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SOME OBSERVATIONS CONCERNING THE SAMPLING OF COMMERCIAL RED SNAPPER FISHERIES IN THE GULF OF MEXICO

by

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This document presents some of the problems with sampling commercial red snapper fisheries in the Gulf of Mexico. The first section discusses the problems with small sample sizes that result from implementing direct random age sampling, and the potential effects of small sample sizes on constructing reliable length frequency distributions. The second section discusses issues surrounding TIP sampling procedures at the trip selection level, and subsampling procedures in which portions of otolith samples are selected for determinations of age.

Red snapper length data have been collected from commercial fisheries through the TIP program since 1984. Starting in 1991, otolith samples were periodically collected from red snappers to determine the ages of these fish. The purpose of this collection of age data was to study the age structure of gulf red snappers. Otoliths collected randomly or nonrandomly can be used to build an age-length-key (ALK), which can then be used to convert the length frequency distribution into an age frequency distribution. In 1998, direct random age (DRA) sampling was implemented. In this procedure, otoliths were collected from every fish that was sampled. However, some agents continued to collect otolith samples for the ALK after 1998.

I. Effect of sample size on the length distribution

(A) Problems of small sample sizes

One problem of using the DRA instead of the ALK sampling method is that it takes much longer to collect otoliths than to collect length data at the sampling site. It usually takes 2-8 min to remove an otolith from a fish. This can greatly limit the sample size, particularly when the samples are collected directly from a loading dock. For example, for a catch of 1500 lb, a sampler may only have 1 hour to take samples before the catch is transported to different dealers. Approximately 10-12 otolith samples can be collected in one hour. If more than one major species are in the catch, the sample size for each species would have to be small. Thus, even though the TIP program recommends a sample size of 30-50 fish per trip, a large percentage of trips have sample sizes considerably below this level.

The small sample sizes resulting from DRA sampling can greatly influence the estimated length frequency distribution of the red snapper in the Gulf region. The problem can be illustrated by comparing the sample length distributions that were constructed with samples of different sizes but from the same catch. Fig. 1 shows the sample length distributions of two individual trips from an agent in Texas. In both trips, a larger length sample and a small otolith sample were taken randomly from the same catch. The resulting length profiles differed greatly for these two sampling methods. The difference is more clear when we combine the data from all 2002 collection trips by this agent and compare the length frequency distribution of length samples and otolith samples (Fig. 2). The percentage of larger fish was much higher when sample sizes were smaller. This kind of sampling problem may cause serious distortion of the length frequency distribution, particularly in areas where the total number of fish sampled was small. For example, in Texas, the sample length frequency distributions for samples of different sizes differed greatly (Fig. 3). It is unclear which one of these three sample length frequency distributions represents the true length frequency distribution for the area studied.

The effect of sample size on the length frequency distribution of red snappers sampled from the entire Gulf of Mexico in 2002 (Fig. 4) is similar to that in the data subset from Texas. The mean, the median, and the CV (coefficient of variation) for the small sample size group were larger than those for the larger sample size group in 2002 (Table 1). In 2002, the percentage of fish larger than 25 inches (the approximate length of 10-year-old fish) increased 138% when the small sample size group was included in the construction of the overall length distribution (Table 2). Interestingly, the ratio of 10-year-old to 4- or 5-year-old red snappers was estimated to be about 1 to 300-400 in the commercial catch, according to Wilson et al. (Goodyear, 98). However, if we assume that fish larger than 25 inches were at least 10 years old, then the ratio estimated from the length distribution of red snappers in 2002 would be much higher (about 1 to 12; Table 2). Whether this change was due to a real increase in number of older fish in the Gulf or due to changes in sampling practices remains unclear. Moreover, the percentage of smaller fish is also significantly lower in the small sample size group (Table 3).

The above analysis shows that a change in sample size can significantly influence the estimated length frequency distributions. Given that length is correlated with age, the age frequency distribution may also be influenced by sample size. Thus, it is important to take the factor of sample size into account when constructing the age structure for a stock assessment.

(B) Factors that influence the sample size

For the past three years, sampling trips with small sample sizes ($n < 15$) ranged between 34 to 36% of trips (Table 4). When the data of Table 4 are broken down by state, this percentage may be as high as 80% (Table 5). Without question, different sampling practices can significantly change the length frequency distribution in local areas.

Several factors may have contributed to the observed small sample sizes. As stated above, the limited time available for sampling on loading docks may be one major reason for small otolith sample sizes. This possibility is supported by the much higher percentage of fisherman samples (i.e., samples taken directly from the loading dock) in small sample sizes group (Table 6). Small landing weights may also lead to a small sample size. However, although the average landing weights for the small sample size group were generally lower (Table 7), the average number of fish in a catch would still be much greater than 15 if one assumes a mean fish weight of about 3.5 lb. Also, only a small percentage of sampling trips over the last three years actually represent full catches in all sample size groups (Table 8). Thus, the number of available fish may not be a major contributor to small sample sizes.

(C) Longline gear and small sample size

Another potential cause for the different length frequency distributions in the small sample size group is the percentage of longline gear present in this group. Red snappers caught with longline gear have different length frequency distributions than those caught with handline gear (Figs. 5). The percentage of longline gear is higher in the small sample size group (Table 9). Thus, the higher percentage of larger fish caught by longline gear may contribute to the different length frequency distributions within the small sample size group. On the other hand, the different length profiles observed with catches obtained with longline gear may also be due in part to the small sample size. In general, the sample size of longline catches is smaller than those of handline catches (Table 10). The small sample sizes of longline catches were not due to limited fish available for sampling. Indeed, the percentage of samples representing full catches from a longline trip is small. For example, only 8% of longline trips represent full catches in 2002. Thus, small sample sizes may be one of the reasons for the observed different length frequency distributions for longline fishing, although the vulnerability of smaller fish to this gear may also be relatively lower than to other gears.

(D) Optimum sample size

The current guideline in the TIP manual for the sample size of individual trips is 30-50 fish. In practice, only about 20% of trips have length sample sizes above 30 (Table 11). A more detailed classification of sample size using all length data from 2002 illustrate again the effect of sample size on the length frequency distribution (Fig. 5). The effect of small sample size seems more apparent in longline trips than in handline trips (Figs. 7 and 8). It appears that the minimum sample size should be at least 30, especially for longline trips.

The question remains whether the recommended sample size is achievable for direct random otolith sampling. Since approximately 50% of all sampling trips over the last three years have occurred on loading docks (Table 6), and the time available for sampling is usually limited in this situation, it may not be practical to obtain a minimum otolith sample size of 30. Since small sample sizes may distort the age frequency distribution, it may be better to use the ALK method as it is much easier to obtain length samples with a minimum size of 30. However, the length at a given age can vary considerably, which may reduce the benefit of the ALK method. More research is needed to examine which of the two sampling methods used so far (DRA vs ALK) is better. More information from the 1998 intensive sampling program may prove to be useful in this regard and therefore it may be desirable to continue processing age samples archived during this year.

II. TIP sampling and subsampling procedures

Length data have been collected for TIP and recorded in the TIP database since 1984. The otolith samples collected by TIP port agents were usually sent to the Panama City Lab for determinations of fish ages. The Panama City Lab randomly subsampled a proportion of the otolith samples to determine age. Age data are currently housed only in the Panama City Lab and have not been incorporated into TIP. The following section discuss some of the problems of the TIP sampling and subsampling procedures. All data are those collected as of December, 2003.

A. Unbalanced sampling of otolith samples

Large numbers of red snapper otolith samples have been collected and processed since 1998. Sampling and subsampling procedures used in the collection of these otolith samples might have led to unbalanced sampling efforts in different areas. For example, the percent of otoliths sampled from landings is much higher in Mississippi, and lower in Texas, than in other states (Table 13). Such imbalanced sampling activities may lead to problems in interpretation if different age/length frequency distributions are found in different areas. Table 14 shows that sampling activities among dealers are also out of proportion relative to dealer-specific landings. About 70% of all otolith samples were collected by two agents in 2002 (Table 15).

As stated in the previous section, a reasonably large otolith sample (ideally more than 30 otoliths) is needed from each sampling trip to ensure that samples accurately represent the catches from which they came, if the DRA method is used. However, limited facilities and personnel for sampling and age determinations complicate the planning of sampling activities. A reevaluation of how the DRA and ALK sampling methods are applied given these limitations is needed to ensure that proper sampling is done and that resources are allocated appropriately among all the species needing management.

B. The age database is not linked to TIP

The Panama City Laboratory has put out much effort to build and improve the age database in the past years. However, using the Panama City age database for subsampling procedures has been complicated by the fact that this database is not linked to the TIP database. This lack of linkage means that age data are not available in TIP, and that some TIP information is not available in the age database. For example, some of the sample type information was not recorded in the age database. Since one of the sample types, quota samples, has different length frequency distributions compared to nonquota samples (fig 9), this type of information needs to be incorporated into the age database so that quota samples may be considered separately. Also, a small fraction of red snapper otolith sampling trips classified under the commercial fisheries heading of the age database were not found in the TIP database. This complicates determining the sampling strategy used in these collection trips. Thus, more effort is needed to link the two databases and insure that all information is available in both databases.

Summary

In summary, the above analysis shows that (1) small otolith sample sizes may seriously change the estimated length frequency distribution of the stock, (2) small otolith sample sizes are mostly due to insufficient time for collecting otoliths as fish are unloaded, (3) small otolith sample sizes may be a particular problem for longline trips, and (4) the ideal sample size should be at least 30. Small sample sizes associated with direct random age (otolith) sampling may represent a problem for this kind of sampling method. A reevaluation of the two sampling methods that takes into account the limited resources available for sampling may be needed.

It should be noted that some analyses in this paper only represent data from a single year. More analysis may be needed to study the effects of sample size on the age/length frequency distribution. In any case, the present analysis indicates that stock assessment analysts need to be aware of the potential problems associated with small sample sizes when they develop historical assessments. The issue of small sample sizes should also be taken into consideration when planning future sampling activities.

Table 1. Mean and median fork lengths and coefficients of variation (cv) for samples with different sample sizes (n). (Note: the n>0 group includes all trips in which otolith were collected)

year	mean n>0	mean n>30	mean n<15	median n>0	median n>30	median n<15	cv n>0	cv n>30	cv n<15
1984	18.01	-	18.01	16.83	-	16.83	0.33	-	0.33
1985	19.02	-	19.02	17.52	-	17.52	0.33	-	0.33
1986	17.98	-	17.98	15.53	-	15.53	0.35	-	0.35
1987	17.80	-	17.80	15.30	-	15.30	0.36	-	0.36
1988	17.20	-	17.20	15.41	-	15.41	0.31	-	0.31
1989	16.27	-	16.27	15.20	-	15.20	0.27	-	0.27
1990	16.03	-	16.03	14.89	-	14.89	0.25	-	0.25
1991	15.92	-	15.92	14.57	-	14.57	0.27	-	0.27
1992	15.40	14.21	15.42	14.37	13.86	14.37	0.22	0.13	0.22
1993	16.66	15.15	16.62	15.82	14.76	15.75	0.21	0.15	0.21
1994	16.73	-	16.72	15.53	-	15.55	0.21	-	0.21
1995	17.73	-	17.71	16.42	-	16.38	0.24	-	0.24
1996	17.49	17.20	17.52	16.31	17.17	16.34	0.20	0.13	0.21
1997	17.81	19.25	17.80	16.57	18.80	16.57	0.21	0.14	0.21
1998	17.82	18.57	17.58	16.42	16.93	16.22	0.22	0.24	0.22
1999	18.05	17.67	18.08	16.93	16.61	16.89	0.21	0.20	0.22
2000	17.93	17.79	17.82	16.63	16.38	16.61	0.22	0.21	0.21
2001	17.79	17.31	17.67	16.61	16.26	16.50	0.21	0.19	0.21
2002	17.58	16.90	17.71	16.22	15.83	16.34	0.22	0.19	0.22
2003	17.41	16.86	17.48	16.18	15.98	16.22	0.21	0.18	0.22

Table 2. Total number of otolith samples, and percentage of samples, with fork lengths greater than 25 inches in each sample size group.

year	#otolith, n>0	% fl>25, n>0	# otolith, n>30	% fl>25, n>30	#otolith, n<15	%fl>25, n<15
1992	156	5.13%	108	0.00%	33	24.24%
1993	843	8.42%	32	3.12%	485	8.66%
1994	1155	13.07%	0	0.00%	760	16.71%
1995	608	18.42%	0	0.00%	456	19.08%
1996	634	6.15%	35	0.00%	128	14.06%
1997	559	8.05%	31	6.45%	63	14.29%
1998	3482	11.03%	1991	12.66%	278	9.35%
1999	2995	6.41%	1501	5.80%	297	13.80%
2000	2085	9.59%	965	6.11%	381	7.61%
2001	5553	7.74%	2156	3.94%	592	15.37%
2002	7538	7.91%	3450	3.33%	717	19.53%
2003	6829	6.57%	3639	2.78%	687	14.70%

Table 3. Percentage of otolith samples with fork lengths less than 16 inches in each sample size group.

year	# otolith, n>0	% fl <16, n>0	# otolith, n>30	% fl<16, n>30	# otolith, n<15	%fl < 16, n<15
1992	156	65.38%	108	85.19%	33	3.03%
1993	843	37.72%	32	62.50%	485	37.32%
1994	1155	42.42%	0	0.00%	760	34.34%
1995	608	36.84%	0	0.00%	456	36.18%
1996	634	50.79%	35	40.00%	128	40.62%
1997	559	39.36%	31	3.23%	63	34.92%
1998	3482	34.55%	1991	36.92%	278	31.65%
1999	2995	34.09%	1501	39.31%	297	24.58%
2000	2085	36.31%	965	44.56%	381	22.05%
2001	5553	38.56%	2156	46.24%	592	27.03%
2002	7538	45.74%	3450	52.99%	717	26.50%
2003	6829	45.20%	3639	50.67%	687	27.22%

Table 4. Percent of red snapper sampling trips with otolith sample sizes less than 15 in the Gulf of Mexico (1991 to 2003)

YEAR	total # trips	# trips with n<15	% trips n<15
1991	8	5	62.50%
1992	14	11	78.57%
1993	88	71	80.68%
1994	124	108	87.10%
1995	69	63	91.30%
1996	43	21	48.84%
1997	33	14	42.42%
1998	141	39	27.66%
1999	144	49	34.03%
2000	114	57	50.00%
2001	268	91	33.96%
2002	340	122	35.88%
2003	301	108	35.88%

Table5. Percent of trips with otolith sample sizes less than 15 in the five states bordering the Gulf of Mexico (1991-2003) (State codes: 01-AL, 11-FL west, 21-LA, 27-MS, 46-TX)

year	state	# trips, n<15	total # trips	% trips with n<15
1991	11	5	8	62.50%
1992	11	11	14	78.57%
1993	11	33	36	91.67%
1993	21	37	51	72.55%
1993	46	1	1	100.00%
1994	11	30	32	93.75%
1994	21	78	92	84.78%
1995	1	2	2	100.00%
1995	11	19	19	100.00%
1995	21	42	48	87.50%
1996	11	6	6	100.00%
1996	21	15	37	40.54%
1997	11	8	9	88.89%
1997	21	6	24	25.00%
1998	1	0	2	0.00%
1998	11	20	46	43.48%
1998	21	10	64	15.62%
1998	27	2	9	22.22%
1998	46	7	20	35.00%
1999	1	4	9	44.44%
1999	11	21	36	58.33%
1999	21	18	58	31.03%
1999	27	1	13	7.69%
1999	46	5	28	17.86%
2000	1	9	13	69.23%
2000	11	32	66	48.48%
2000	21	12	20	60.00%
2000	27	2	12	16.67%
2000	46	2	3	66.67%
2001	1	8	10	80.00%
2001	11	72	183	39.34%
2001	21	7	61	11.48%
2001	27	0	7	0.00%
2001	46	4	7	57.14%
2002	1	4	6	66.67%
2002	11	76	185	41.08%
2002	21	38	124	30.65%
2002	27	0	9	0.00%
2002	46	4	16	25.00%
2003	1	1	7	14.29%
2003	11	88	184	47.83%
2003	21	15	81	18.52%
2003	27	0	5	0.00%
2003	46	4	24	16.67%

Table 6. Percent of otolith sampling trips where samples were obtained on the loading dock (code fs=fisherman sample)

YEAR	%trips=fs,	%trips=fs,	% trips=fs,
1992	100.00%	100.00%	100.00%
1993	98.86%	100.00%	98.57%
1994	100.00%	0.00%	100.00%
1995	100.00%	0.00%	100.00%
1996	97.67%	0.00%	100.00%
1997	93.94%	0.00%	92.31%
1998	40.77%	35.14%	55.56%
1999	68.03%	60.00%	76.32%
2000	55.67%	47.06%	68.75%
2001	36.58%	28.30%	58.23%
2002	51.50%	25.64%	84.62%
2003	52.16%	35.96%	78.64%

Table 7. Average landing weights of otolith sampling trips for different sample size groups

YEAR	avg lw (lb), n> 0	avg lw (lb), n>30	avg lw (lb), n<15
1992	18.89	0.00	18.89
1993	36.29	0.00	36.29
1994	224.20	0.00	224.20
1995	1440.79	0.00	1402.73
1996	1394.08	1880.00	1056.94
1997	1129.32	0.00	289.38
1998	1433.57	1782.48	847.83
1999	1346.56	1481.62	910.24
2000	1096.28	1654.69	880.32
2001	1218.17	1673.10	727.81
2002	1302.76	1698.24	846.46
2003	1129.60	1589.48	581.90

Table 8. Percent of otolith sampling trips in which samples represent the full catch

YEAR	% full catch, n>0	% full catch, n>30	% full catch, n<15
1992	57.14%	0.00%	80.00%
1993	18.18%	0.00%	22.86%
1994	6.45%	0.00%	7.77%
1995	7.25%	0.00%	8.20%
1996	11.63%	0.00%	25.00%
1997	15.15%	0.00%	38.46%
1998	12.31%	2.70%	33.33%
1999	27.87%	30.00%	28.95%
2000	13.40%	0.00%	14.58%
2001	4.28%	3.77%	7.59%
2002	4.49%	1.28%	8.65%
2003	6.98%	4.49%	15.53%

Table 9. Percent of otolith sampling trips that involved fish landed via longline fishing.

YEAR	% trips longline, n>0	%trip longline, n>30	%trip longline, n<15
1992	50.00%	33.33%	60.00%
1993	15.91%	0.00%	20.00%
1994	3.23%	0.00%	3.88%
1995	10.14%	0.00%	11.48%
1996	11.63%	0.00%	25.00%
1997	12.12%	0.00%	30.77%
1998	6.92%	5.41%	13.89%
1999	9.02%	3.33%	26.32%
2000	12.37%	5.88%	8.33%
2001	10.51%	0.00%	22.78%
2002	16.17%	2.56%	38.46%
2003	17.28%	0.00%	38.83%

Table 10. Average, maximum and minimum sample sizes for otolith sampling trips involving either handline (H) or longline (L) fishing.

YEAR	Gear type	avg sample size	max sample size	min sample size	# of trips
1992	H	15	39	2	7
1992	L	7	34	1	7
1993	H	11	32	1	74
1993	L	4	10	1	14
1994	H	10	30	1	120
1994	L	2	5	1	4
1995	H	9	25	1	62
1995	L	3	6	1	7
1996	H	16	35	1	38
1996	L	2	6	1	5
1997	H	19	31	1	29
1997	L	4	7	1	4
1998	H	27	102	1	121
1998	L	28	115	1	9
1999	H	26	120	1	111
1999	L	9	38	2	11
2000	H	22	147	1	85
2000	L	18	36	1	12
2001	H	23	100	1	230
2001	L	10	24	1	27
2002	H	25	148	1	280
2002	L	10	45	1	54
2003	H	26	93	1	249
2003	L	9	24	1	52

Table 11. Number and percent of all red snapper sampling trips (otolith and length sampling combined) for each sample size group in the Gulf of Mexico (2002)

sample size	# trip	Percent
n<=10	116	22.92%
10<n<=20	100	19.76%
20<n<=30	190	37.55%
30 < n <=40	40	7.91%
40 < n <=50	41	8.10%
n>50	19	3.75%

Table 12. Percent of otoliths used for determinations of age

year	# of lengths sampled by TIP	# otoliths collected	# of otoliths read	percent otoliths read from otolith samples
1991	13177	875	875	100.00%
1992	12896	805	805	100.00%
1993	12290	1874	1057	56.40%
1994	11020	1621	1188	73.29%
1995	9189	618	618	100.00%
1996	11037	119	119	100.00%
1997	14036	110	110	100.00%
1998	15560	4315	1650	38.24%
1999	11974	8308	2871	34.56%
2000	10068	6301	3076	48.82%
2001	10283	6922	2373	34.28%
2002	12511	8680	3901	44.94%

Table 13. Percent of landing sampled in each state (2002)

state	estimated # of fish landed	# of length samples	# of otoliths collected	# of otoliths read	%lengths sampled	% of otoliths collected	% of otoliths read
AL	45096	270	77	75	0.60%	0.17%	0.17%
FL(W)	283373	4878	4081	1134	1.72%	1.44%	0.40%
LA	647757	5336	3497	1669	0.82%	0.54%	0.26%
MS	13708	901	515	515	6.57%	3.76%	3.76%
TX	442207	708	508	508	0.16%	0.11%	0.11%

Table 14. Percent of landings sampled for each dealer in 2002 (not all dealers are listed).

dealer	state	landing weight (1000 Kg)	# of fish	% of otoliths sampled from landing	% of lengths sampled from landing	# of otoliths sampled (not # of otoliths read)	# of lengths sampled
0	Texas	-	-	-	-	84	286
388	Alabama	29.93	19747	-	-	0	0
460	Mississippi	17.29	11412	4.92%	7.90%	561	901
1895	Louisiana	49.50	32664	0.00%	0.07%	0	24
2100	Louisiana	87.58	57791	0.00%	1.04%	0	600
2278	Texas	34.20	22566	-	-	0	0
2381	Texas	26.07	17200	-	-	0	0
2443	Texas	319.01	210507	0.16%	0.16%	343	343
2500	Louisiana	71.38	47100	-	-	0	0
2504	Texas	68.27	45049	0.03%	0.03%	14	14
2676	Texas	72.41	47783	0.09%	0.09%	41	41
2819	Florida_west	39.20	25865	1.88%	1.88%	485	485
2968	Florida_west	18.79	12399	2.82%	2.82%	350	350
2968	Louisiana	-	-	-	-	310	310
3110	Texas	41.25	27218	-	-	0	0
3898	Florida_west	33.61	22175	1.56%	1.56%	345	345
3898	Louisiana	-	-	-	-	1042	1066
5157	Florida_west	203.47	134264	1.63%	1.63%	2192	2193
5157	Louisiana	-	-	-	-	701	701
5883	Louisiana	183.57	121133	0.00%	0.10%	0	125
7072	Texas	27.98	18463	-	-	0	0
7859	Louisiana	33.05	21812	-	-	0	0
8036	Louisiana	74.15	48928	0.00%	0.31%	0	152
9343	Louisiana	72.26	47681	0.07%	1.60%	31	763
9412	Louisiana	188.81	124591	0.43%	0.48%	536	597
9594	Louisiana	32.81	21650	0.00%	0.88%	0	190
9719	Louisiana	65.34	43114	0.06%	0.87%	25	376

Table 15. Percent of otoliths collected by each agent in 2002.

Agent	# otoliths collected	% of total otoliths collected	# of length samples	% of total length samples
3	0	0.00%	52	0.40%
14	0	0.00%	144	1.10%
4B	0	0.00%	70	0.53%
68	0	0.00%	340	2.59%
7B	0	0.00%	40	0.31%
AG	1	0.01%	1	0.01%
AL	0	0.00%	1260	9.61%
AM	0	0.00%	747	5.70%
BS	0	0.00%	42	0.32%
BV	24	0.31%	78	0.59%
CD	30	0.39%	42	0.32%
DF	2120	27.38%	2144	16.35%
EM	0	0.00%	114	0.87%
GC	0	0.00%	32	0.24%
GF	37	0.48%	125	0.95%
GG	0	0.00%	124	0.95%
GH	5	0.06%	162	1.24%
GR	633	8.18%	689	5.26%
JB	0	0.00%	233	1.78%
JF	0	0.00%	50	0.38%
JM	0	0.00%	550	4.19%
JV	0	0.00%	225	1.72%
JW	3522	45.49%	3523	26.87%
KD	60	0.77%	208	1.59%
KR	357	4.61%	357	2.72%
LB	124	1.60%	140	1.07%
LH	0	0.00%	56	0.43%
MG	0	0.00%	1	0.01%
MH	0	0.00%	124	0.95%
MP	41	0.53%	41	0.31%
NE	0	0.00%	166	1.27%
PA	0	0.00%	27	0.21%
PM	0	0.00%	7	0.05%
RL	561	7.25%	561	4.28%
RR	30	0.39%	92	0.70%
RW	0	0.00%	145	1.11%
SR	0	0.00%	201	1.53%
TF	198	2.56%	198	1.51%

Fig 1. Red snapper fork length frequency distributions for two individual trips by one agent in 2002

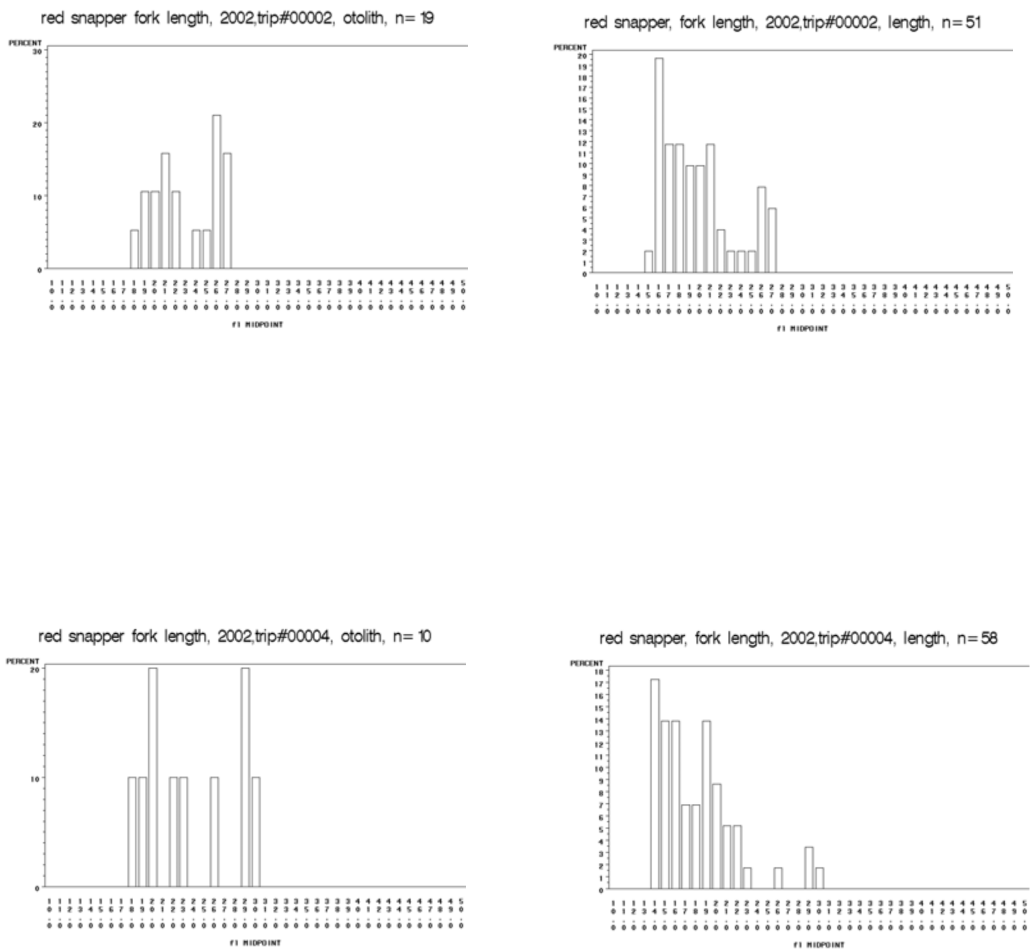
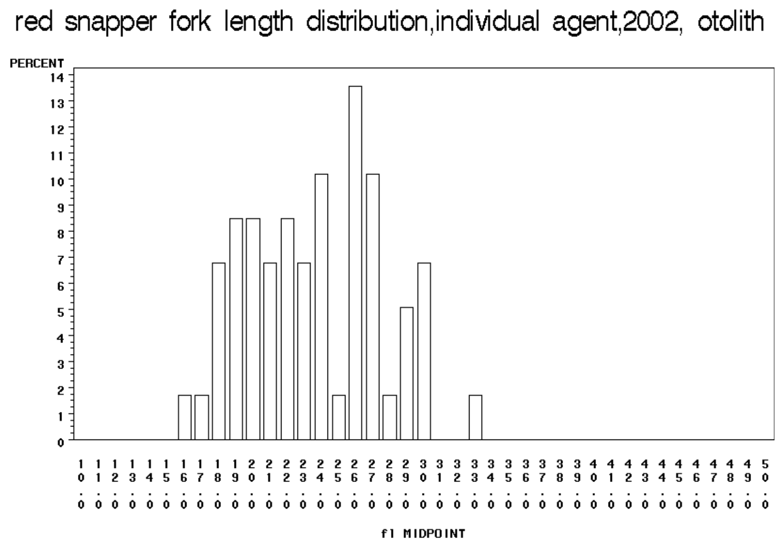


Fig 2. Red snapper fork length frequency distributions for otolith samples (n=59, 4trips) and length samples (n=207, 4 trips) taken by one agent in 2002



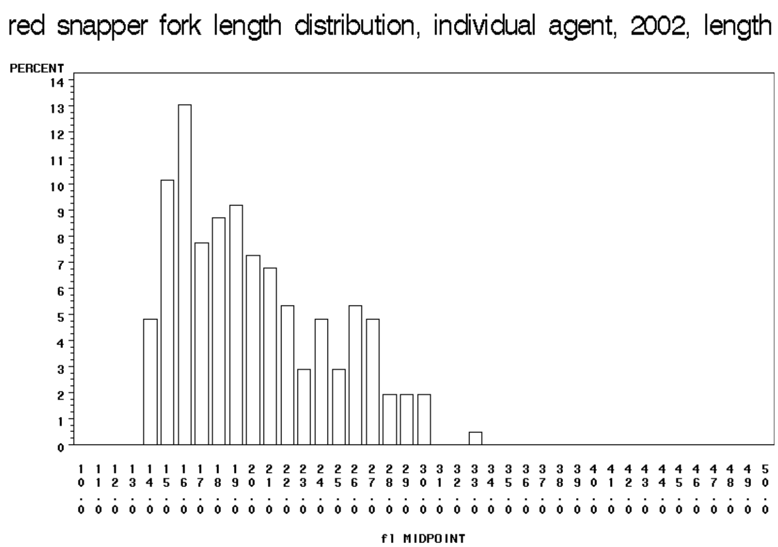
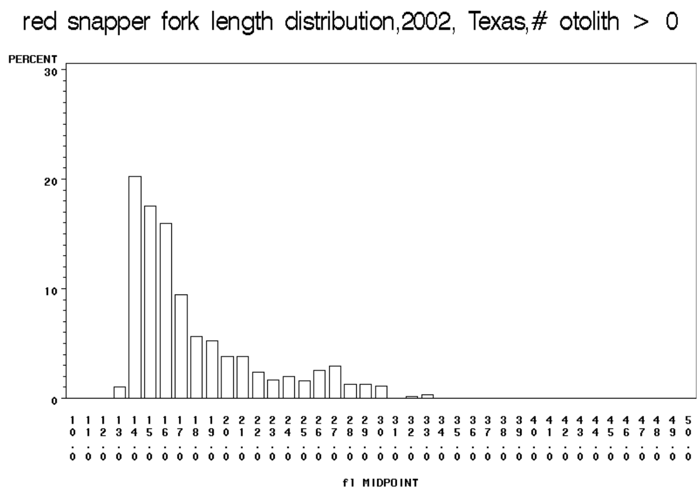
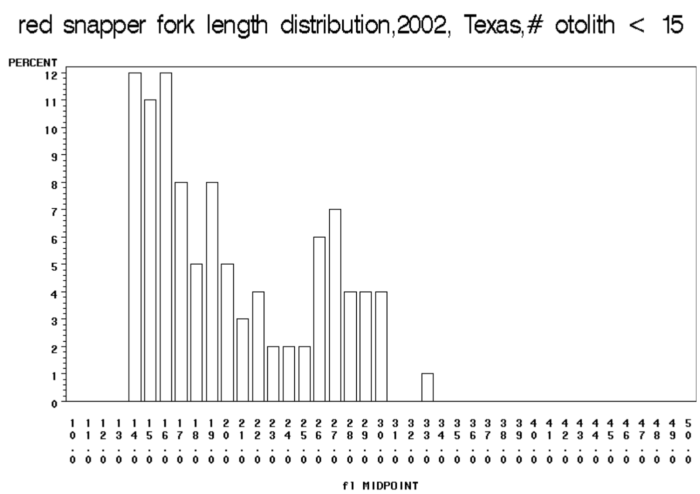


Fig 3. Red snapper fork length frequency distributions for different sample sizes (Texas, 2002)





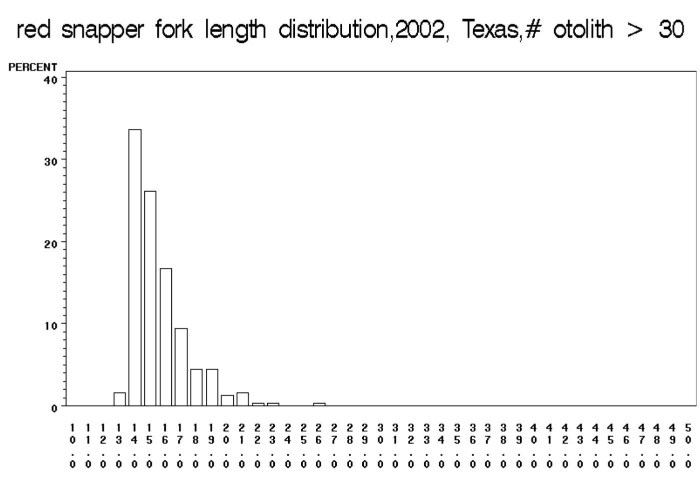
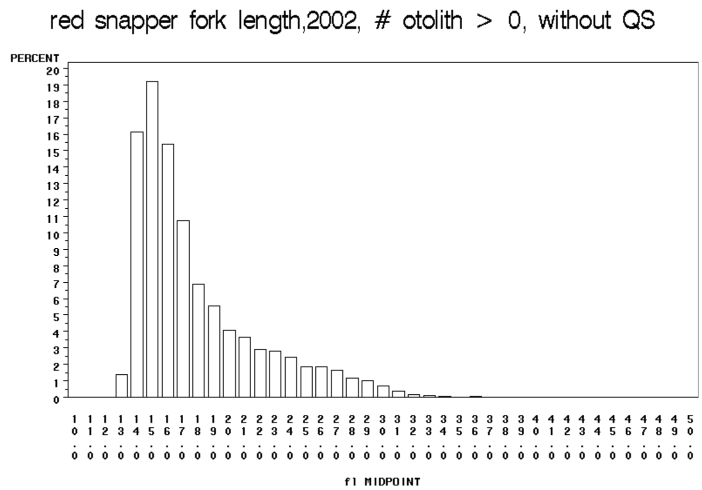
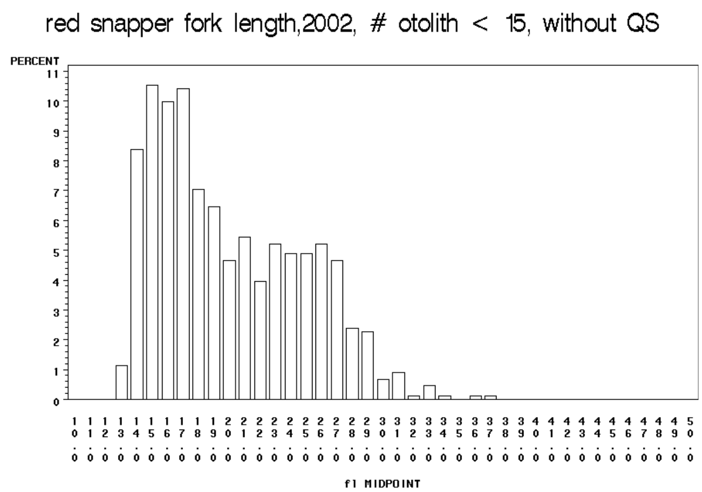


Fig 4. Red snapper fork length frequency distributions for different otolith sample size (2002) (QS: quota samples)





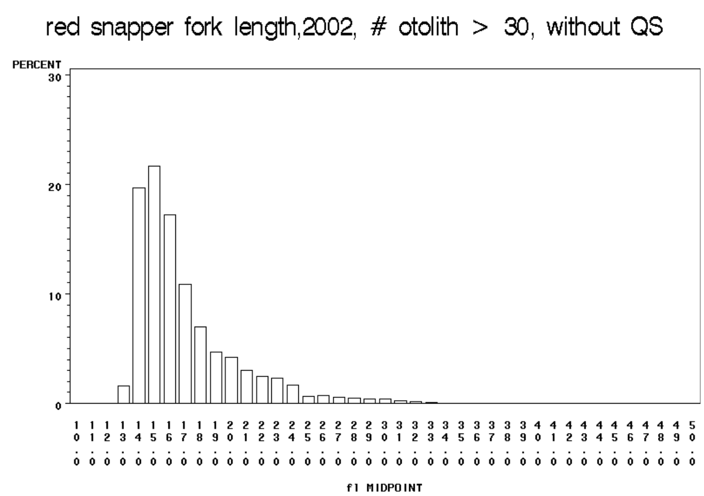
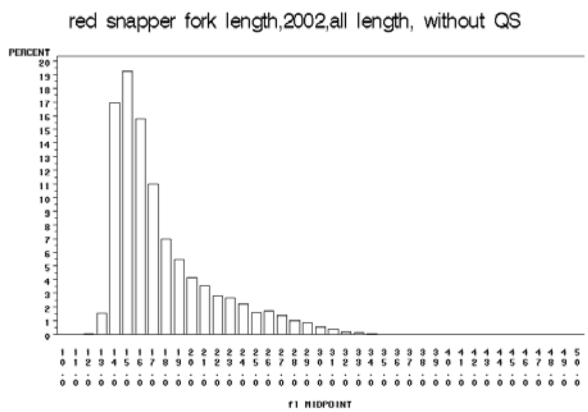
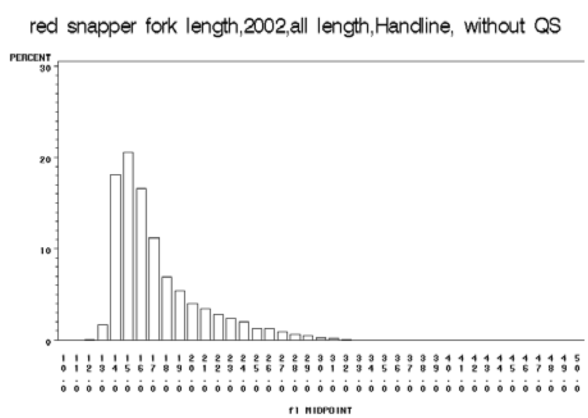


Fig 5. Comparison of length frequency distributions from handline and longline catches in the Gulf of Mexico in 2002





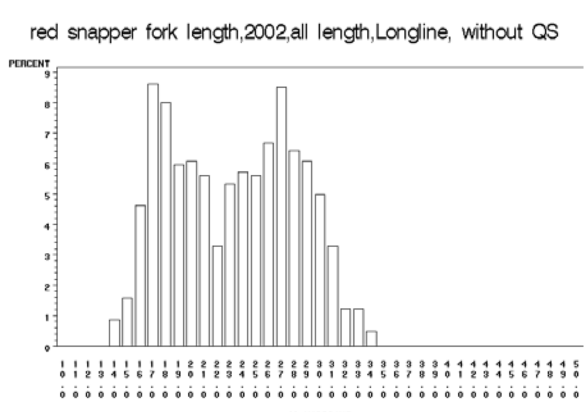
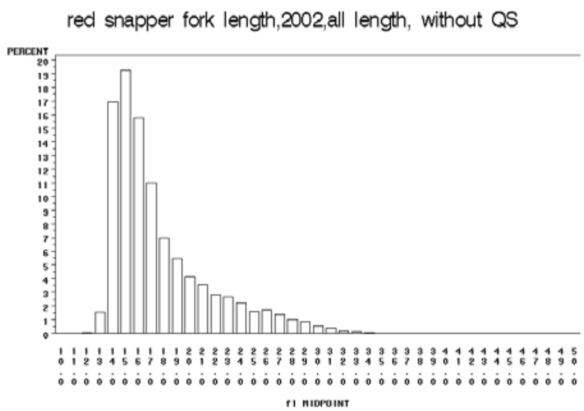
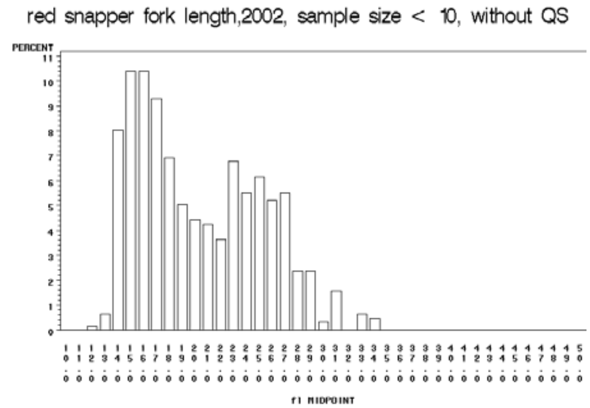
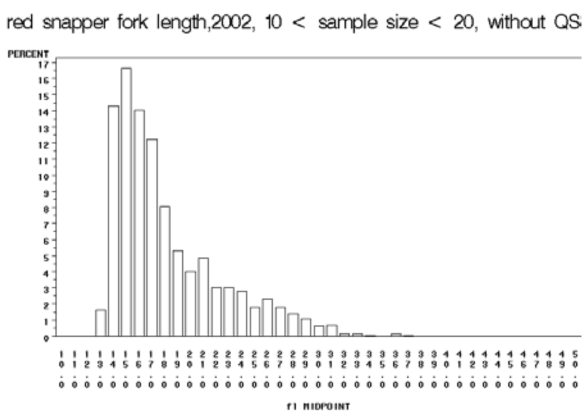
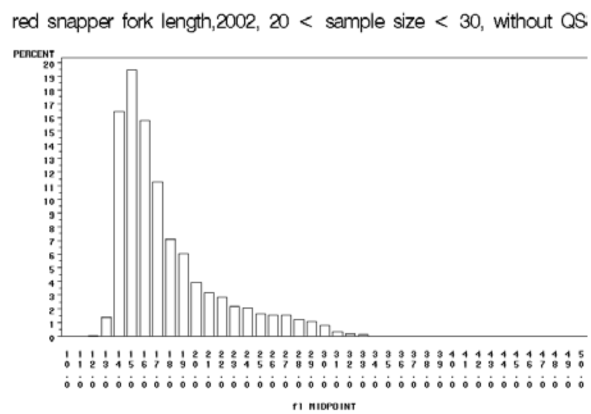


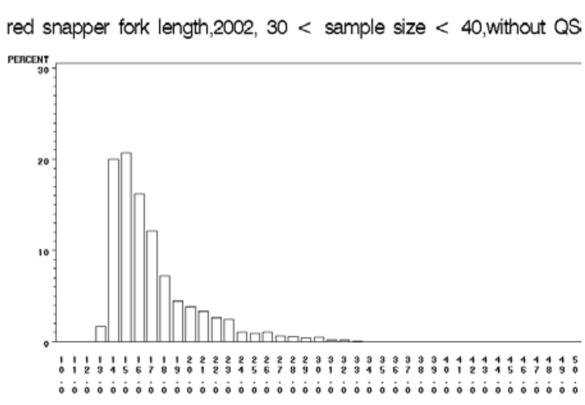
Fig 6. Red snapper fork length frequency distributions (2002, all length data included)

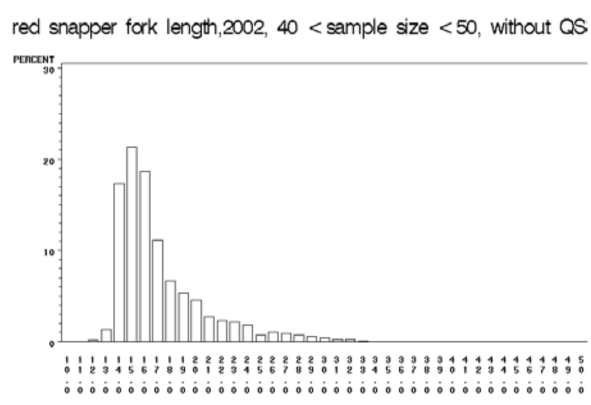












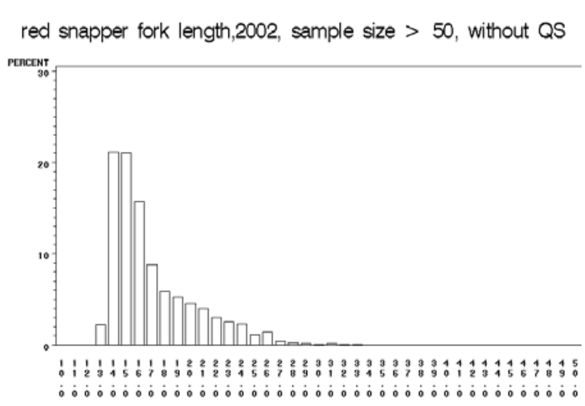
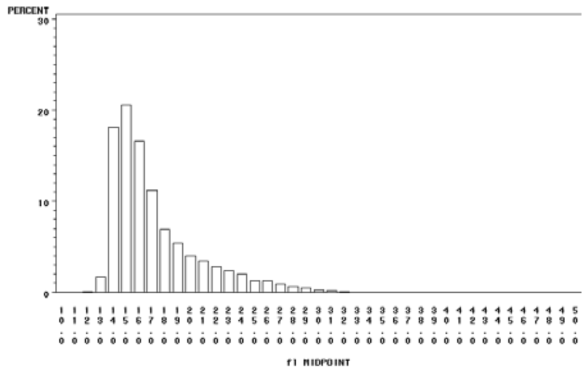
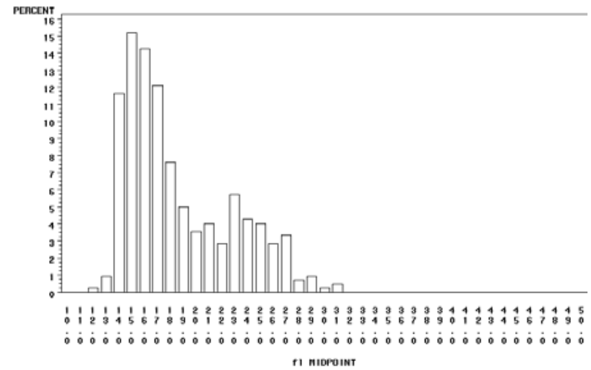


Fig7. Red snapper fork length frequency distributions (2002, handline)

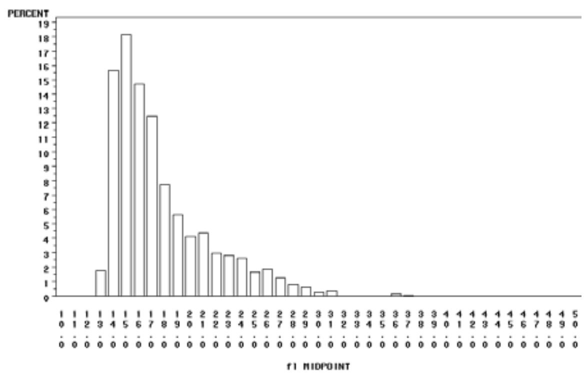
red snapper fork length,2002,all length,Handline, without QS



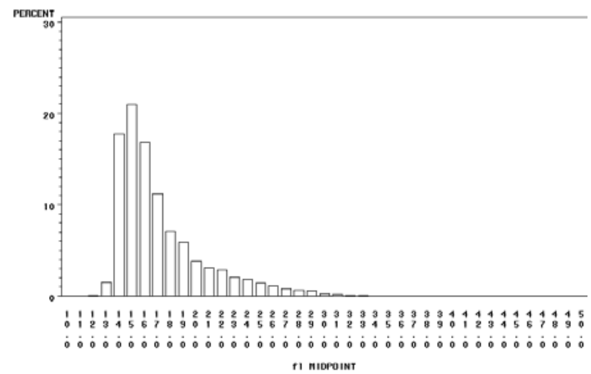
red snapper fork length,2002, sample size < 10, Handlin,without QS



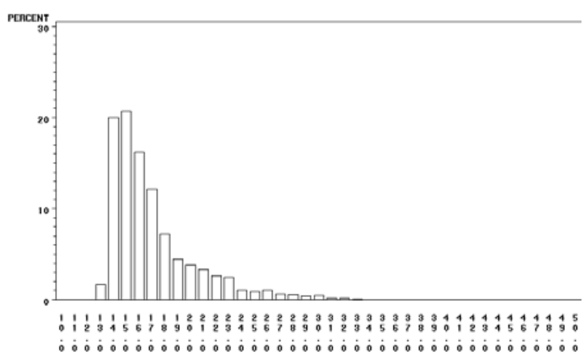
red snapper fork length,2002, 10 < sample size < 20, Handline,without QS



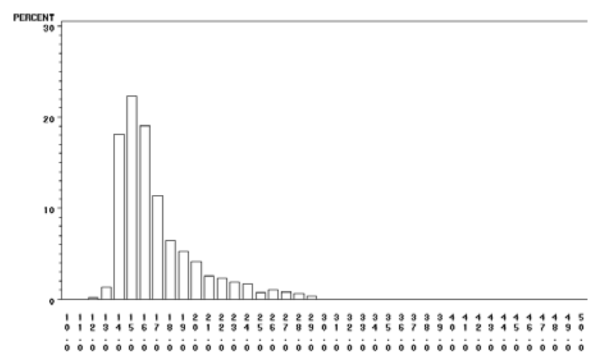
red snapper fork length,2002, 20 < sample size < 30, Handline,without QS



red snapper fork length,2002, 30 < sample size < 40,Handline,without QS



red snapper fork length,2002, 40 <sample size <50, Handline,without QS



red snapper fork length,2002, 40 <sample size <50, Handline,without QS

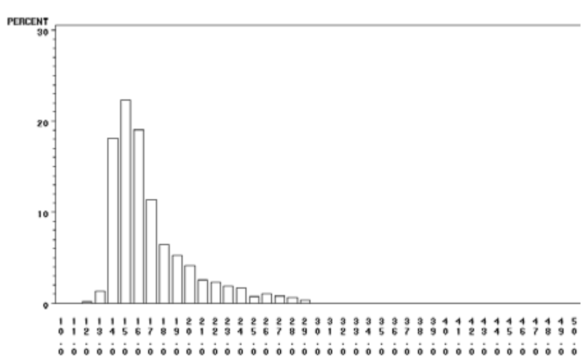
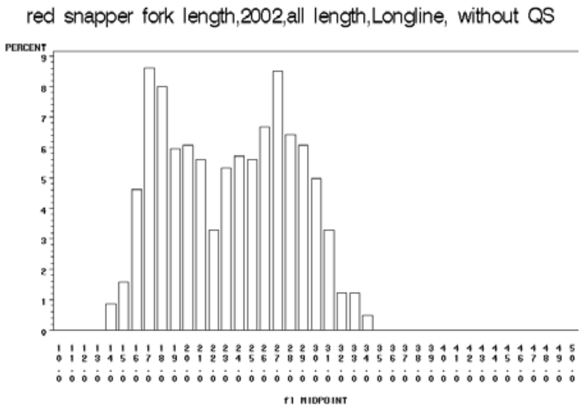
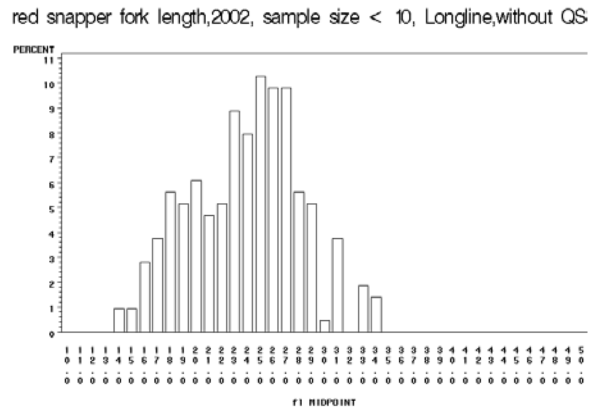
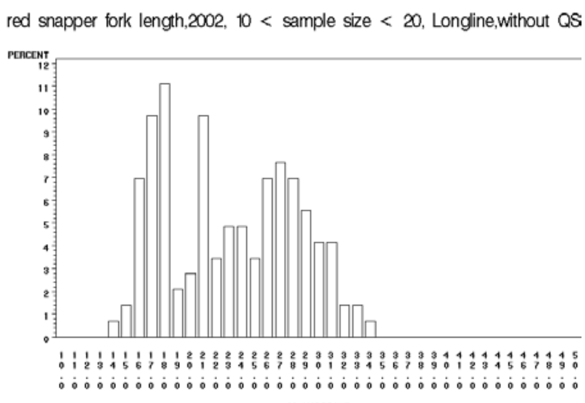
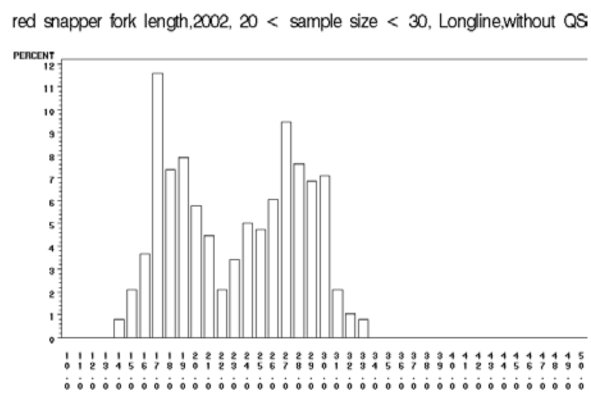


Fig 8. Red snapper fork length distributions (2002, longline)









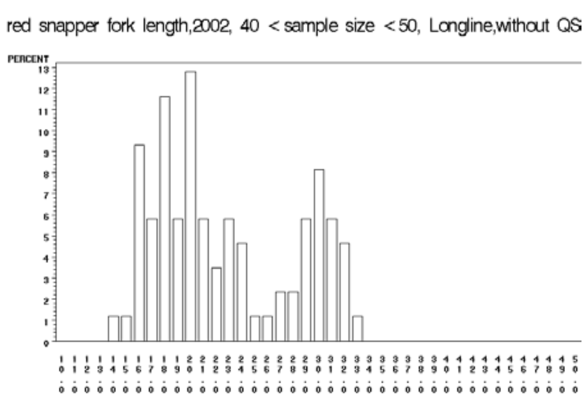


Fig 9. Red snapper fork length distributions (1991-2003)