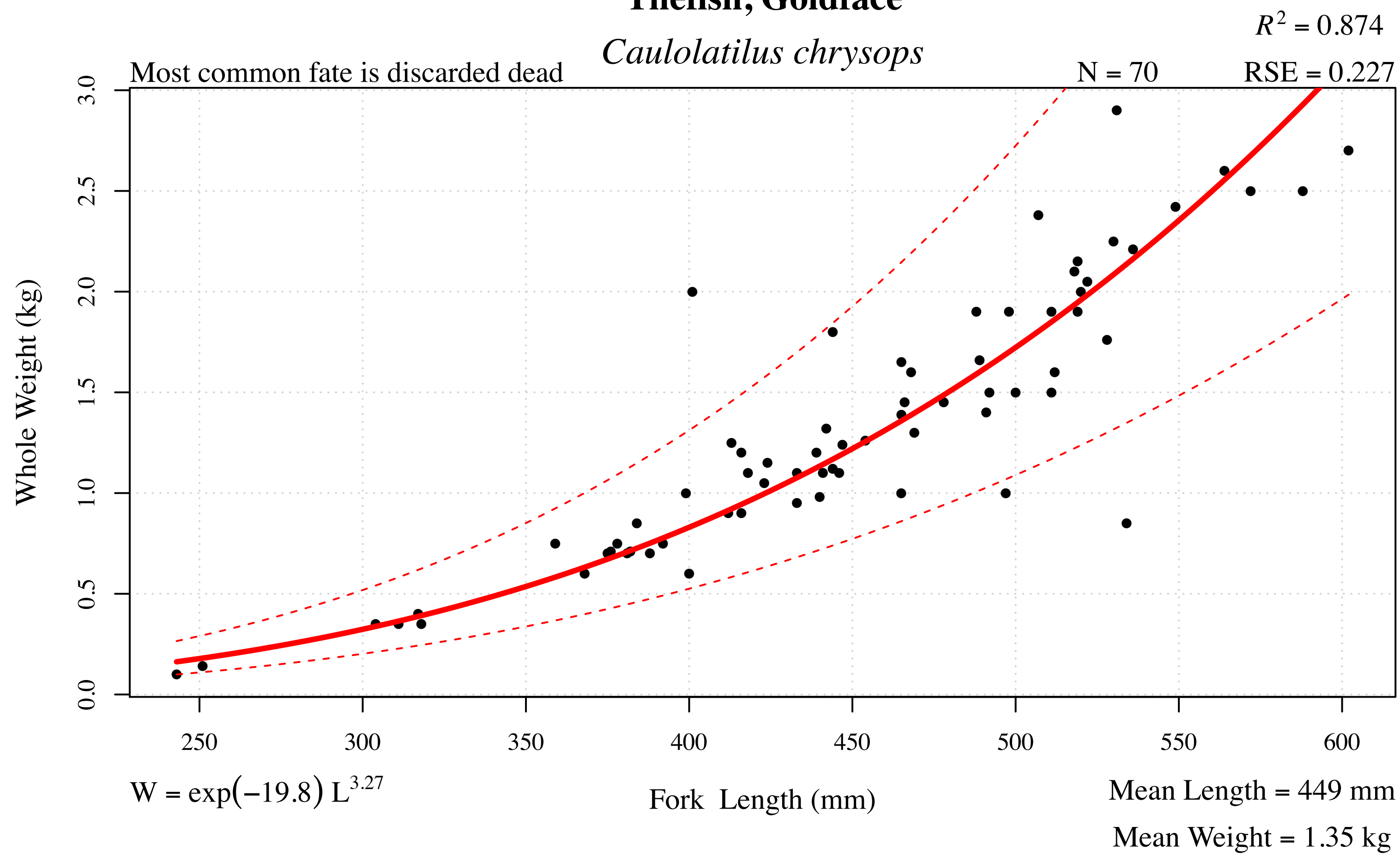


Figure 35 . Regression model, location, and depth information for tilefish, blueline (*Caulolatilus microps*).

Tilefish, Goldface

Caulolatilus chrysops



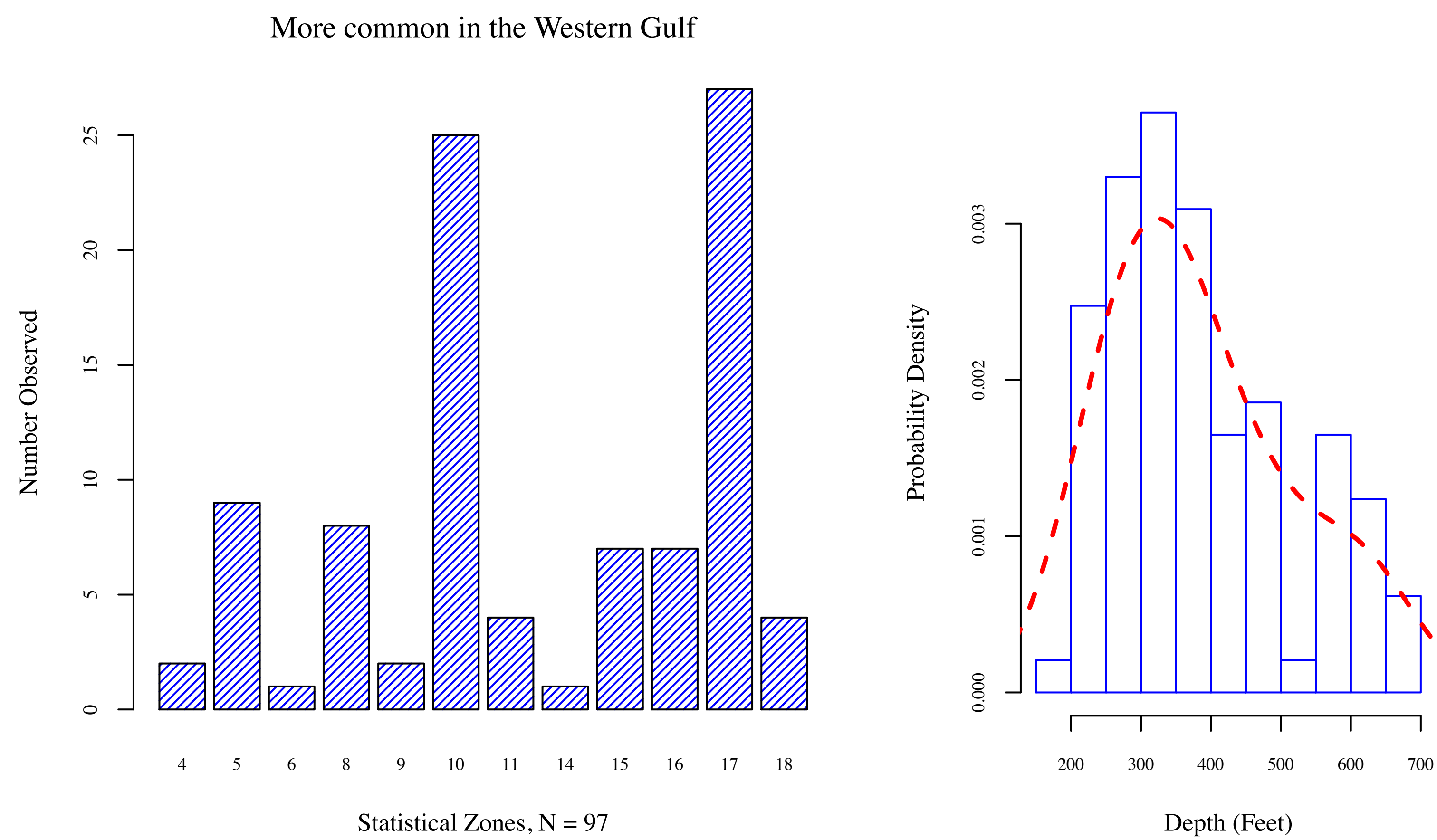


Figure 36 . Regression model, location, and depth information for tilefish, goldface (*Caulolatilus chrysops*).

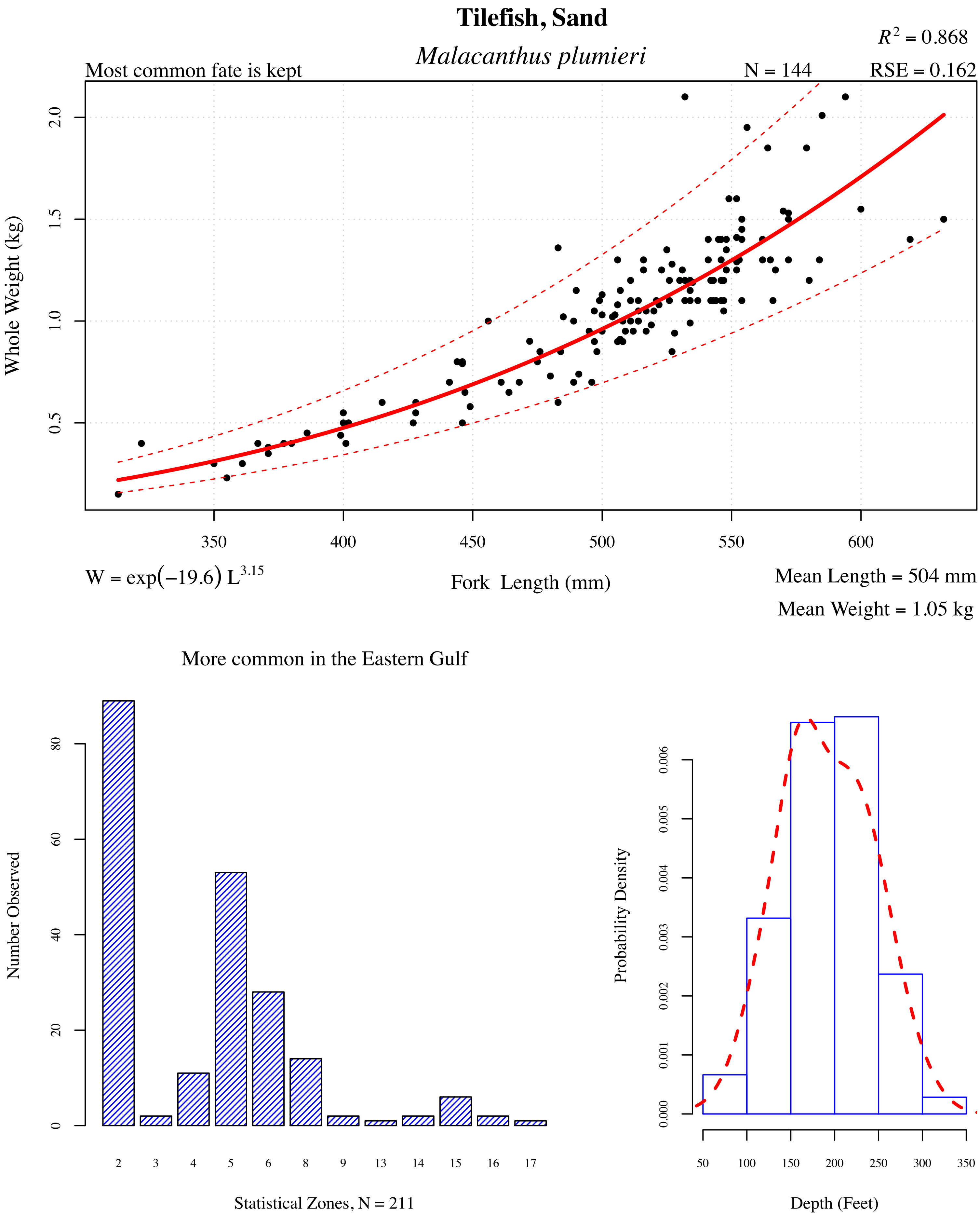


Figure 37 . Regression model, location, and depth information for tilefish, sand (*Malacanthus plumieri*).

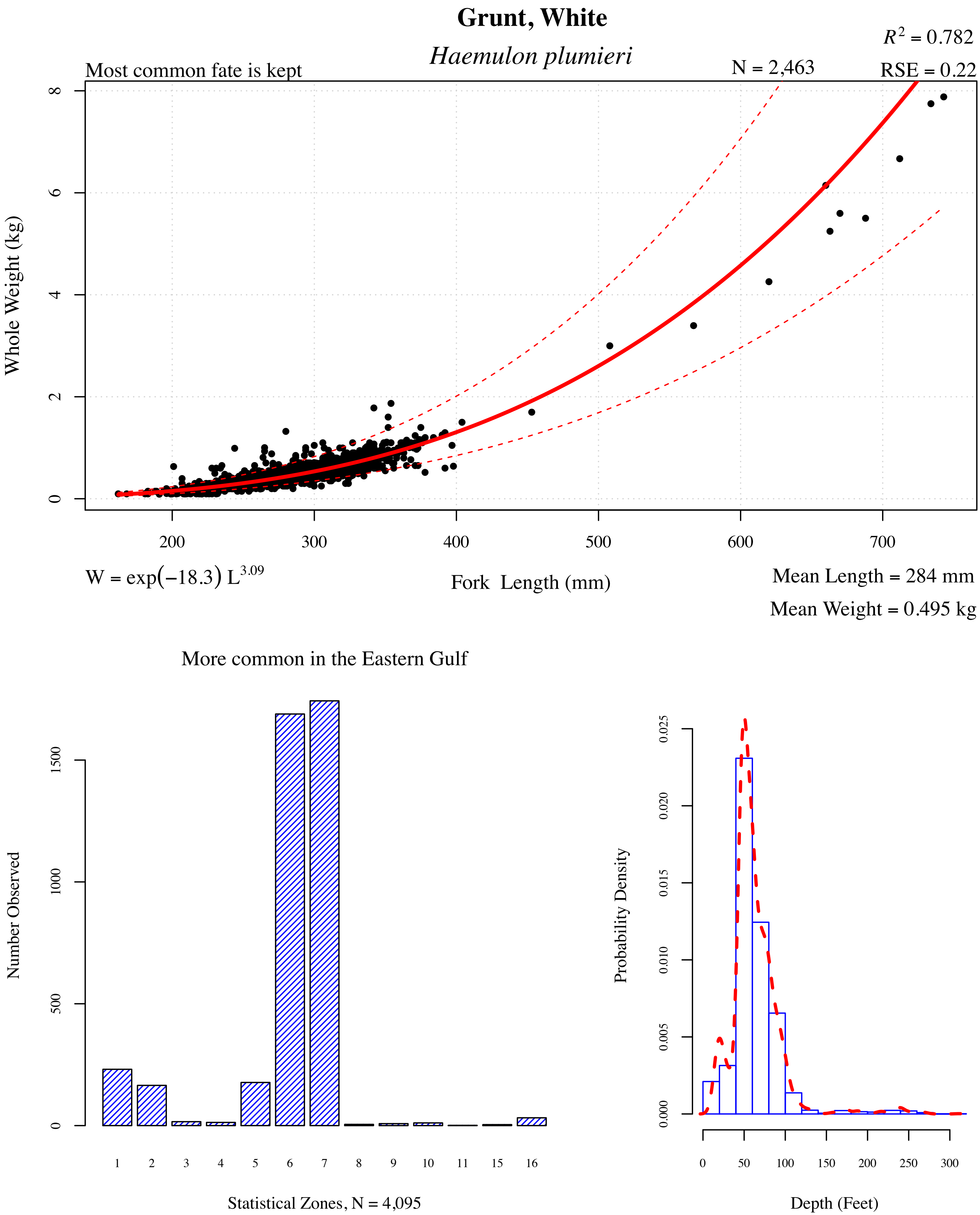
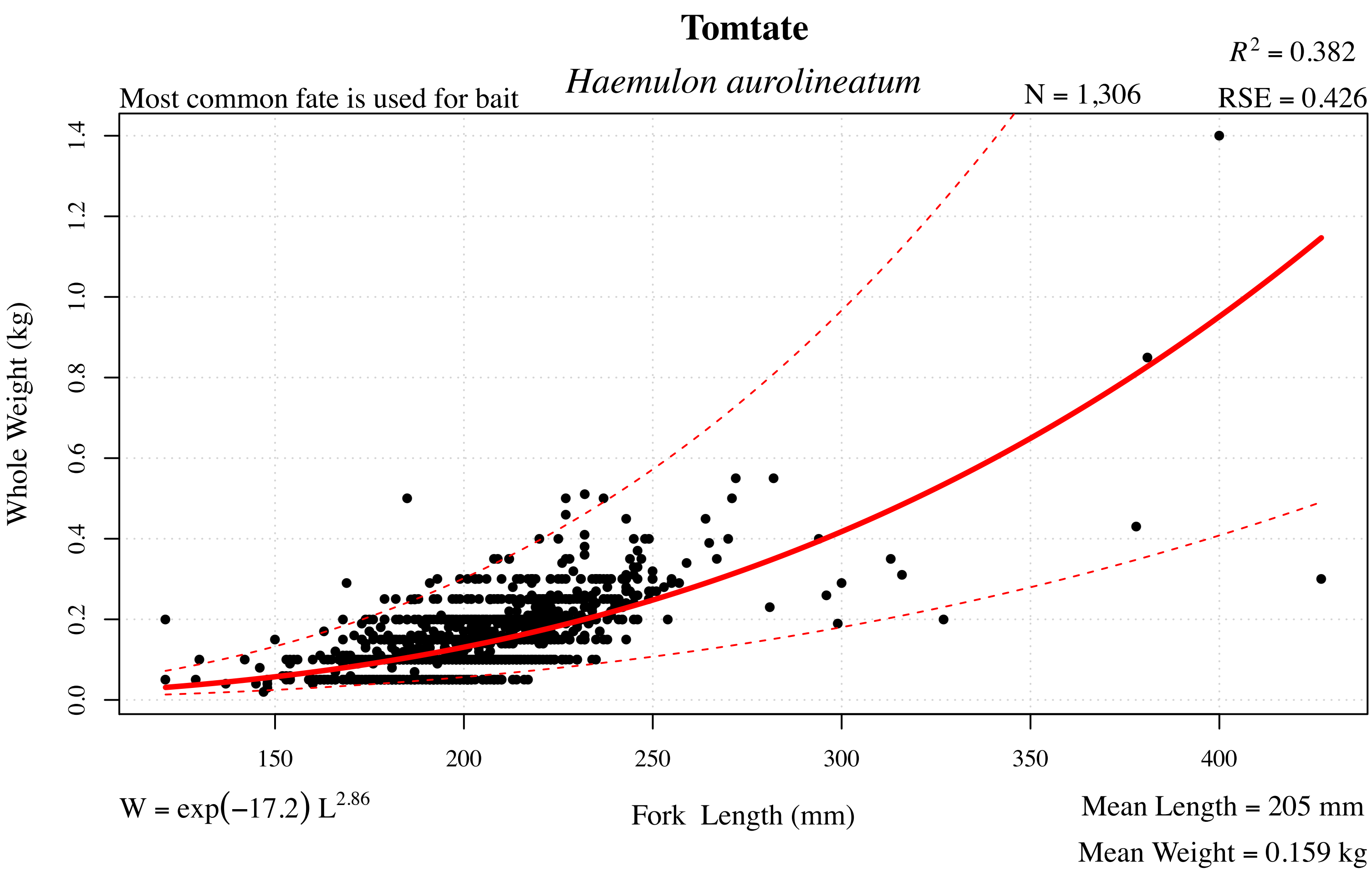
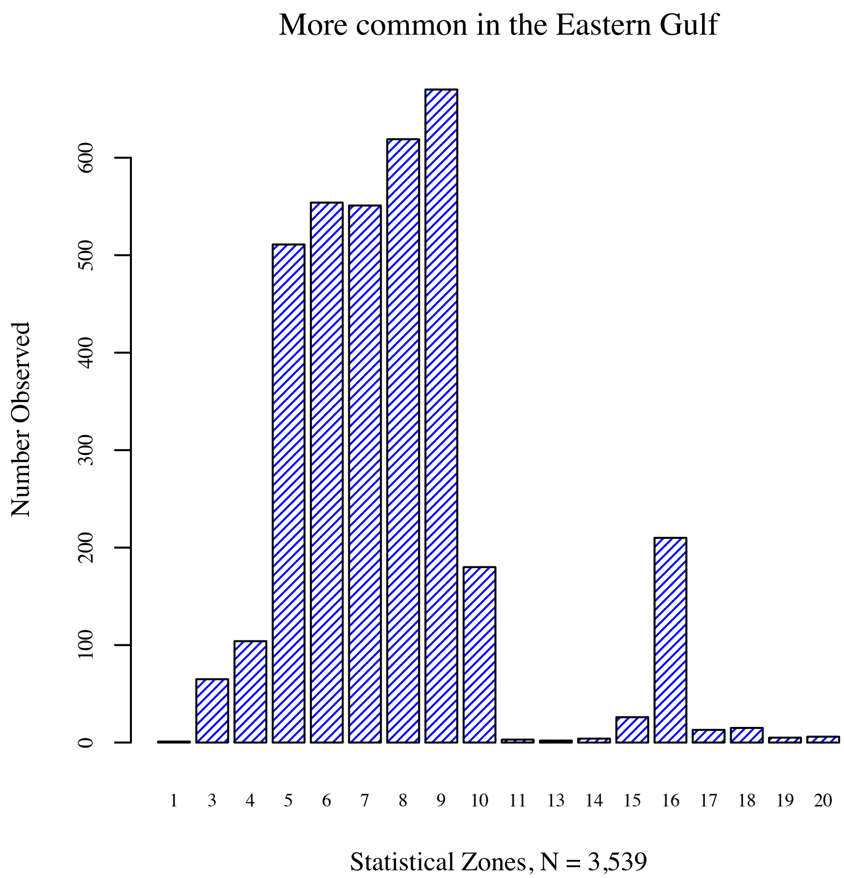


Figure 38 . Regression model, location, and depth information for grunt, white (*Haemulon plumieri*).





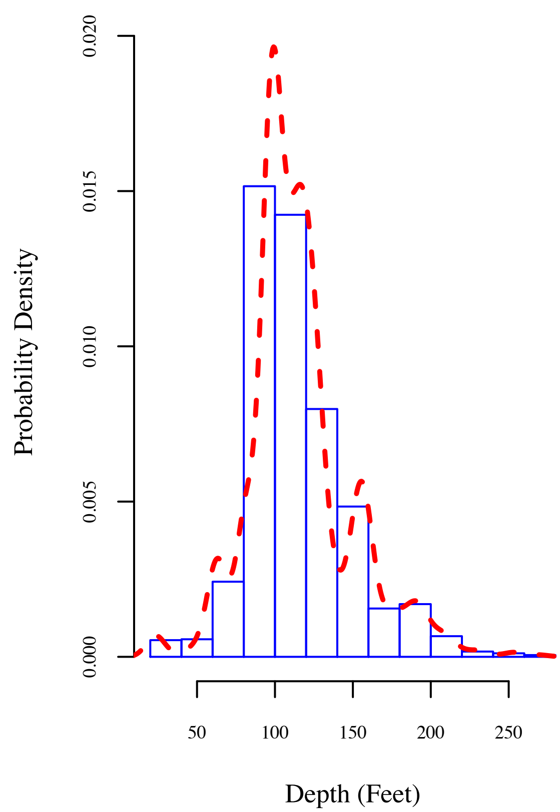


Figure 39 . Regression model, location, and depth information for tomtate (*Haemulon aurolineatum*).

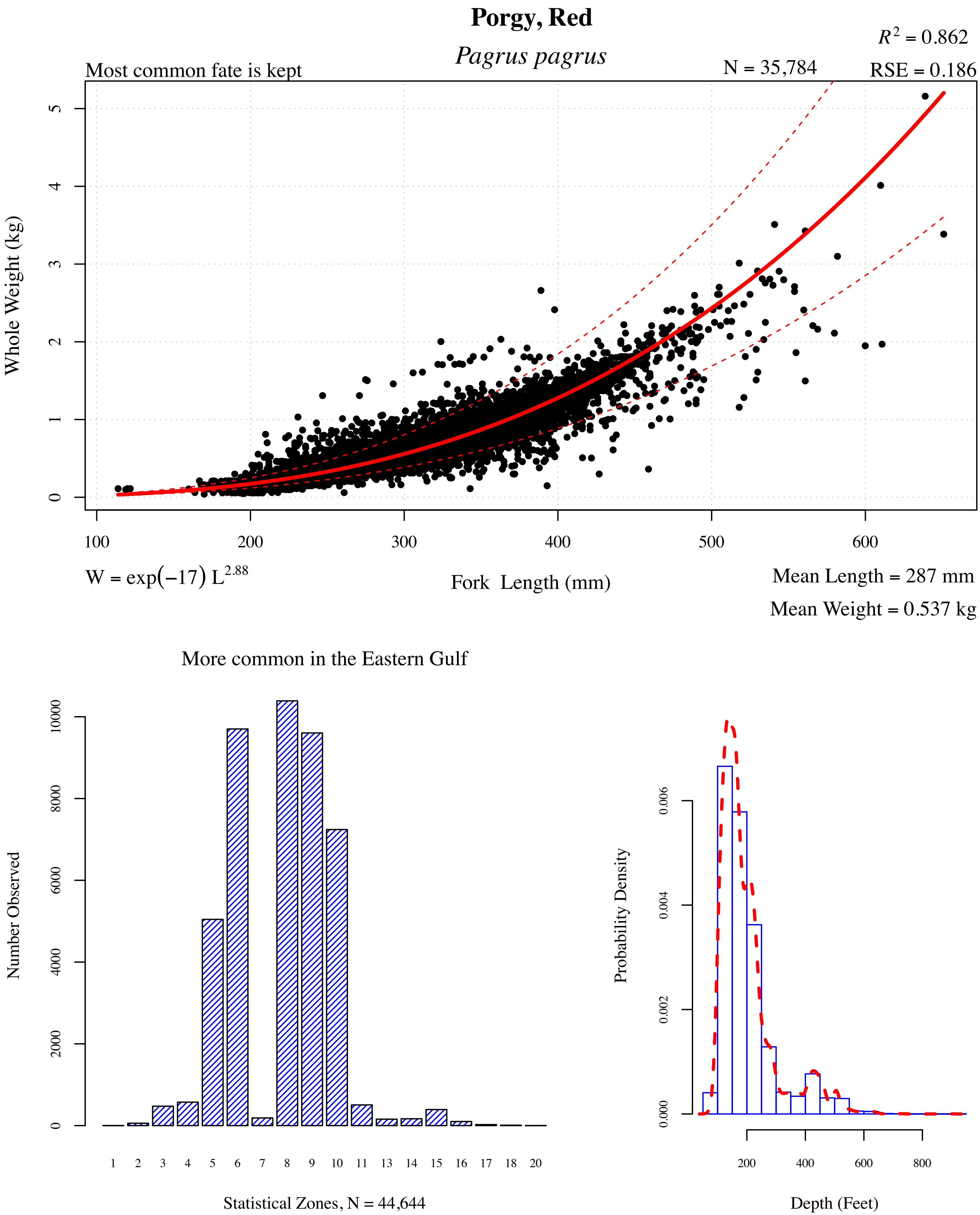
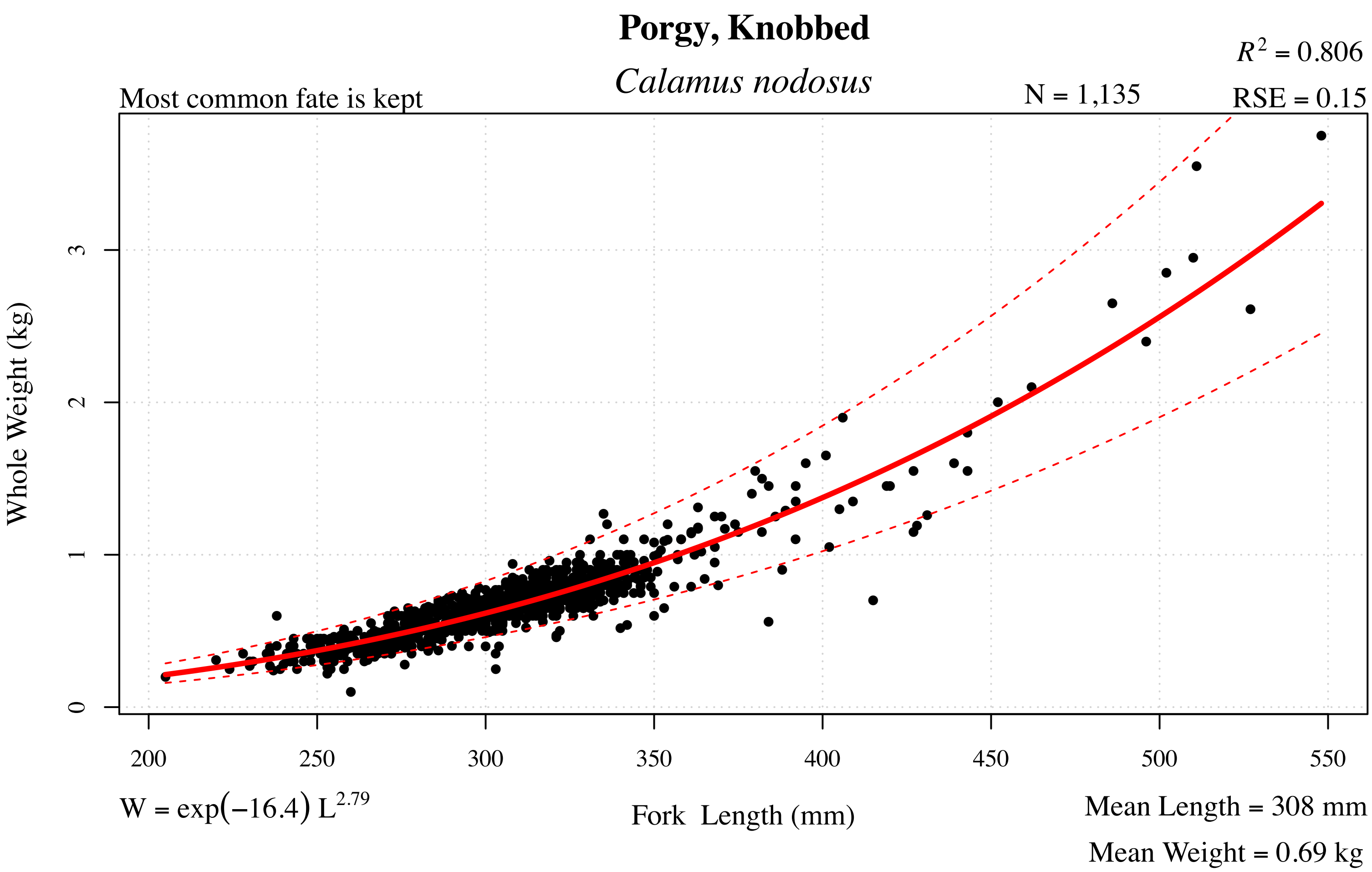
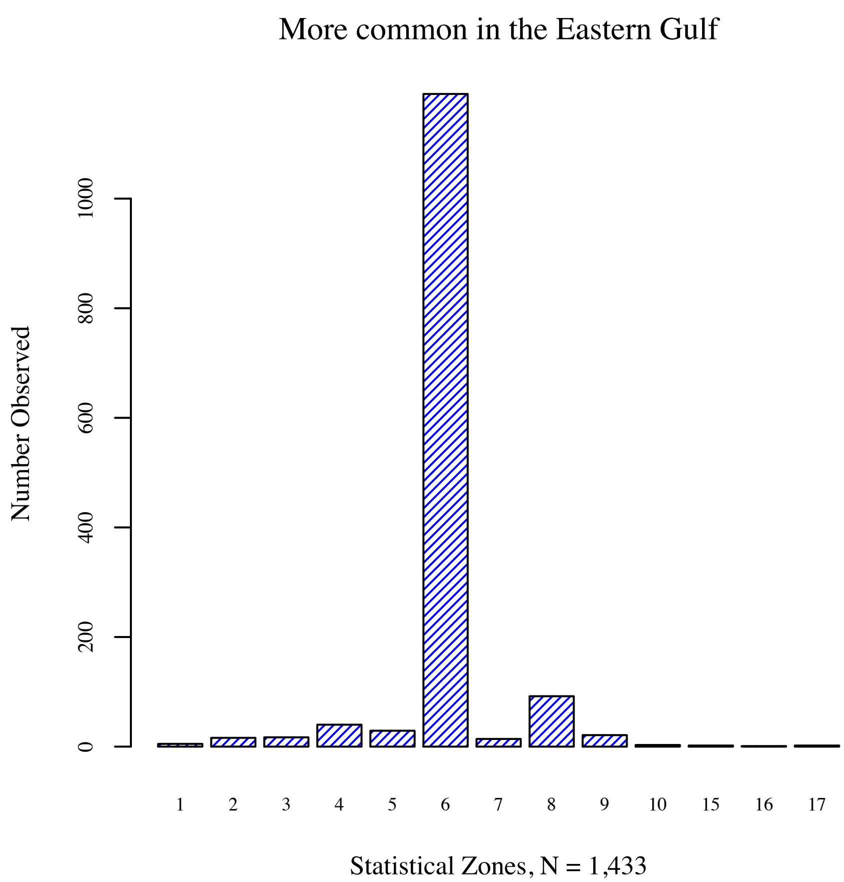


Figure 40 . Regression model, location, and depth information for porgy, red (*Pagrus pagrus*).





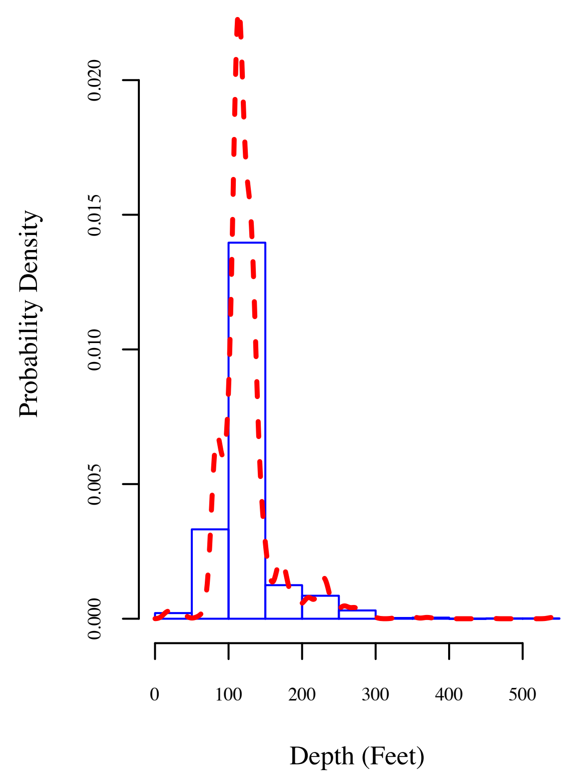
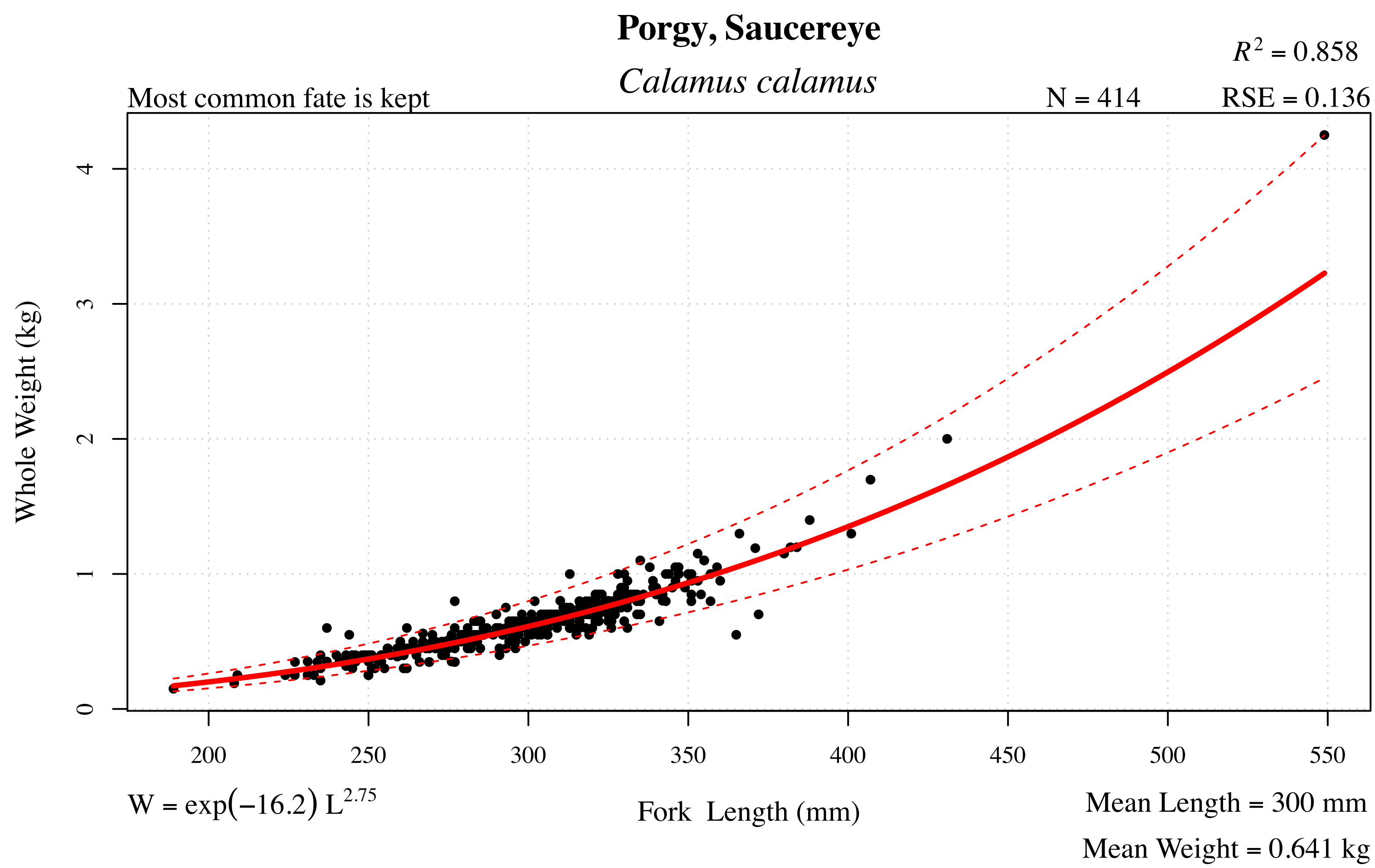
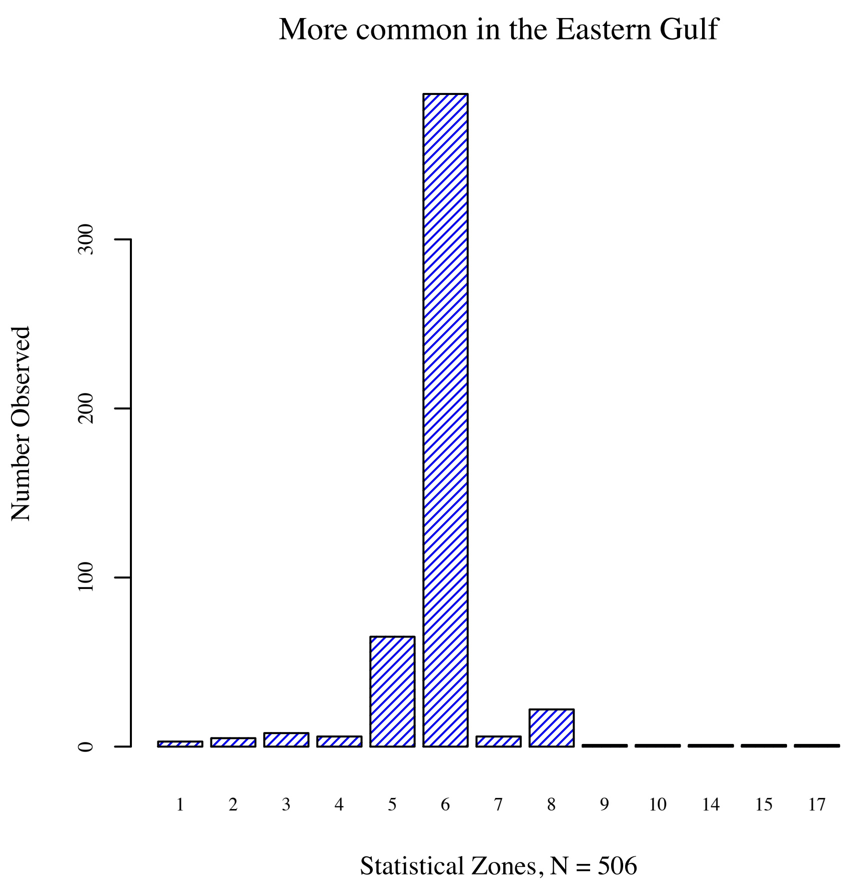


Figure 41 . Regression model, location, and depth information for porgy, knobbed (*Calamus nodosus*).





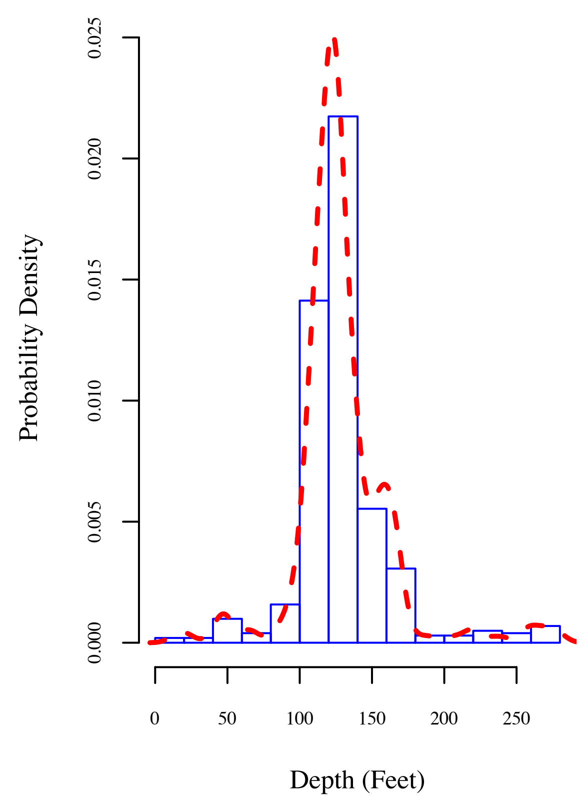


Figure 42 . Regression model, location, and depth information for porgy, saucereye (*Calamus calamus*).

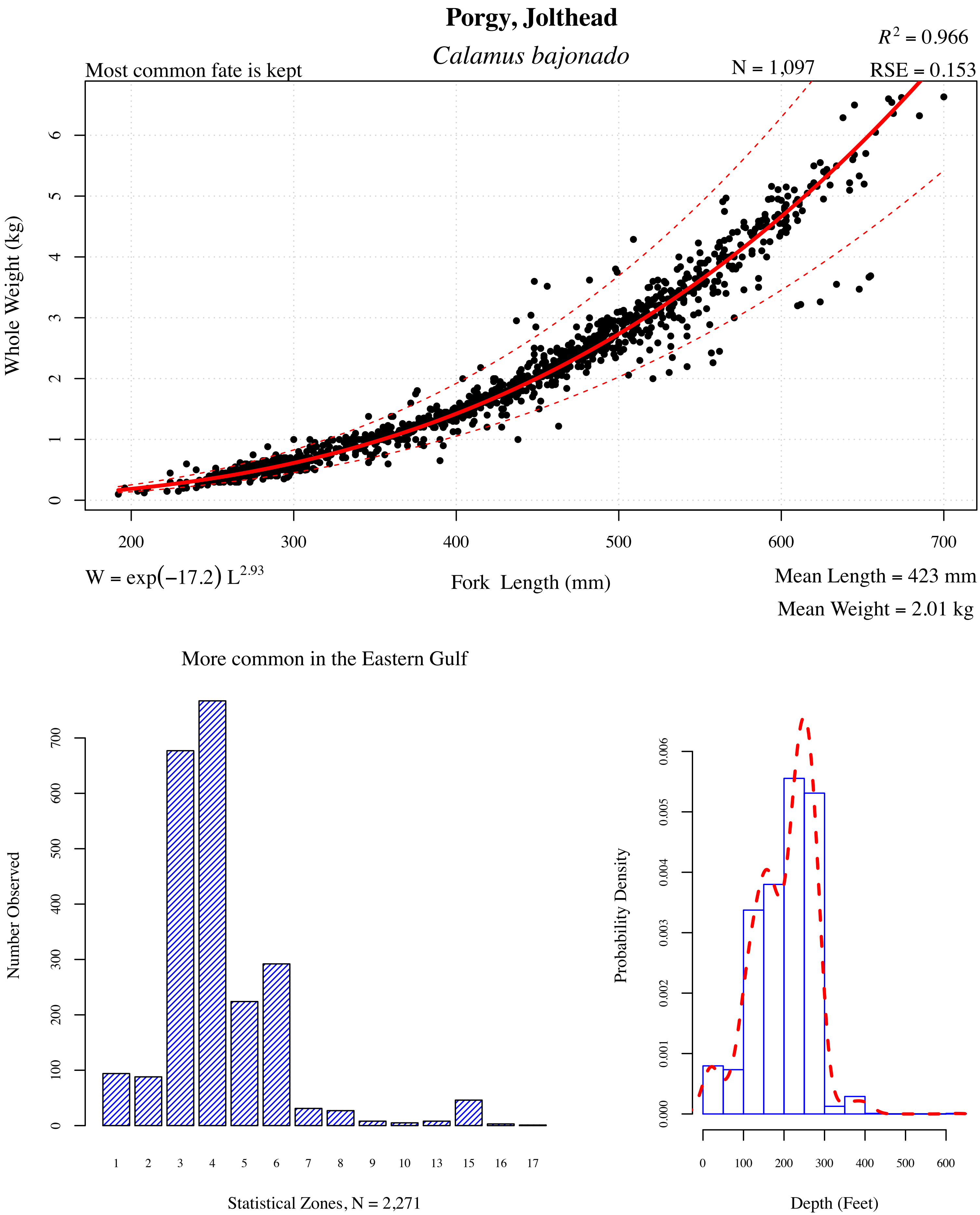


Figure 43 . Regression model, location, and depth information for porgy, jolthead (*Calamus bajonado*).

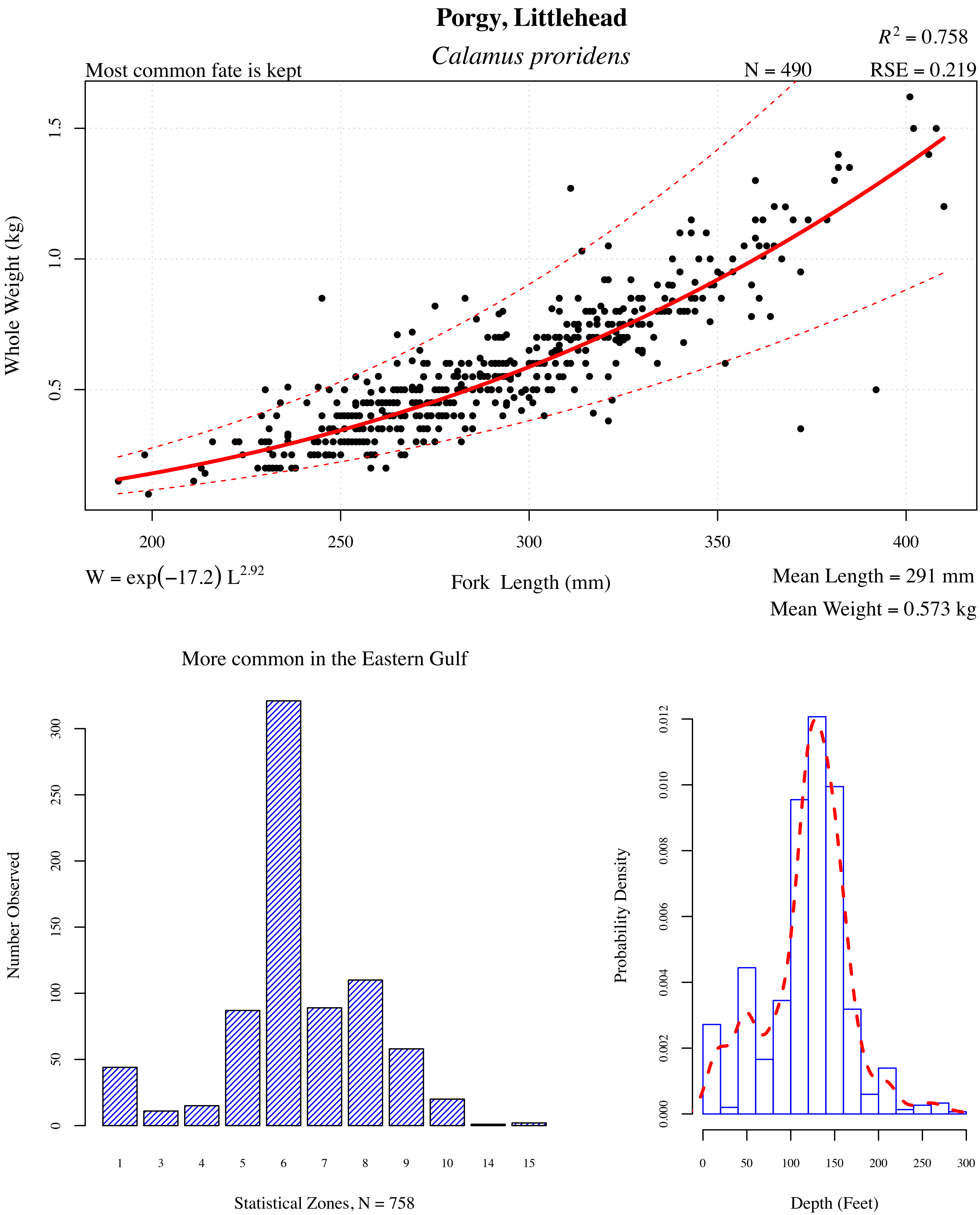


Figure 44 . Regression model, location, and depth information for porgy, littlehead (*Calamus proridens*).

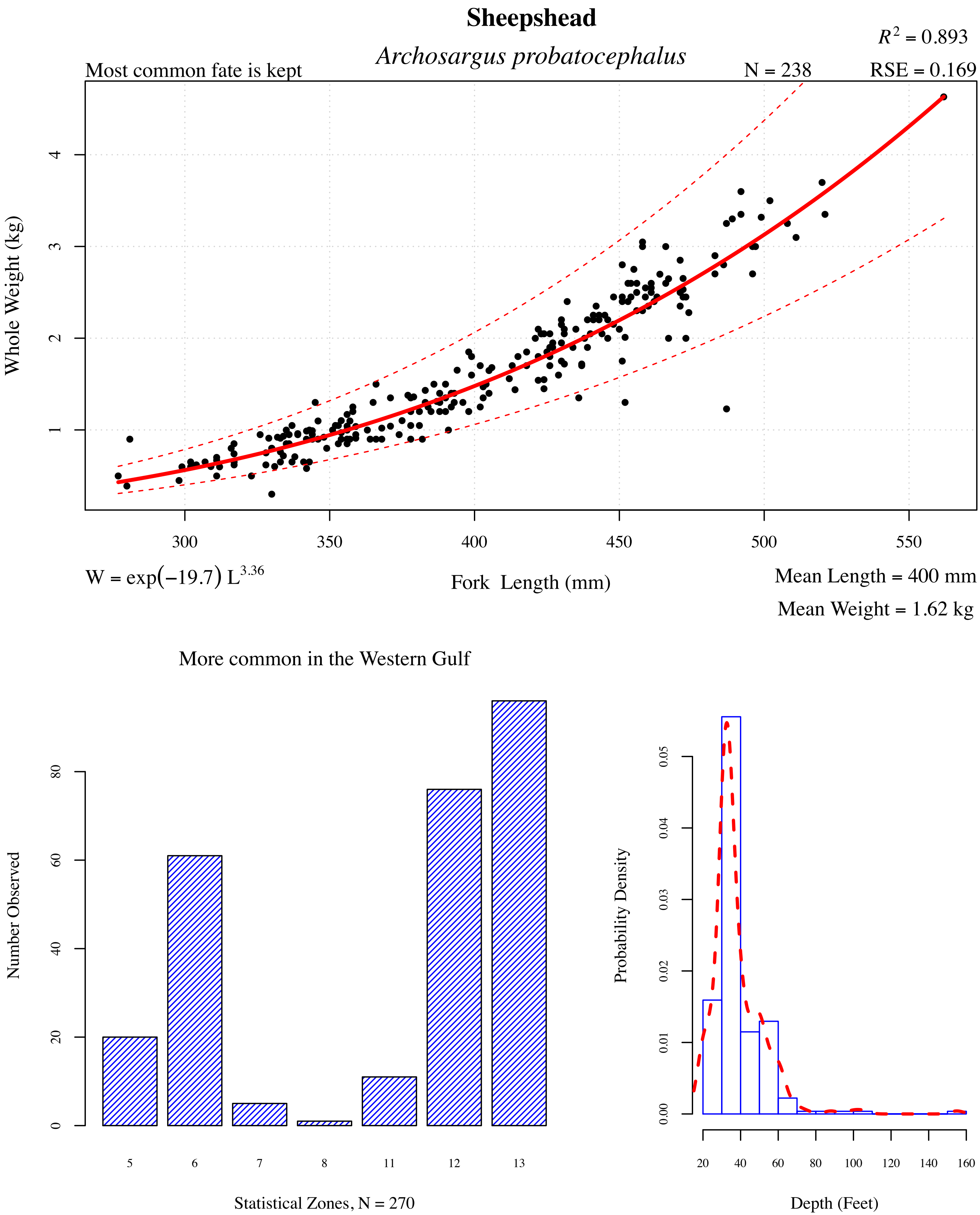
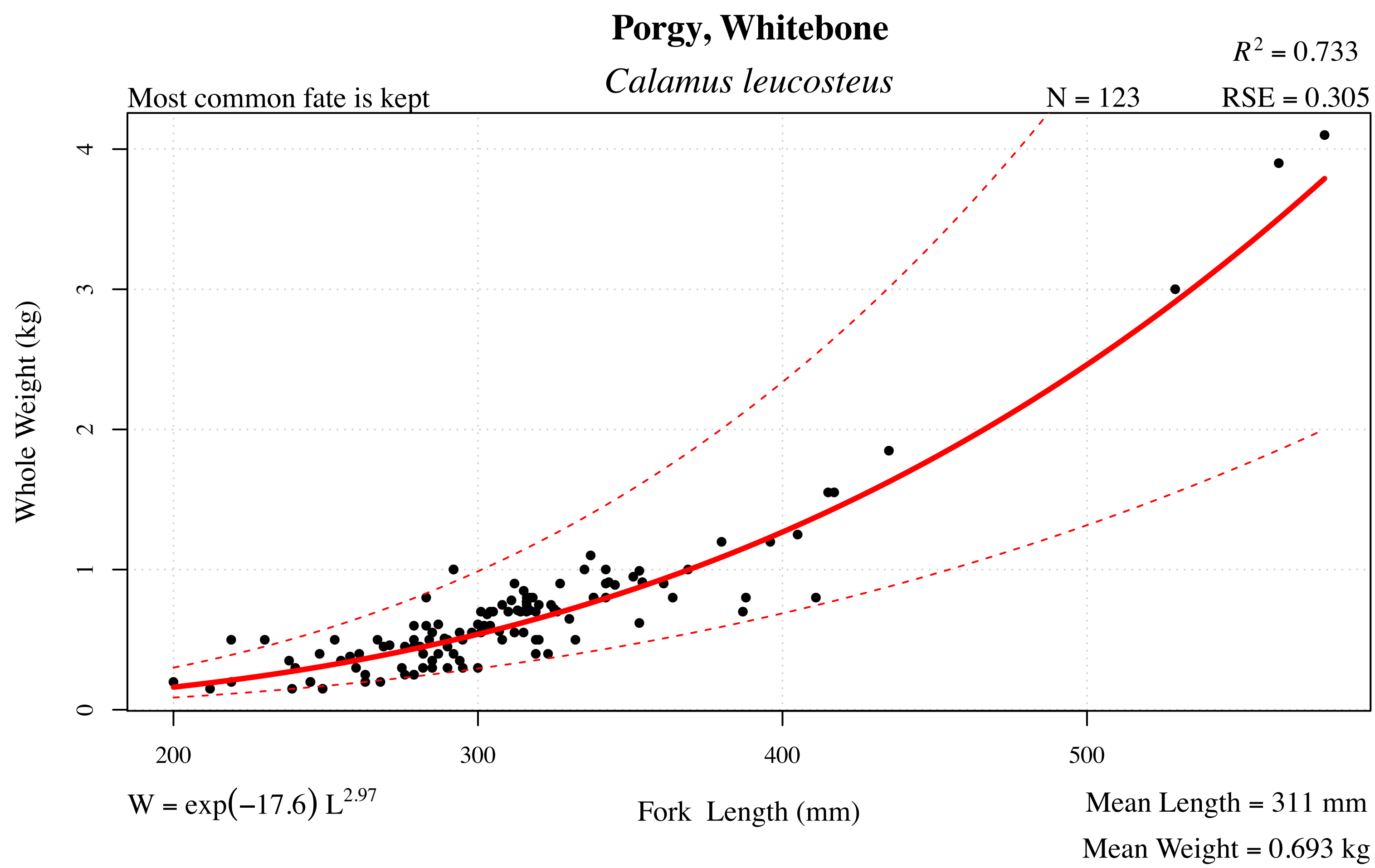
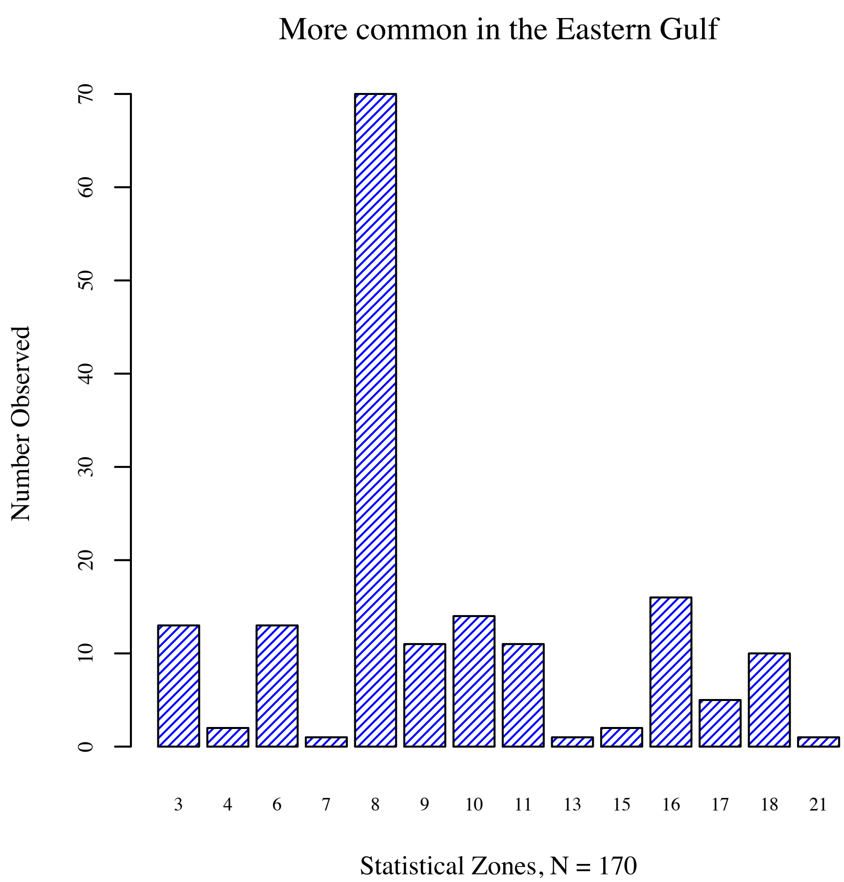


Figure 45 . Regression model, location, and depth information for sheepshead (*Archosargus probatocephalus*).





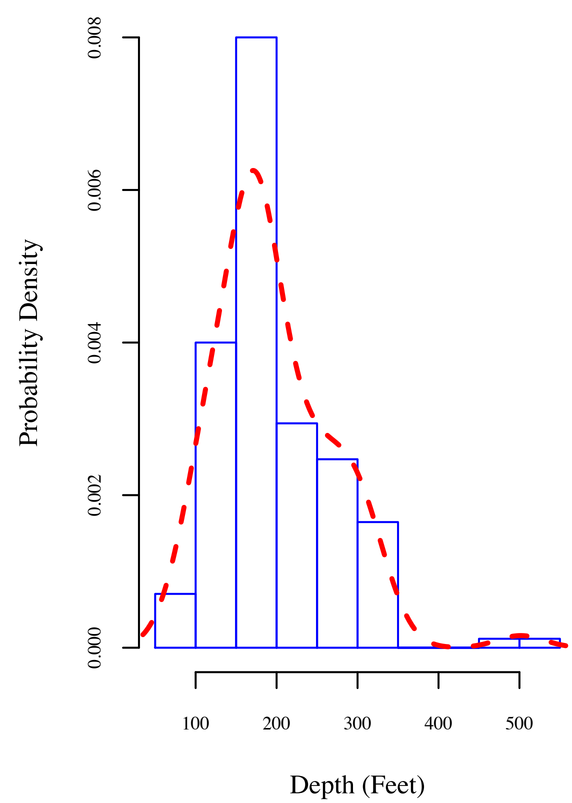


Figure 46 . Regression model, location, and depth information for porgy, whitebone (*Calamus leucosteus*).

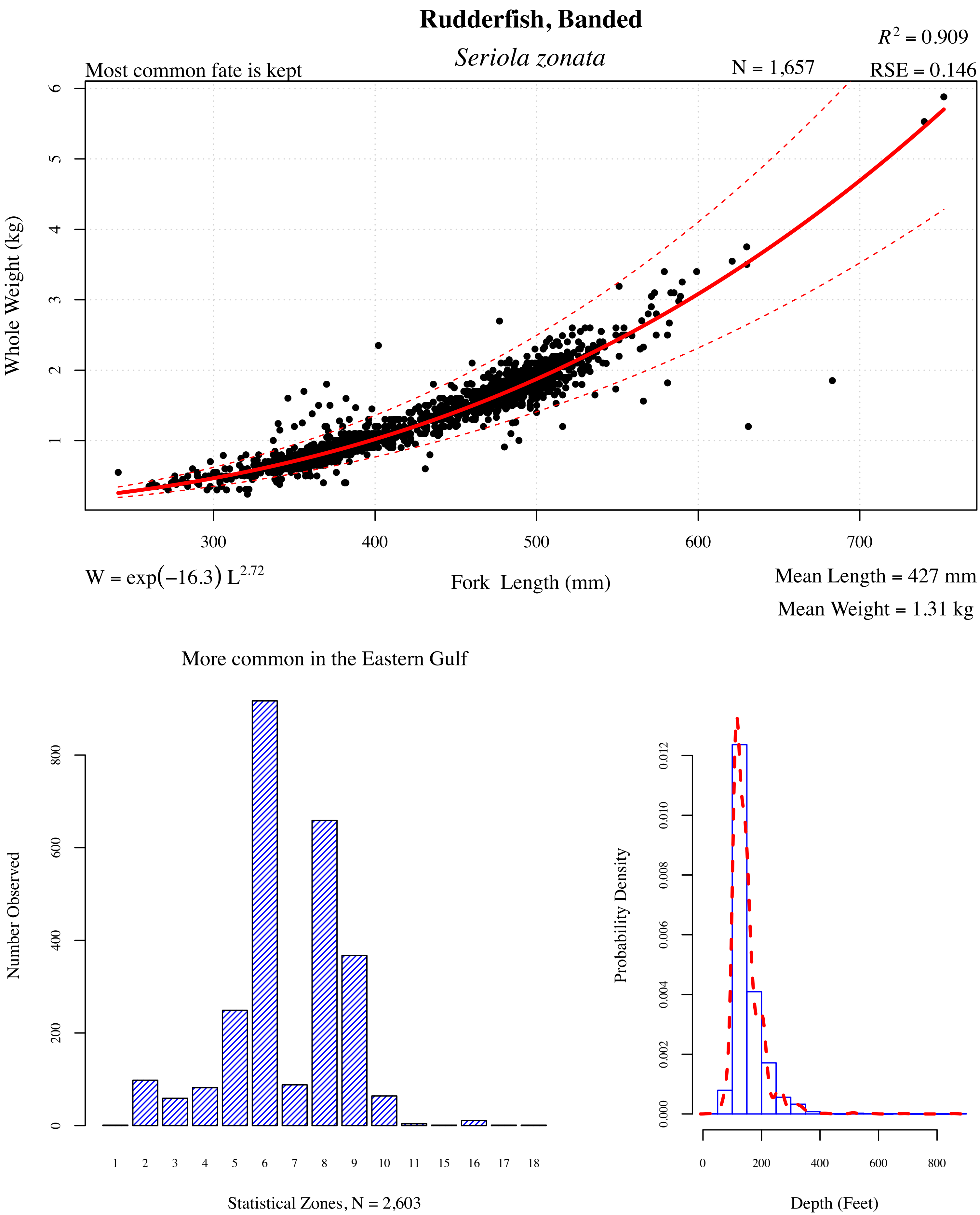


Figure 47 . Regression model, location, and depth information for rudderfish, banded (*Seriola zonata*).

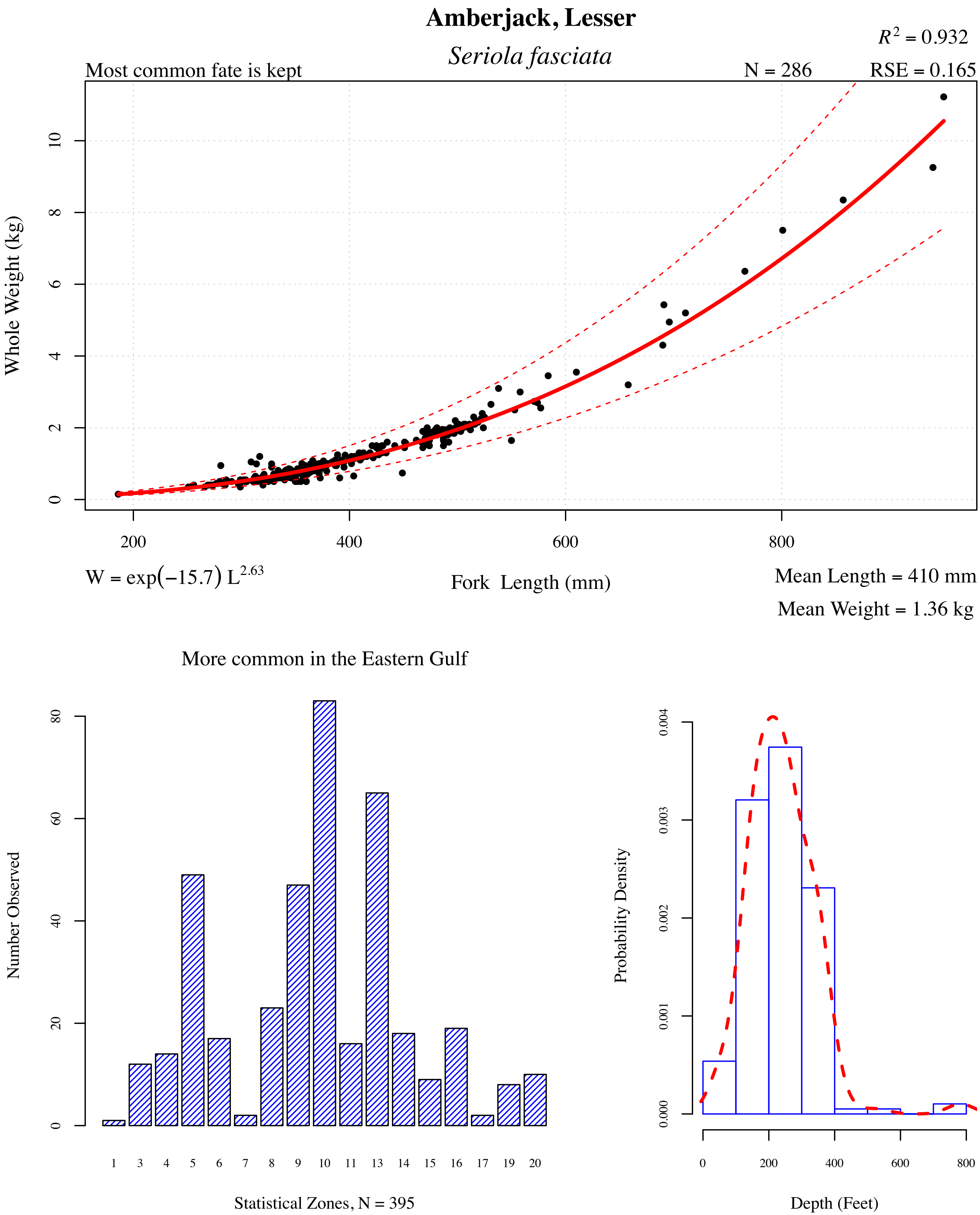


Figure 48 . Regression model, location, and depth information for amberjack, lesser (*Seriola fasciata*).

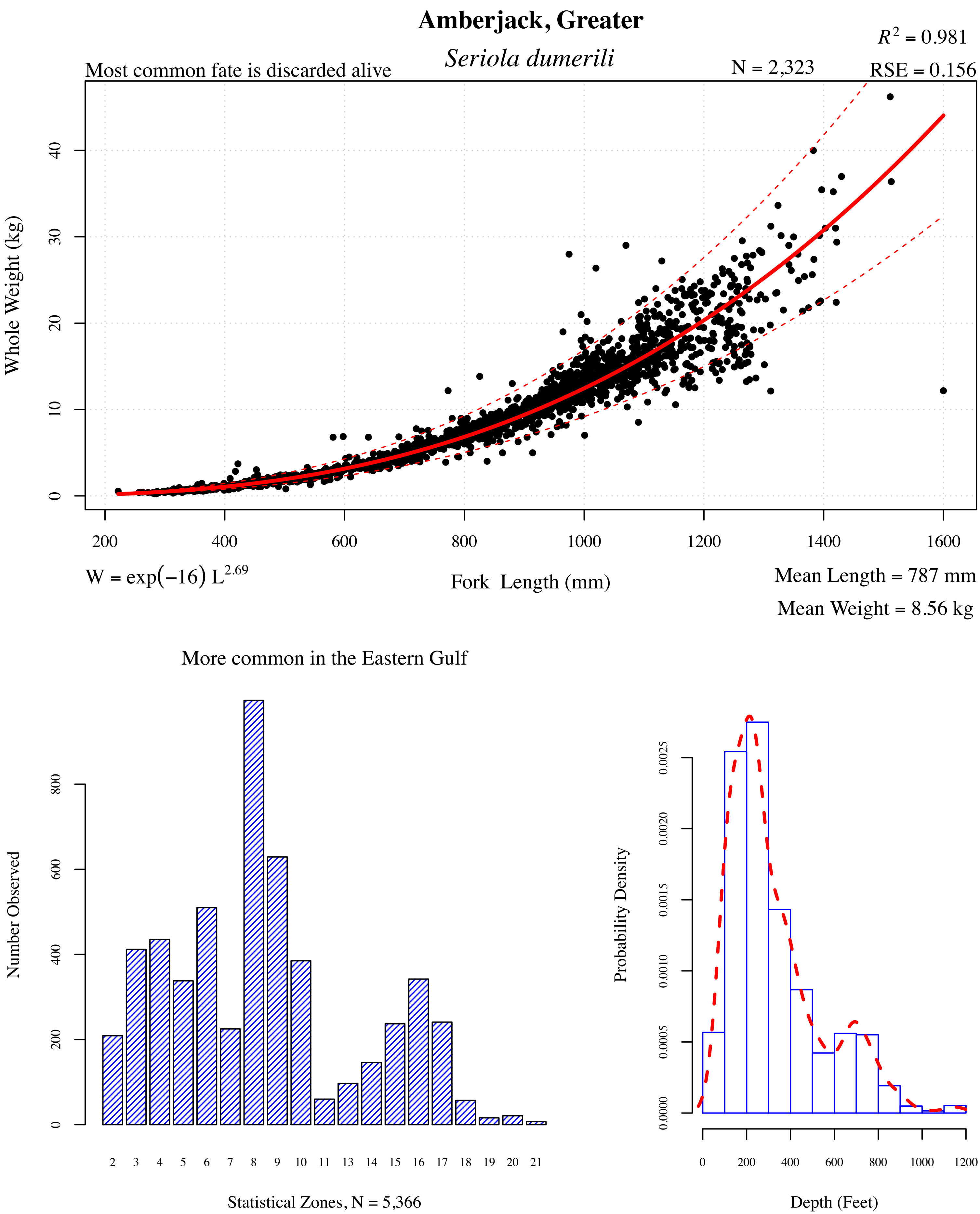


Figure 49 . Regression model, location, and depth information for amberjack, greater (*Seriola dumerili*).

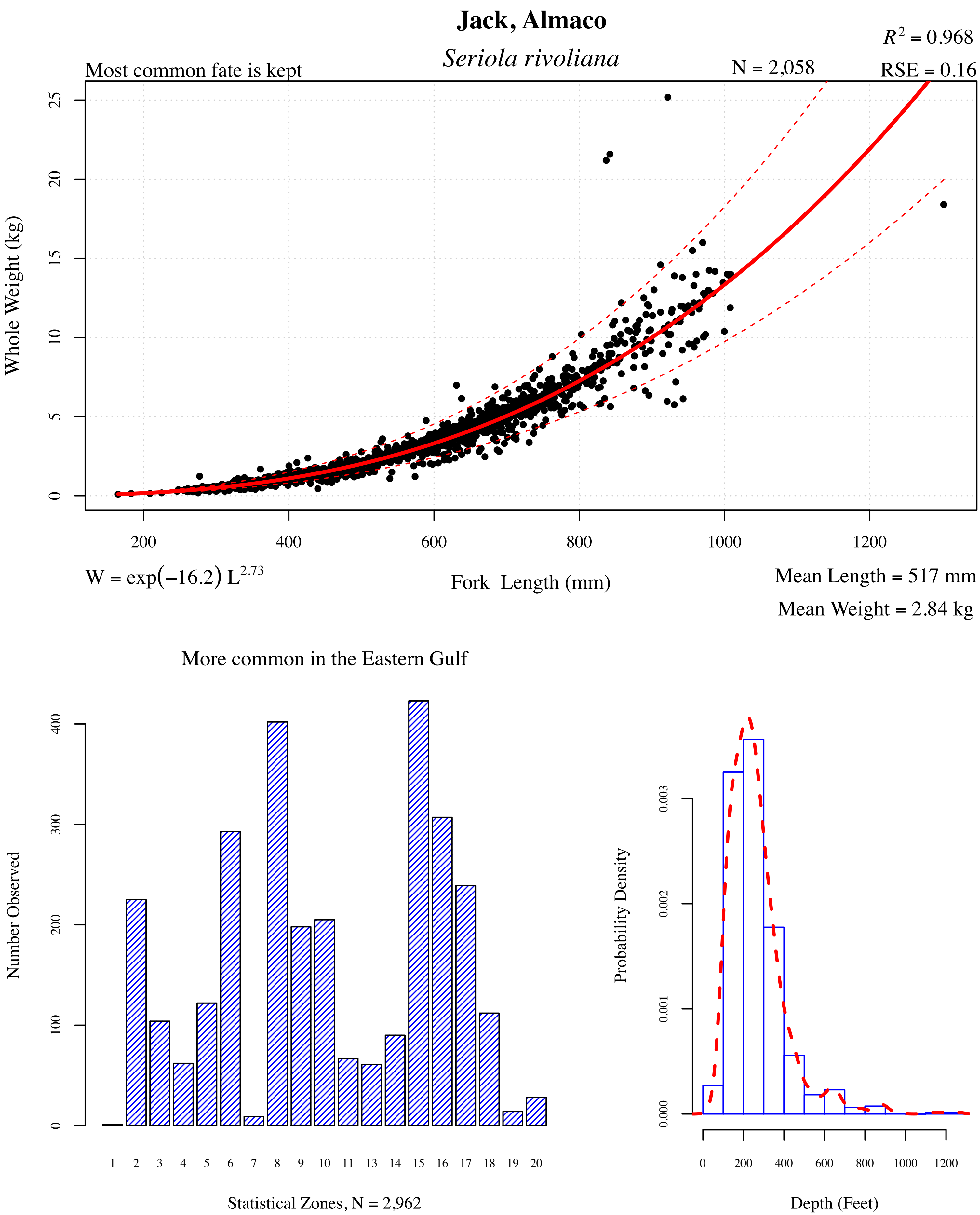
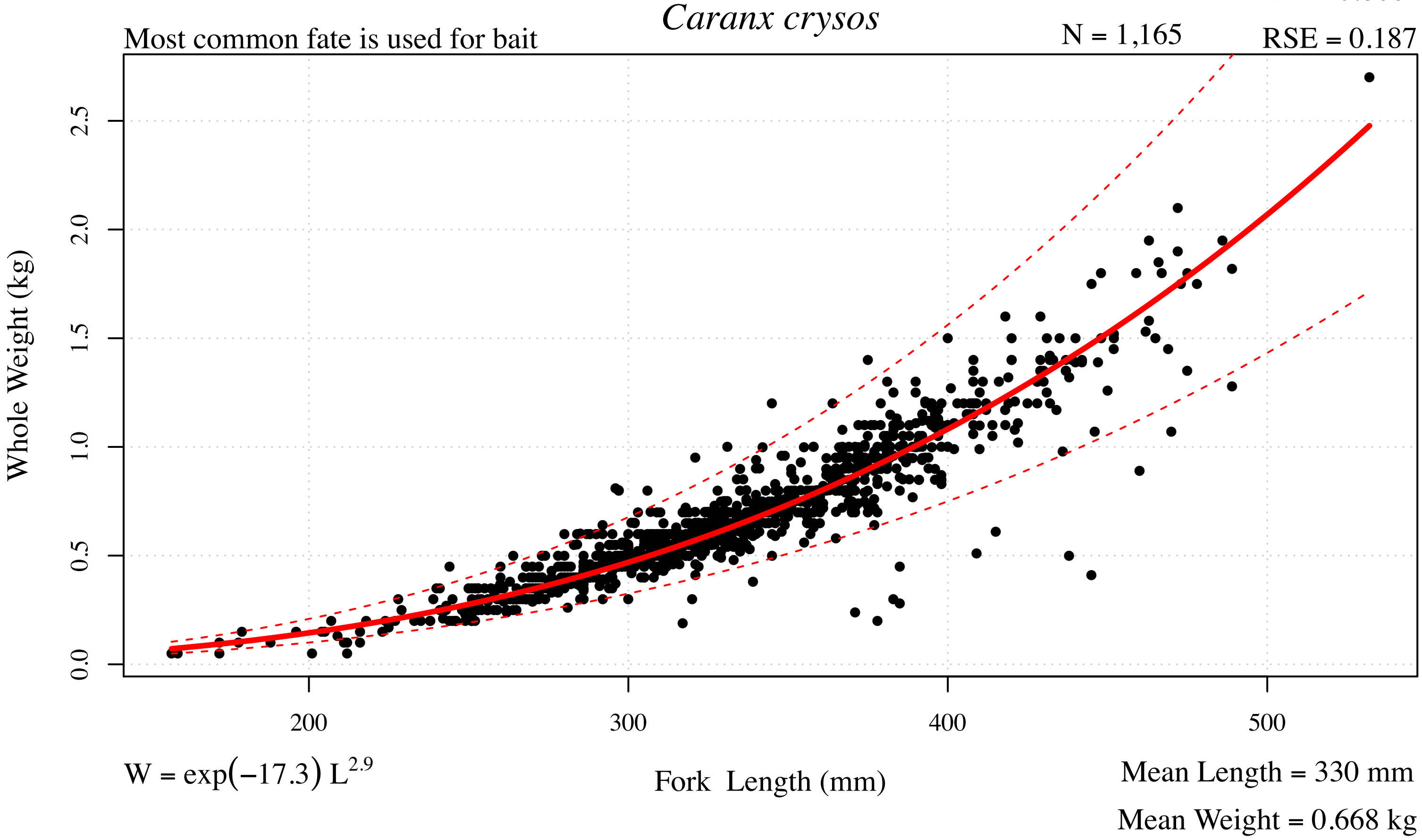
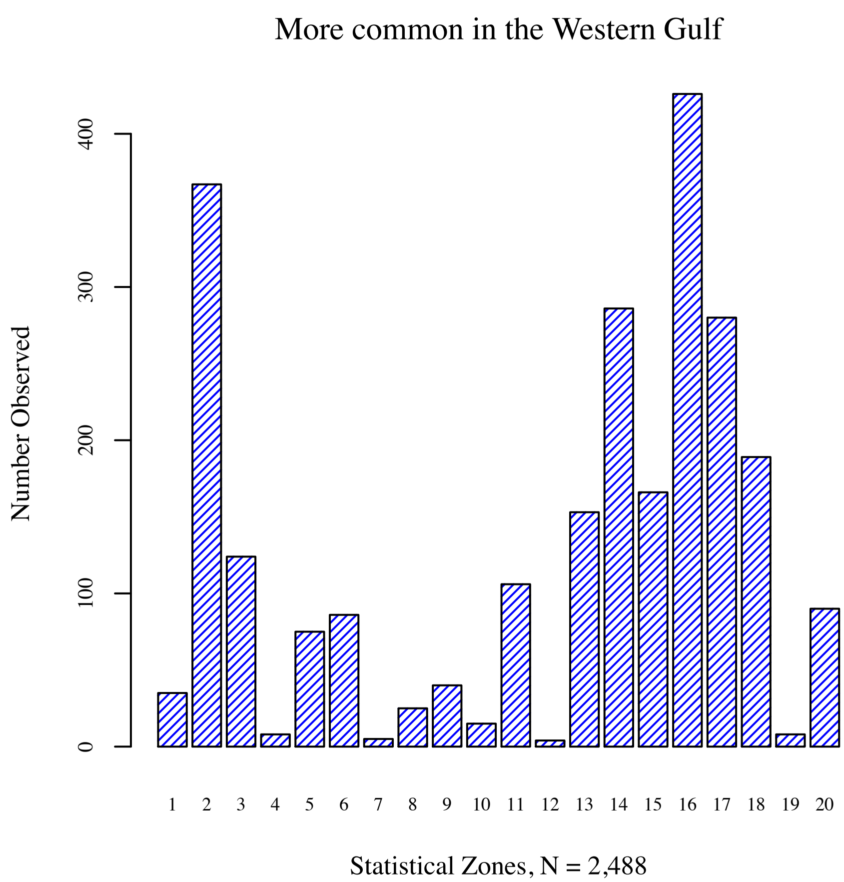


Figure 50 . Regression model, location, and depth information for jack, almaco (*Seriola rivoliana*).

Runner, Blue

Caranx crysos





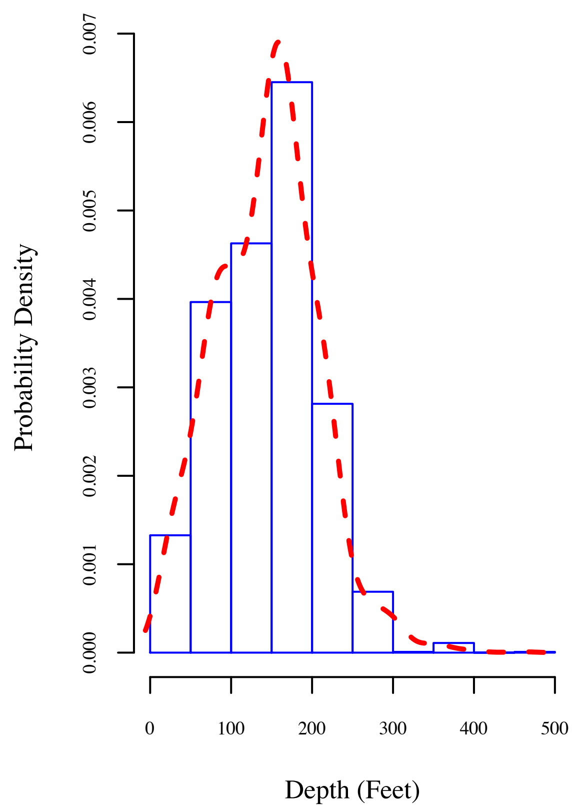
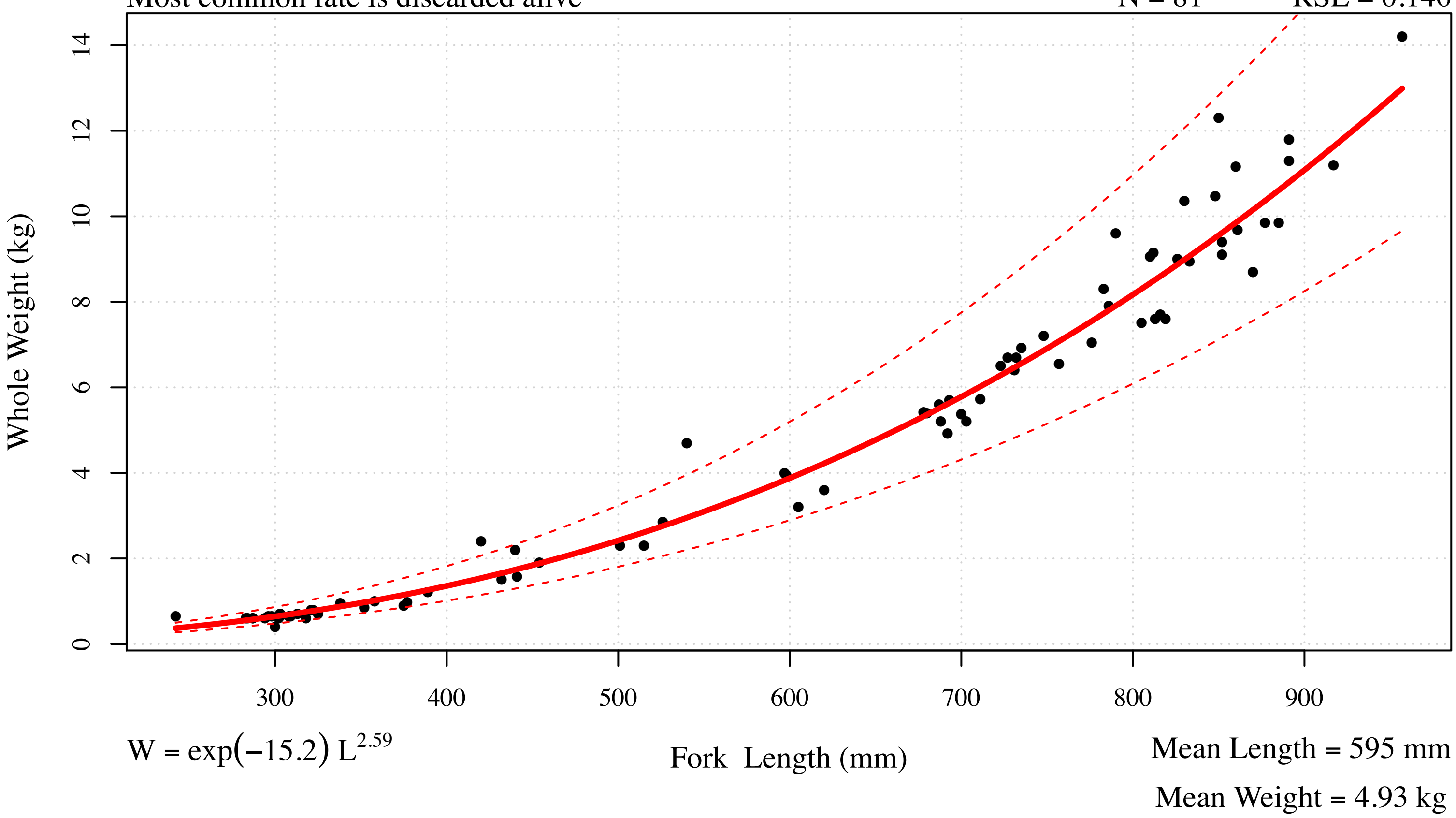
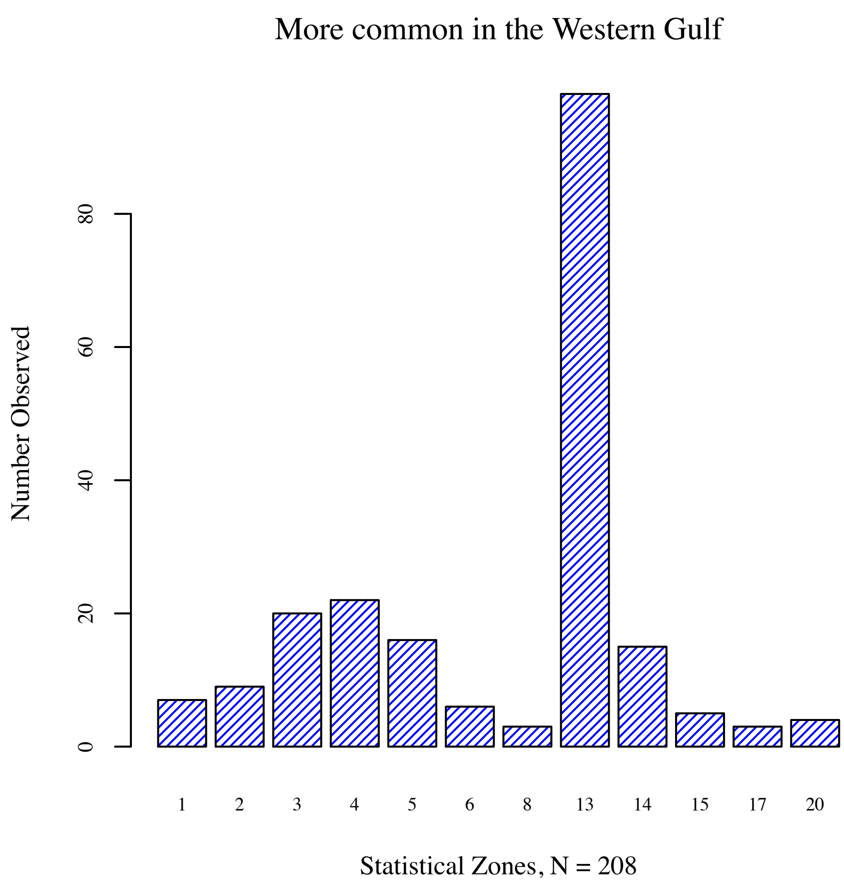


Figure 51 . Regression model, location, and depth information for runner, blue (*Caranx crysos*).

Jack, Common Crevalle

Caranx hippos





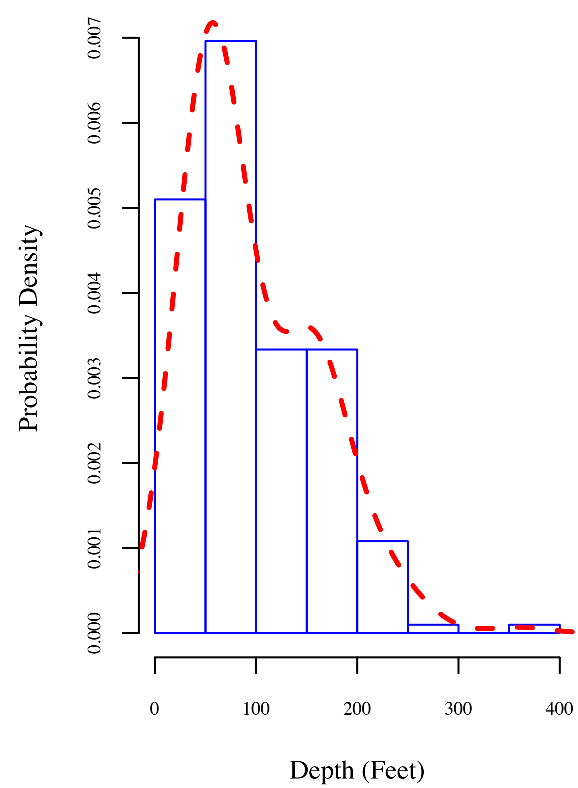


Figure 52 . Regression model, location, and depth information for jack, common crevalle (*Caranx hippos*).

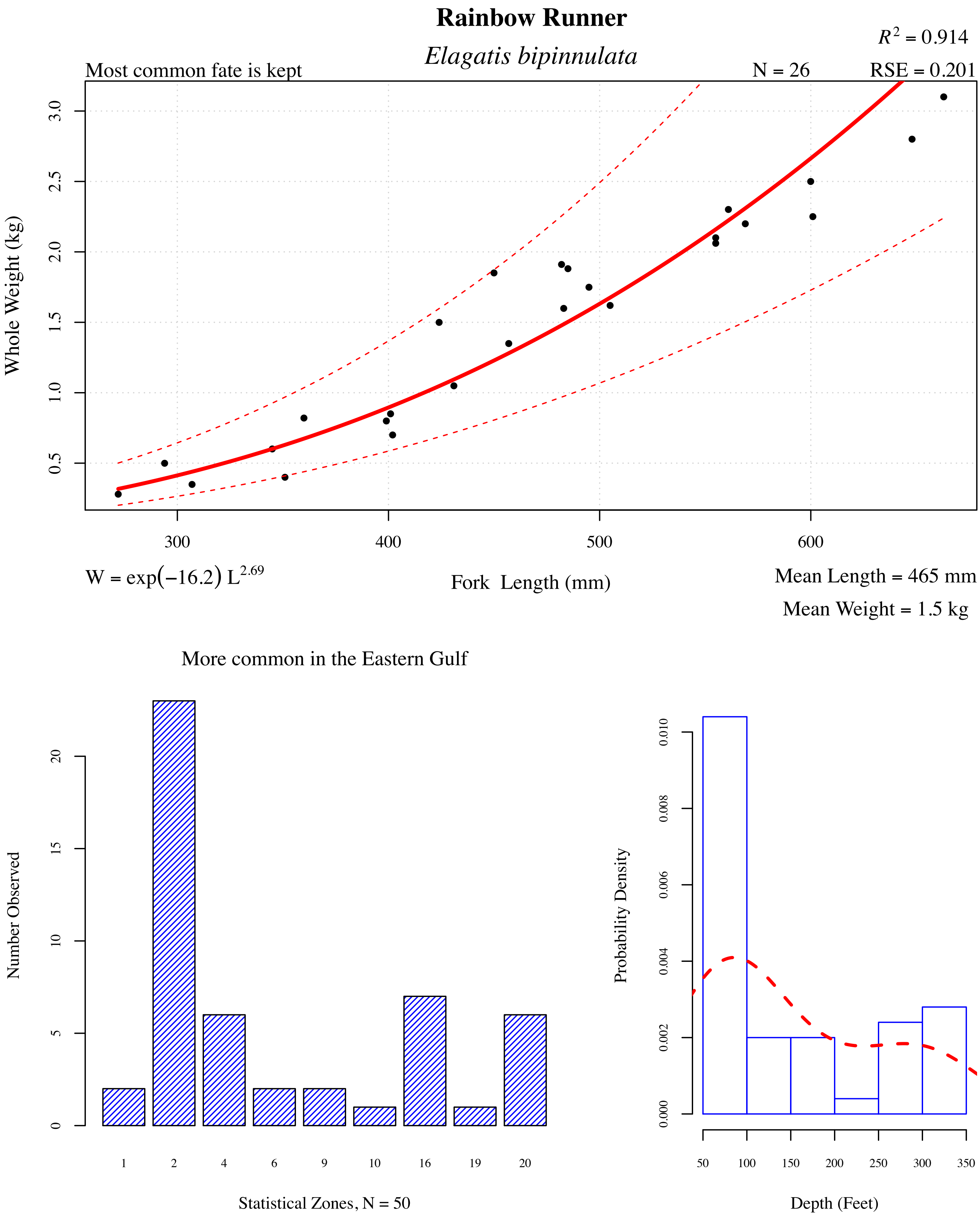
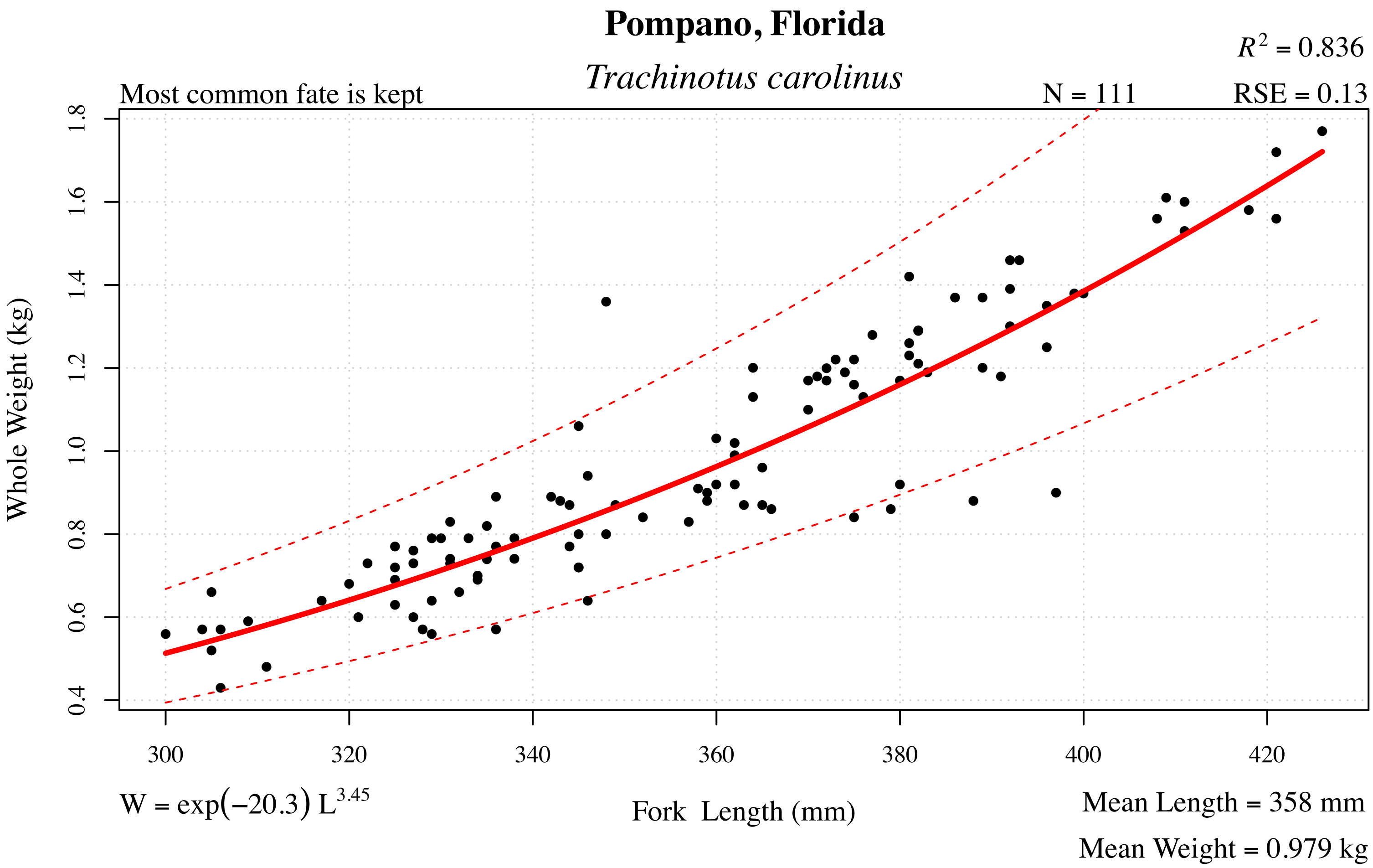
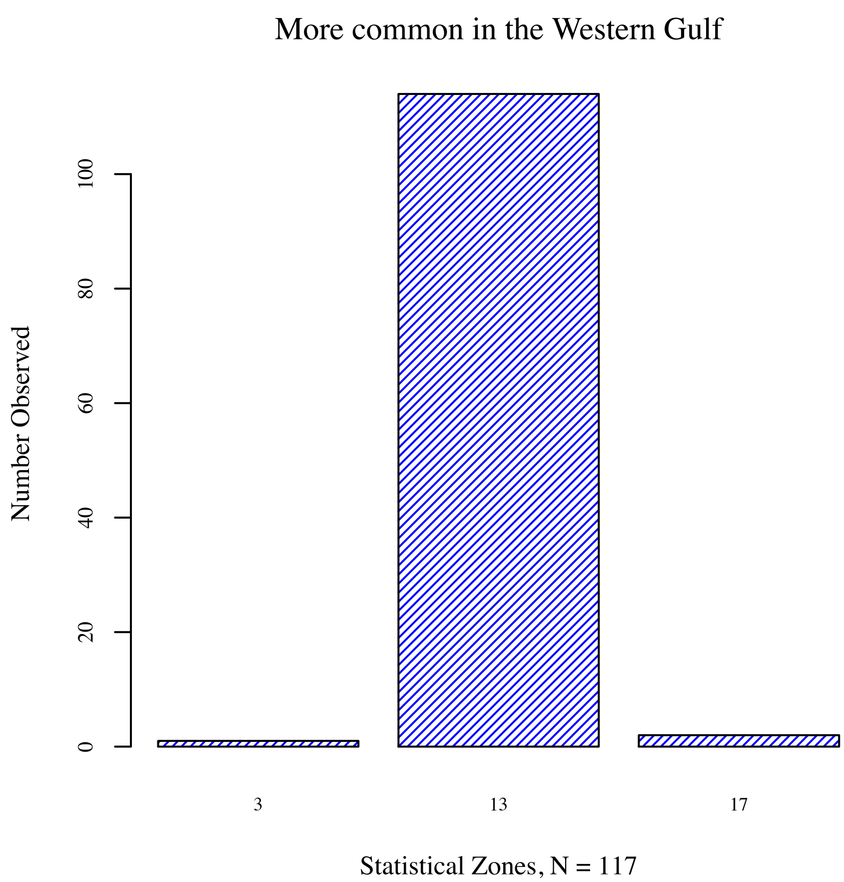


Figure 53 . Regression model, location, and depth information for rainbow runner (*Elagatis bipinnulata*).





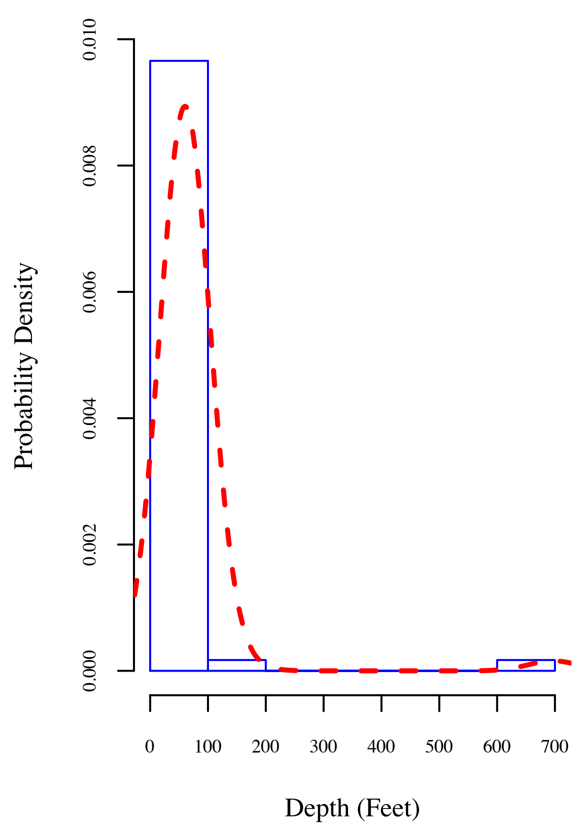
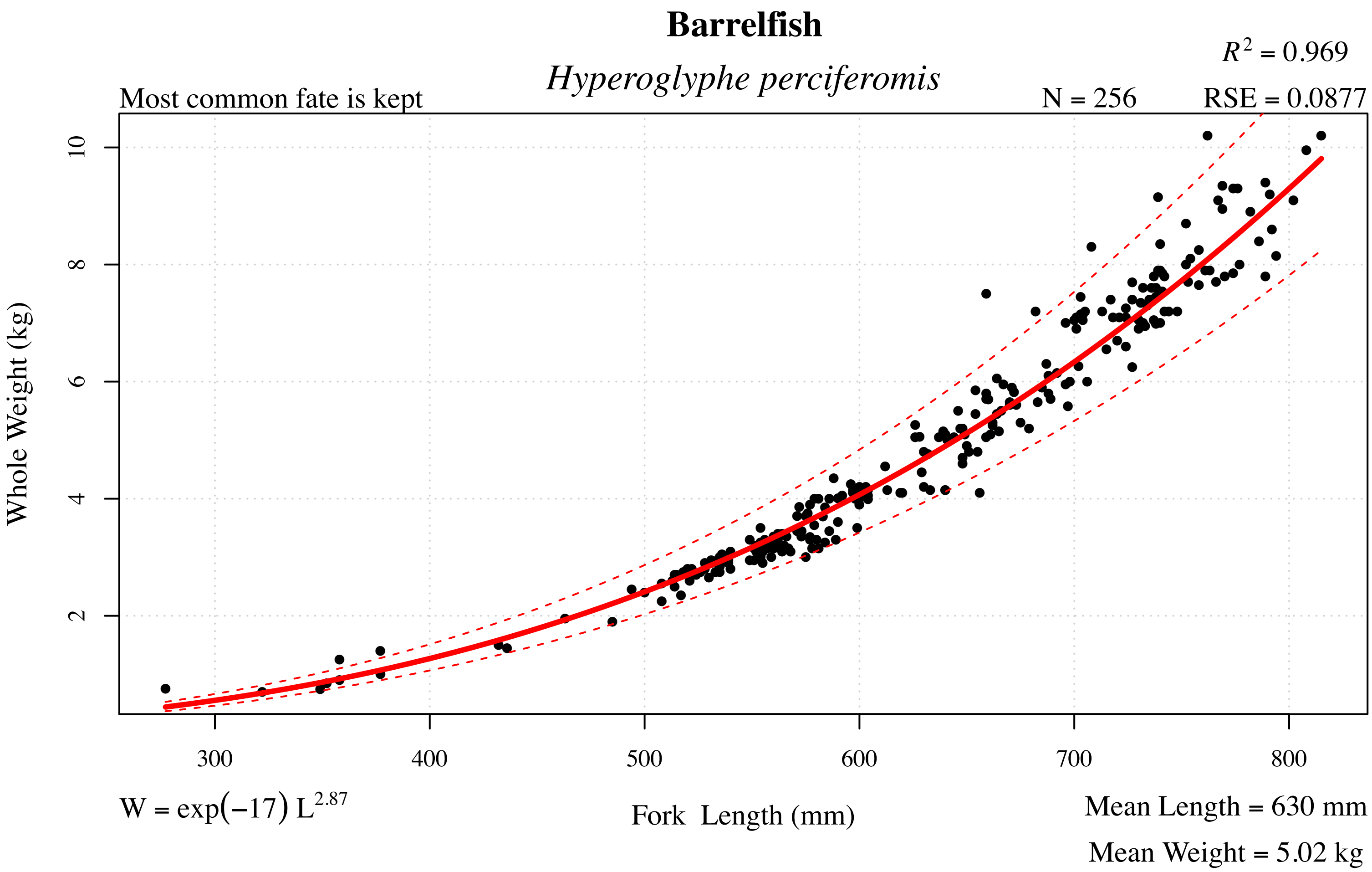
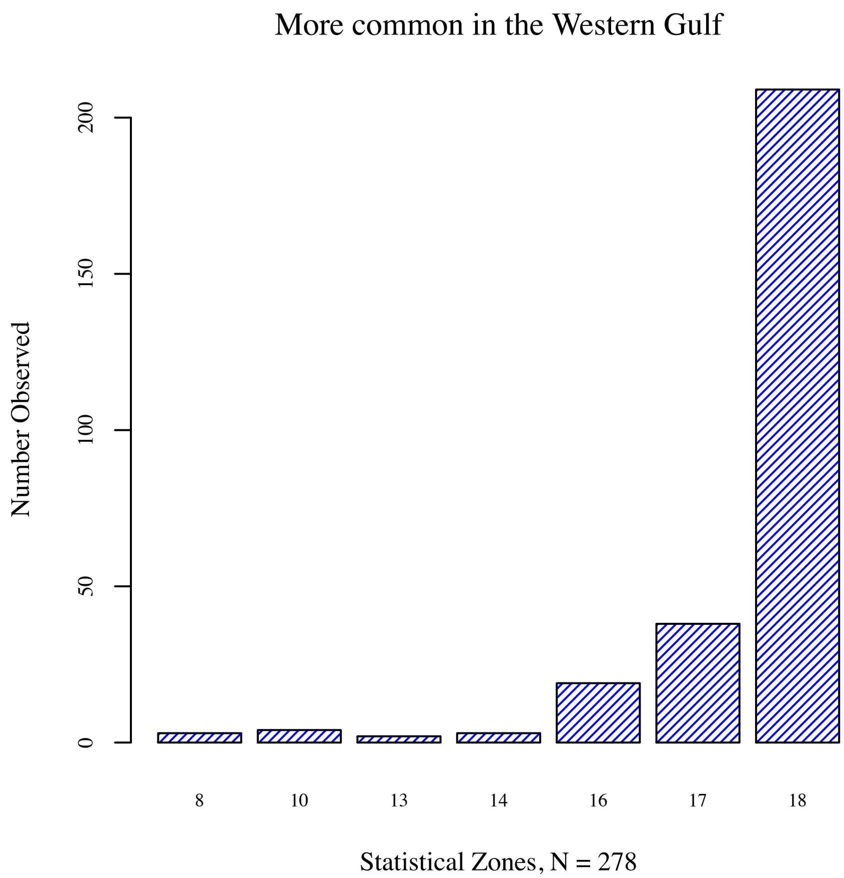


Figure 54 . Regression model, location, and depth information for pompano, florida (*Trachinotus carolinus*).





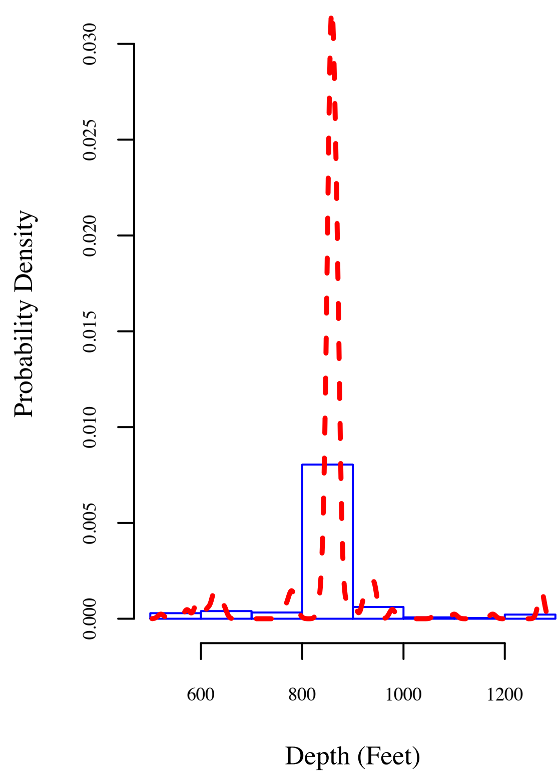
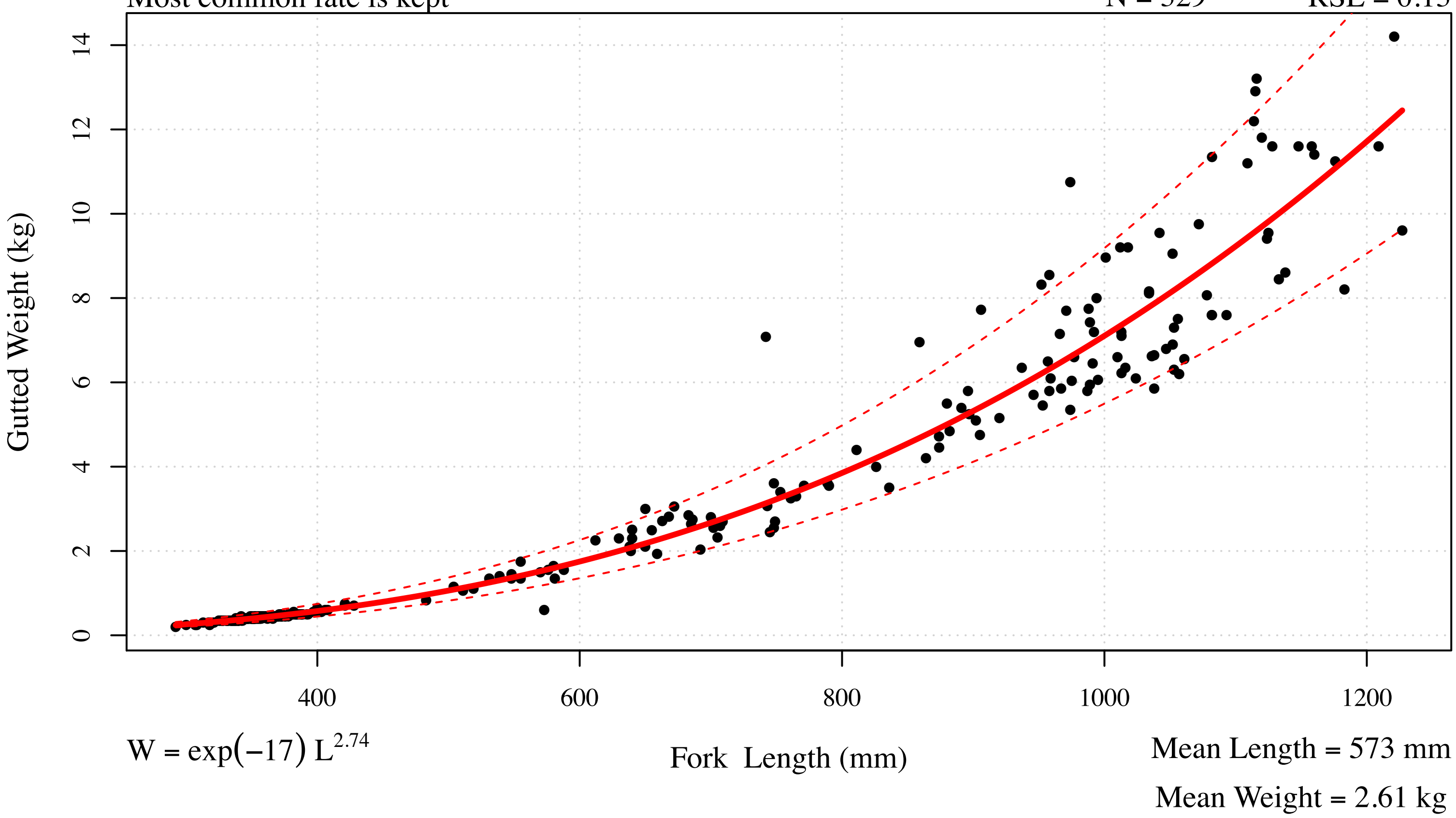


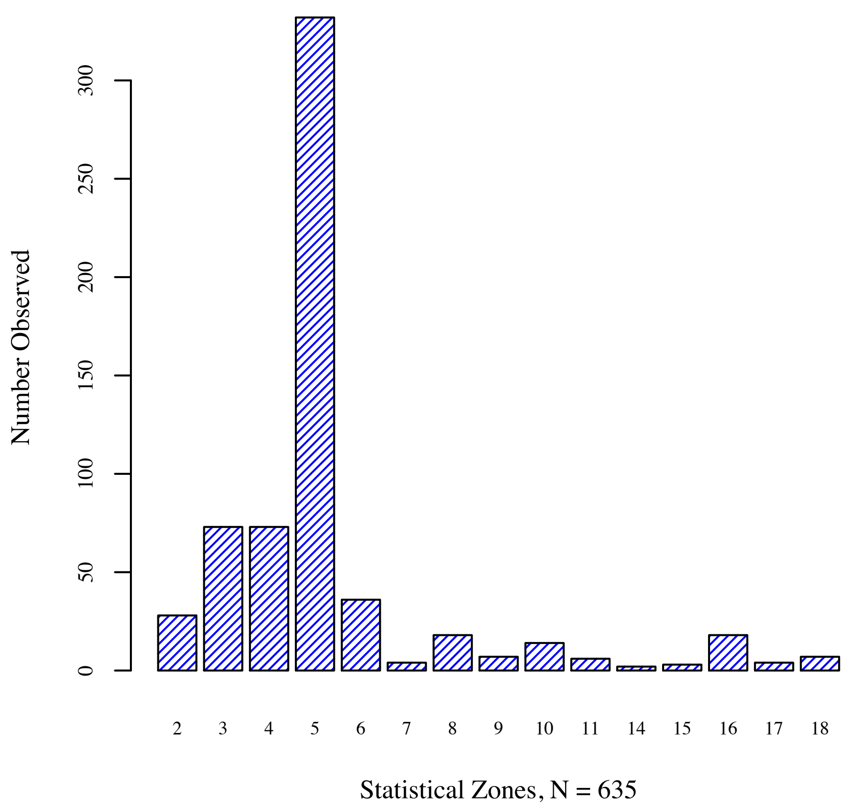
Figure 55 . Regression model, location, and depth information for barrelfish (*Hyperoglyphe perciferomis*).

Dolphin

Coryphaena hippurus



More common in the Eastern Gulf



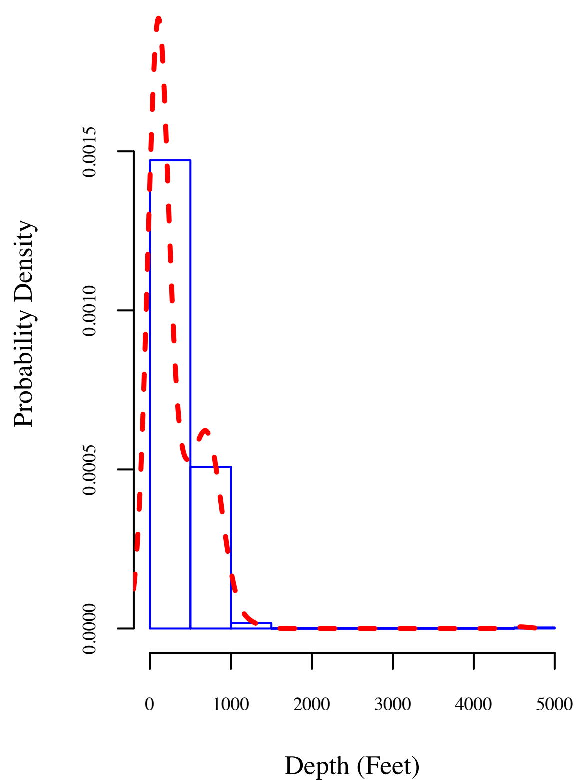


Figure 56 . Regression model, location, and depth information for dolphin (*Coryphaena hippurus*).

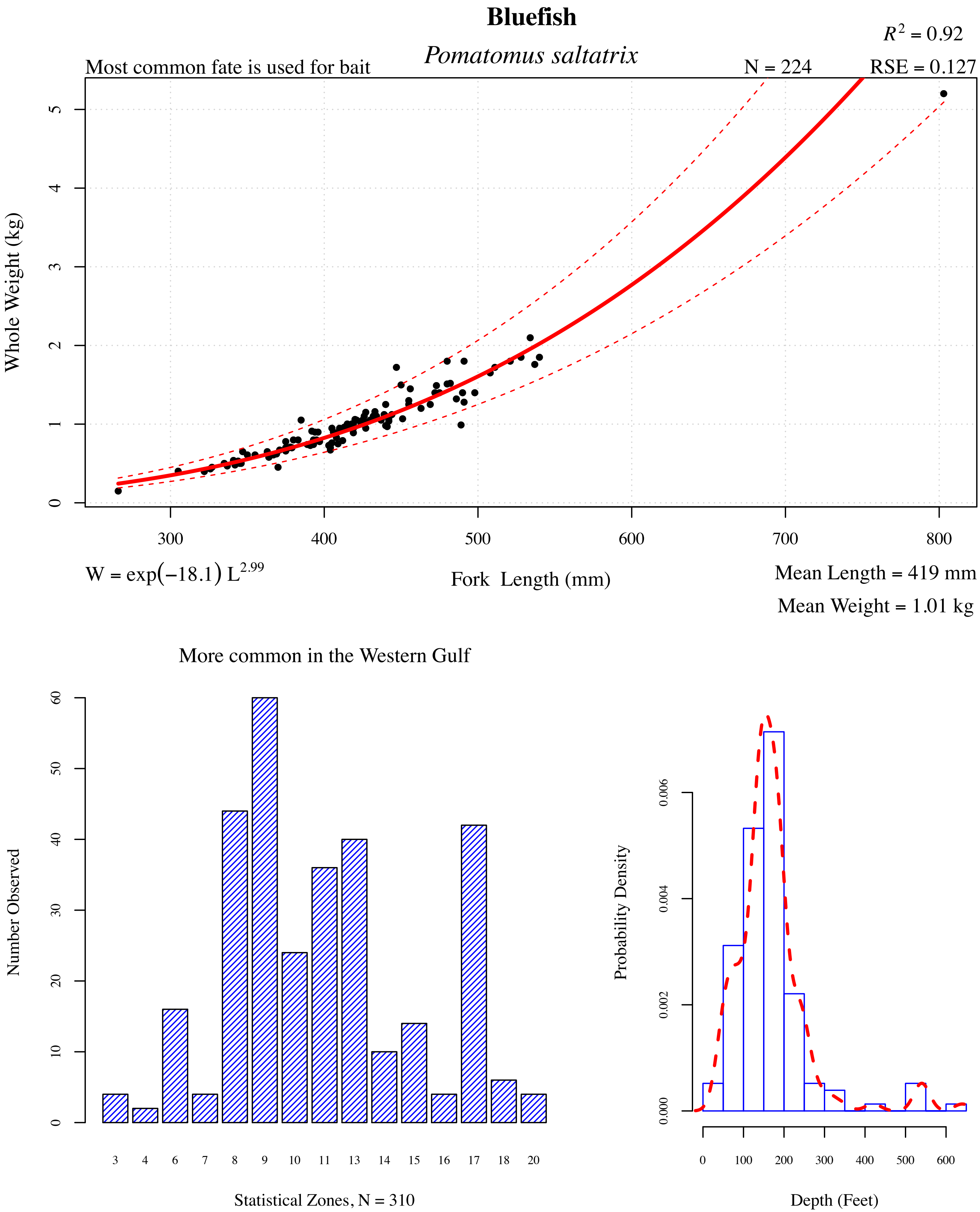


Figure 57 . Regression model, location, and depth information for bluefish (*Pomatomus saltatrix*).

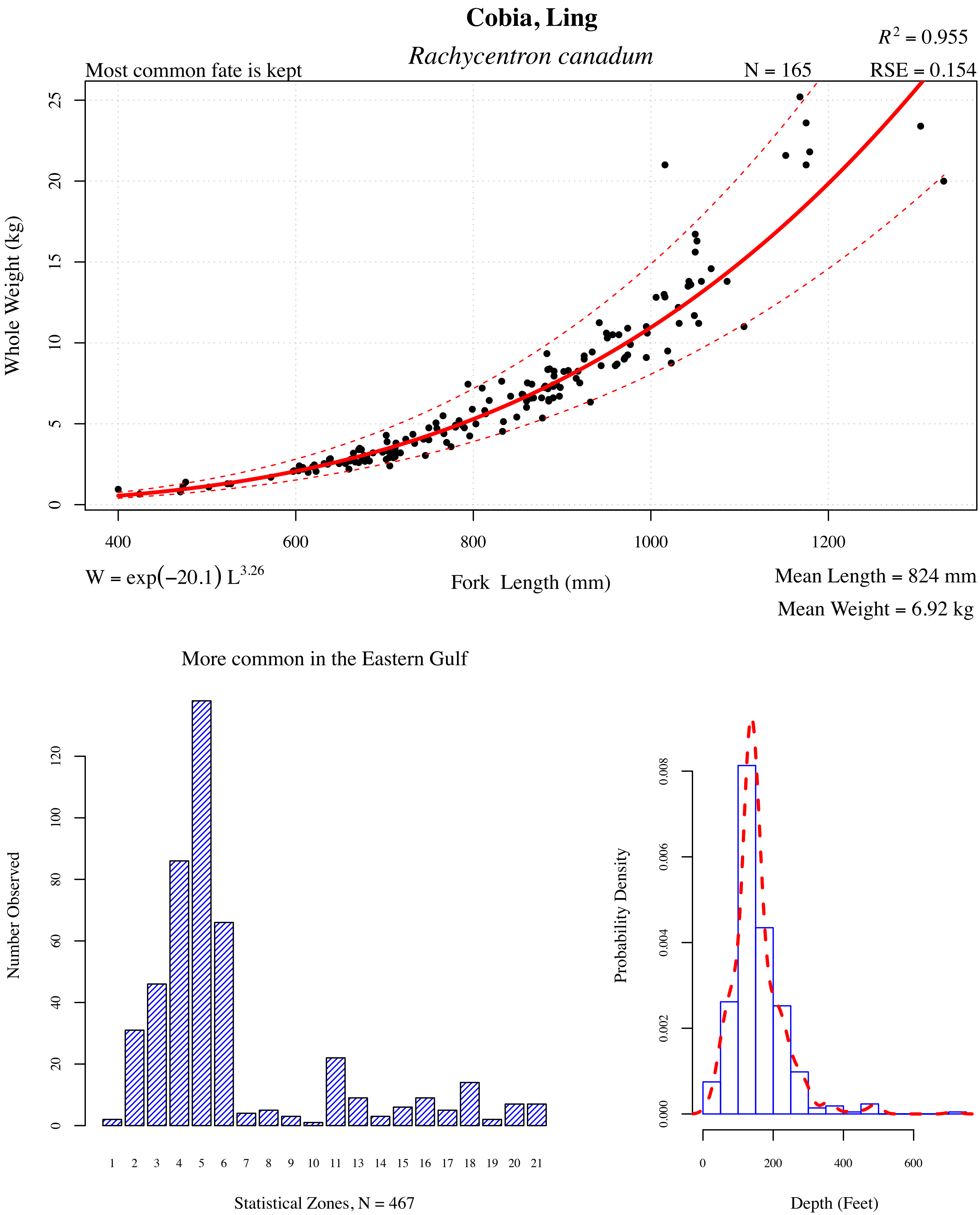


Figure 58 . Regression model, location, and depth information for cobia, ling (*Rachycentron canadum*).

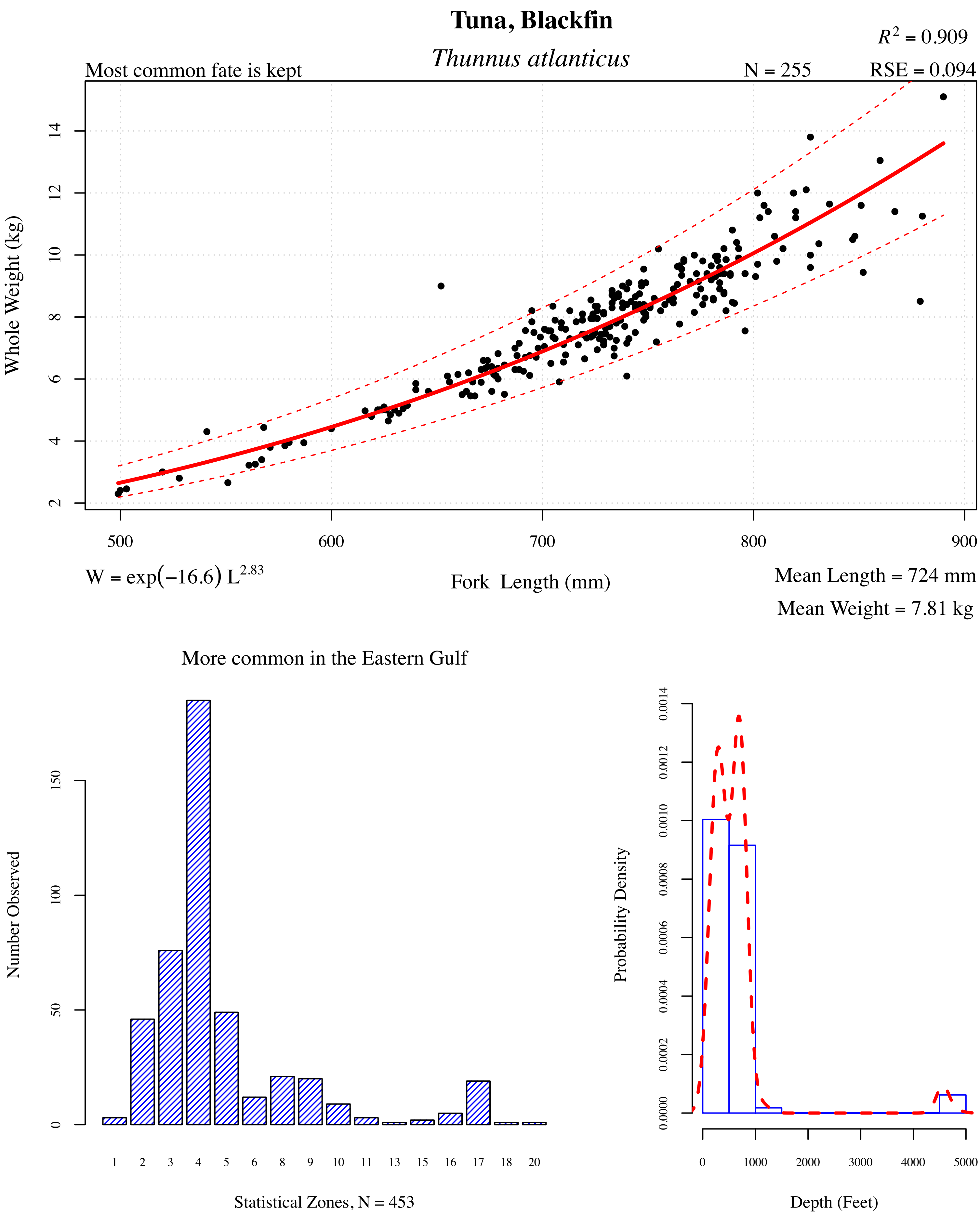


Figure 59 . Regression model, location, and depth information for tuna, blackfin (*Thunnus atlanticus*).

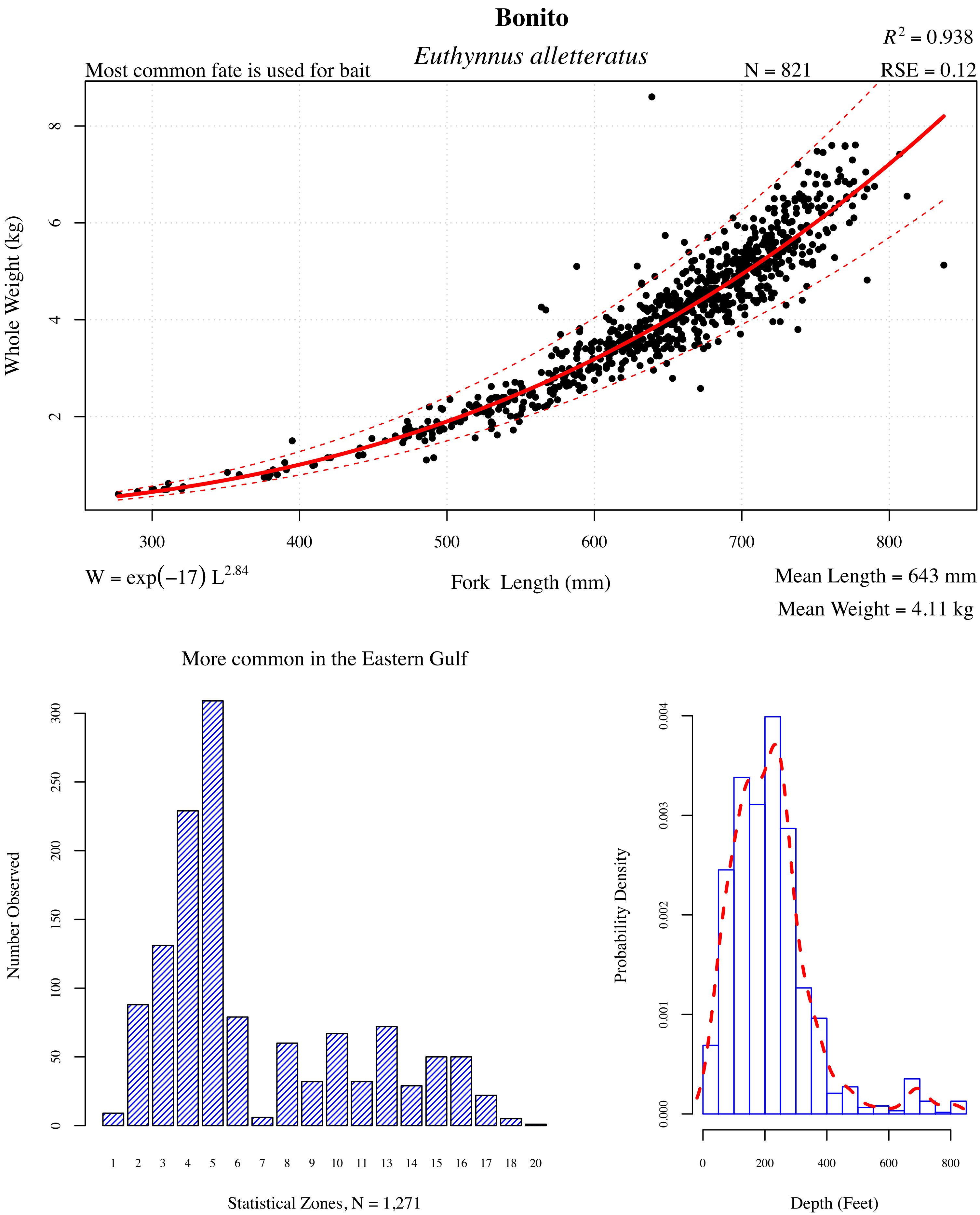
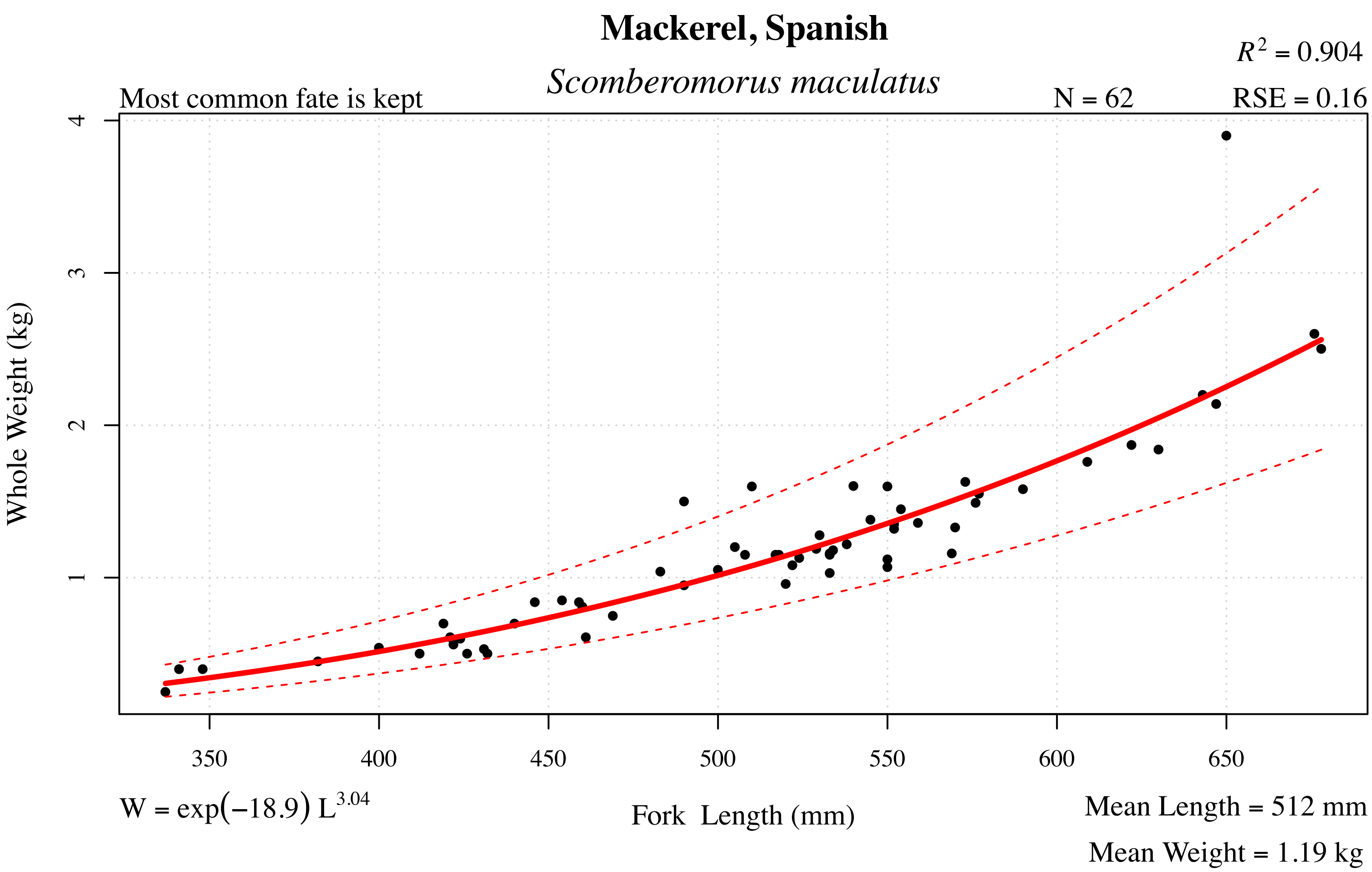
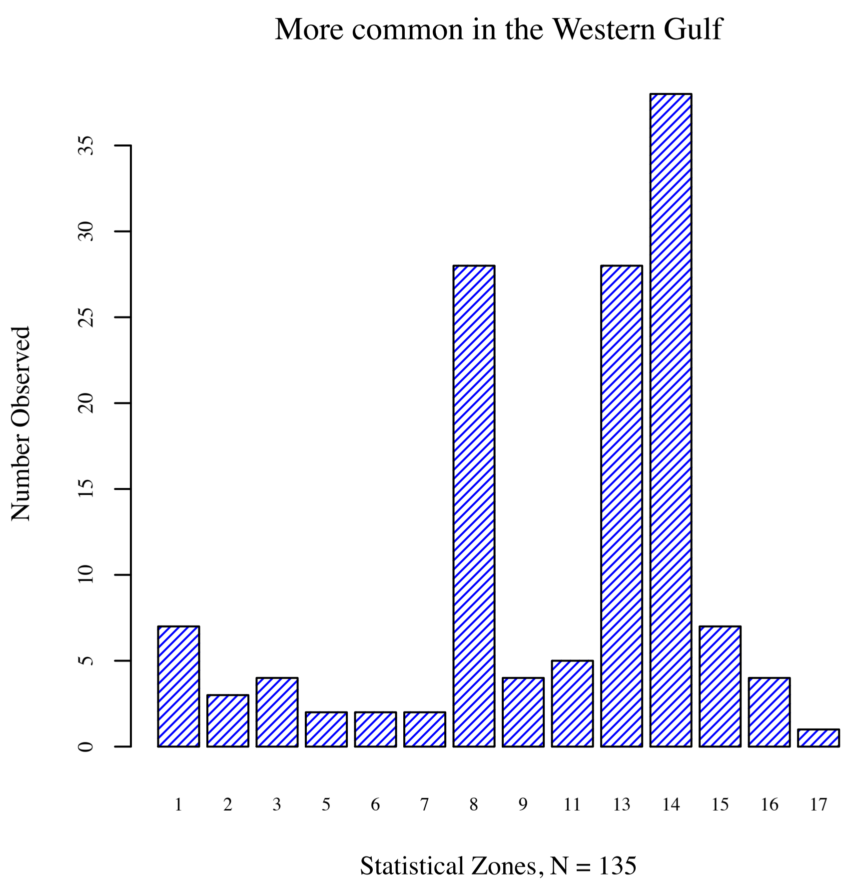


Figure 60 . Regression model, location, and depth information for bonito (*Euthynnus alletteratus*).





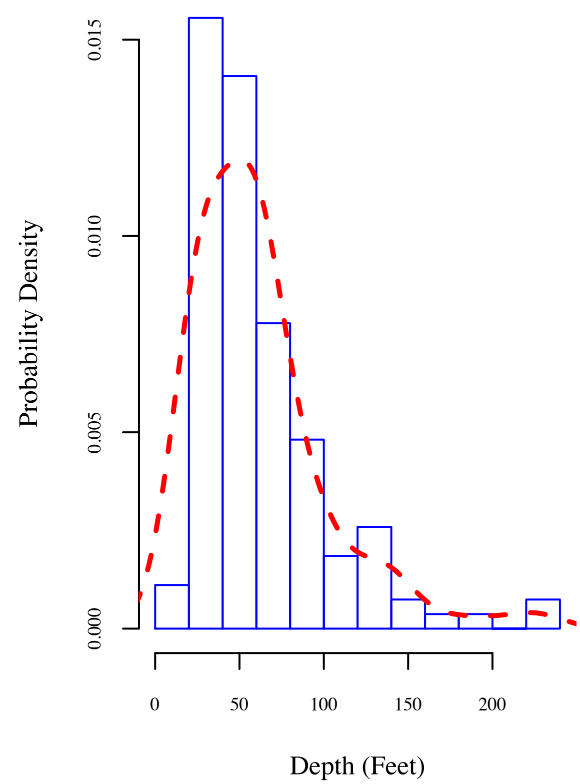


Figure 61 . Regression model, location, and depth information for mackerel, spanish (*Scomberomorus maculatus*).

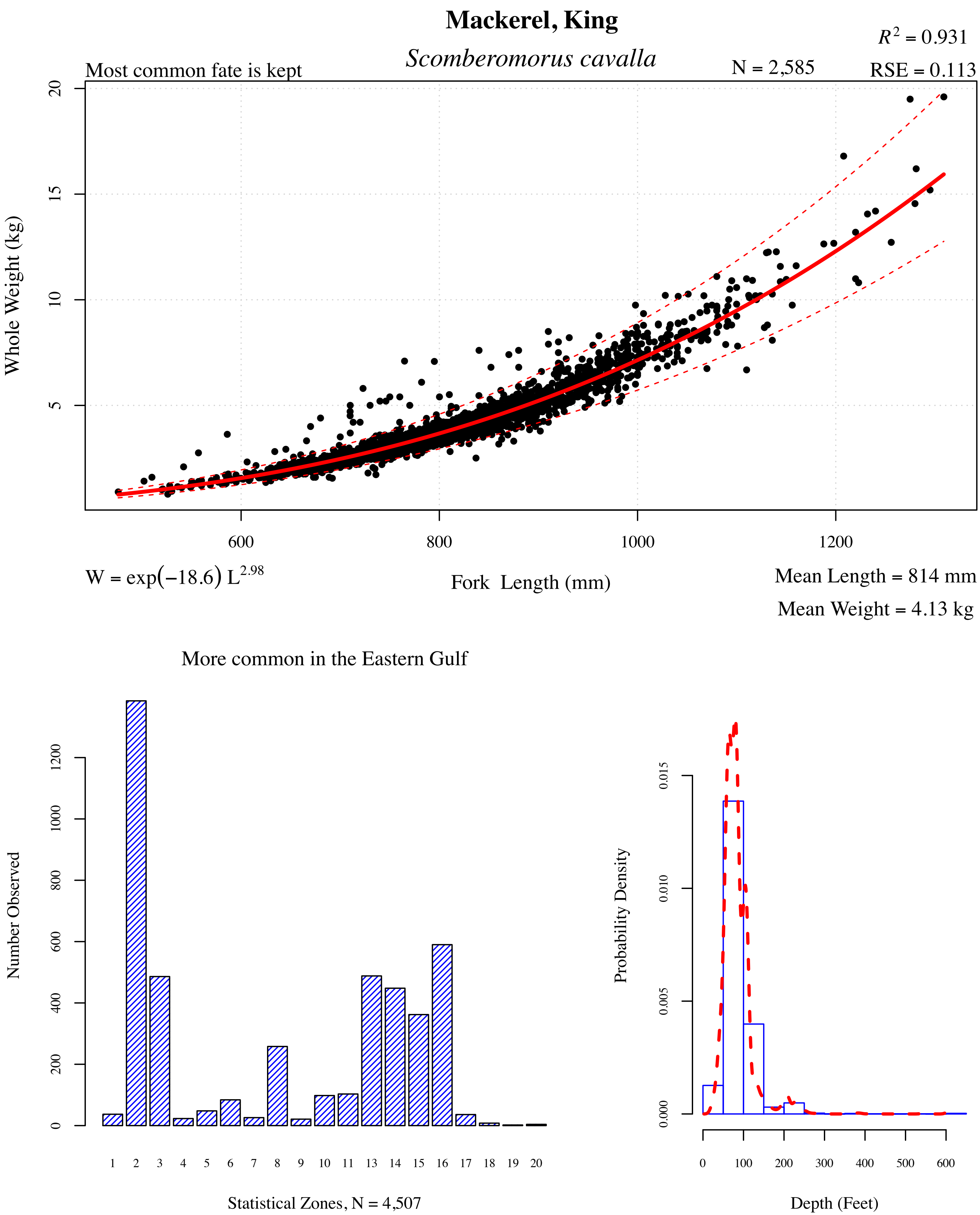
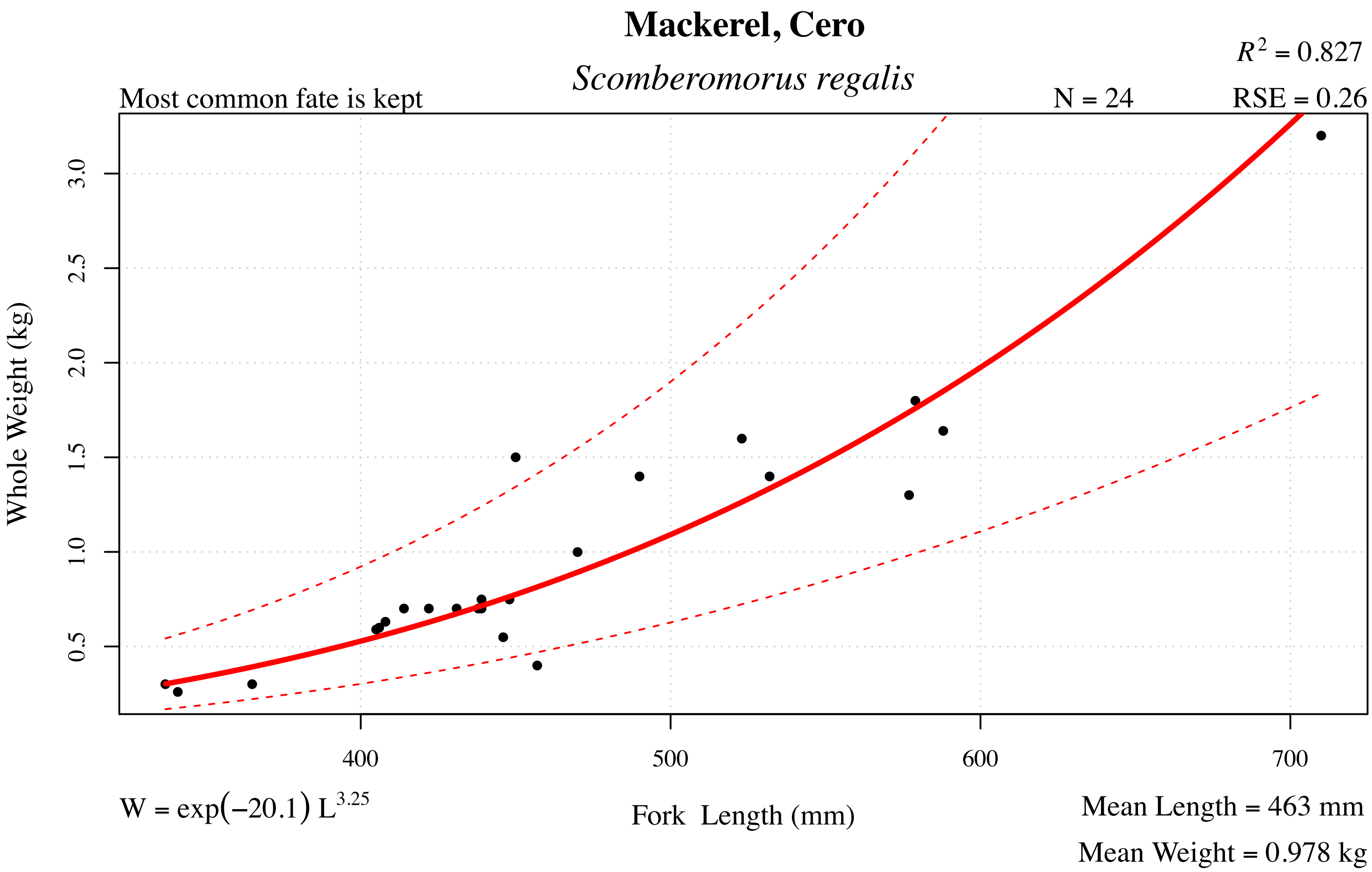
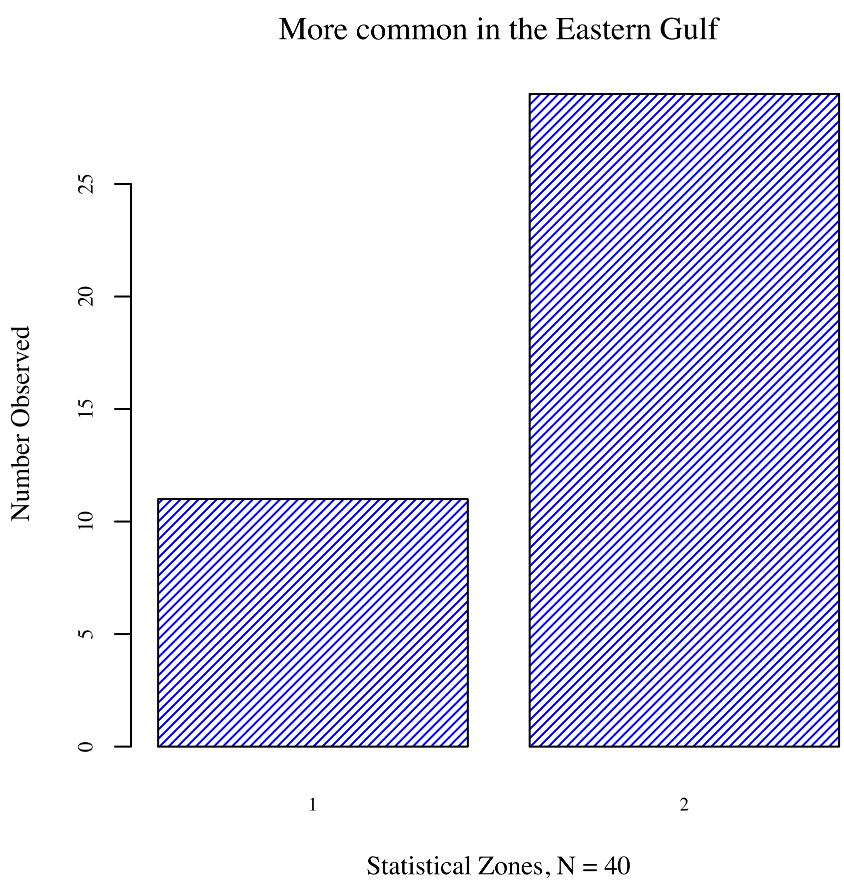


Figure 62 . Regression model, location, and depth information for mackerel, king (*Scomberomorus cavalla*).





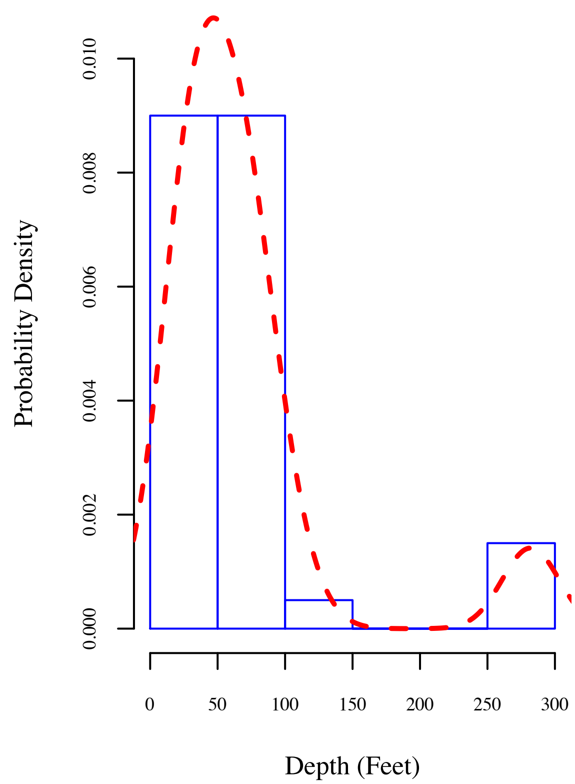
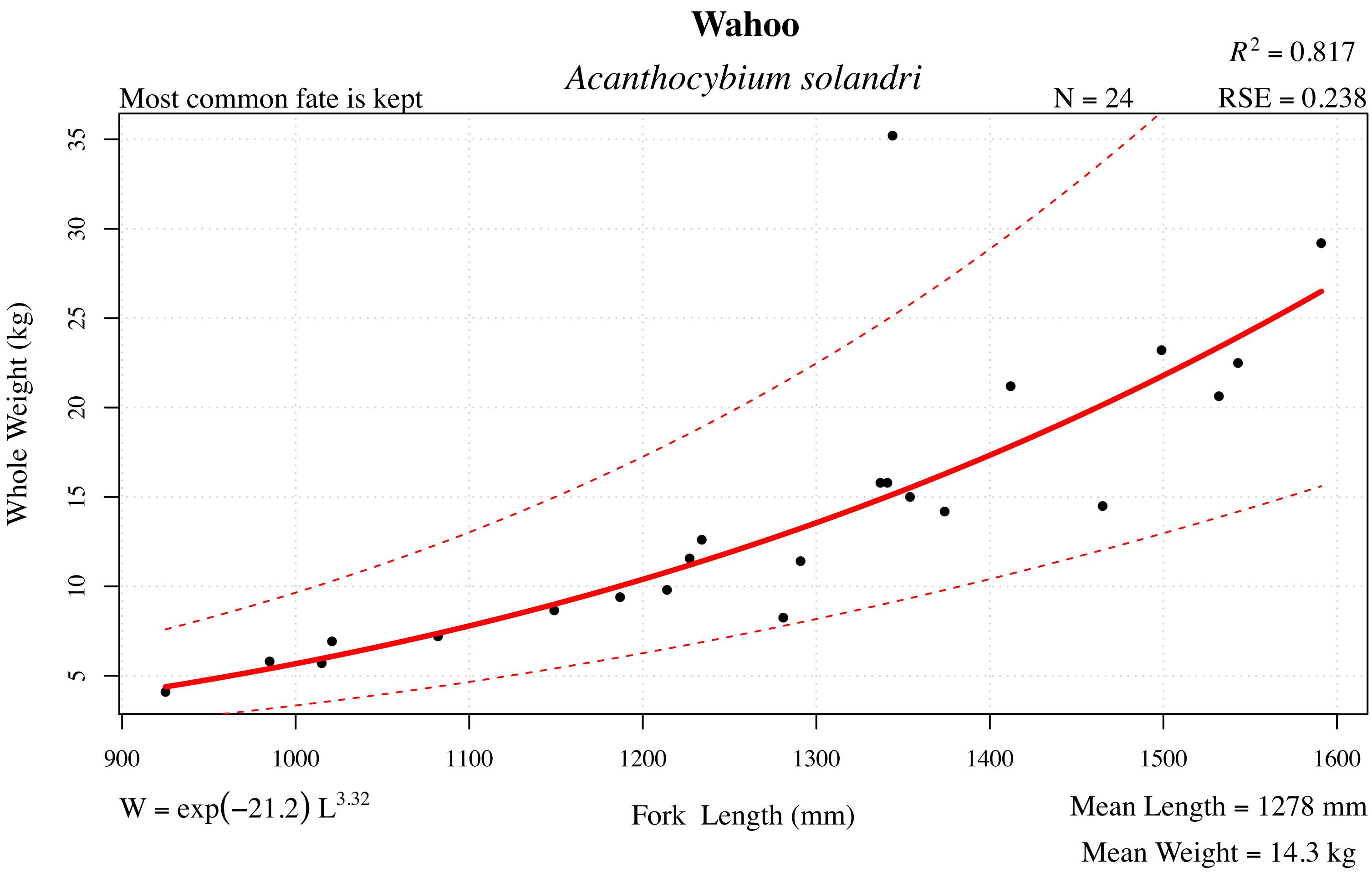
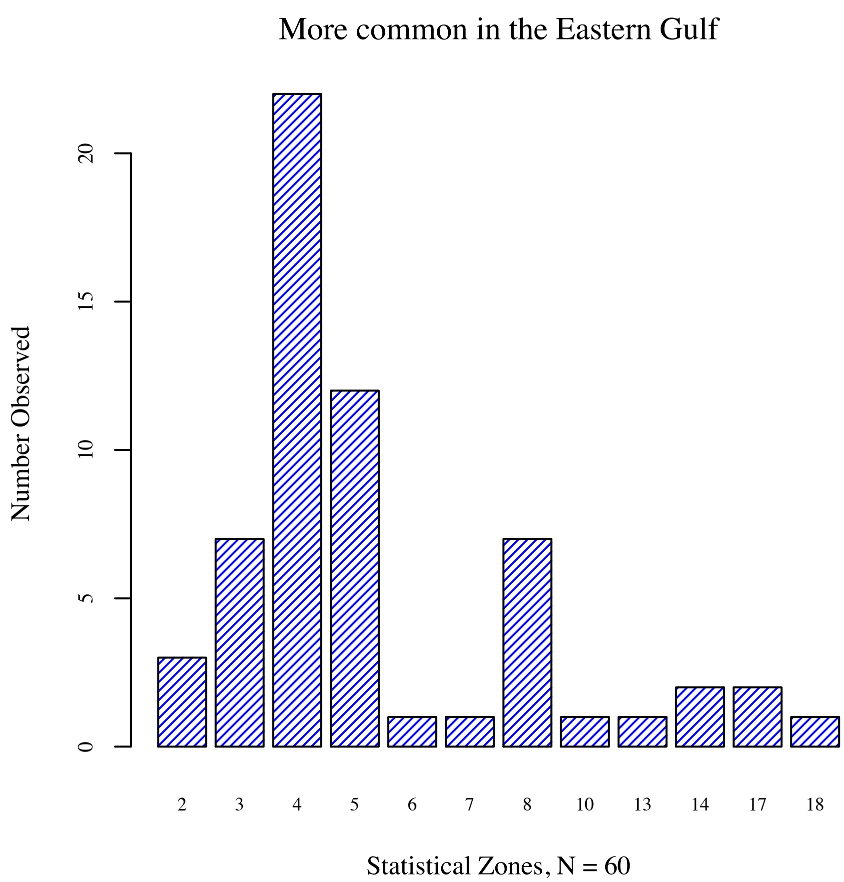


Figure 63 . Regression model, location, and depth information for mackerel, cero (*Scomberomorus regalis*).





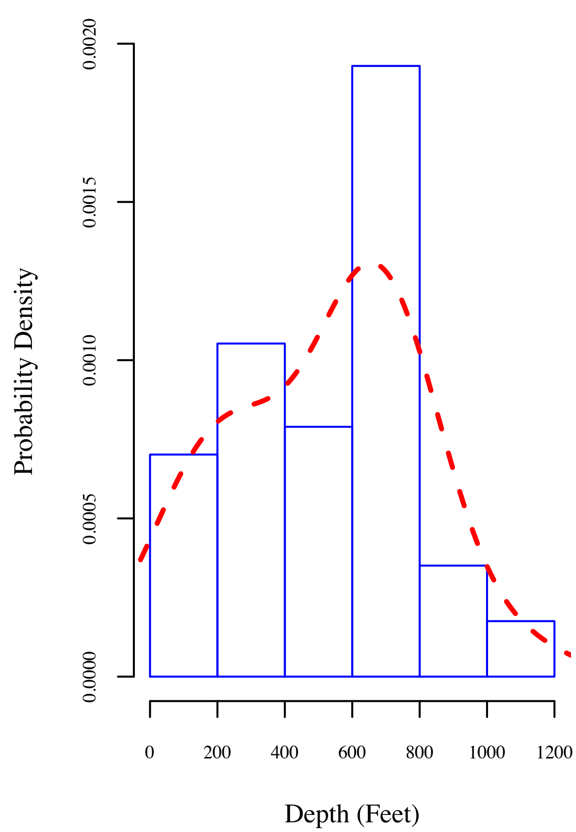
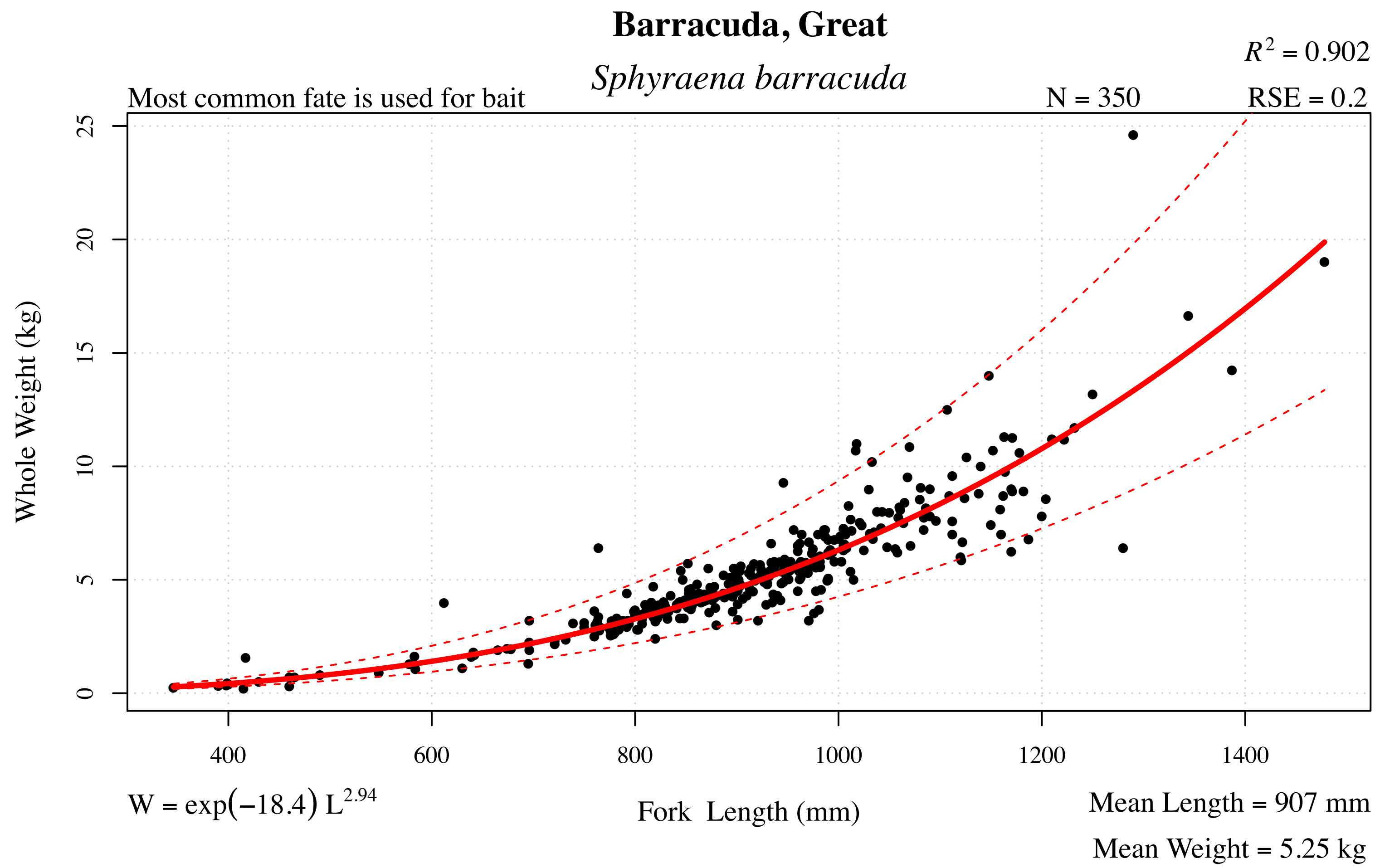
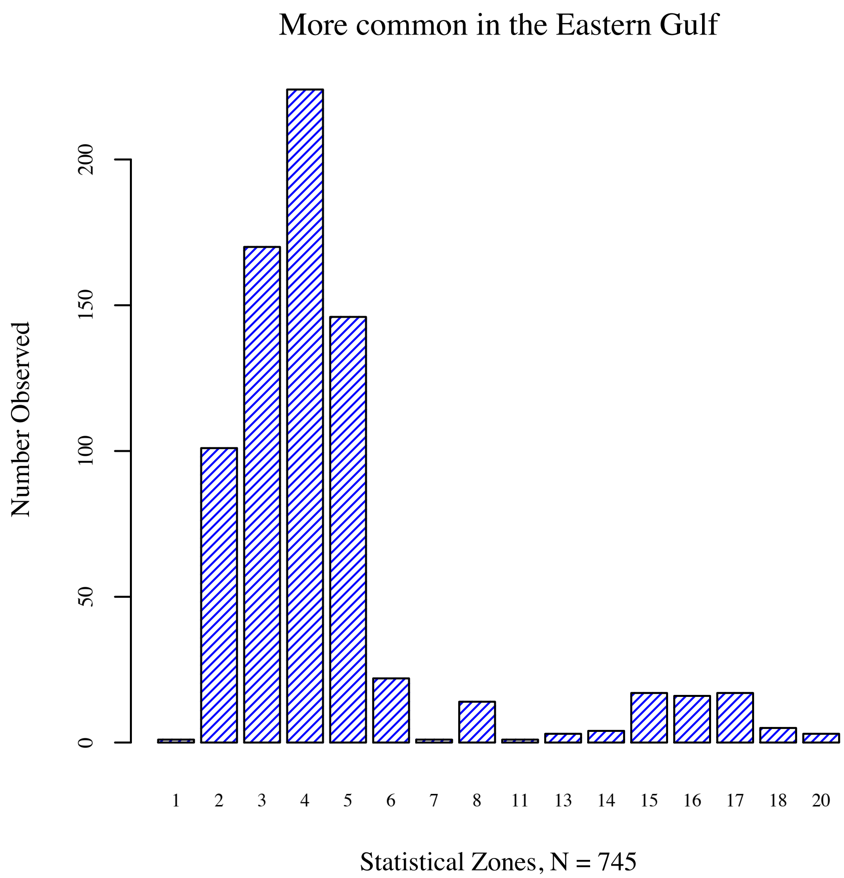


Figure 64 . Regression model, location, and depth information for wahoo (*Acanthocybium solandri*).





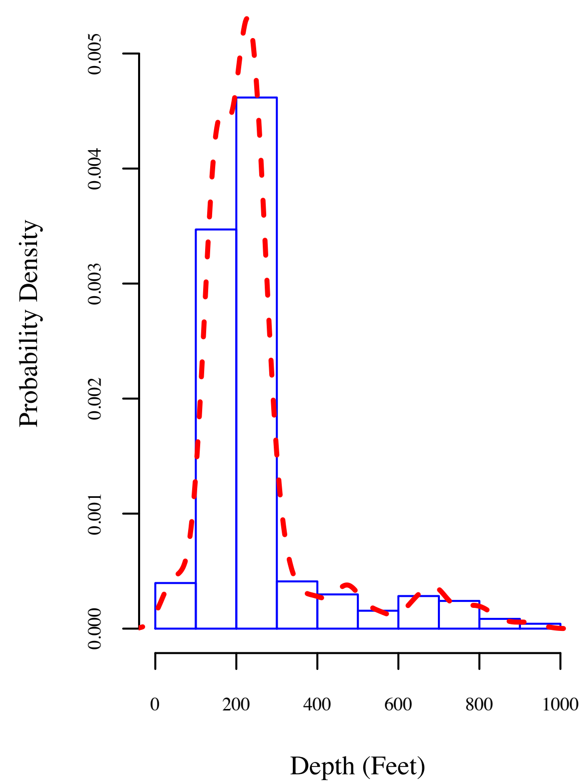


Figure 65 . Regression model, location, and depth information for barracuda, great (*Sphyraena barracuda*).

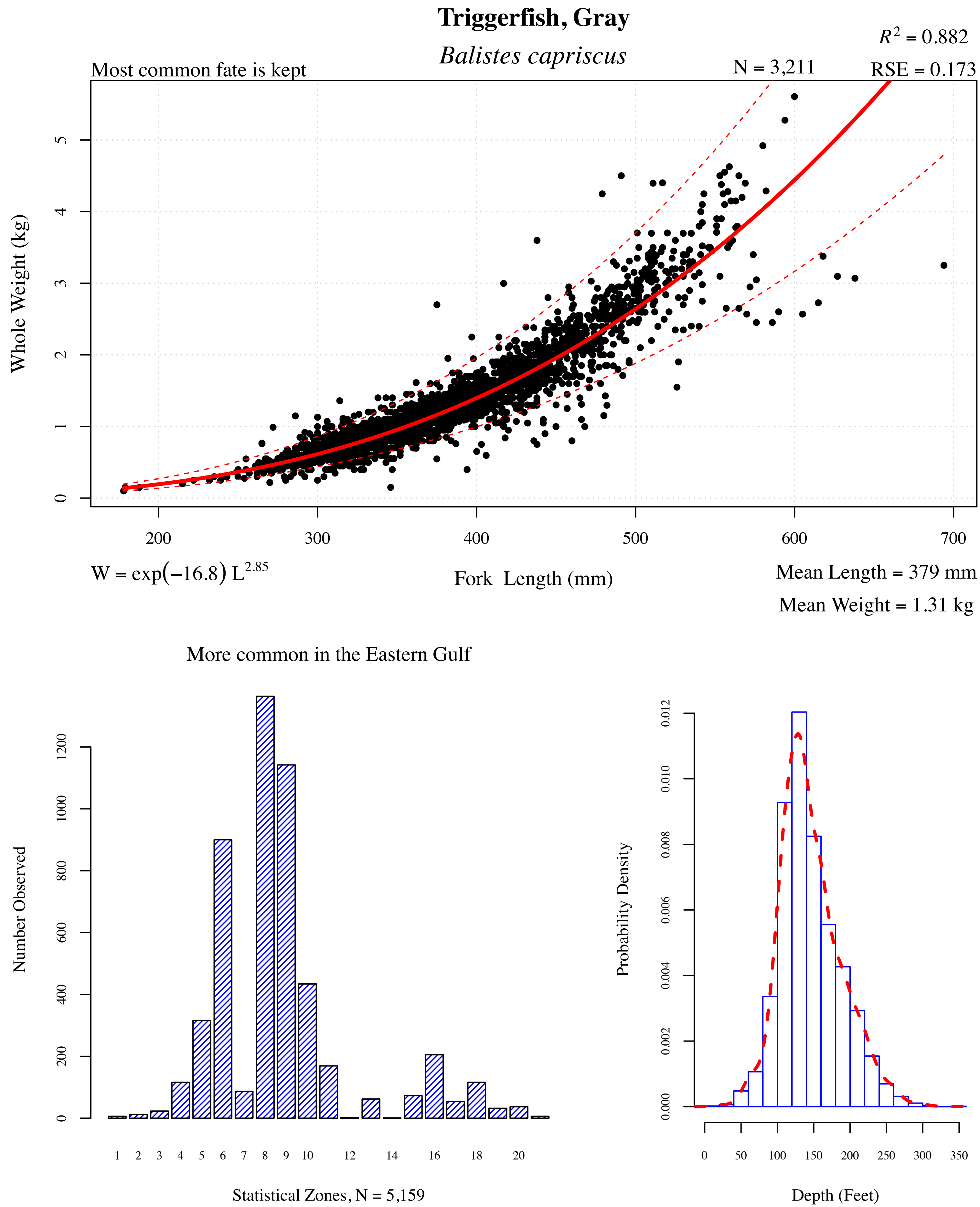


Figure 66 . Regression model, location, and depth information for triggerfish, gray (*Balistes capriscus*).

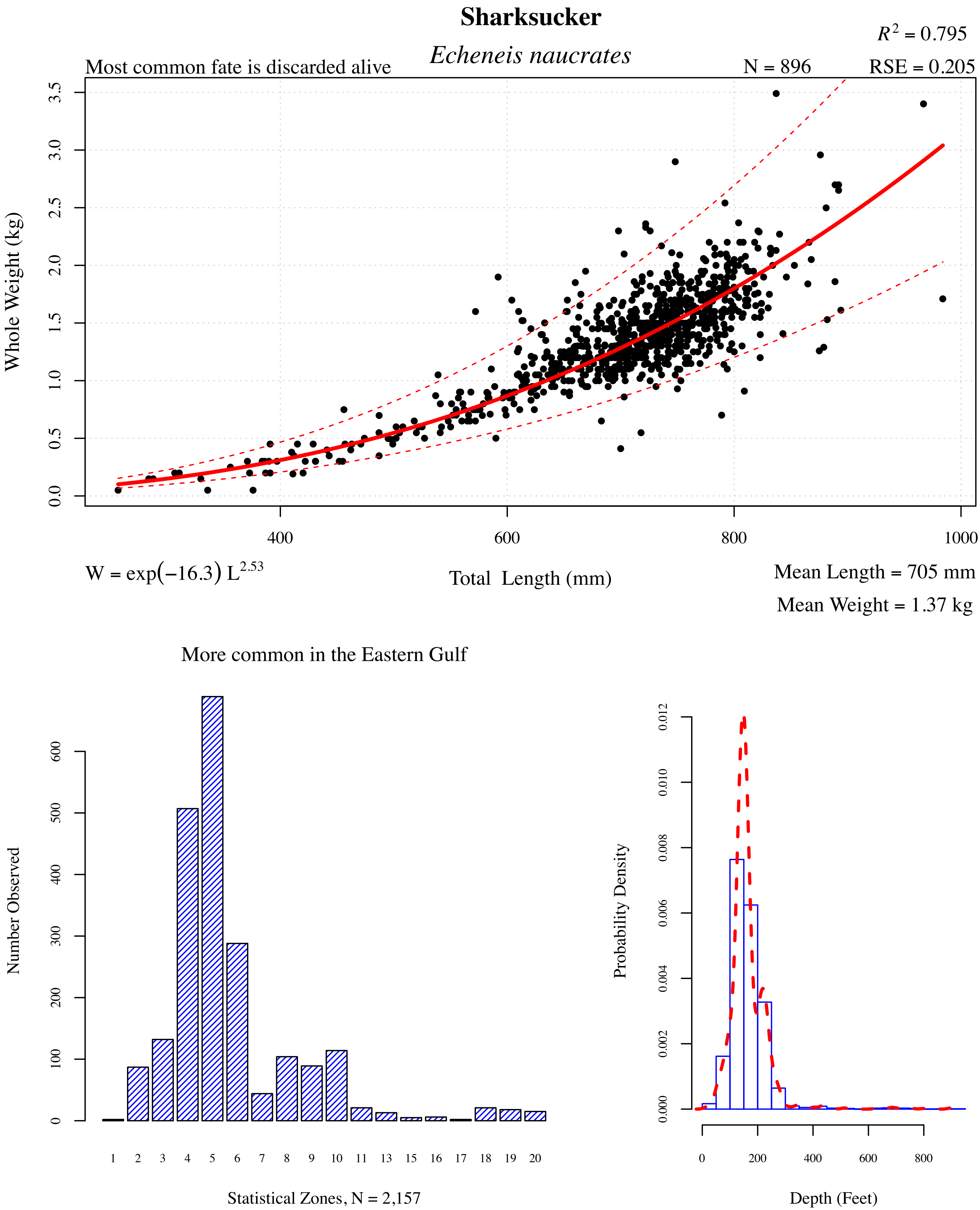


Figure 67 . Regression model, location, and depth information for sharksucker (*Echeneis naucrates*).

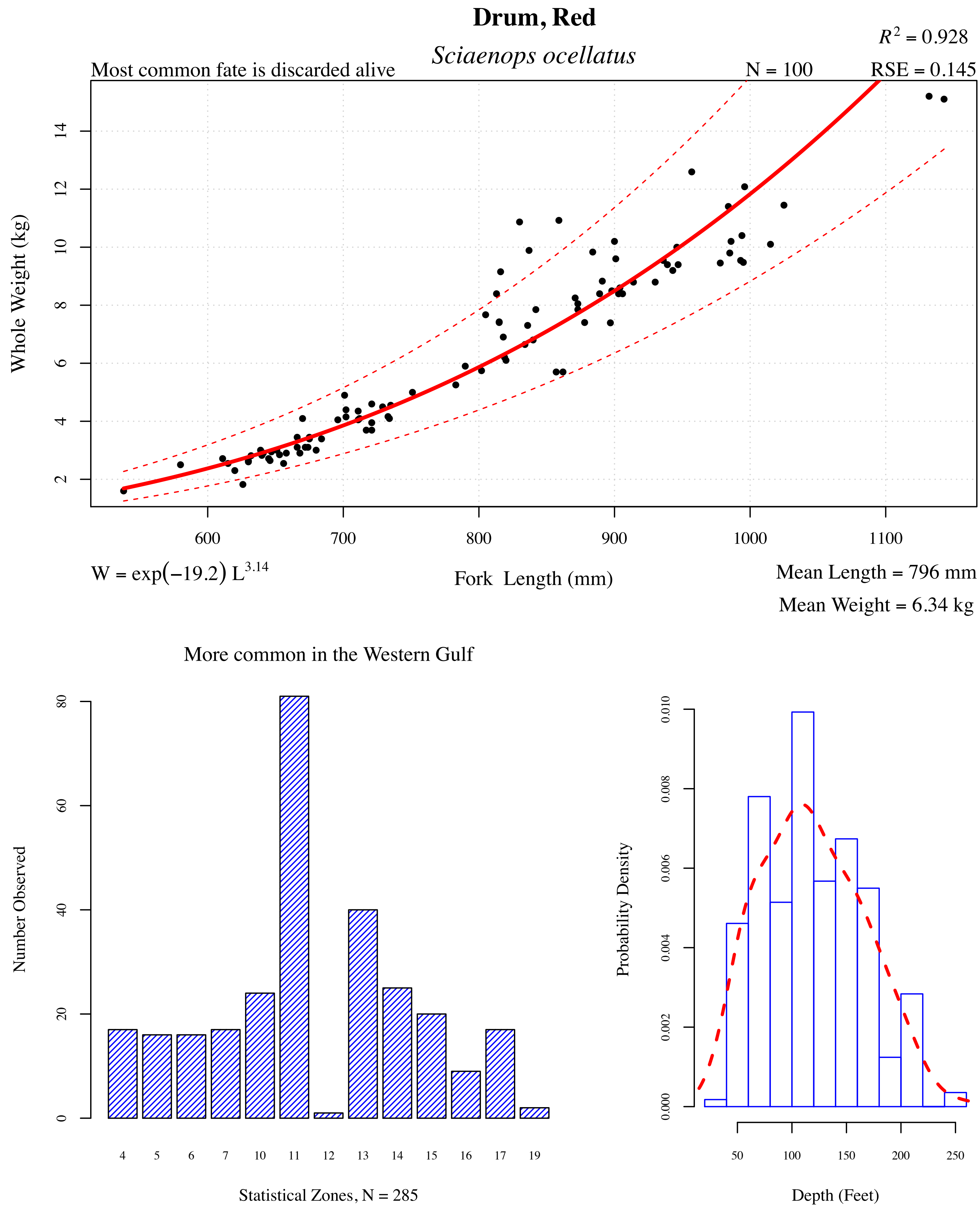


Figure 68 . Regression model, location, and depth information for drum, red (*Sciaenops ocellatus*).

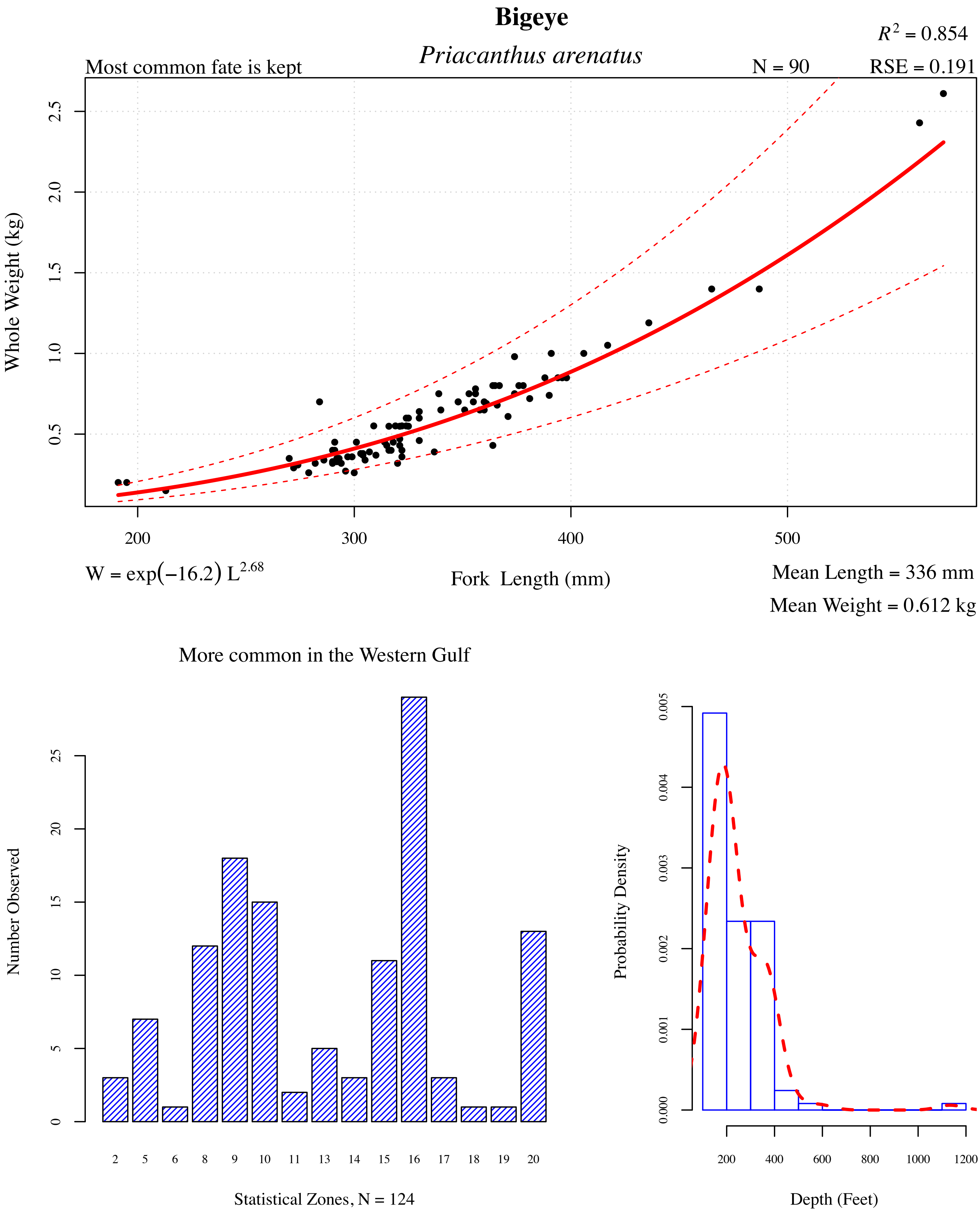


Figure 69 . Regression model, location, and depth information for bigeye (*Priacanthus arenatus*).

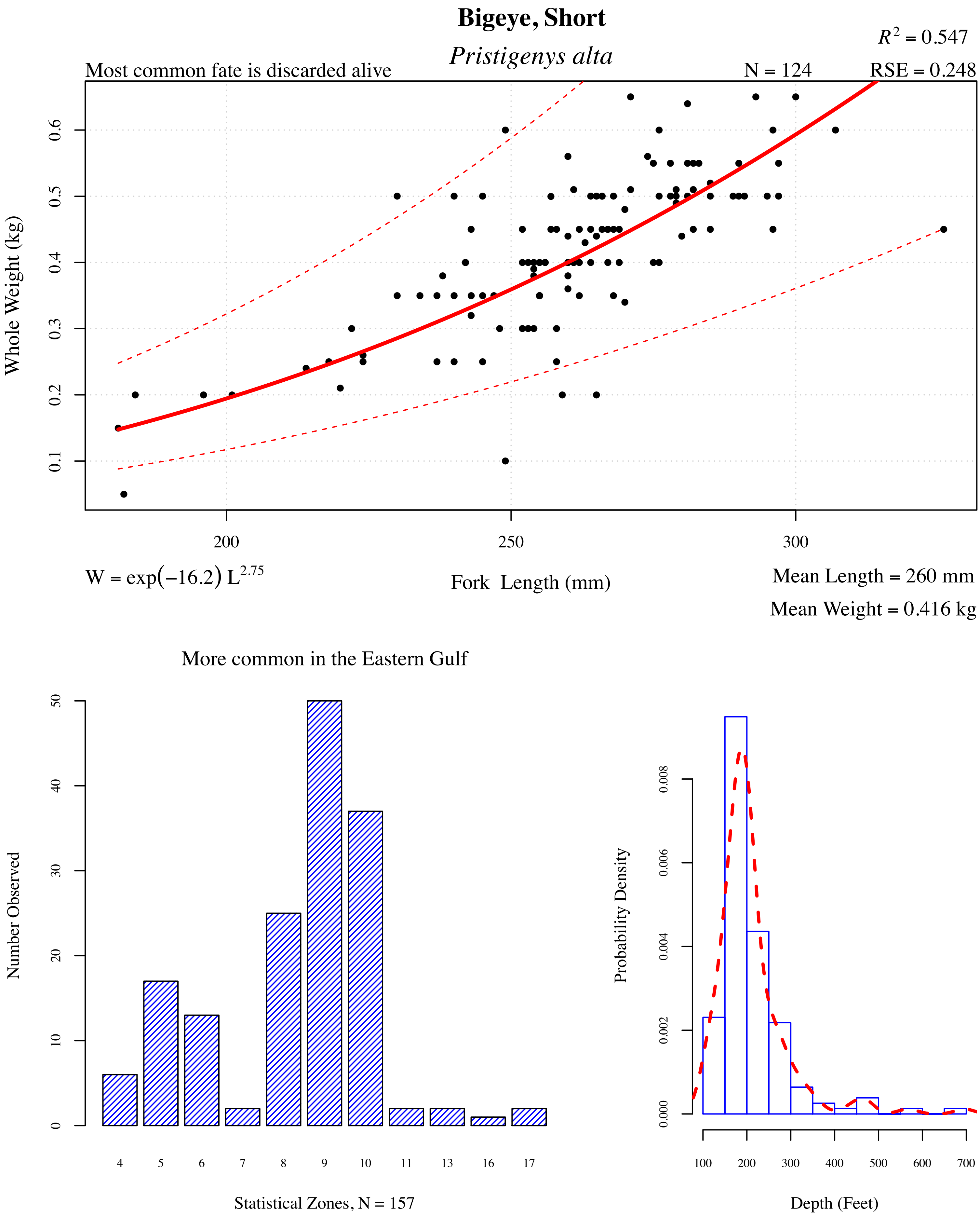
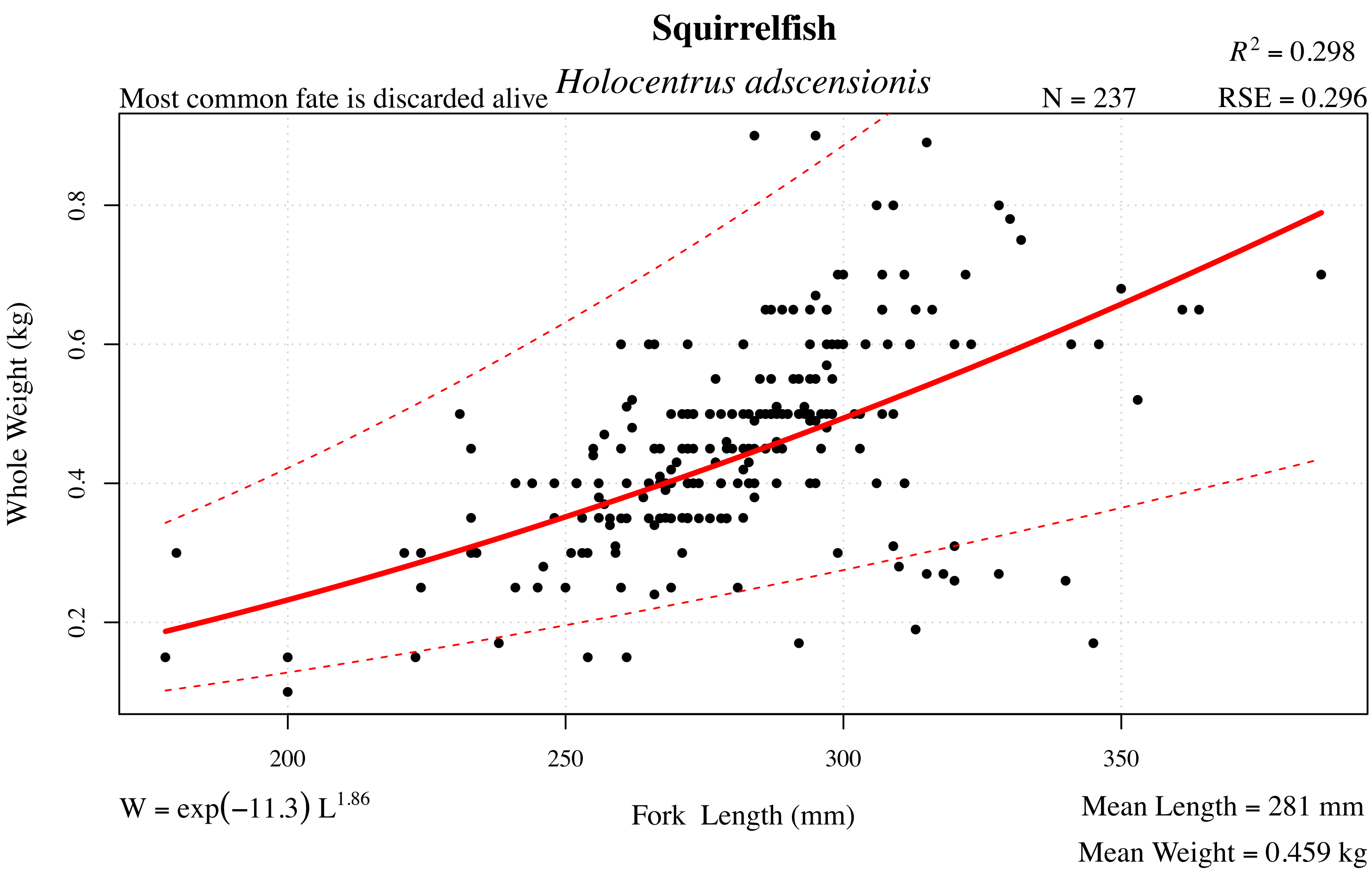
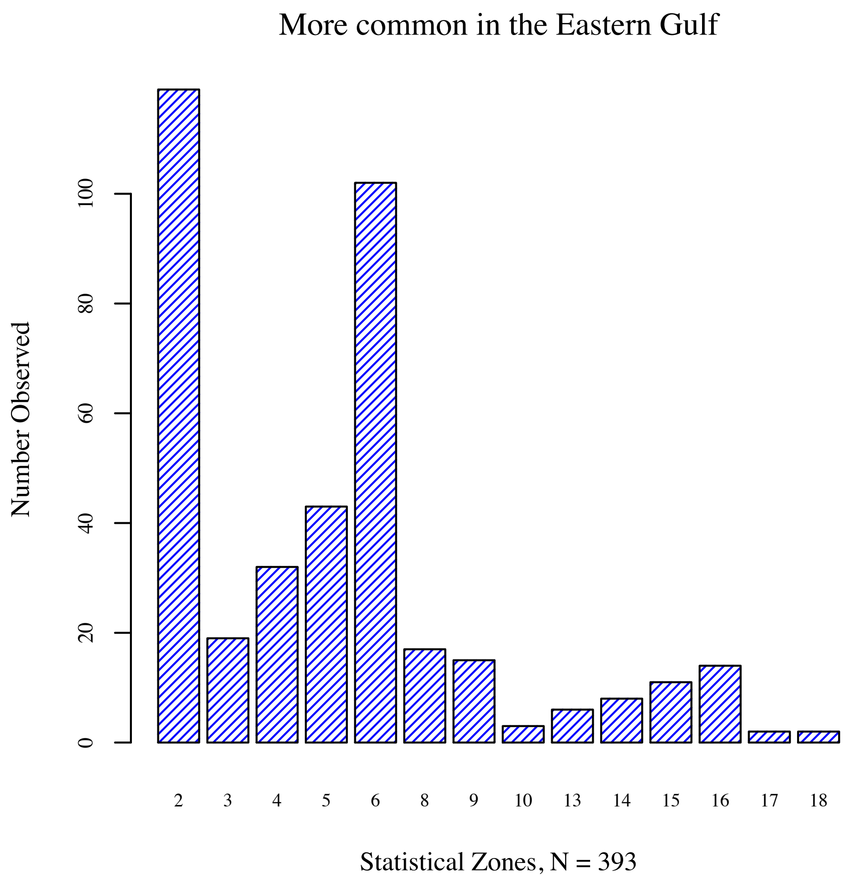


Figure 70 . Regression model, location, and depth information for bigeye, short (*Pristigenys alta*).





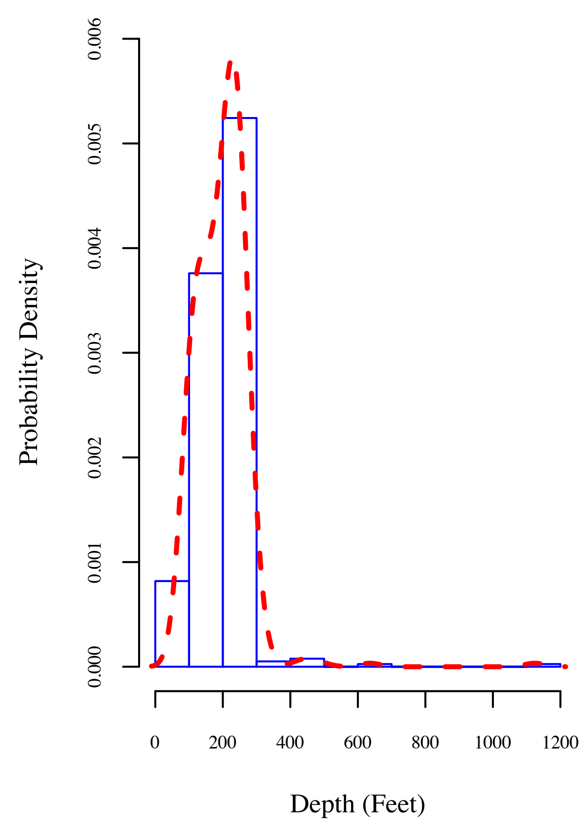


Figure 71 . Regression model, location, and depth information for squirrelfish (*Holocentrus adscensionis*).

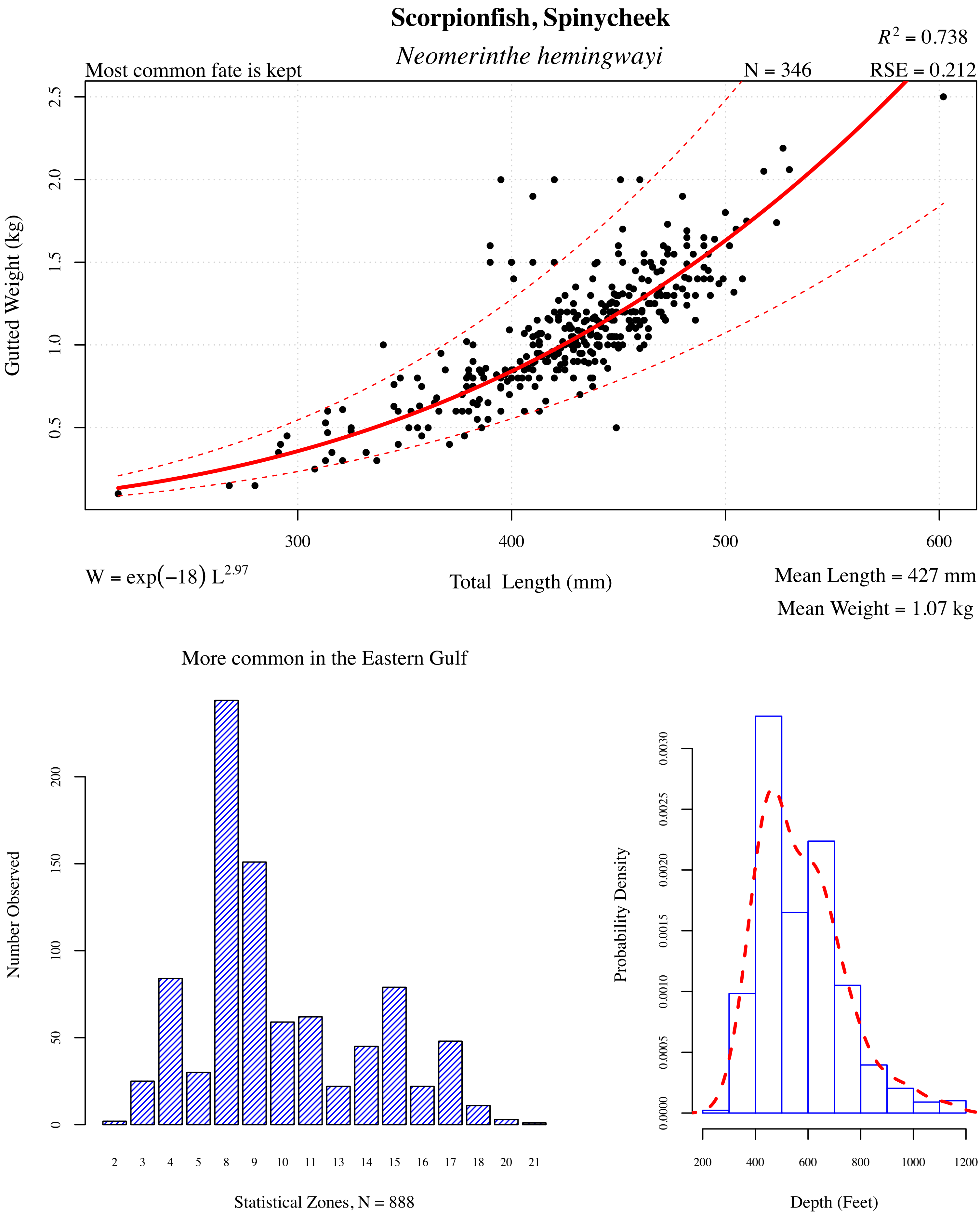


Figure 72 . Regression model, location, and depth information for scorpionfish, spinycheek (*Neomerinthe hemingwayi*).

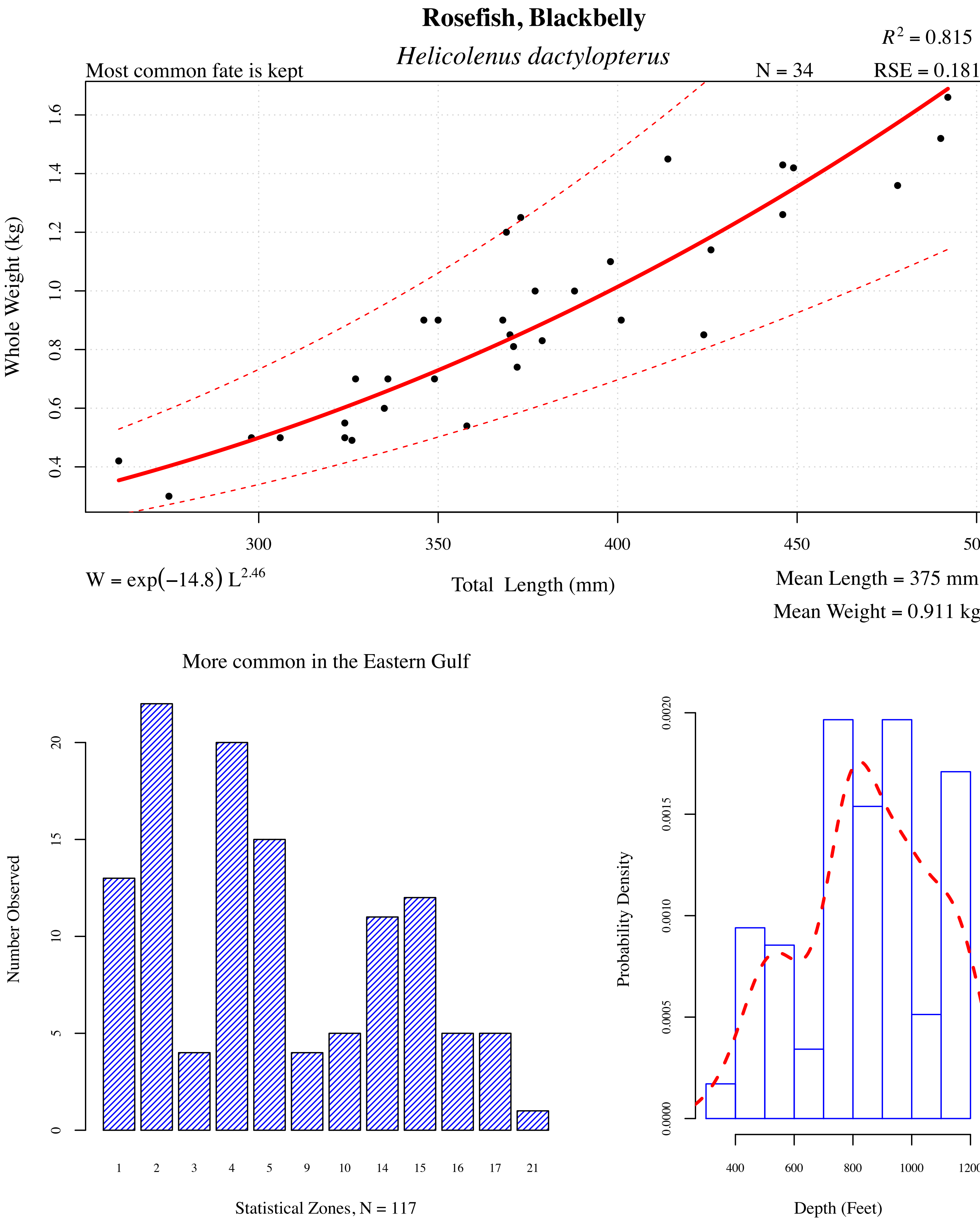


Figure 73 . Regression model, location, and depth information for rosefish, blackbelly (*Helicolenus dactylopterus*).

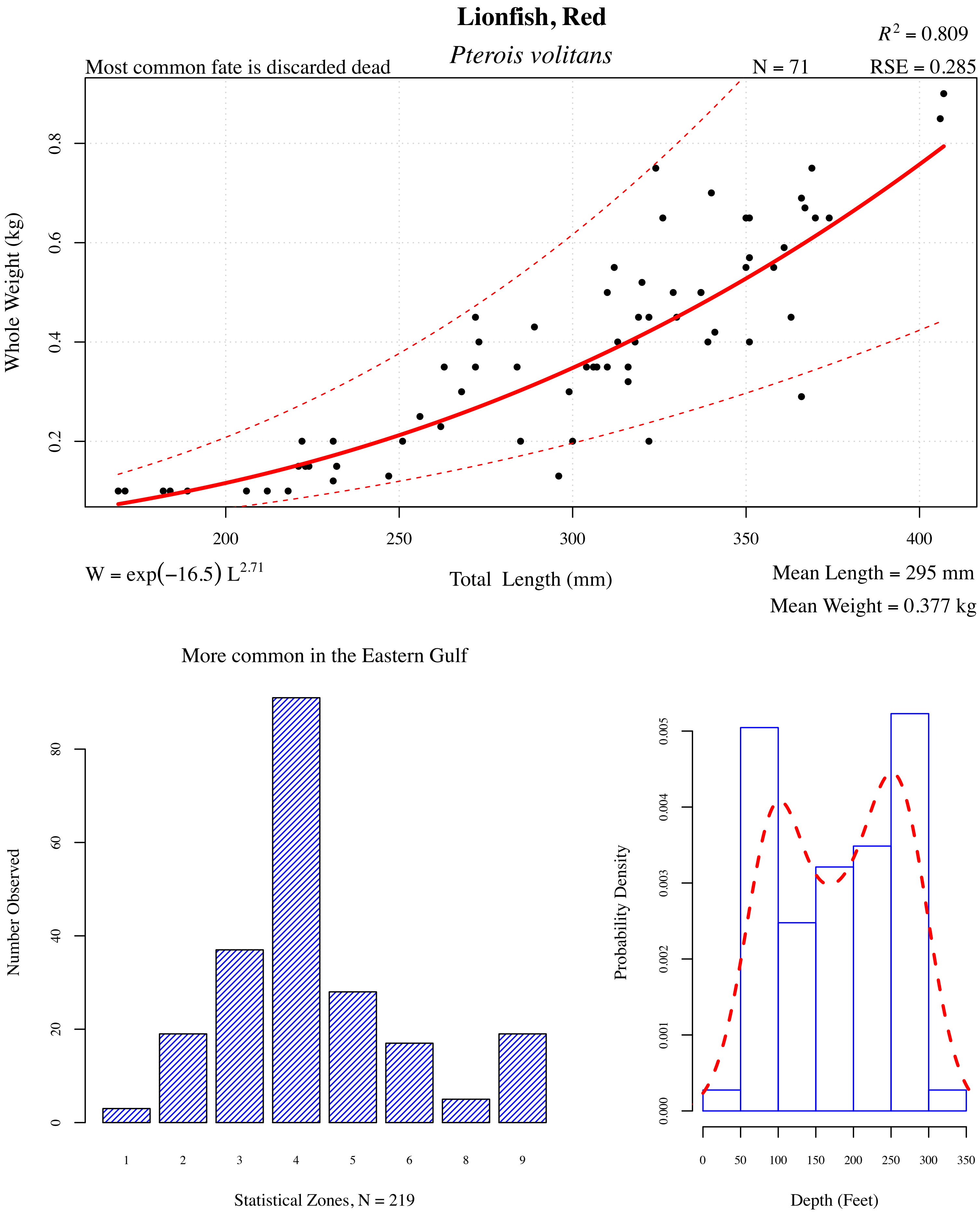
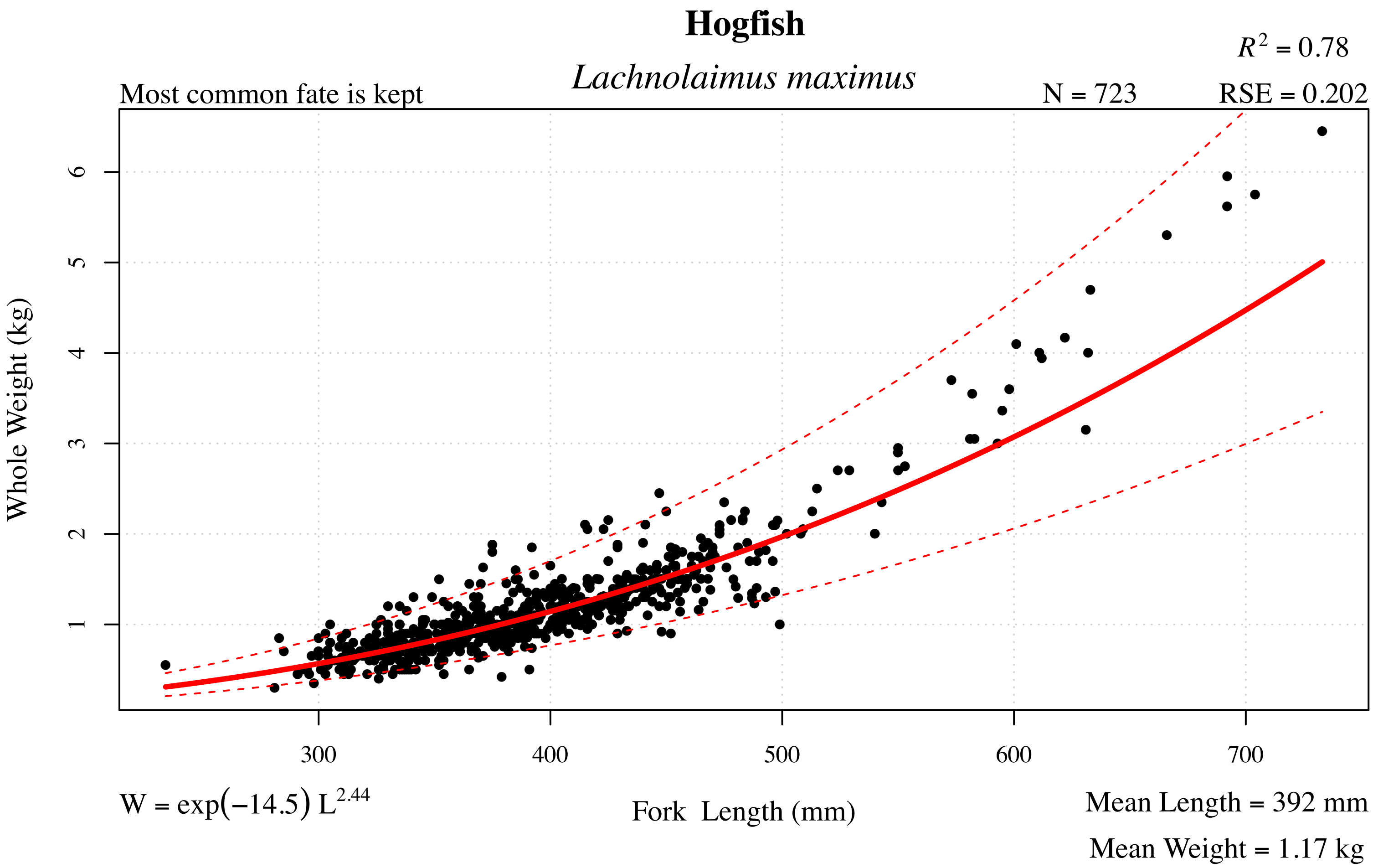


Figure 74 . Regression model, location, and depth information for lionfish, red (*Pterois volitans*).



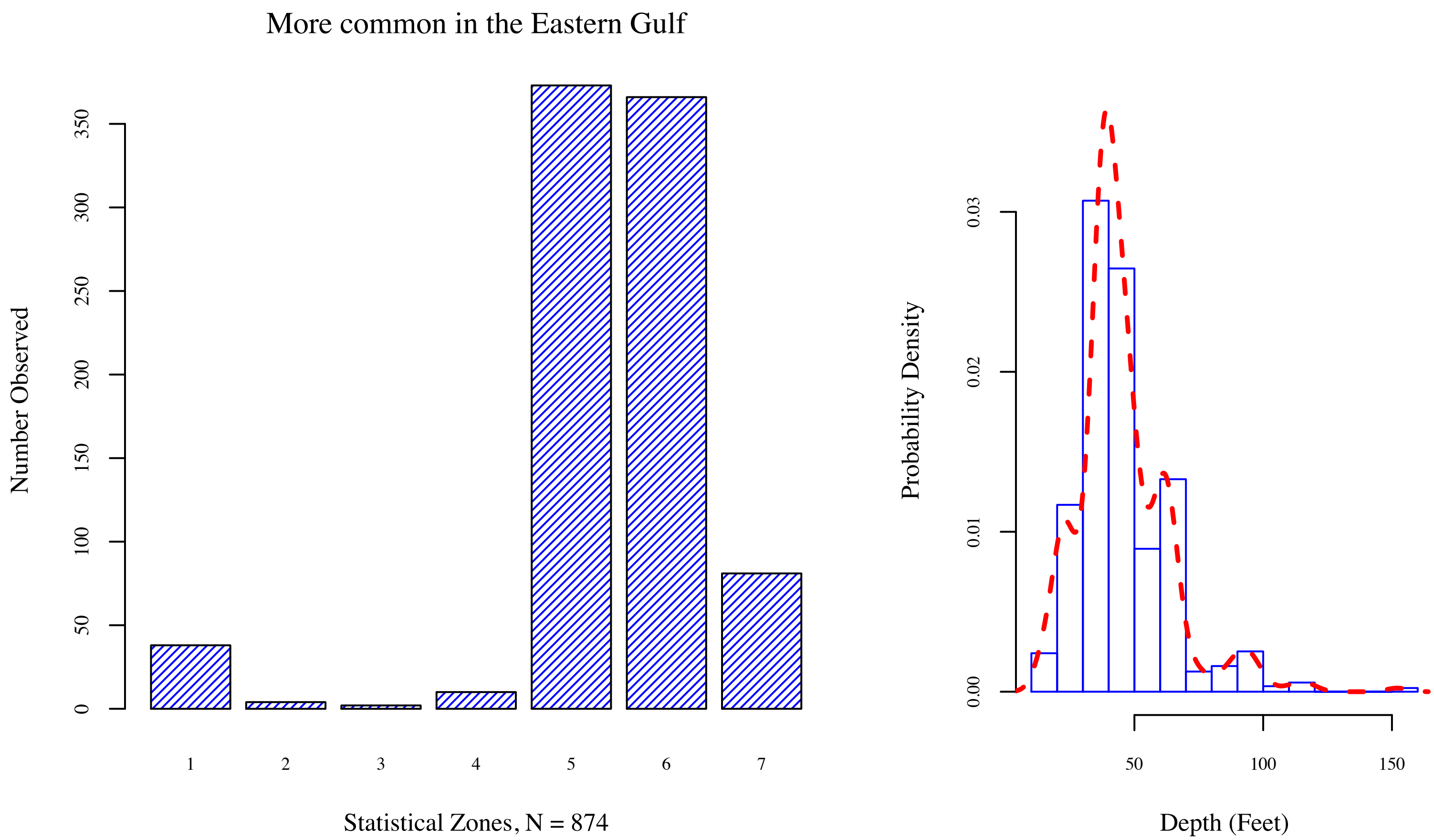


Figure 75 . Regression model, location, and depth information for hogfish (*Lachnolaimus maximus*).

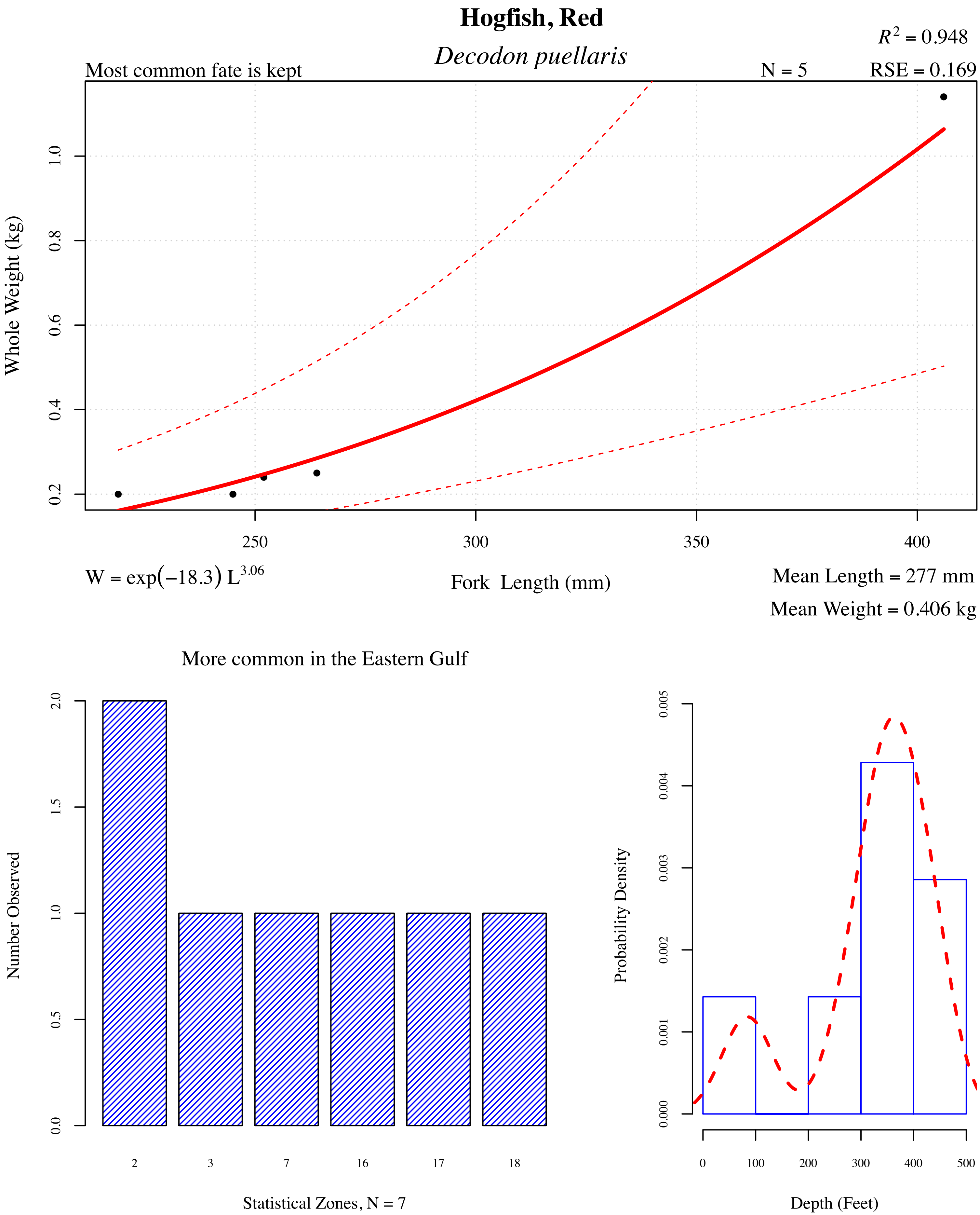
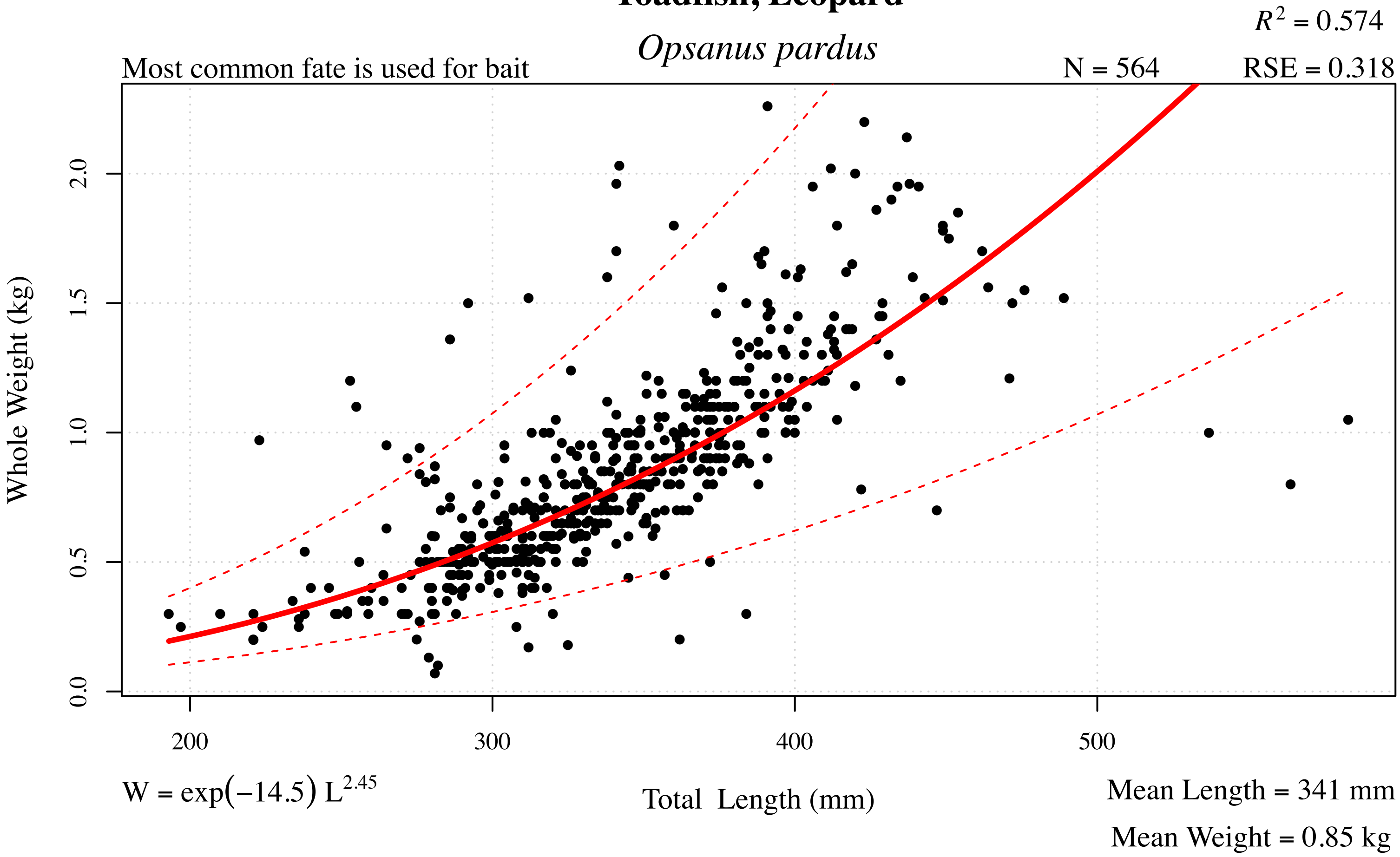
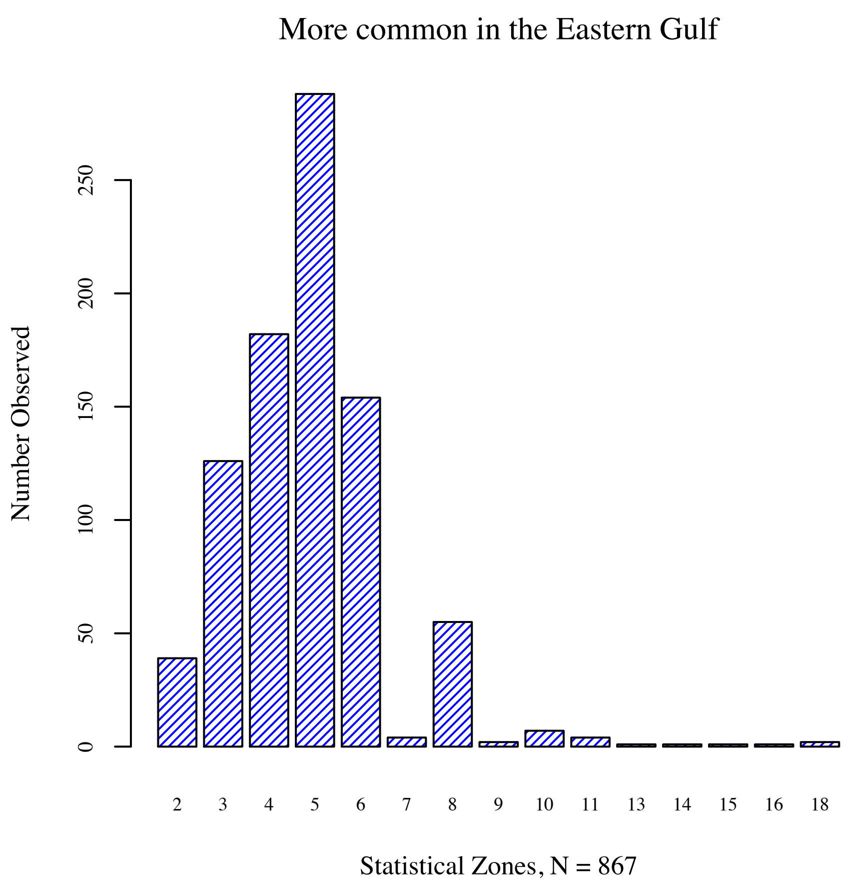


Figure 76 . Regression model, location, and depth information for hogfish, red (*Decodon puellaris*).

Toadfish, Leopard

Opsanus pardus





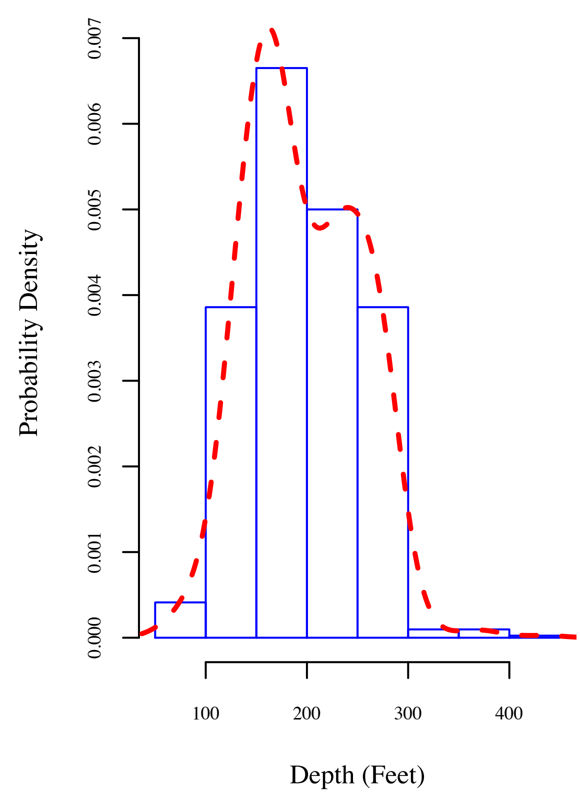


Figure 77 . Regression model, location, and depth information for toadfish, leopard (*Opsanus pardus*).

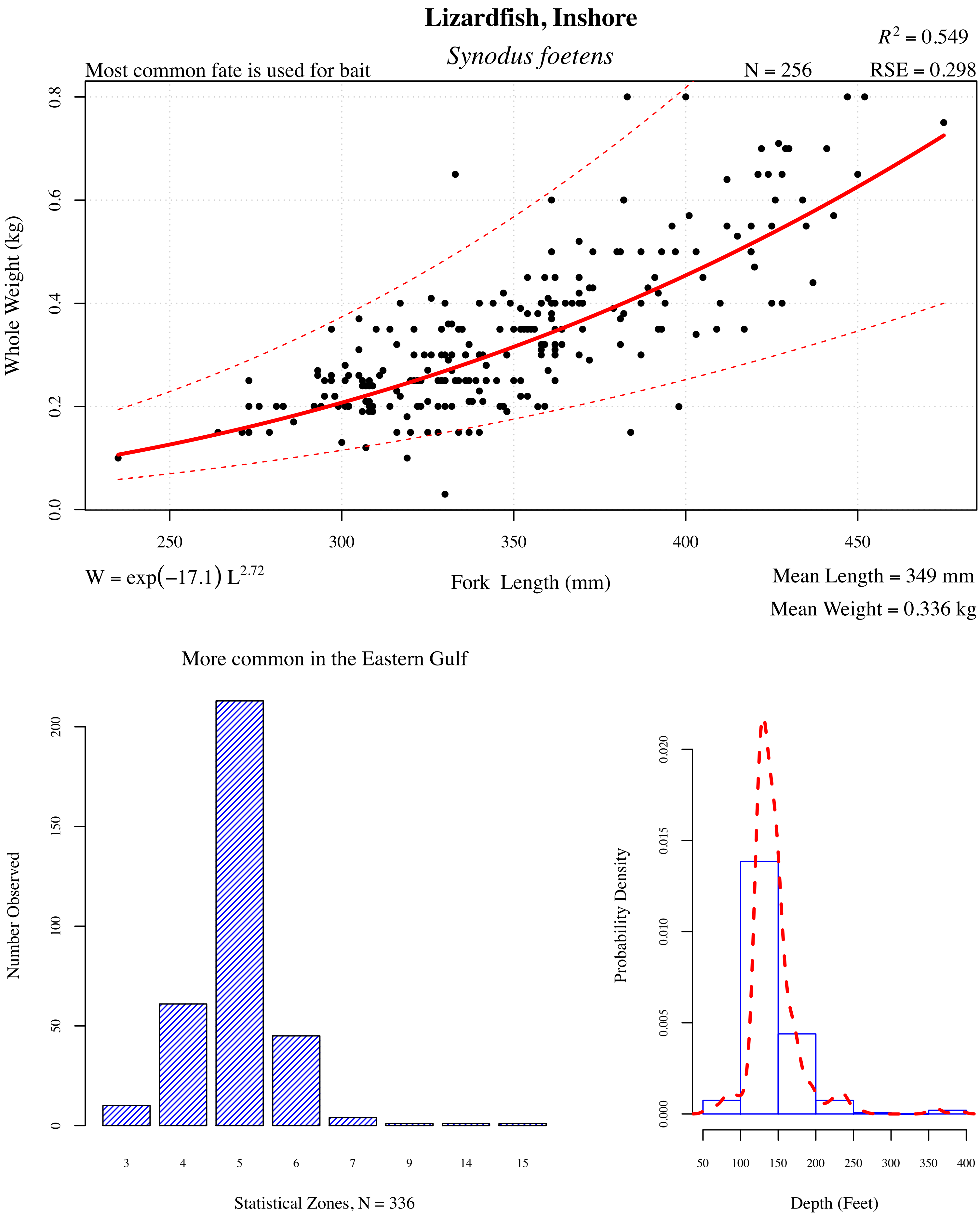
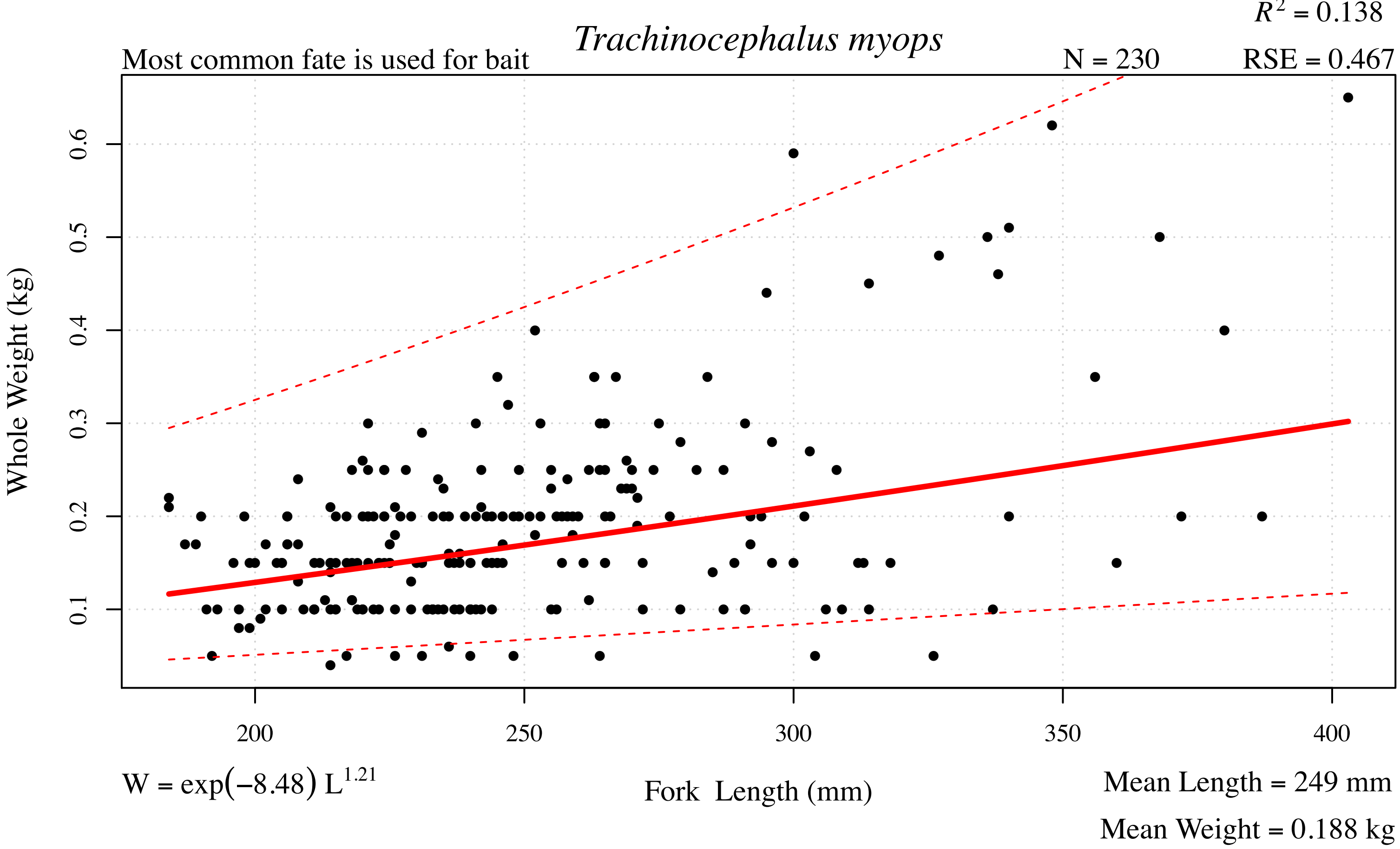
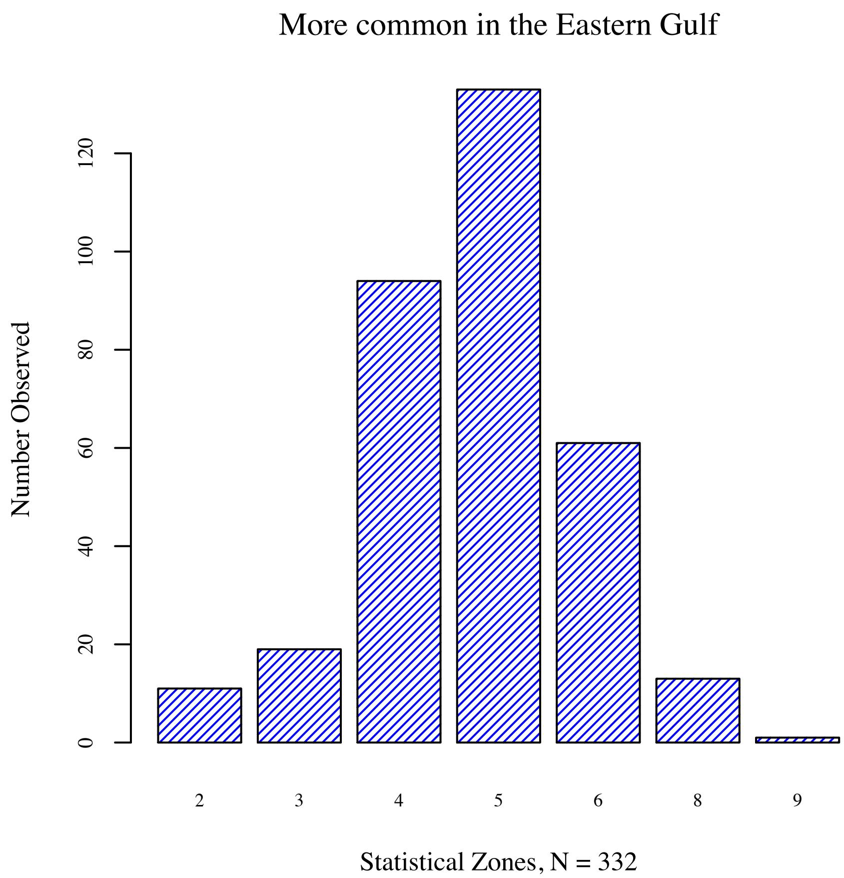


Figure 78 . Regression model, location, and depth information for lizardfish, inshore (*Synodus foetens*).

Snakefish





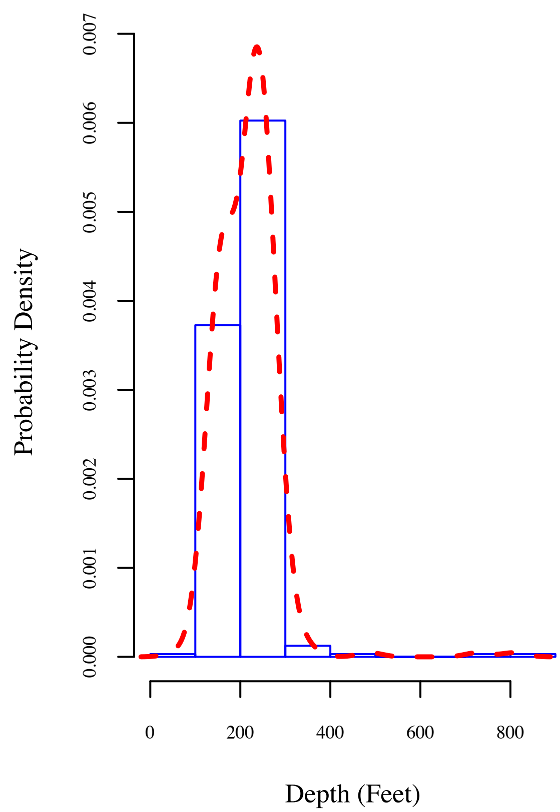


Figure 79 . Regression model, location, and depth information for snakefish (*Trachinocephalus myops*).

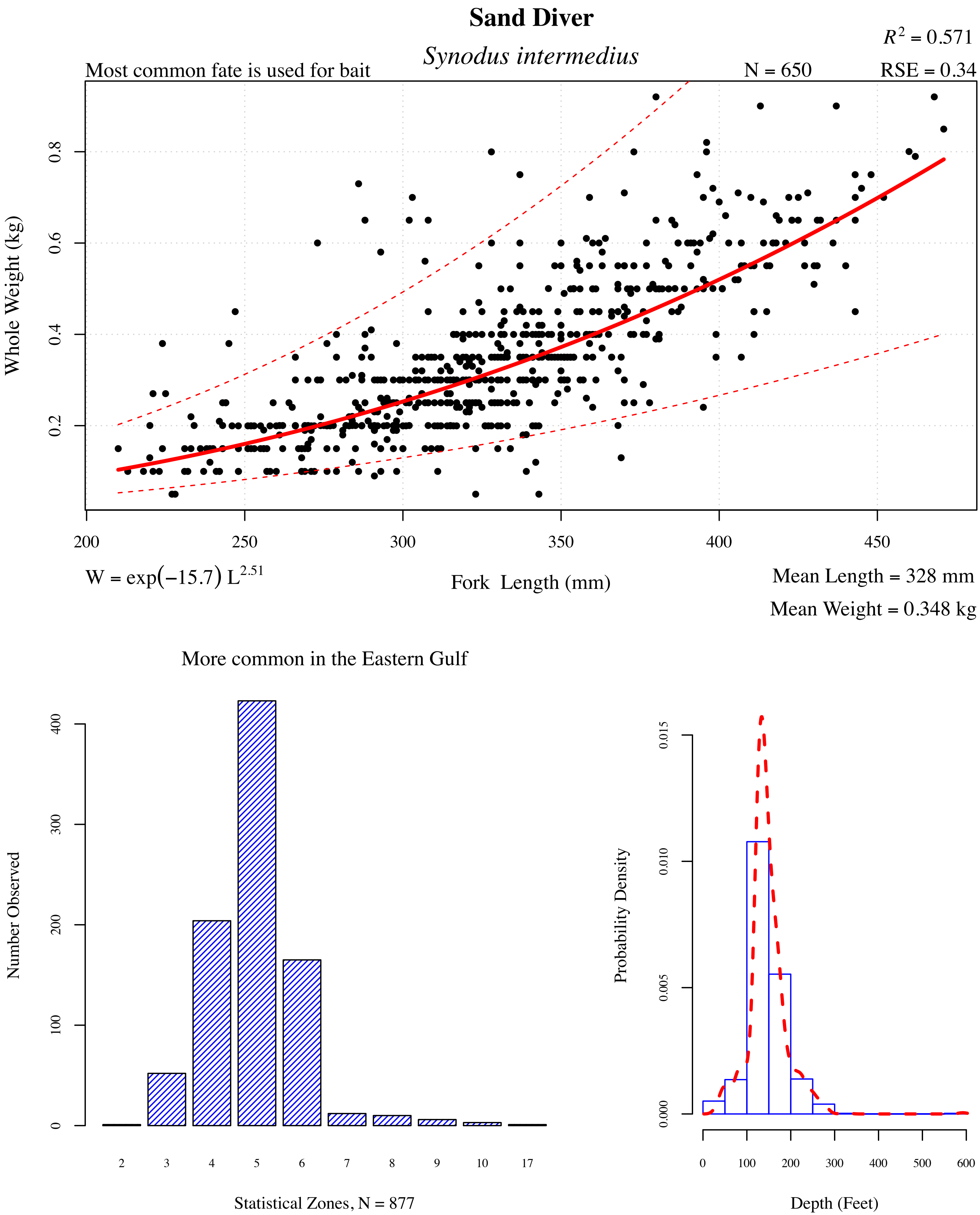
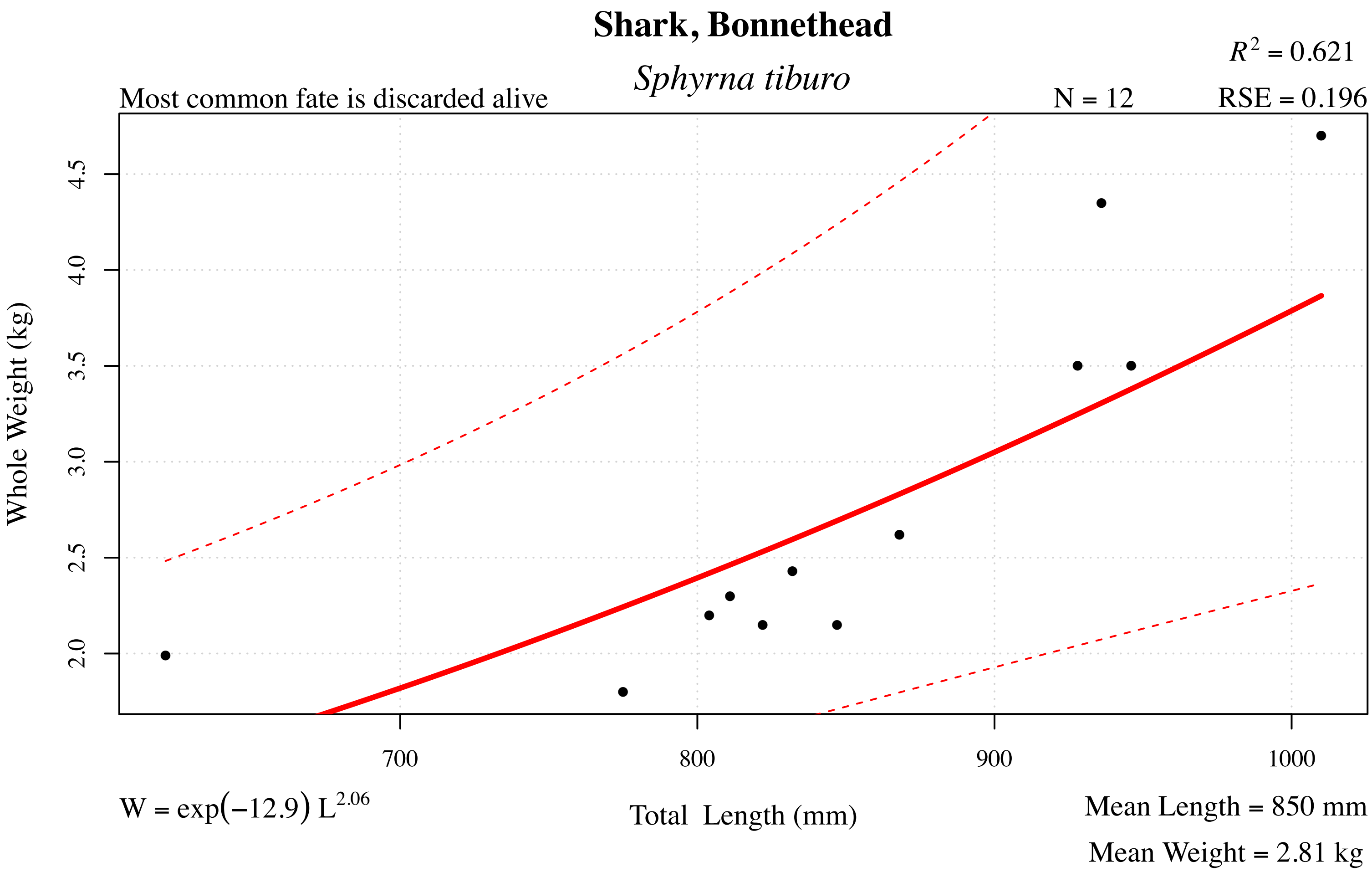


Figure 80 . Regression model, location, and depth information for sand diver (*Synodus intermedius*).



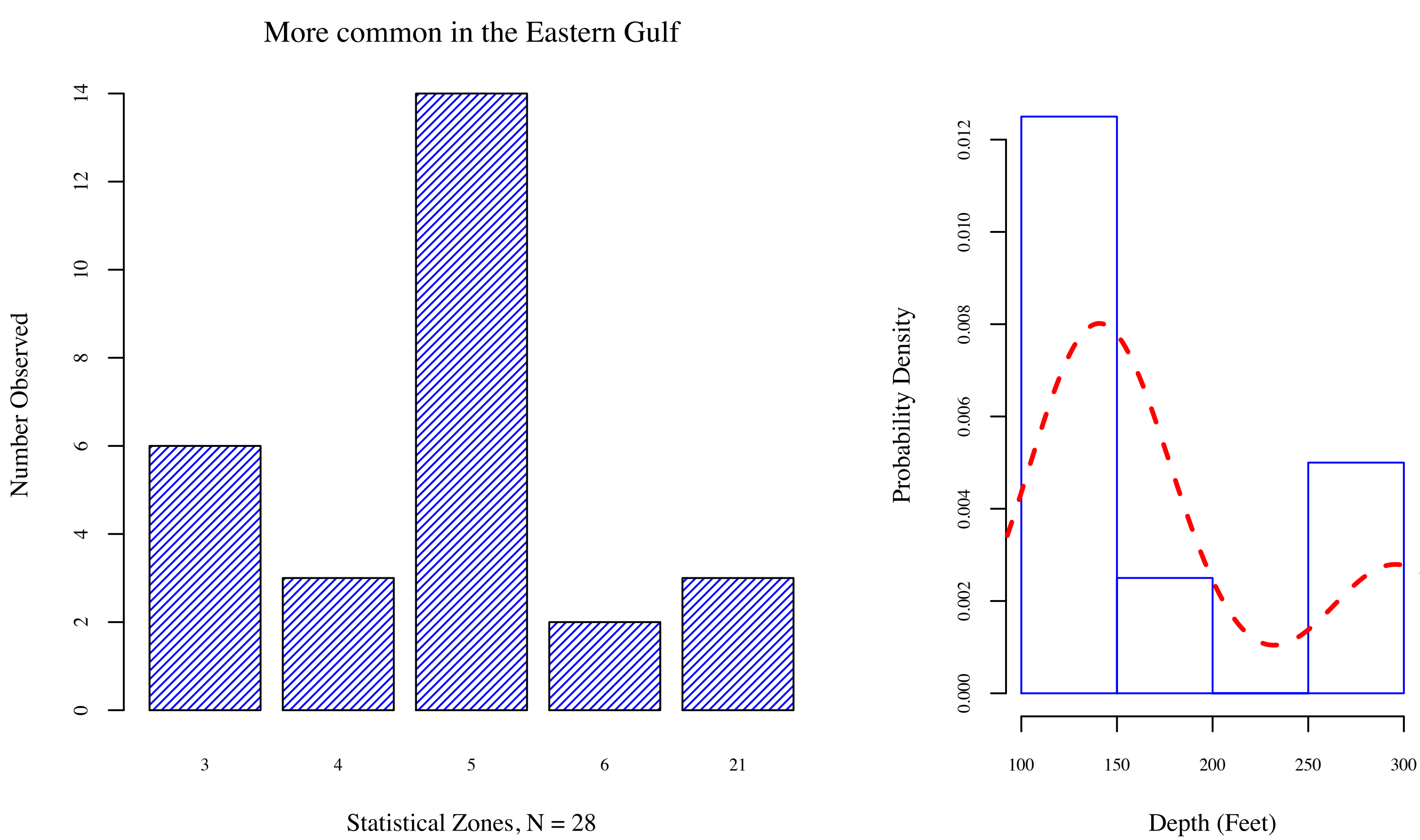
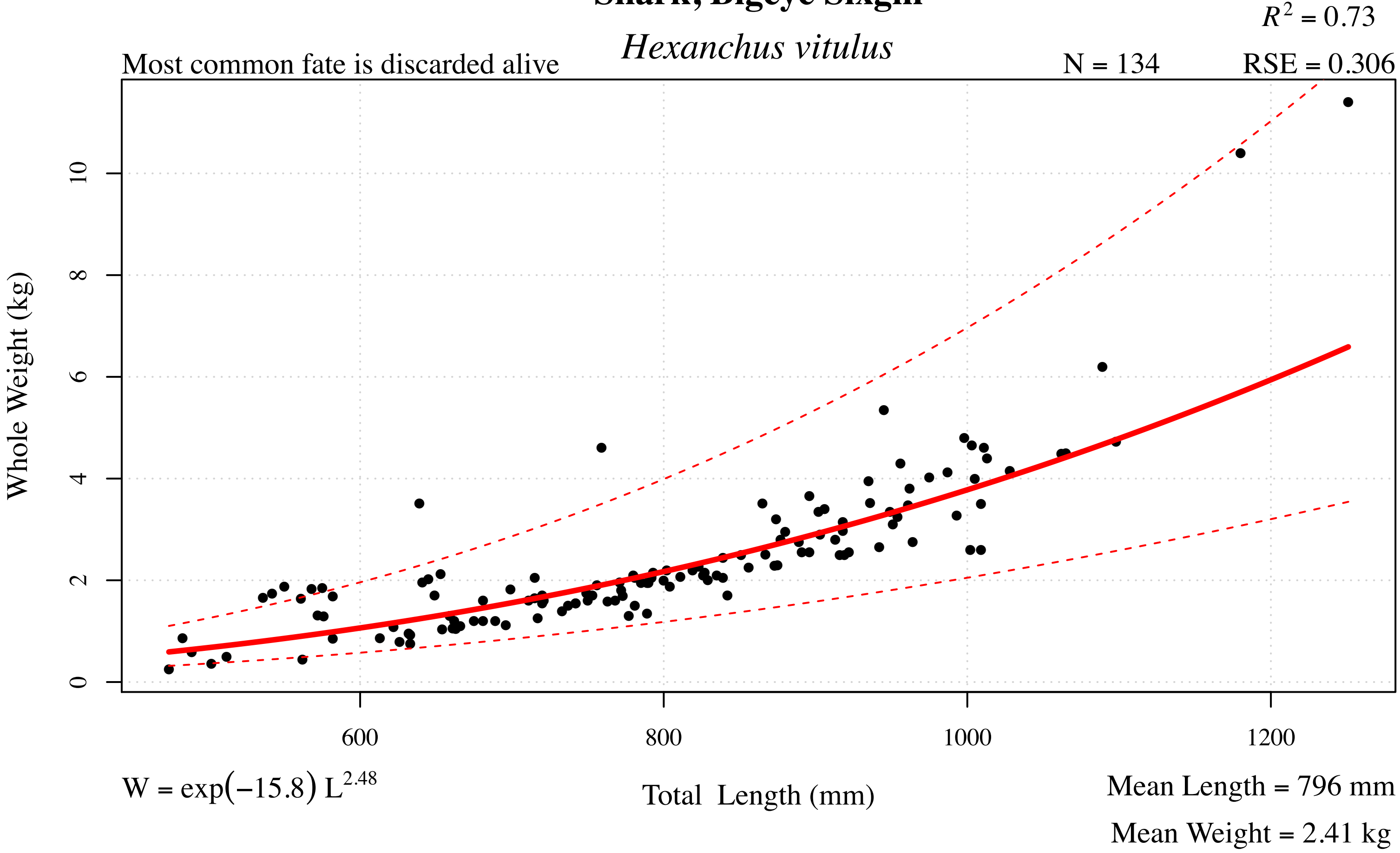
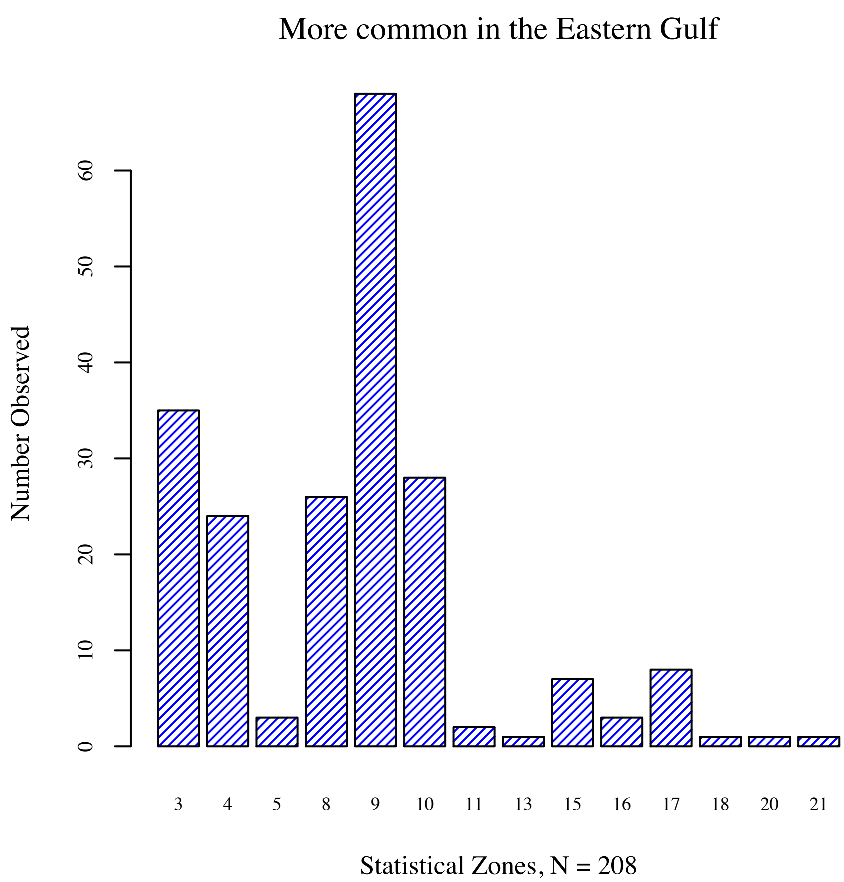


Figure 81 . Regression model, location, and depth information for shark, bonnethead (*Sphyrna tiburo*).

Shark, Bigeye Sixgill





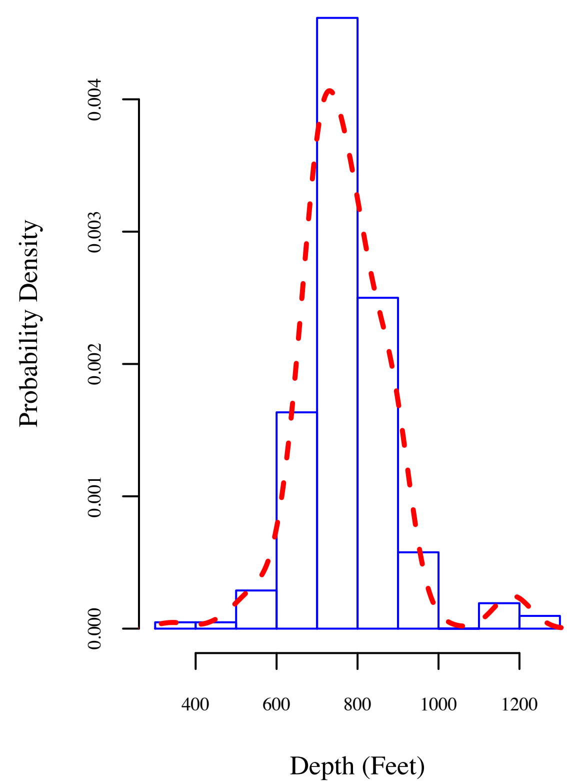


Figure 82 . Regression model, location, and depth information for shark, bigeye sixgill (*Hexanchus vitulus*).

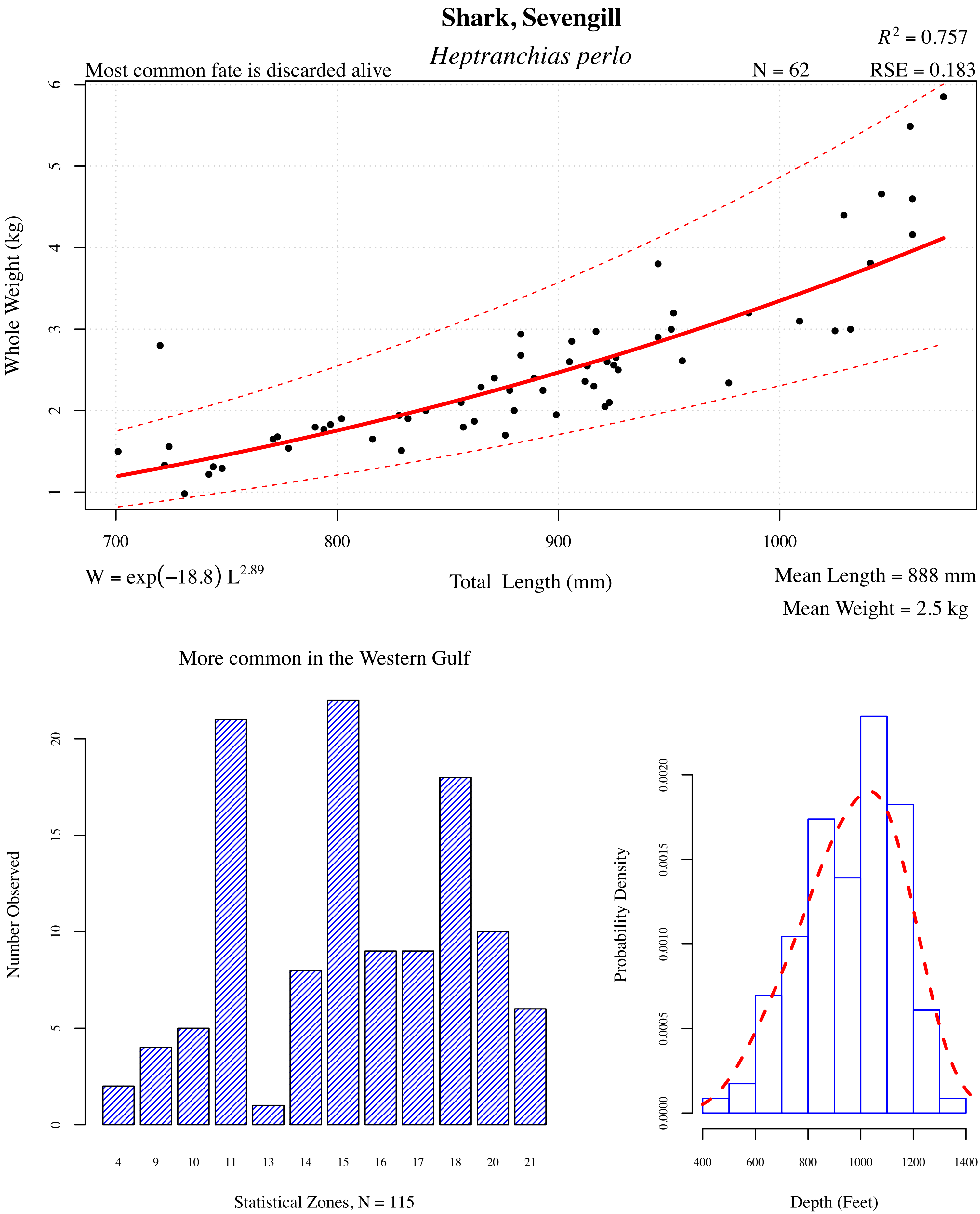


Figure 83 . Regression model, location, and depth information for shark, sevengill (*Heptranchias perlo*).

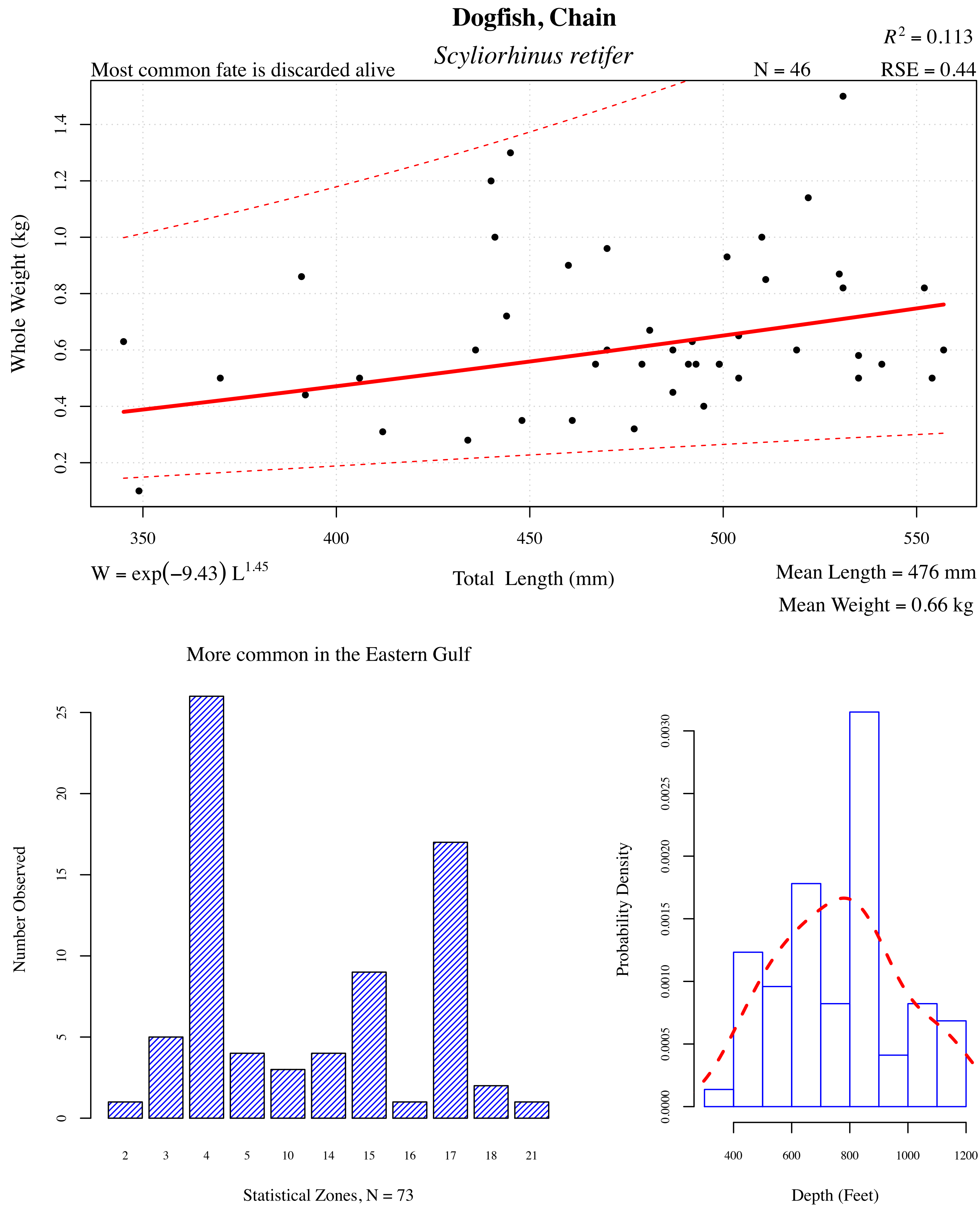


Figure 84 . Regression model, location, and depth information for dogfish, chain (*Scyliorhinus retifer*).

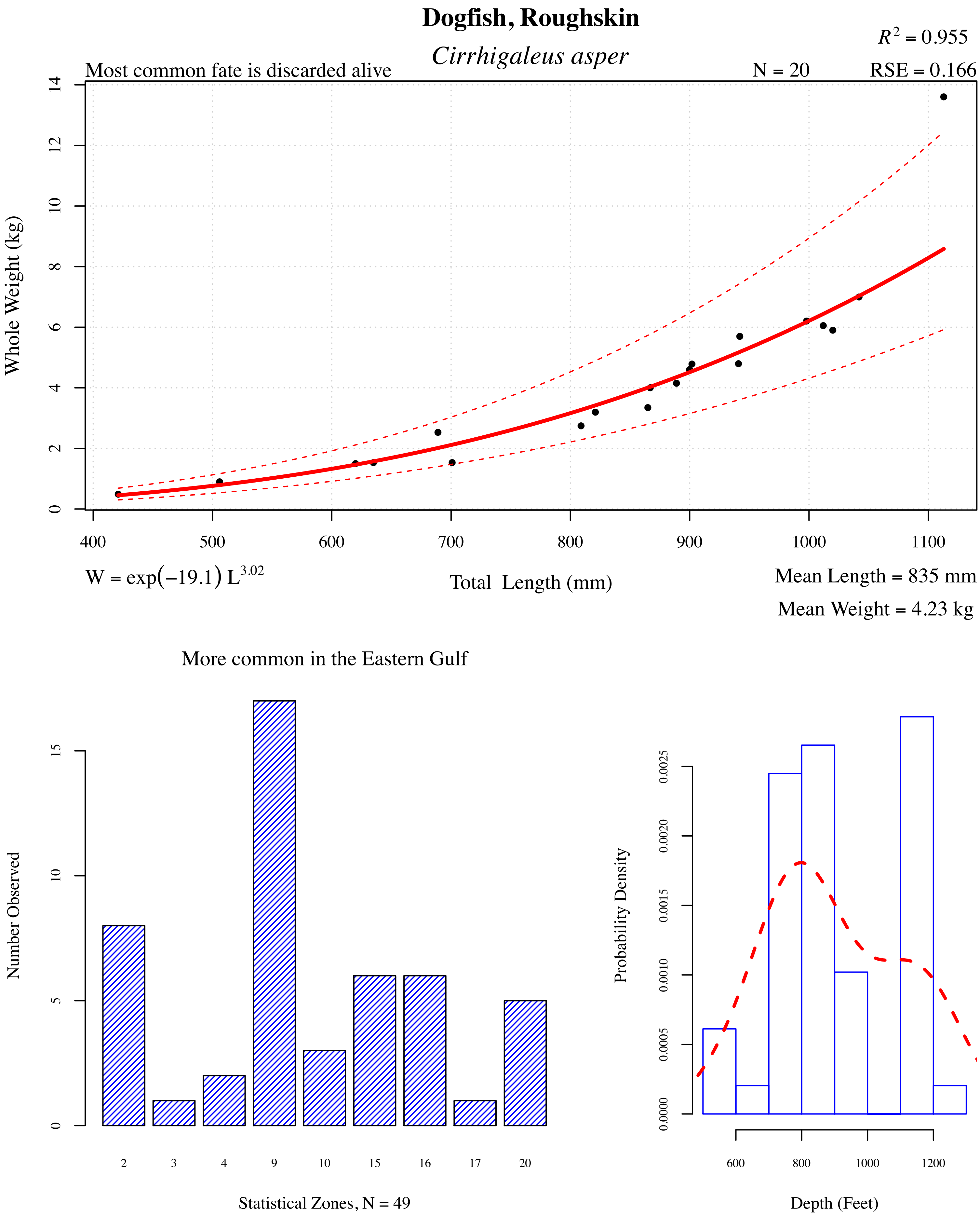


Figure 85 . Regression model, location, and depth information for dogfish, roughskin (*Cirrhigaleus asper*).

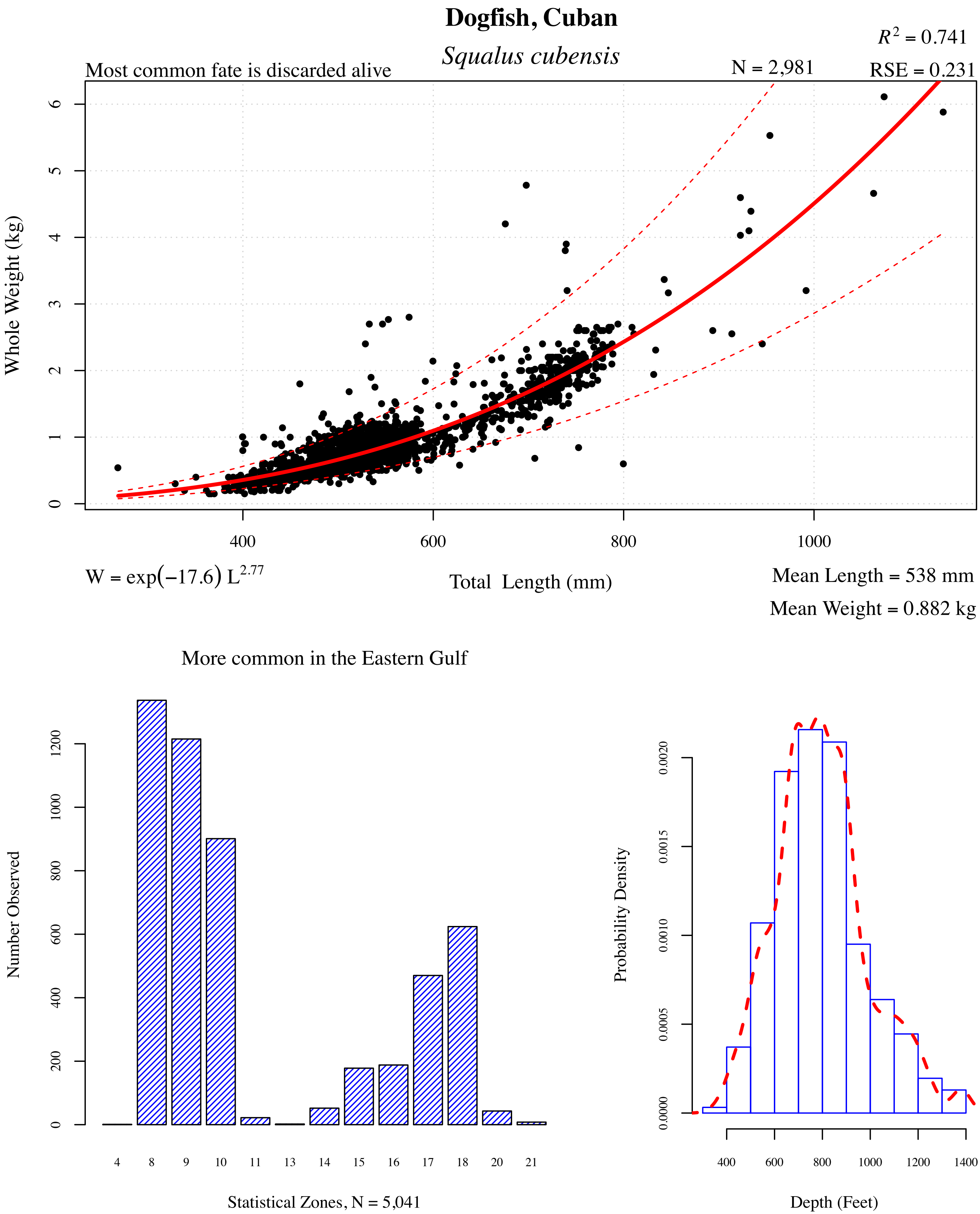


Figure 86 . Regression model, location, and depth information for dogfish, cuban (*Squalus cubensis*).

Dogfish, Shortspine

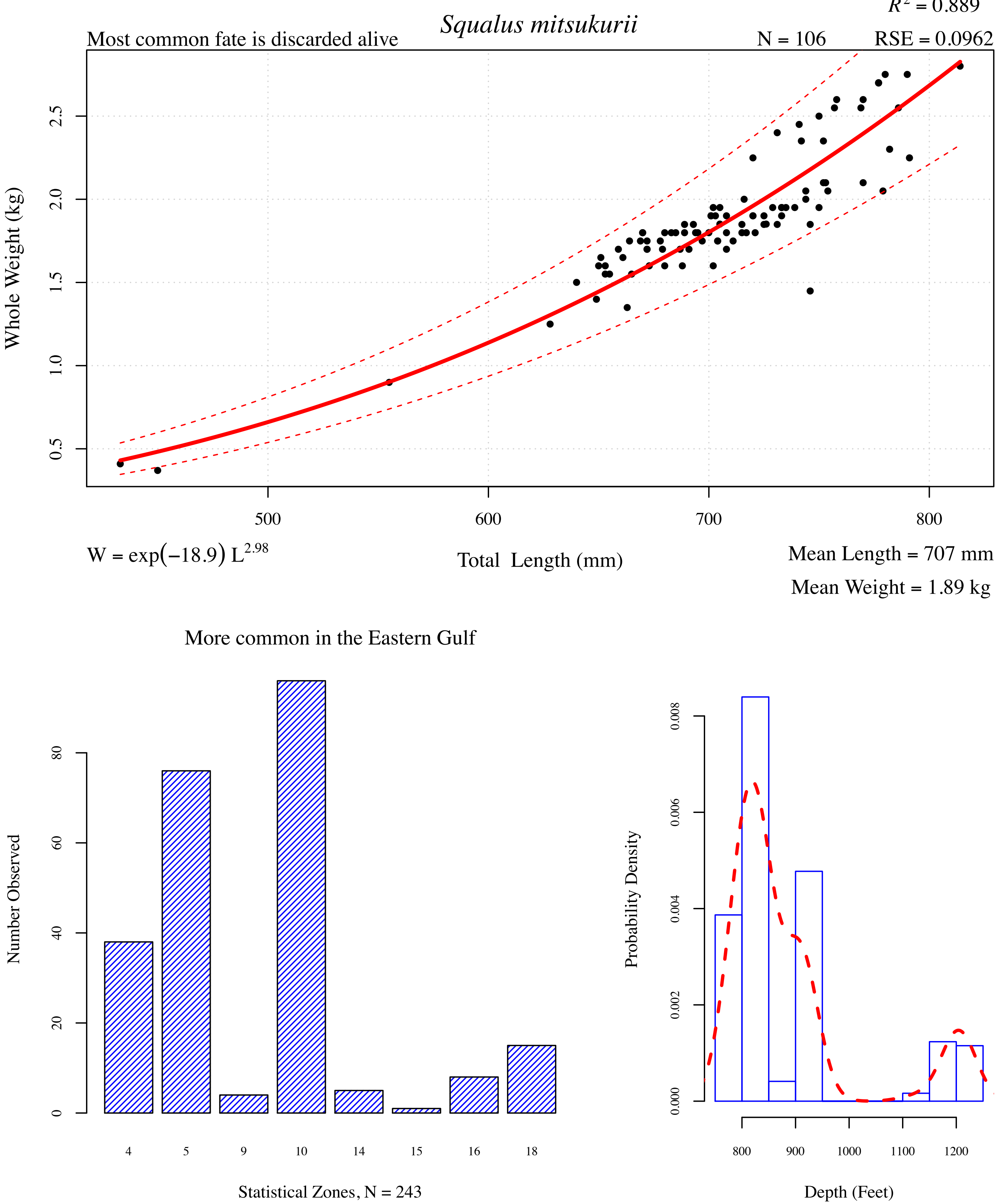


Figure 87 . Regression model, location, and depth information for dogfish, shortspine (*Squalus mitsukurii*).

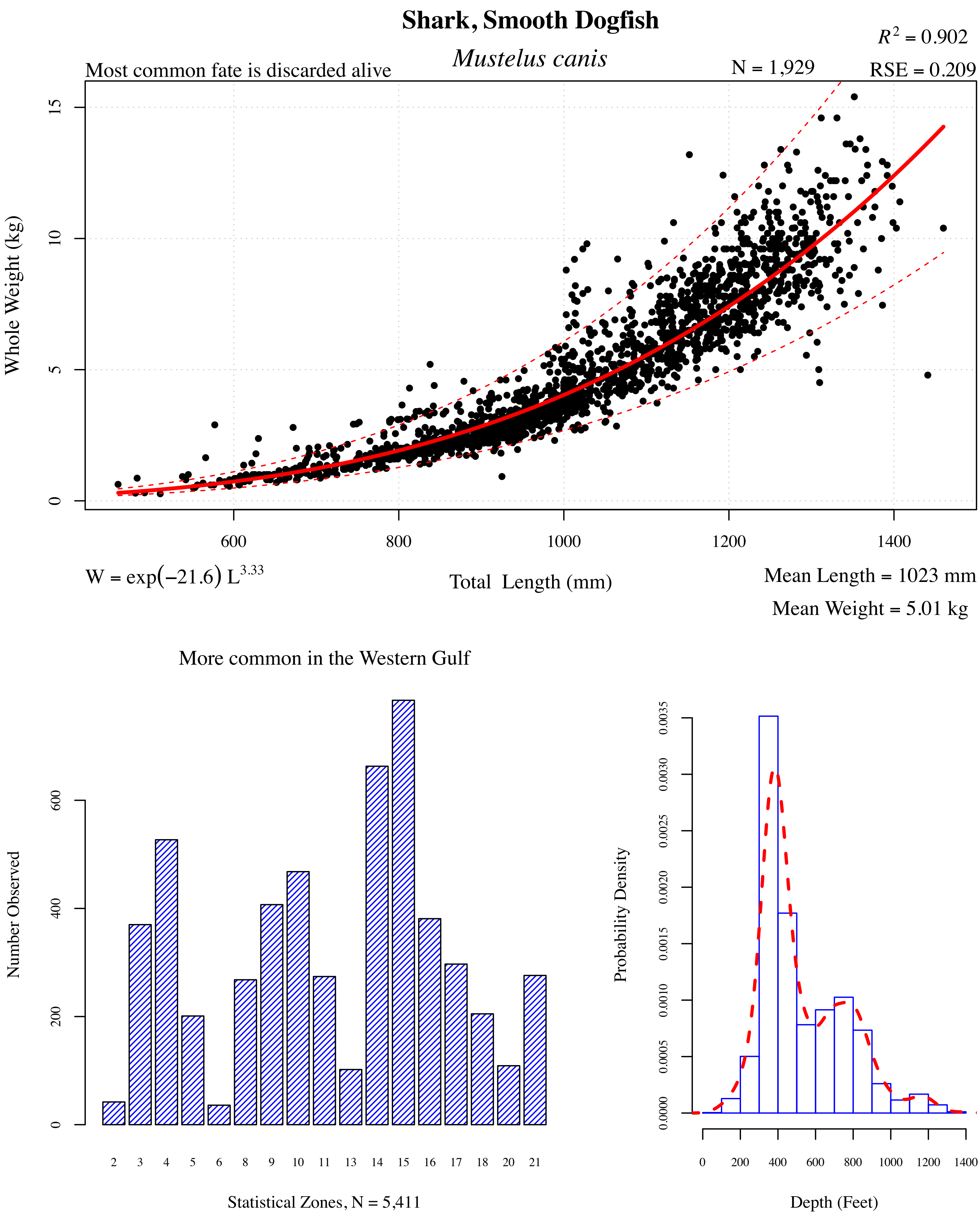


Figure 88 . Regression model, location, and depth information for shark, smooth dogfish (*Mustelus canis*).

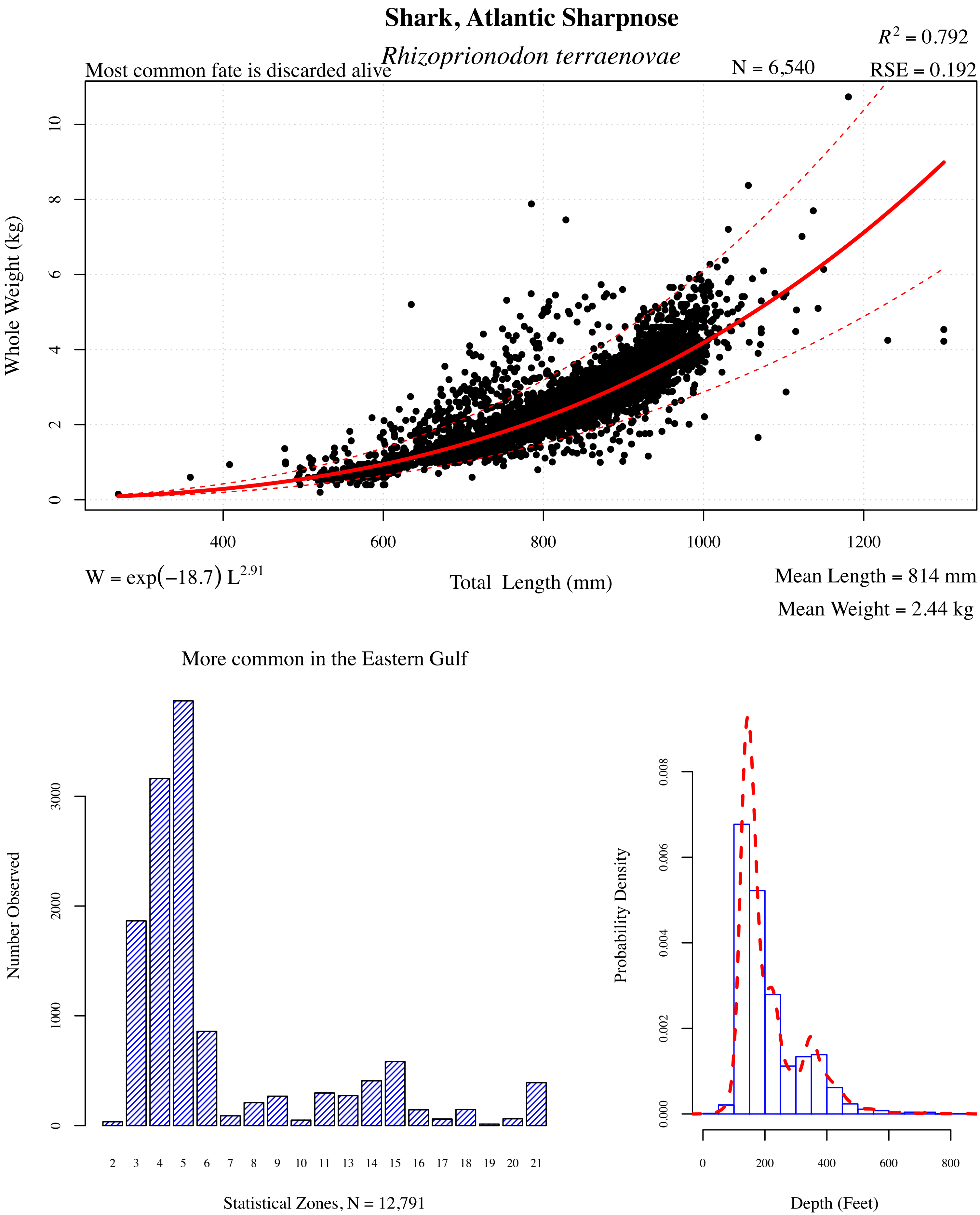


Figure 89 . Regression model, location, and depth information for shark, atlantic sharpnose (*Rhizoprionodon terraenovae*).

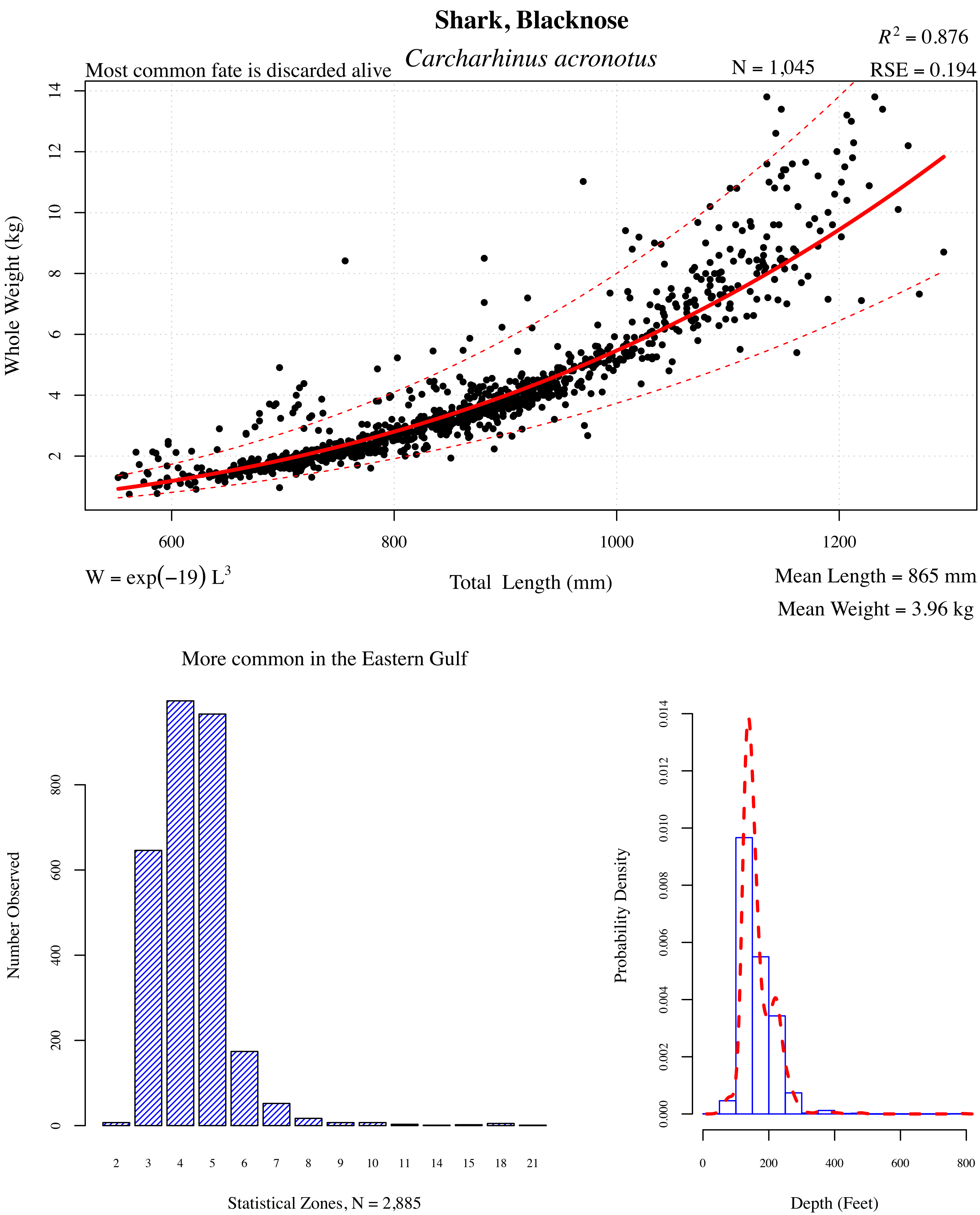


Figure 90 . Regression model, location, and depth information for shark, blacknose (*Carcharhinus acronotus*).

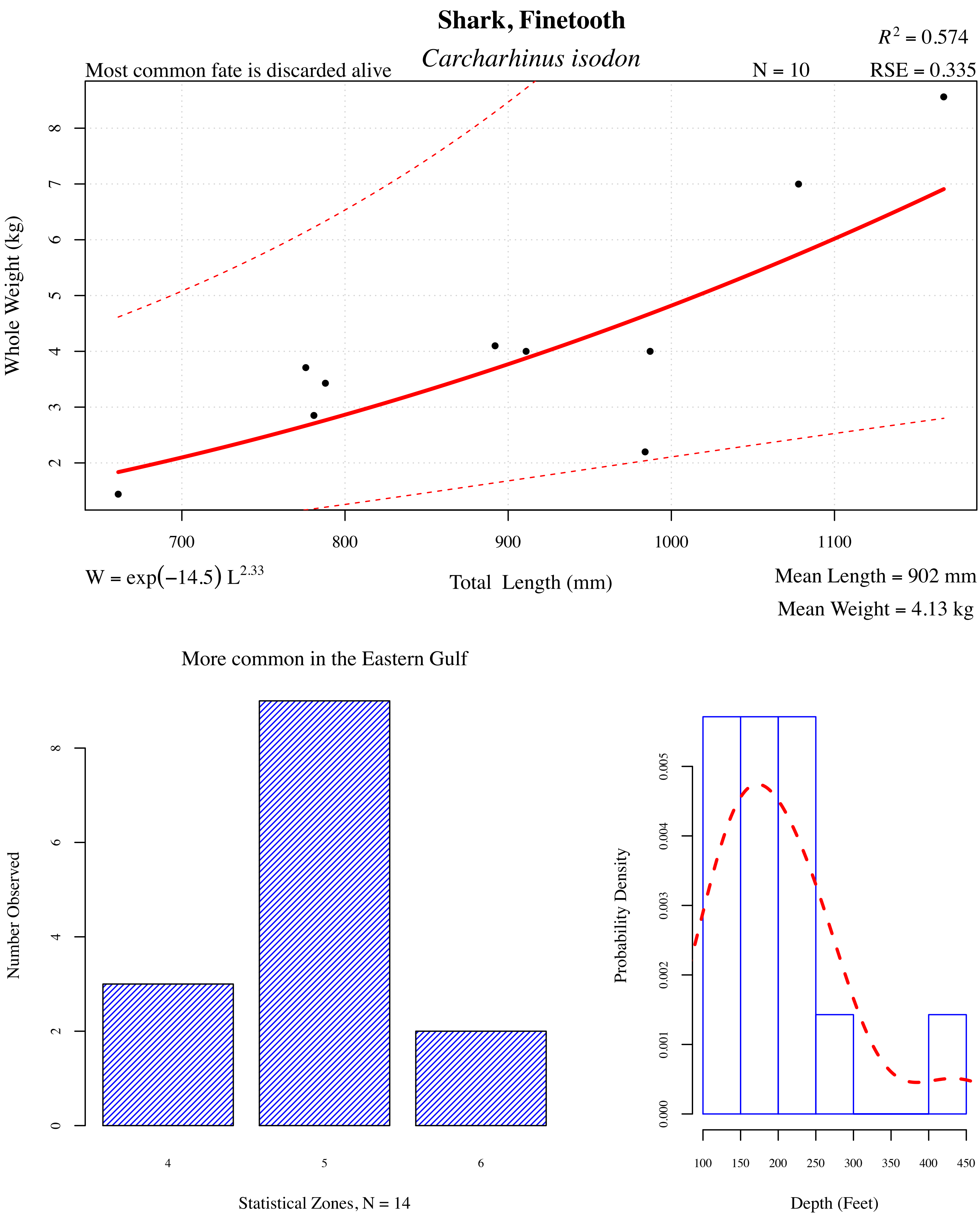


Figure 91 . Regression model, location, and depth information for shark, finetooth (*Carcharhinus isodon*).

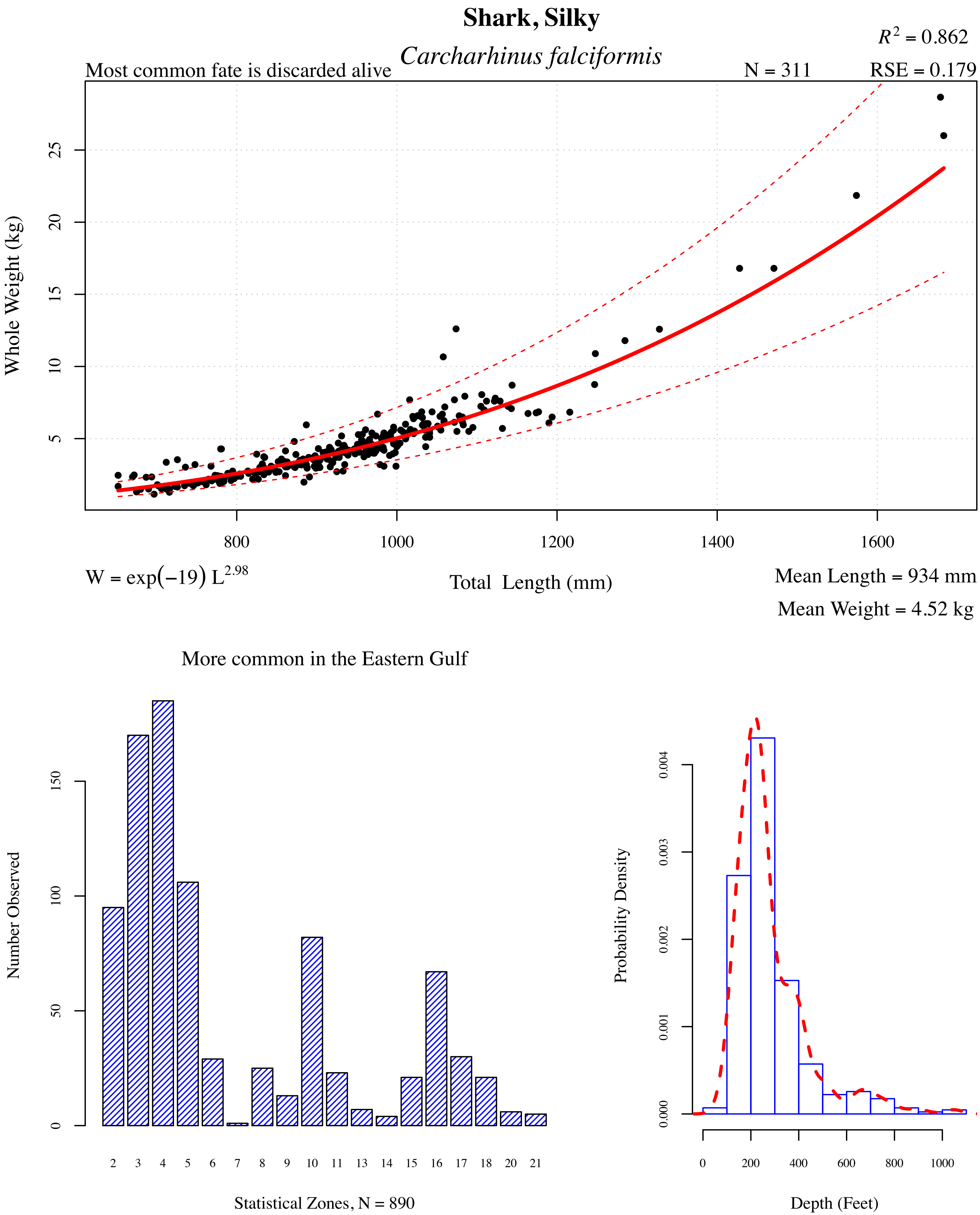


Figure 92 . Regression model, location, and depth information for shark, silky (*Carcharhinus falciformis*).