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A descriptive analysis of the size and species composition of the Papua New Guinea purse seine catch

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A Descriptive Analysis of the Size and Species Composition of the Papua New Guinea Purse Seine Catch

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ABSTRACT

Independent Port Sampling was conducted on catches landed or transshipped by purse seiners and carriers in Papua New Guinea from May 2009 to April 2010. The size of sampling reflected approximately 20% of the catch for the respective vessels sampled. Species composition of the catch was dominated by Skipjack (71.3%), followed by Yellowfin (24.3%), Bigeye (1.7%) and Other Species made up the remaining 2.7%. Percentages of Skipjack increased in the last quarter of 2009 through to 2010 from 52.7 - 70.5% (low) to 71.3-78.6% (high) while Yellowfin decreased from 23.3 – 42% (high) to 17.8 – 24.6% (low). Inter-annual trends in length frequencies were observed for all the major tuna species (Skipjack, Yellowfin and Bigeye) with the shifting of the modal and mean lengths indicating progressive changes in fish sizes. More rigorous analysis is needed to compare these results with previous studies and inter-annual variations for management purposes. Other species were mainly made up of Bullet tuna (62%), Frigate tuna (22%), Mackerel scad (7%), Triggerfish (4%), Rainbow runner (2%) and Black triggerfish (1%) while the rest were below 1% composition. These non-target species should become priority in future analysis.

INTRODUCTION

Purse seine fishing activities has increased dramatically over years in the Papua New Guinea's (PNG) Exclusive Economic Zone (EEZ) as a result of the increase in the number of vessels. The rising effort had caused the purse seine catches to almost double in the past 10 years. (Nicol et al, 2009). The fishery mainly targets *Skipjack* tuna (SKJ) but Yellowfin (YFT) and *Bigeye* tuna (BET) which are common in the catches are also classified as a major species because of their commercial value. Fish aggregating devises (FAD) are widely utilized by purse seiners to increase fishing efficiency in PNG waters.

With the growing fishing pressure on the fish populations in PNG EEZ, it is imperative to monitor the condition and health of the stock. Size and catch composition are important primary indicators that can reveal changes in the population due to fishing or other environmental factors. Understanding and monitoring of these changes is vital for sustainable management of the fishery.

The PNG National Fisheries Authority started collecting species and length data from independent port sampling projects occasionally in 1999, 2005 and 2008. A 12 month extensive sampling was conducted in 2009 to 2010 with the aim of increasing the temporal scale of the data. This paper provides a descriptive analysis on the species composition of the catch by purse seiners in Papua New Guinea from May, 2009 to May, 10 and the size (length frequencies) of major tuna species, *Skipjack*, *Yellowfin* and *Bigeye*. Compositions of other species that interact with the purse seine fishery were also studied.

METHODS

Port Sampling was carried out in major tuna ports of Papua New Guinea (Madang, Lae, Wewak and Rabaul) during the months of May, 2009 to May, 2010. A total of 180 port visits made by 54 catcher vessels and 18 carriers that either landed or transshipped their catches in port were sampled by trained port samplers.

Sampling

A fish storage well in a vessel was divided into three layers; Top, Middle and Bottom in which a number of nets were selected from each and were sampled. The number of nets per layer depended on the total weight of the catch in the well to obtain an estimated 20% of the catch that were unloaded or transshipped. This was done for all storage wells that catch were taken out from. All fish including non-targeted species in the net were identified to species level and their fork lengths were measured to the nearest centimeter using a standard observer caliper. Vessel and catch information were obtain from the the log sheets.

Data Entry and Analysis

All data were entered into a Microsoft Access database designed to cater for all port sampling data including vessel set and catch storage information. Data was then exported into Microsoft Excel were all the analysis were performed.

Species Composition

Species composition analysis was done for major tuna species, *Skipjack*, *Yellowfin* and *Bigeye* while the rest of the by-catch species were grouped as *Other Species*. *Other species* included tuna-like species (eg, Bullet and Frigate tuna), other finfishes, sharks, marine mammals (e.g dolphins), marine reptiles (e.g turtles) and unidentified species that were found in the purse seine catches. Overall species composition and species composition by month were analyzed.

Length Frequency

Frequencies were calculated for individual lengths and length frequency charts were generated by month for *Skipjack*, *Yellowfin* and *Bigeye* tuna. Descriptive statistics were also performed on the lengths for each tuna species using Microsoft Excel Data Analysis Tool Pack.

Other Species

Percentage composition of the *Other species* were calculated and listed from the most dominant to the least.

RESULTS

Species Composition

Skipjack dominated the total number of fish sampled with 1,714,372 (71.3%), followed by Yellowfin with 585,298 (24.3%) and *Bigeye* with 40,330 (1.7%). The remaining 2.7% (64,184) were made up of *Other species* (Figure 1).

Species Composition by Month

Figure 2 shows the percentage composition of *Skipjack*, *Yellowfin*, *Bigeye* and *Other species* for each of the sampling months from May 2009 to May 2010. Low percentages of *Skipjack* were observed from May to September, 2009 (52.7 -70.5%) with the lowest occurring in May, 2009 while higher percentages of Yellowfin were observed (23.3 – 42%) with highest occurring in May, 2009.

Higher percentages of *Skipjack* were observed from October 2009 to May, 2010 (71.3-78.6%) with the highest percentage occurring in November, 2009 while lower

percentages of *Yellowfin* were observed (17.8 – 24.6%) with lowest occurring in November.

Percentages of *Bigeye* ranged from lowest occurring in July and November, 2009 and highest in May, 2009. Percentage composition of *Other species* increased from 2.4% in May, 2009 to its highest at 4.4% in August, 2009 and then steadily declined to 1.1% in May, 2010.

Length Frequencies of Major Tuna Species

Skipjack

Figure 3 shows the length frequencies of *Skipjack* for each sampling months from May-2009 to May-2010. The average mode of the distribution throughout the sampling period was 47.08 cm with fairly sharp peaks and an average mean of 45.08 cm. Increase in smaller sized *Skipjack* (28-40 cm) was evident in June, 2009 with a left-skewed distribution followed by a progressive increase in fish size in following months which resulted in broad mode projections. However, traces of larger sized fish (≈52-73 cm) were observed in July, 2010 which became distinct later in the year (2010) increasing the average mean lengths of *Skipjack* from 42- 43 cm to 44 - 47 cm. The average mean lengths were higher in the months of November, 2009 to May, 2010 compared to the months of June to October, 2009. Distinct bimodal distributions were observed in the months of March, April and May, 2010 with the higher peak at 50 – 51 cm and the lower peak at 35 – 36 cm.

Yellowfin

Length frequencies of *Yellowfin* are shown in Figure 4. The overall average mode of the distribution was 56.84 cm with an average mean length of 61.53 cm. In most of the sampling months, the distributions were slightly skewed towards larger fish with one or two smaller peaks except in July, 2009 and May, 2010 where distribution showed three relatively high modes across a range of 21 – 109 cm. Small peaks of fish size (22 – 44 cm) which were less than the average mode were also observed in the months of Jun-Sep, 2009 and possibly April, 2010 as well.

Bigeye

Length frequencies of *Bigeye* in figure 5 showed clear peaks in the distribution over the sampling months. The average mode was 56.46 cm. A smaller peak at 40 cm relative to the larger at 56 cm was observed in July, 2009. The same bimodal distribution was also captured in August, September, and November, 2009 with the smaller peak at 45-50 cm and the larger at 60 cm while in October, the two peaks were both relatively high. Larger sizes *Bigeye* was observed in samples from January to Apr, 2010.

Other Species

Bullet tuna dominated the sampled catches of *Other species* with more than 62% composition followed by Frigate tuna (22%), Mackeral scad (7%), Trigger fish (4%), Rainbow runner (2%) and Black trigger fish (1%). *Other species* that were also quiet frequent in the samples were Dolphin fish (0.9%), Kawakawa (0.3%) and Yellowtail kingfish (0.2%). All the *other species* contributed less than 0.1% to the overall composition of *other species* of the samples. These include a couple of shark species (Silky, Bignose, Longfinned mako and unidentified spp.), turtles (Leatherback, Olive Ridley and an unidentified spp.) and dolphins. Table 1 is a list of all the *Other species* that were sampled and their catch compostion.

DISCUSSION

Species Composition

The overall species composition for this sampling period from May, 2009 to May, 2010 illustrated the expected *Skipjack* dominated purse catches (Fonteneau, 2008; Nicol et al, 2009). The species composition is fairly similar to the port sampling results conducted in 2008 (Kumoru et al, 2009) with a slight increase in *Skipjack* (1.3%) and *Other species* (0.7%) while *Yellowfin* and Bigeye declined by 1.7% and 0.3% respectively. However, both 2008 and 2009/10 species composition differed greatly from the 1999 and 2005 result presented in Koren, 2007 where *Skipjack* increased from 46.1 – 64% where as *Yellowfin* decreased from 44.9 - 35% as well as *Bigeye* from 9 – 1%. Koren, 2007 concluded that the difference may not necessarily represent a change in catch composition because the sample size for the 2005 data was too small due to only three months of sampling. With the two recent sampling periods we can presume changes in the composition in purse seine catches. The increase in purse seine activities and use of fish aggregating devises (FAD) to increase fishing efficiency has increased the catch of SKJ dramatically (Nicol et al, 2009) and the catch of non-targeted juvenile YFT and BET which contributed to their decline.

Species composition by month

An inverse relationship was observed between the catch composition of *Skipjack* and *Yellowfin* from May, 2009 to May, 2010. *Yellowfin* catches were relatively higher in the early months of sampling period. This may be due annual season patterns affecting horizontal and vertical movement behavior of the species. Due to insufficient analysis of the data it is impossible to say if the FAD closure in August-September had any role in the relatively high composition of *Yellowfin* and relatively low *Skipjack*. *Other species* also had a similar trend to *Yellowfin* percentage composition.

Length Frequencies of Major Tuna Species

There were clear trends in monthly variations in the sizes of all major tuna species (*Skipjack, Yellowfin* and *Bigeye*) indicating changes in fish sizes of purse seine catch.

However, the inter-annual trends were not the same with fish sampled in 1999 for specific months (Koren, 2007). 1999 samples were from locally based vessels that concentrated mainly in archipelagic waters whereas this port sampling covered vessels from other fleets including foreign that fish in PNG waters. Thus, a wider coverage of the PNG EEZ was represented including Solomon Seas.

The modes and means (APPENDIX 1) for *Skipjack* and *Yellowfin* were also lower than those sampled in 1999 indicating a possible decrease in sizes of these two species in purse seine catches. Since the purse seine effort in the PNG EEZ has almost doubled in the past ten years (Nicol et al, 2009), we question the effect of fishing pressure by purse seiners on the sizes and condition on the fish stock. The sizes of *Bigeye* in purse seine catches on the hand seemed to increase over the years as the modes and means were higher than the 1999 samples.

Other Species

Dominant species in the catch composition of *Other species* were similar to the 2008 results (Kumoru et al, 2009) except the inclusion of Triggerfish with 4% in the current sampling period. However, the percentage of Bullet tuna decreased by 16% while Frigate tuna increased by 7%. Catch composition of Mackerel scad and Rainbow runner increased by 3% and 0.98% respectively. Because of the difference in the sampling sizes between the sampling periods we cannot strongly conclude the changes in the catch composition to fishing or environmental impacts. Low percentages of Kawakawa, Dolphinfish and shark spp. were observed in both periods. Nicol et al, 2009, gave a detailed analysis of these non-targeted species using observer data which are more representative of the catch since data was collected at sea. However, most of the species were comparable with the port sampling data except for some, such as the Marlin spp. was not detected in port.

CONCLUSION AND RECOMMENDATIONS

The comparison of the results with previous port sampling studies highlighted in the discussion of this paper indicated changes in the size and species composition of purse seine catches landed or transshipped in PNG over the years. However, more rigorous analysis is needed to confirm and determine the significance of these changes and its impact to fishery as whole. More studies into inter-annual variations are also vital for sustainable management and development of conservation measures. Non-targeted species (*Other Species*) should be a priority in future analysis.

ACKNOWLEDGEMENS

The tireless effort of port sampling coordinators and port samplers throughout PNG is highly valued. Without whose commitment this report would not have been possible. We would also like to thank Mr Augustine Mobiha for comments and guidance in building this report.

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Nicol S., Lawson T., Briand K., Kirby D., Molony B., Bromhead D., Williams P., Schneiter E., Kumoru L. and Hamptom J. (2009). *Characterisation of the tuna purse seine fishery in Papua New Guinea.* ACIAR Technical Report No. 70, 44pp.

TABLES AND FIGURES

Table 1. List of all non-target species that were found in purse seine catches from May, 2009 to May, 2010 and their percentage composition in relation to each other.

SpciesCode	Common Name	Total	Percentage
BLT	Bullet tuna	39,996	62.315
FRI	Frigate tuna	14,094	21.959
MSD	Mackeral scad	4,373	6.813
TRI	Trigger fish	2,642	4.116
RRU	Rainbow runner	1,324	2.063
MEN	Black trigger fish	797	1.242
DOL	Dolphin Fish	578	0.901
KAW	Kawakawa	166	0.259
YTL	Yellowtail kingfish	103	0.160
ALB	Albacore tuna	23	0.036
TRE	Trevallies	15	0.023
FAL	Silky shark	11	0.017
LTB	Leatherback turtle	8	0.012
SHK	Shark unidentified	8	0.012
DLP	Dolphins/porpoises	6	0.009
BRZ	Pomfrets and Ocean breams	5	0.008
RRV	Yelloweye rockFish	5	0.008
TUN	Tuna unidentified	5	0.008
FLF	Filefishes	4	0.006
CXS	Bigeye Trevally	3	0.005
MAN	Manta Rays	3	0.005
TRC	Slimeheads nei	3	0.005
ALN	Scribbled leatherjacket filefish	2	0.003
CNT	Ocean Trigger Fish	2	0.003
CCA	Bignose shark	1	0.002
GLT	Golden trevally	1	0.002
LMA	Long finned mako	1	0.002
OLR	Olive Ridly turtle	1	0.002
STT	Stingrays	1	0.002
TST	Sickle pomfret	1	0.002
TTX	Marine turtle	1	0.002
UNG	Threespo swimming crab	1	0.002
Total		**64,184**	100.000

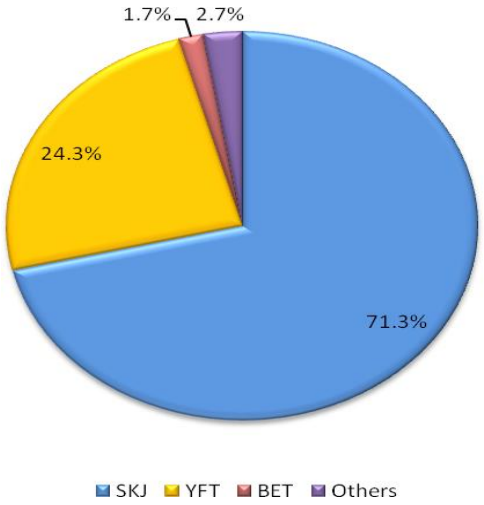
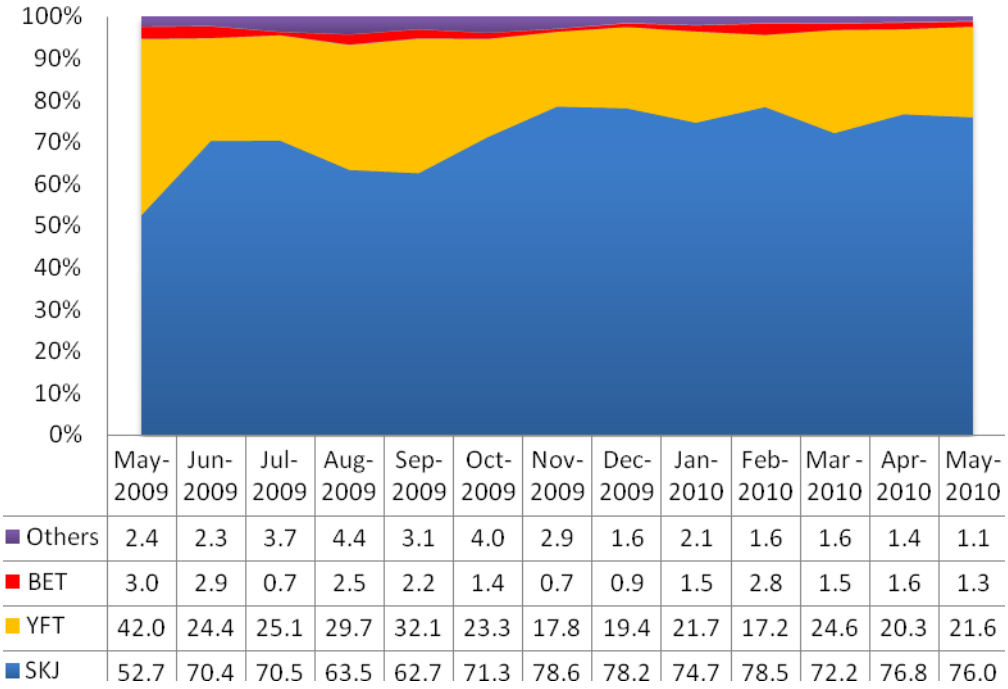


Figure 1: Overall species composition of purse seine catches sampled in port from May, 2009 to May 2010.



	May-2009	Jun-2009	Jul-2009	Aug-2009	Sep-2009	Oct-2009	Nov-2009	Dec-2009	Jan-2010	Feb-2010	Mar-2010	Apr-2010	May-2010
Others	2.4	2.3	3.7	4.4	3.1	4.0	2.9	1.6	2.1	1.6	1.6	1.4	1.1
BET	3.0	2.9	0.7	2.5	2.2	1.4	0.7	0.9	1.5	2.8	1.5	1.6	1.3
YFT	42.0	24.4	25.1	29.7	32.1	23.3	17.8	19.4	21.7	17.2	24.6	20.3	21.6
SKJ	52.7	70.4	70.5	63.5	62.7	71.3	78.6	78.2	74.7	78.5	72.2	76.8	76.0

Figure 2: Species composition by month of purse seine catches sampled in port from May, 2009 to May, 2010.

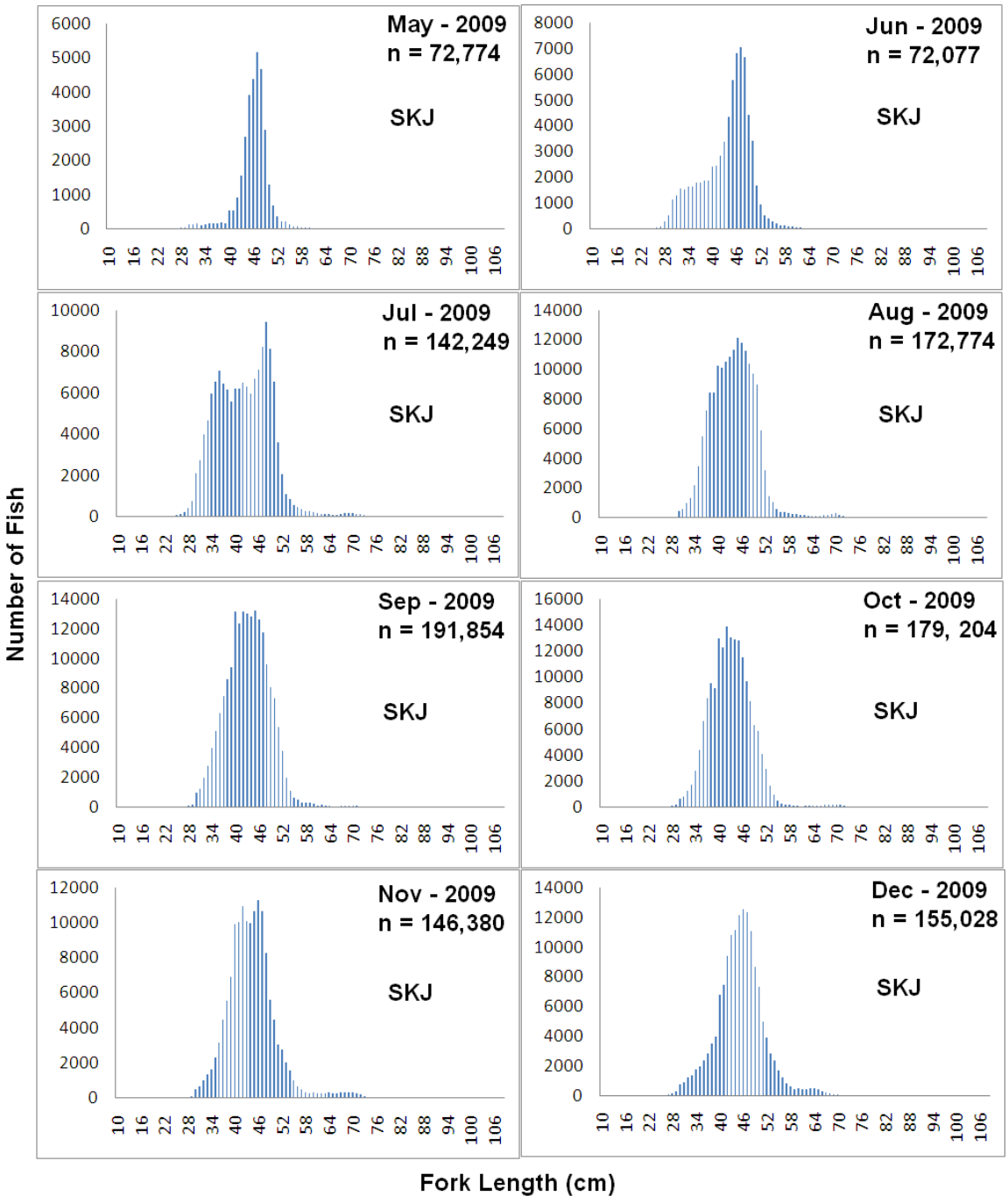
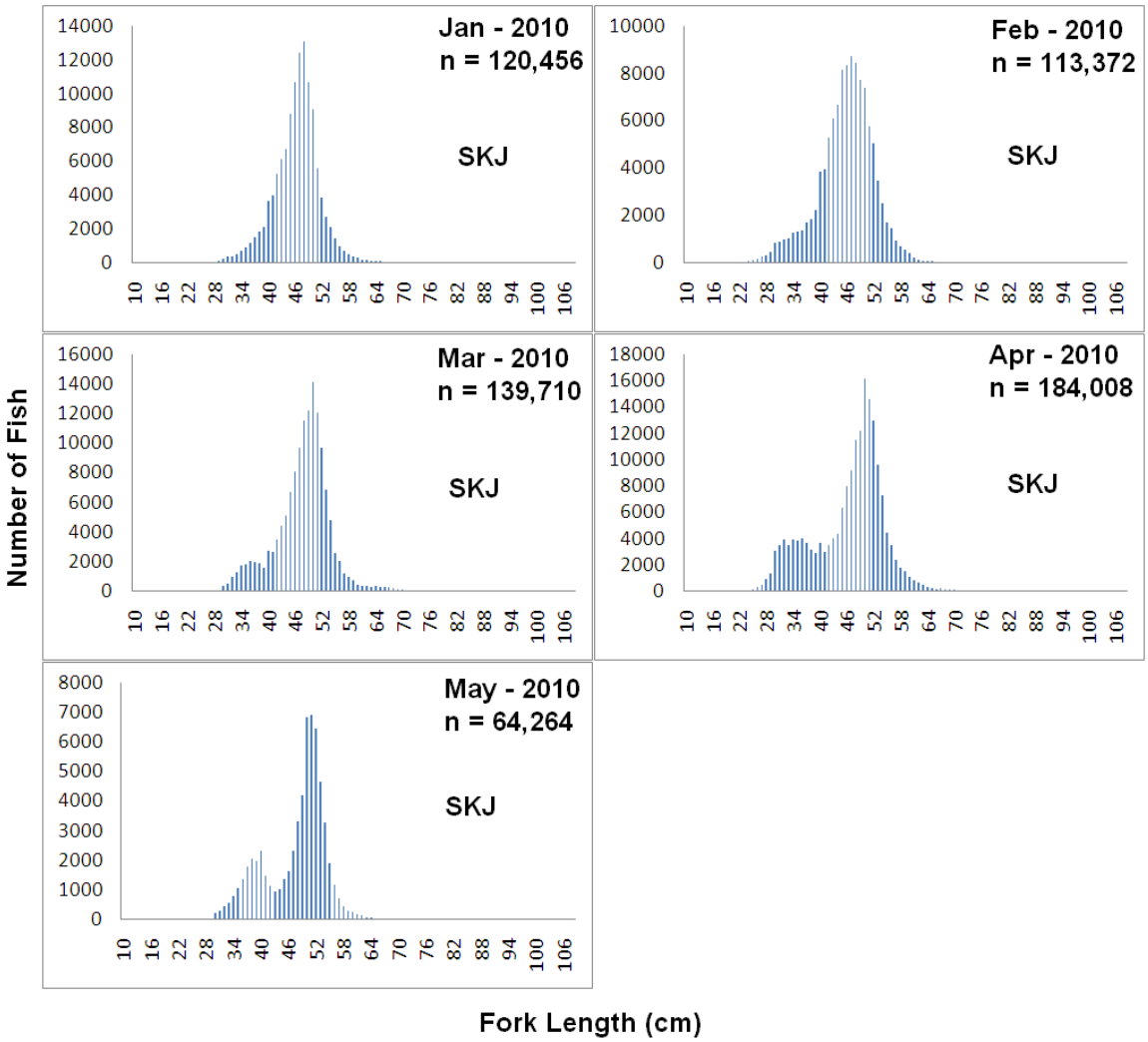


Figure 3: Length frequency distribution of *Skipjack* tuna caught by purse seiners from May, 2010 to May, 2010.



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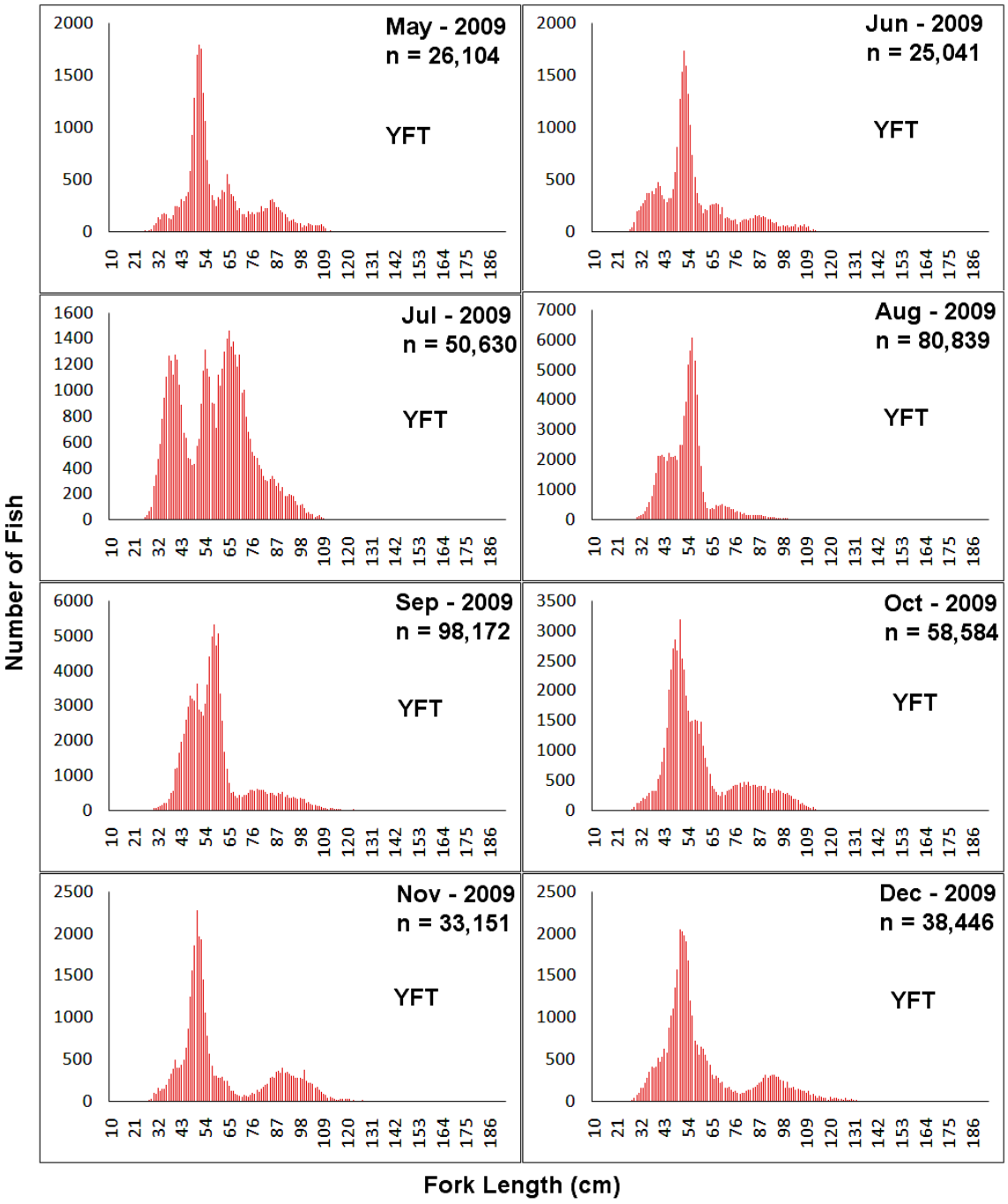
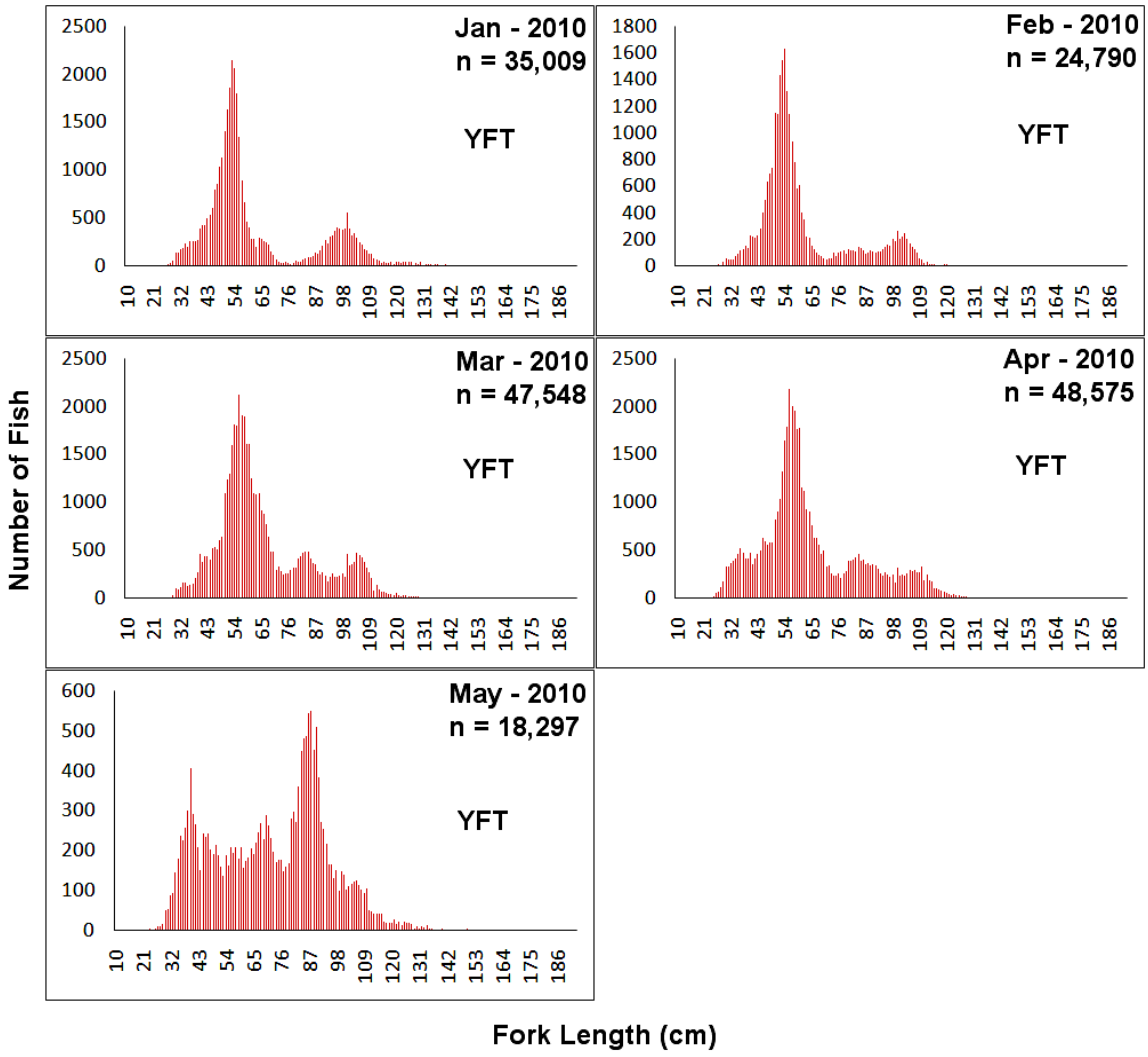


Figure 4: Length frequency distribution of *Yellowfin* tuna caught by purse seiners from May, 2009 to May, 2010.



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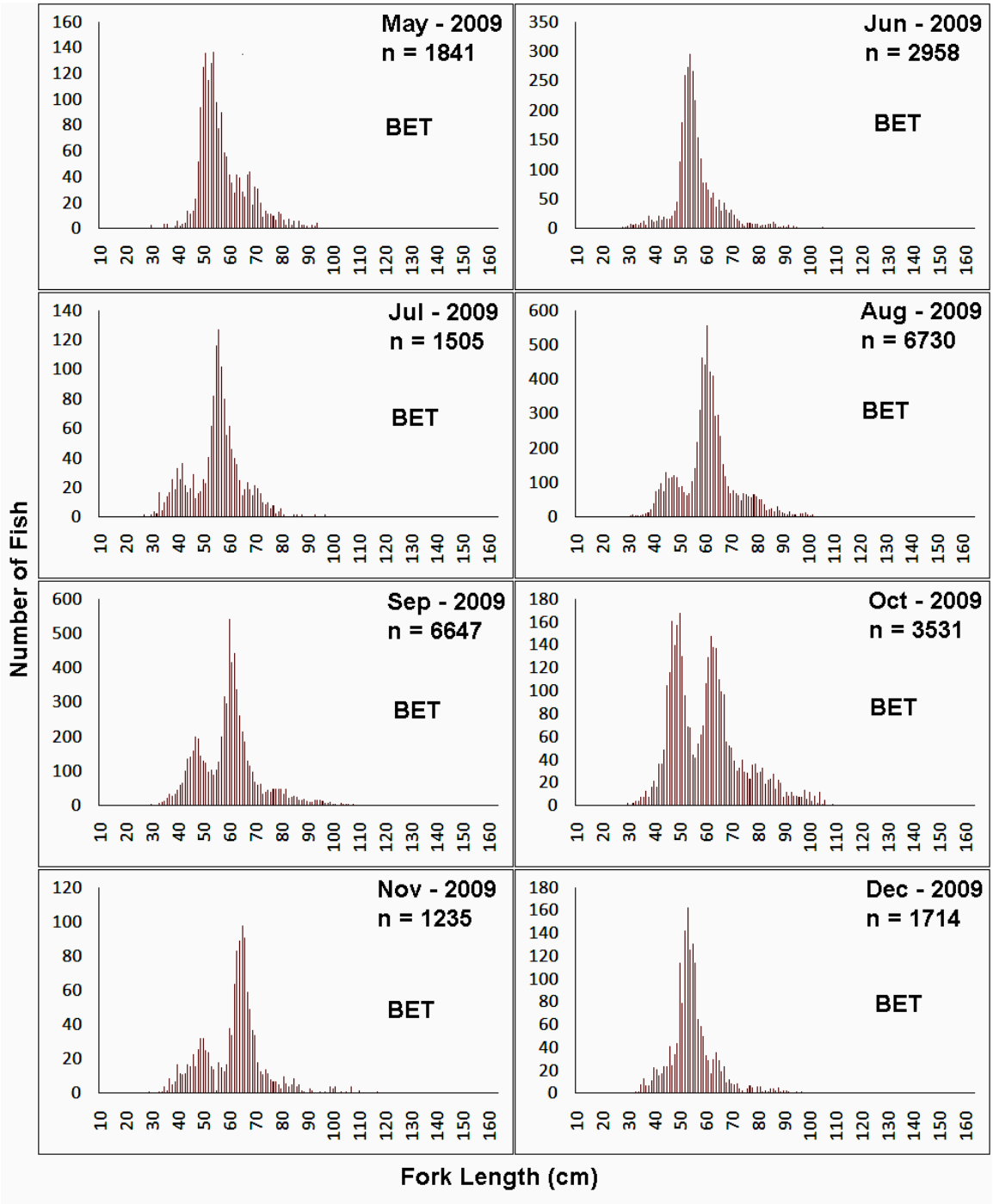

Figure 5: Length frequency distribution of *Bigeye* tuna caught by purse seiners from May, 2009 to May, 2010.

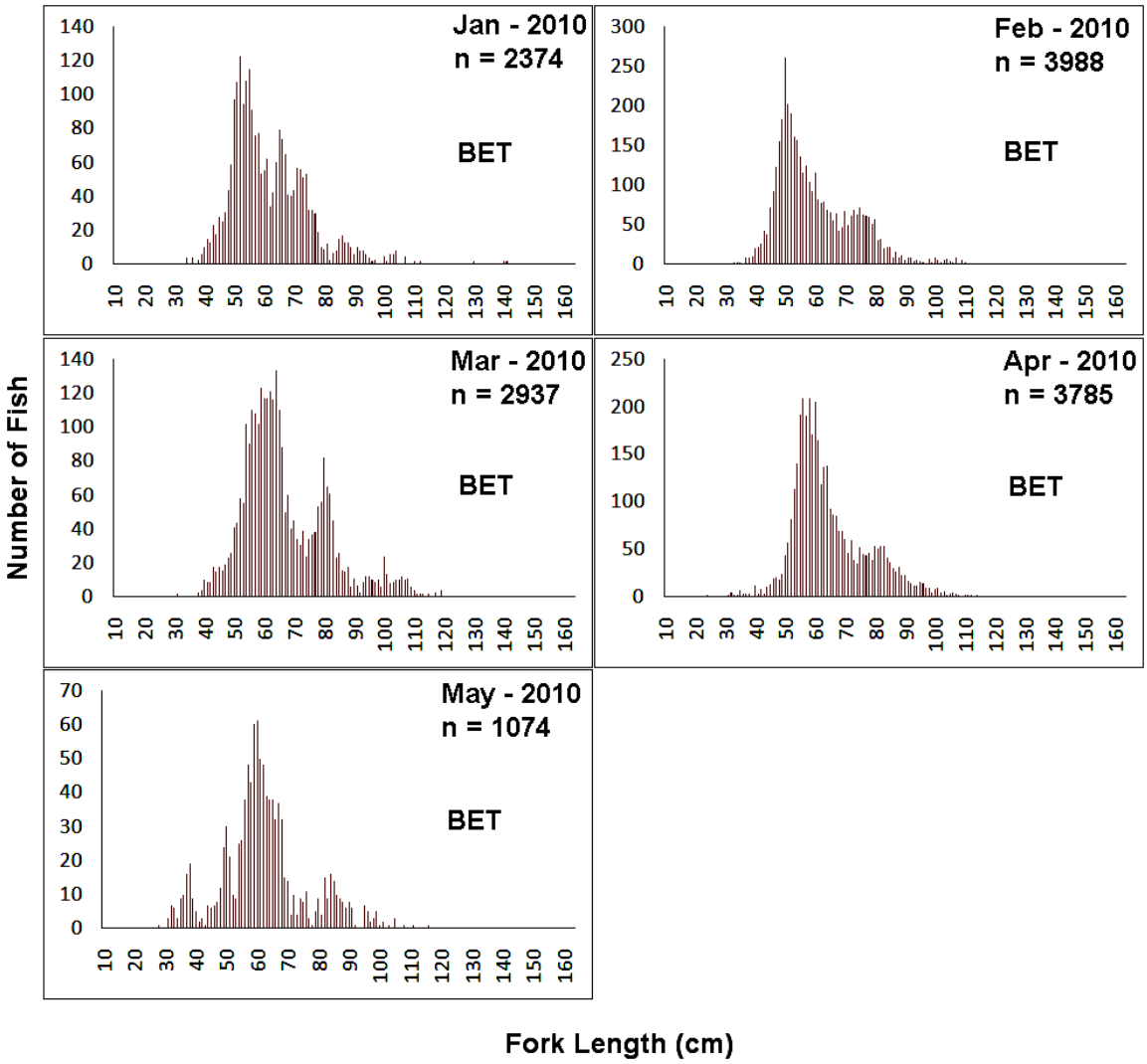

Figure 5: continued...

APPENDIX 1 - Descriptive Statistical Tables.

Analysis of Skipjack length measurements (cm)

	Sampling Months													
Descriptive Statistics	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Average
Mean	45.75456	43.53855	42.33301	44.02574	43.2525	43.12902	44.37865	45.35714	46.46725	45.87804	47.81007	46.45578	47.69689	45.08286
Standard Error	0.024437	0.023703	0.019146	0.01432	0.013454	0.01393	0.017081	0.016117	0.014968	0.019149	0.016933	0.018785	0.026857	0.018375
Median	46	45	42	44	43	43	44	45	47	46	49	48	50	45.53846
Mode	47	47	48	45	45	42	46	46	48	47	50	50	51	47.07692
Standard Deviation	5.133779	6.363615	7.221244	5.952185	5.894799	5.896799	6.535311	6.343507	5.194933	6.447685	6.329113	8.057926	6.808251	6.321473
Sample Variance	26.35569	40.49559	52.14636	35.42851	34.74866	34.77224	42.71029	40.24008	26.98733	41.57265	40.05767	64.93017	46.35228	40.52289
Kurtosis	15.18233	2.97917	2.10819	4.163761	6.538716	6.512717	6.549583	4.652739	4.304972	5.353495	9.287644	4.028399	9.154463	6.216629
Skewness	1.406371	-0.21269	0.627536	0.935233	0.87186	1.222834	1.470385	0.662159	0.038606	0.050567	0.276447	-0.23255	-0.06677	0.542307
Range	98	92	90	130	83	97	97	87	81	96	88	96	83	93.69231
Minimum	10	11	13	18	11	11	11	19	18	11	20	12	22	14.38462
Maximum	108	103	103	101	106	108	108	106	99	107	108	108	105	105.3846
Sum	2019286	3138128	6021828	7606504	8302836	7728893	6496147	7026048	5597259	5201285	6679545	8548236	3065193	5956245
Count	44133	72077	142249	172774	191962	179204	146380	154905	120456	113372	139710	184008	64264	132730.3
Confidence Level(95.0%)	0.047898	0.046458	0.037527	0.028067	0.02637	0.027302	0.033479	0.03159	0.029337	0.037532	0.033188	0.036818	0.052639	0.036016

Analysis of Yellowfin length measurements (cm)

	Sampling Months													
Descriptive Statistics	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Average
Mean	60.19134	56.76375	58.70401	53.70903	59.37336	59.61944	62.29037	61.03067	63.34514	61.72126	66.48313	64.60994	72.04596	61.5298
Standard Error	0.095472	0.112736	0.075002	0.039988	0.05117	0.073654	0.119186	0.10698	0.124042	0.123169	0.092183	0.096837	0.167344	0.09829
Median	54	53	60	54	56	53	52	53	54	55	60	59	75	56.76923
Mode	51	52	65	56	58	50	50	50	53	54	56	56	88	56.84615
Standard Deviation	17.38945	17.83973	16.8763	11.36954	16.03558	17.82736	21.70067	20.96641	23.2092	19.39282	20.10099	21.34272	22.63603	18.97591
Sample Variance	302.393	318.2558	284.8093	129.2665	257.1399	317.8149	470.9191	439.5901	538.6668	376.0813	404.05	455.5118	512.3898	369.7606
Kurtosis	0.424927	1.611251	-0.05309	4.962982	3.049708	0.802902	-0.15438	0.997904	0.295845	0.794862	0.320847	0.1162	-0.78823	0.95244
Skewness	0.998525	1.247973	0.376608	1.490918	1.573438	1.168906	0.973093	1.281919	1.112554	1.265313	0.934833	0.798118	-0.01031	1.016299
Range	134	149	150	148	183	175	141	153	160	156	180	143	140	154.7692
Minimum	19	11	10	10	10	10	10	10	10	10	10	10	10	10.76923
Maximum	153	160	160	158	193	185	151	163	170	166	190	153	150	165.5385
Sum	1996908	1421421	2972184	4341784	5830880	3492745	2064988	2344188	2217650	1530070	3161140	3138428	1318225	2756201
Count	33176	25041	50630	80839	98207	58584	33151	38410	35009	24790	47548	48575	18297	45558.23
Confidence Level(95.0%)	0.187128	0.220969	0.147005	0.078377	0.100292	0.144363	0.233609	0.209683	0.243127	0.241419	0.18068	0.189803	0.32801	0.192651

Analysis of Bigeye length measurements (cm)

	Sampling Months													
Descriptive Statistics	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Average
Mean	57.53442	56.2054	55.49369	60.31887	59.88566	60.54036	61.95304	55.12894	62.19629	59.92001	66.95738	64.82563	62.02607	60.22967
Standard Error	0.228444	0.170069	0.276787	0.133217	0.143903	0.236216	0.339063	0.233476	0.288547	0.20704	0.27165	0.206309	0.430444	0.243474
Median	55	55	56	60	60	60	64	54	59	56	63	61	61	58.76923
Mode	54	54	56	60	60	50	65	53	52	50	64	56	60	56.46154
Standard Deviation	10.41112	9.199471	10.73775	10.92868	11.73231	14.03649	11.91553	9.666008	14.05906	13.07473	14.71178	12.69263	14.10648	12.09785
Sample Variance	108.3915	84.63028	115.2993	119.4361	137.6472	197.0229	141.98	93.4317	197.6572	170.9485	216.4365	161.1028	198.9928	149.4597
Kurtosis	1.898107	4.784375	1.51413	1.59619	1.660762	0.469757	1.754761	4.599848	4.192793	1.12868	1.567266	0.835991	0.6978	2.053882
Skewness	1.137005	1.236228	0.346509	0.572415	0.765411	0.817443	0.453215	1.455555	1.530789	1.047833	1.050759	0.895475	0.487459	0.907392
Range	79	85	84	115	104	90	88	83	107	102	134	93	88	96.30769
Minimum	30	28	24	27	30	22	29	29	34	25	29	24	28	27.61538
Maximum	109	113	108	142	134	112	117	112	141	127	163	117	116	123.9231
Sum	119499	164457	83518	405946	398060	213768	76512	94491	147654	238961	196386	245365	66616	188556.4
Count	2077	2926	1505	6730	6647	3531	1235	1714	2374	3988	2933	3785	1074	3116.846
Confidence Level(95.0%)	0.448003	0.333468	0.542929	0.261148	0.282097	0.463134	0.665203	0.457928	0.56583	0.405915	0.532643	0.404488	0.844607	0.477492