Commercial length versus age based sampling: Are there regional effects in sampling?

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Introduction

During SEDAR-12-DW it was discussed to further investigate the comparisons of Trip Interview Program (TIP) commercial length frequency data versus the lengths from age based sampling. In particular, there was concern that age based samples were not randomly collected. Age based samples may contain larger red grouper that were size-selected than randomly selected from the catch. Also, it was noted that red grouper may exhibit regional growth patterns (Lombardi-Carlson et al. 2006, SEDAR 12-DW-03). Therefore, length frequency comparisons created by Chin-Ping 2006 (SEDAR-12-DW-10) may not have recognized the regional differences in sampling for lengths versus sampling for age based structures. Thus, length and age based length frequency data were further divided by commercial gear and region, and visually compared. If age based samples are concluded to not be random, than age length keys may be the more appropriate method to calculate the age of the catch.

Methods

Length frequency comparisons were restricted to several factors: overlapping years, commercial gear, and region. Overlapping years pertain to only those years that both age and length samples were collected (1991-2005). Commercial gear codes were grouped into two major categories, hand-line (TIP gear codes: 600, 610, 611, 612, 613, 614, and 616) and long-line (TIP gear codes: 675, 676, 677). Two regional allocations were made, north (Grids 6, 7, 8, 9, 10, and 11) and south (Grids 1, 2, 3, 4, and 5). Regions were based on the NMFS Statistical Grid allocated by the TIP port agent.

Box plots were constructed to compare the median, upper and lower quartiles and the range of the lengths from both length and age based sampling. Length based samples were compared by region (north, south) and within gear types (hand-line, long-line). Lengths obtained from length versus age based sampling were compared by gear type and region. Finally, length

frequency distributions by sampling type (length versus age) will be compared by year, gear, and region.

Discussion

Regional stratification of length data resulted in larger median lengths collected south of 28^{o} latitude, than length data collected north for both gears for most years (Figure 1). Length frequencies were similar for a few years, hand-line gear (1993) and long-line gear (1992, 1999-2000). Northern long-line lengths collected in 1991 and 1993 were larger. Outliers were present for most years for both gears. Red grouper caught by long-line gear were larger than those from the hand-line fishery (Figure 2; long-line range 550-780mm, hand-line range 500-750mm).

Length and age based samples lengths were compared by gear (hand-line, long-line) and region (North, South). Northern hand-line length data were similar between the sample types (age vs length) for 10 of the 15 years (1992, 1993, 1995-1998, 2001, 2003, 2005; Figure 2). Age based samples had a larger median size only for 3 years (1991, 1999, 2004). Similarly, southern hand-line length data were similar for 9 of the 15 years (1992-1994, 2000-2005). Length frequency data from the south were larger compared to age based samples for 8 years (1991-1993, 1995-1996, 1998-1999, 2002, 2004). Of those years, age based samples were collected in limited numbers ($n<25$; Table 1; 1991-1993, 1995, 1996, 1998). Median lengths of age based samples were slightly larger in 5 years (1994, 2000-2001, 2003, 2005; Figure 2) but upper and lower quartiles overlapped. No age based samples were collected from the southern region in 1997.

Long-line length based data were comparable in median length compared to lengths from age based sampling for 9 (1991, 1995, 1998-1999, 2001-2005) out of the 15 years from the north and 10 years (1992-1995, 1998-2000, 2003-2005) from the south (Figure 3). No age based long-line samples were collected from the north in 1996 and 1997 (Table 1). Long-line age based samples from the south were collected in fairly good sample sizes except for the years 1991 and 1997. Northern median lengths of age based samples were slightly larger for 8 years (1991, 1993-1995, 1999-2001, 2004) and southern median lengths of age based samples were also larger for 9 years (1995-1997, 2000-2005), however, in both regions upper and lower quartiles overlapped.

Comparisons of hand-line annual length frequency distribution comparisons are limited to only those years with ample number of age based samples. Of the 15 years, sufficient sample sizes were collected for 10 of the 15 years (Table 1; Figure 4; 1993-1996, 2000-2005) from the northern region and only 6 years (2000-2005) from the southern region. Lengths of northern age based samples were similar in distribution of the length based sampling (for those 10 years), however, 1993 length based sampling consisted of larger red grouper. Regional length frequency distributions showed southern age based samples were smaller than those fish measured for length based data (2000-2005).

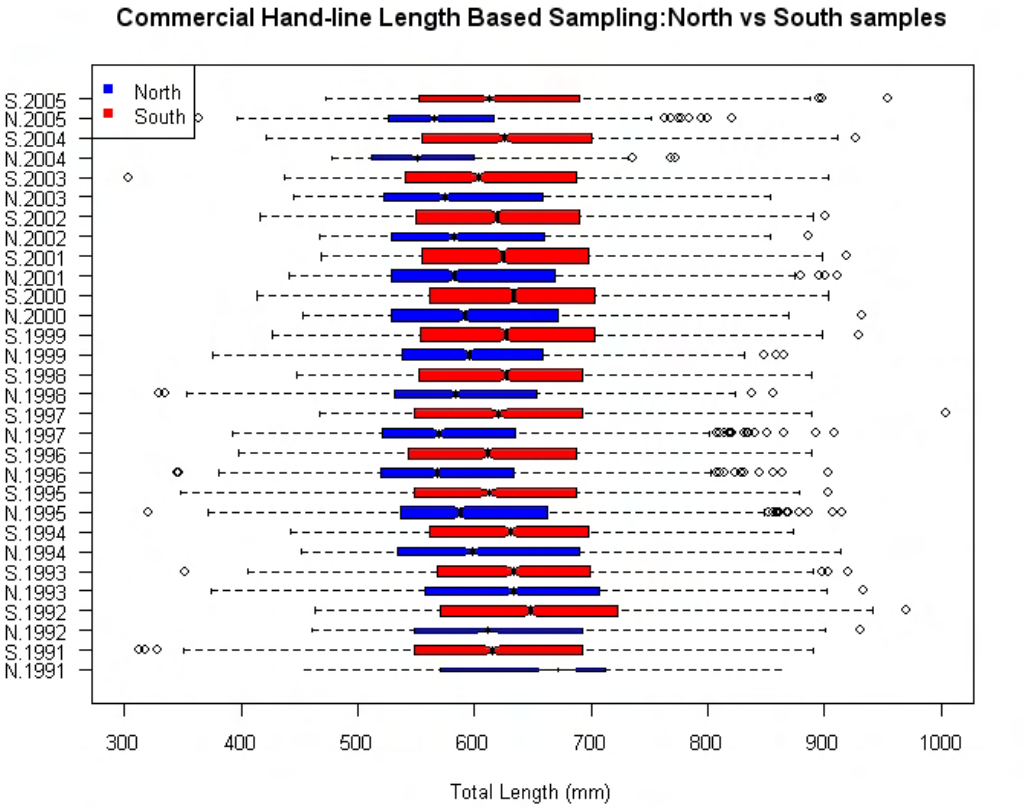
Northern long-line age based sampling was not consistent in the collection of otoliths until 1999, thus limited the length frequency comparisons for only 7 years. Age based sampling in the south was more frequent only two years, 1991 and 1997 (due to low sample sizes), can not be analyzed. In 1999 and 2000, age based sampling from the north collected larger fish than length based sampling. Nevertheless, northern age and length based sampling from 2001-2005 had similar length distributions (Figure 5). Southern age based sampling showed larger length distributions for 3 (1992, 1995, and 1996) of the 13 years that sufficient sample sizes enabled comparisons (Figure 5).

The inconsistent sampling for otoliths prior to 2000 limits the entire time series of length frequency to be compared by year, gear and region. But with the increase in sample sizes in 2000 for both gears and regions, comparisons of length frequency data demonstrate age and length based sampling measuring similar sized fish for both gears within regions. Red grouper display a tendency to be larger in the southern region regardless of gear type, and may require separate regional age length keys to adequately estimate the age of the catch. Landings of red grouper by the long-line fishery are larger in the south, which may contribute to the larger size distributions of fish caught.

Table 1. Commercial hand-line and long-line samples sizes for length and age based samples. Sample sizes <60 are highlighted.

	Hand-Line				Long-line			
	Length based		Age based		Length based		Age based	
Year	North	South	North	South	North	South	North	South
1991	53	885	28	15	648	2367	35	2
1992	184	1242	20	22	178	3181	1	140
1993	739	950	80	12	725	3409	10	190
1994	624	1180	184	55	660	3282	24	64
1995	1323	664	178	2	1487	4183	14	126
1996	954	1217	79	6	2172	2694	--	96
1997	809	785	35	--	3057	4231	--	7
1998	805	1539	6	20	2041	10462	37	72
1999	1296	2072	53	24	2904	14327	96	547
2000	1558	2508	144	62	1856	9852	137	268
2001	1773	2135	346	209	2148	6339	872	338
2002	731	1892	155	94	1379	6078	607	456
2003	559	1161	312	215	1069	6860	234	827
2004	300	915	528	198	570	6250	200	817
2005	500	557	399	127	1376	3763	269	835
Totals	12208	19702	2547	1061	22240	87278	2536	4785

Figure 1. Box plots of the gear specific commercial length based samples by region, including the median, upper and lower quartiles (boxes: drawn in proportion to the square root of the sample size), upper and lower range (dashed line), and outliers (open circles).



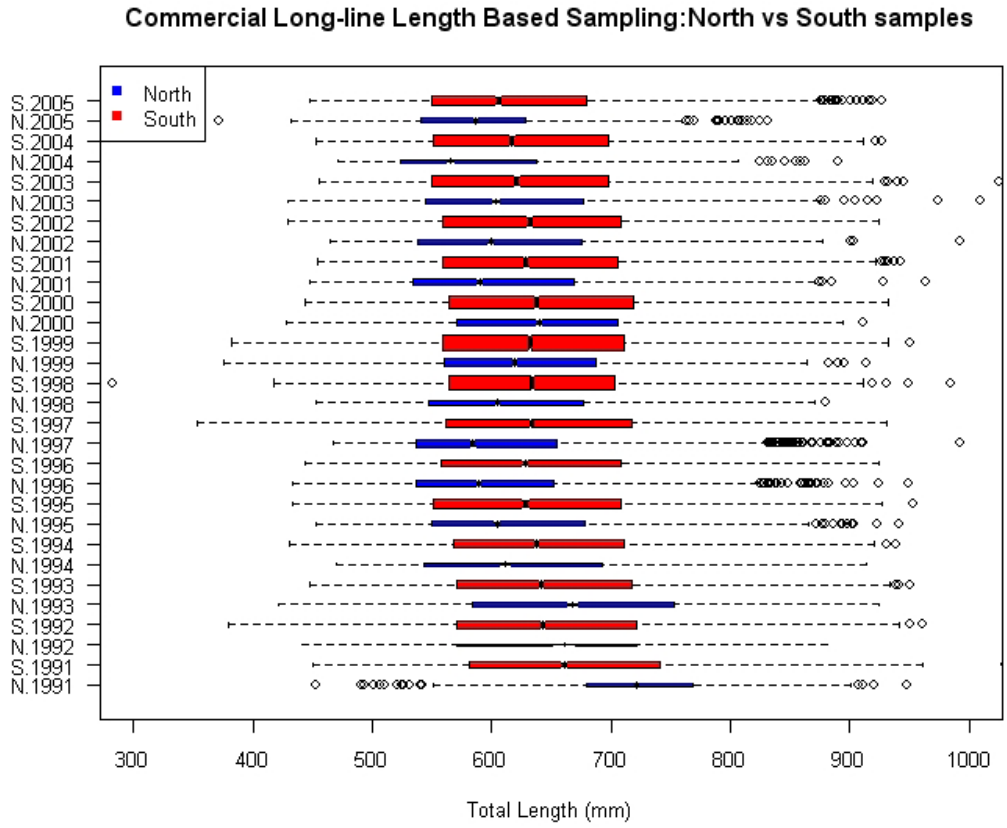
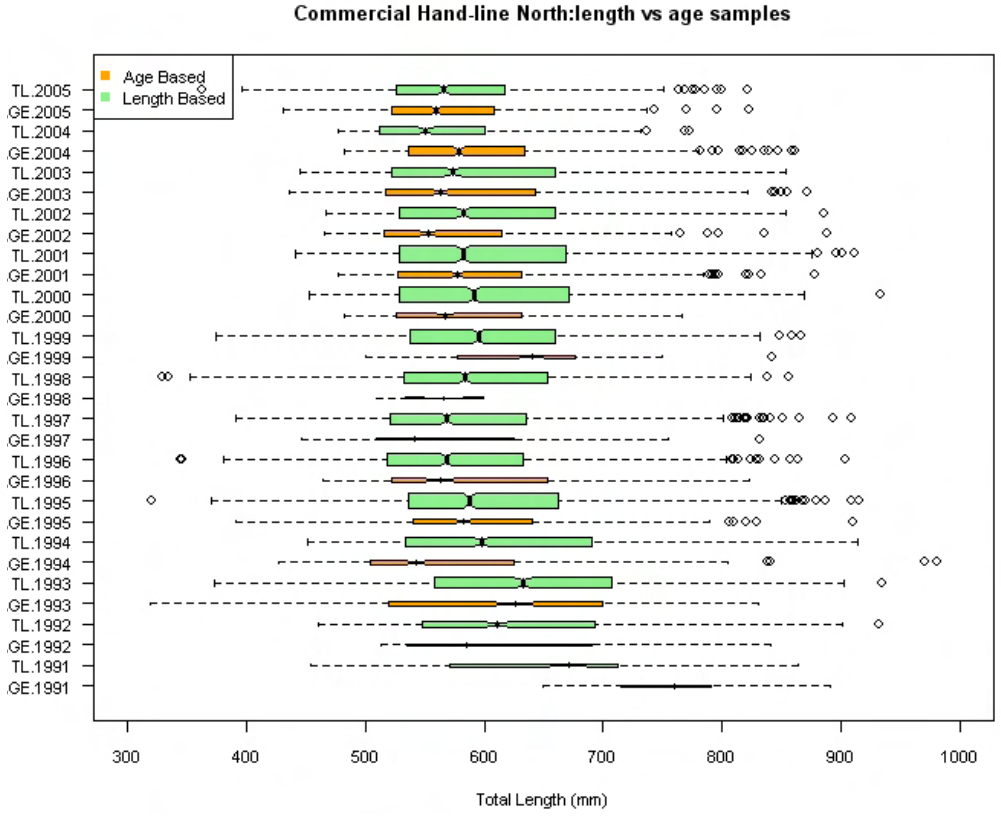


Figure 2. Box plots of region specific commercial hand-line length and age based samples, including the median, upper and lower quartiles (boxes: drawn in proportion to the square root of the sample size), upper and lower range (dashed line), and outliers (open circles).



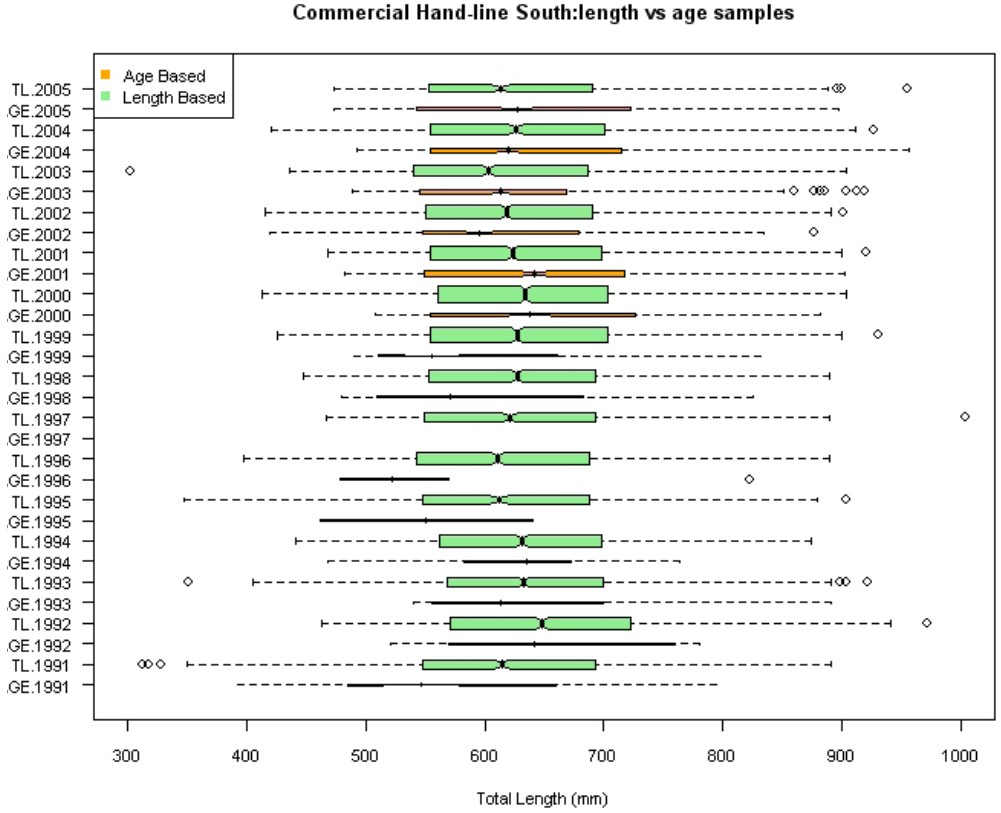


Figure 3. Box plots of region specific commercial long-line length and age based samples, including the median, upper and lower quartiles (boxes: drawn in proportion to the square root of the sample size), upper and lower range (dashed line), and outliers (open circles).

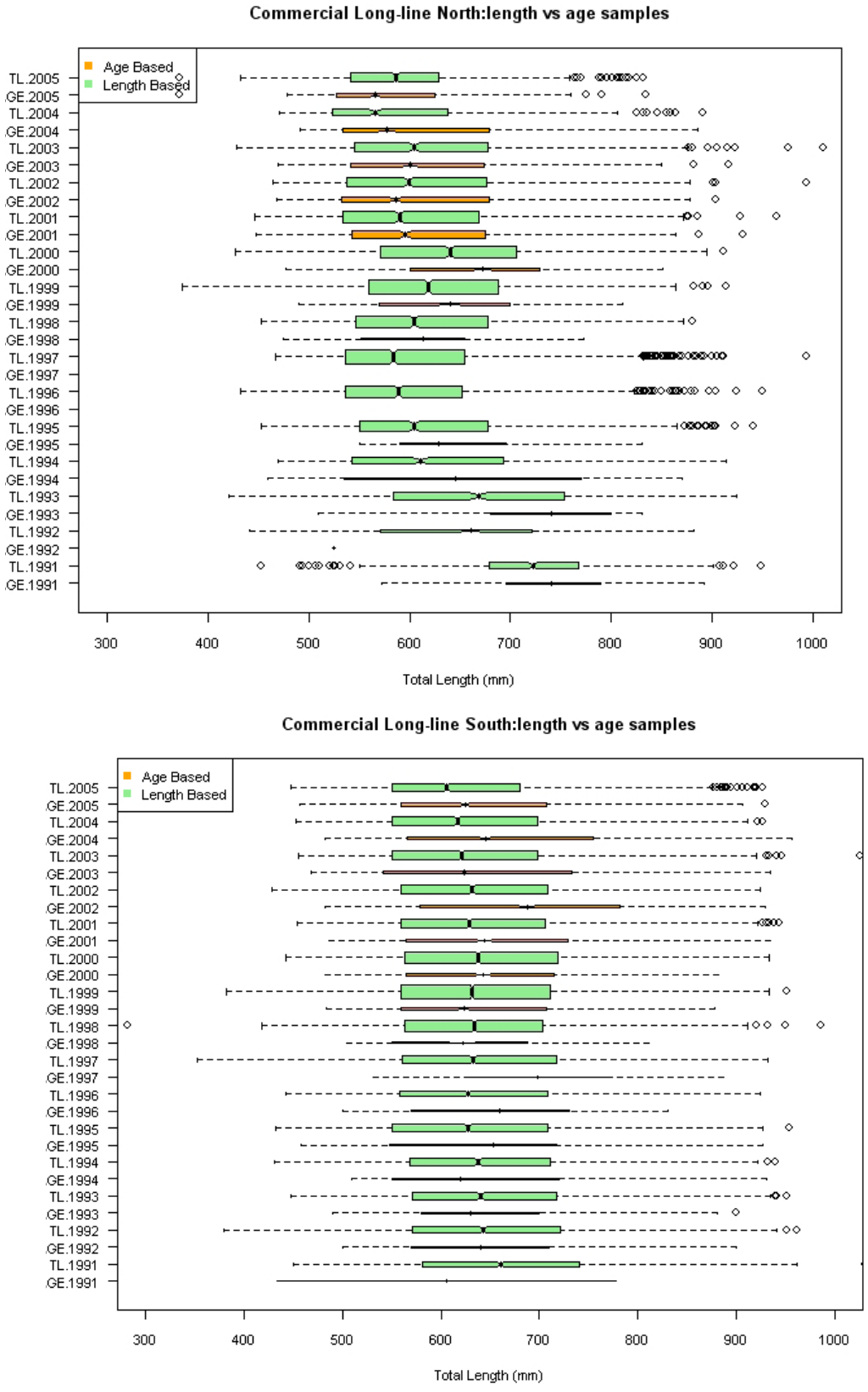
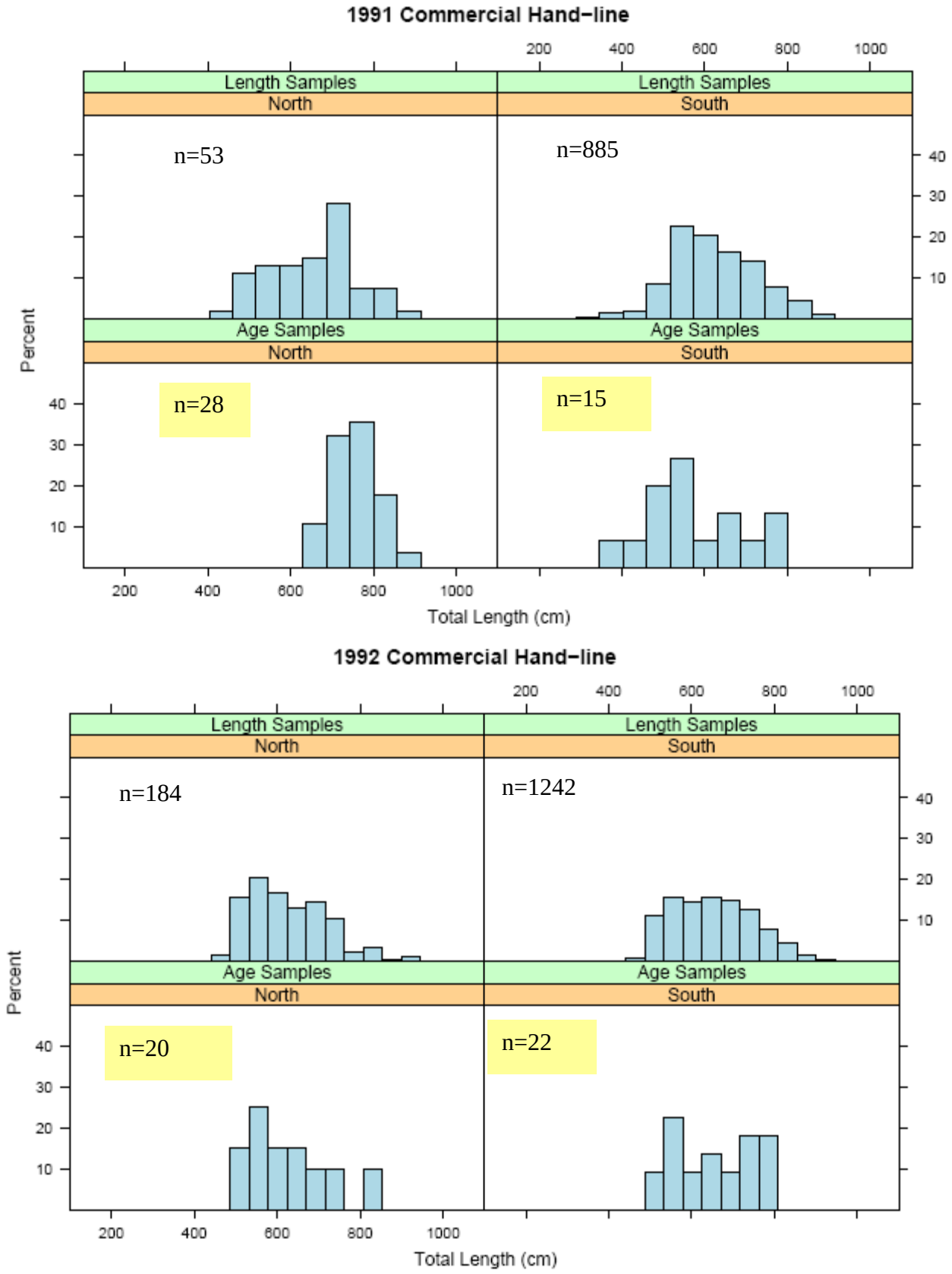
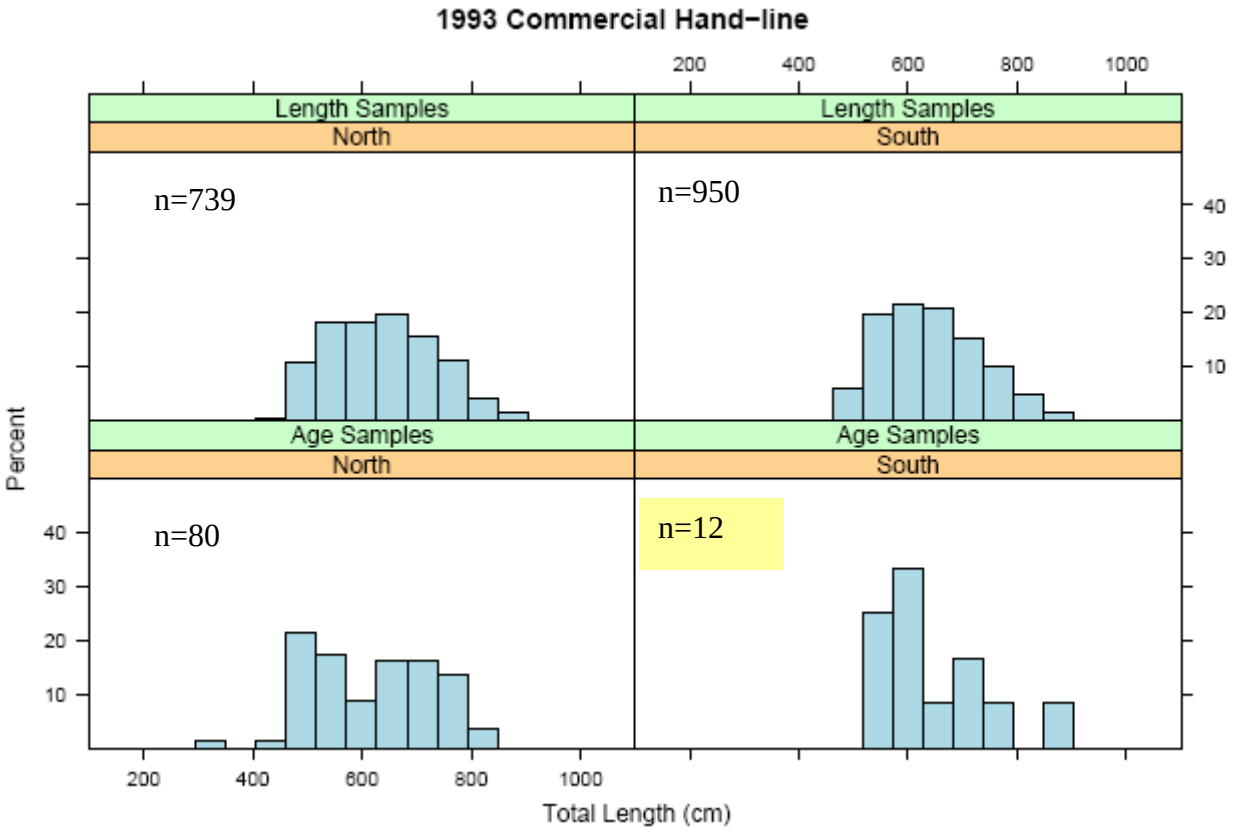
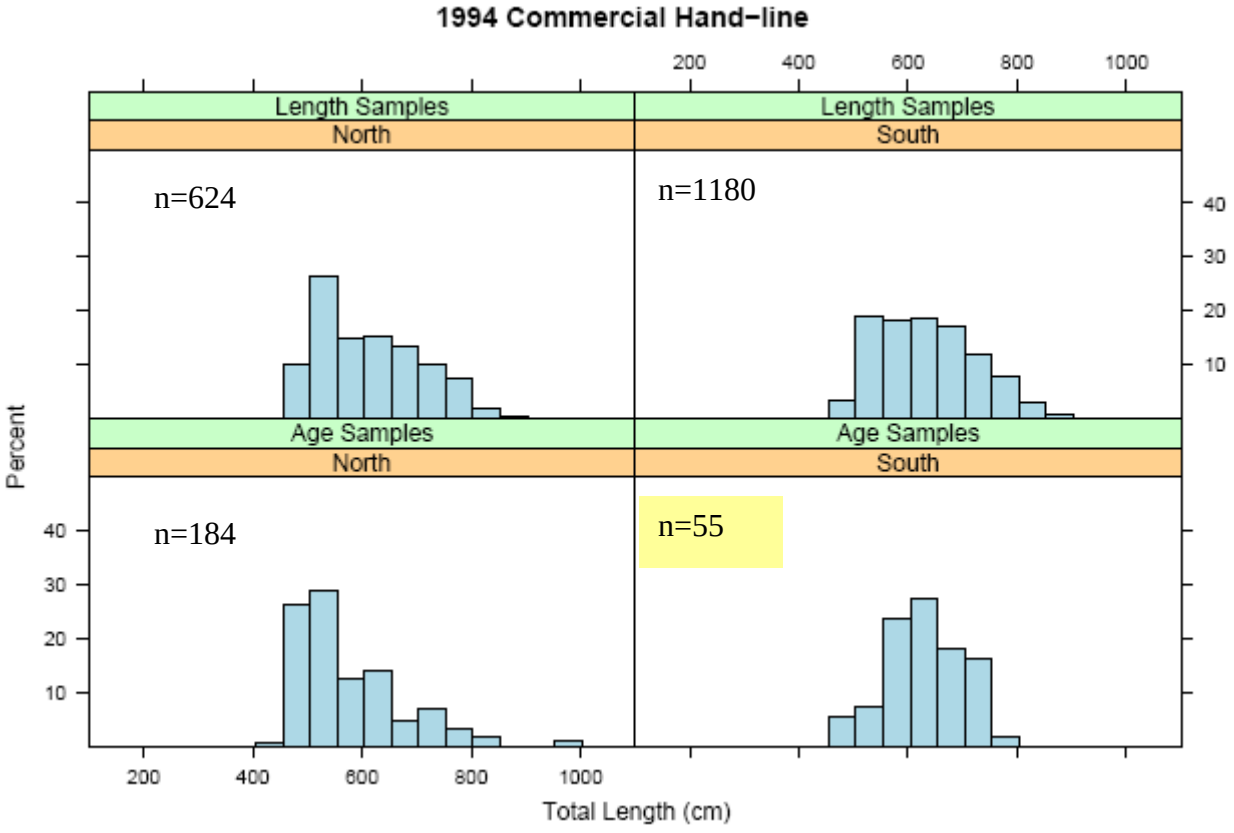
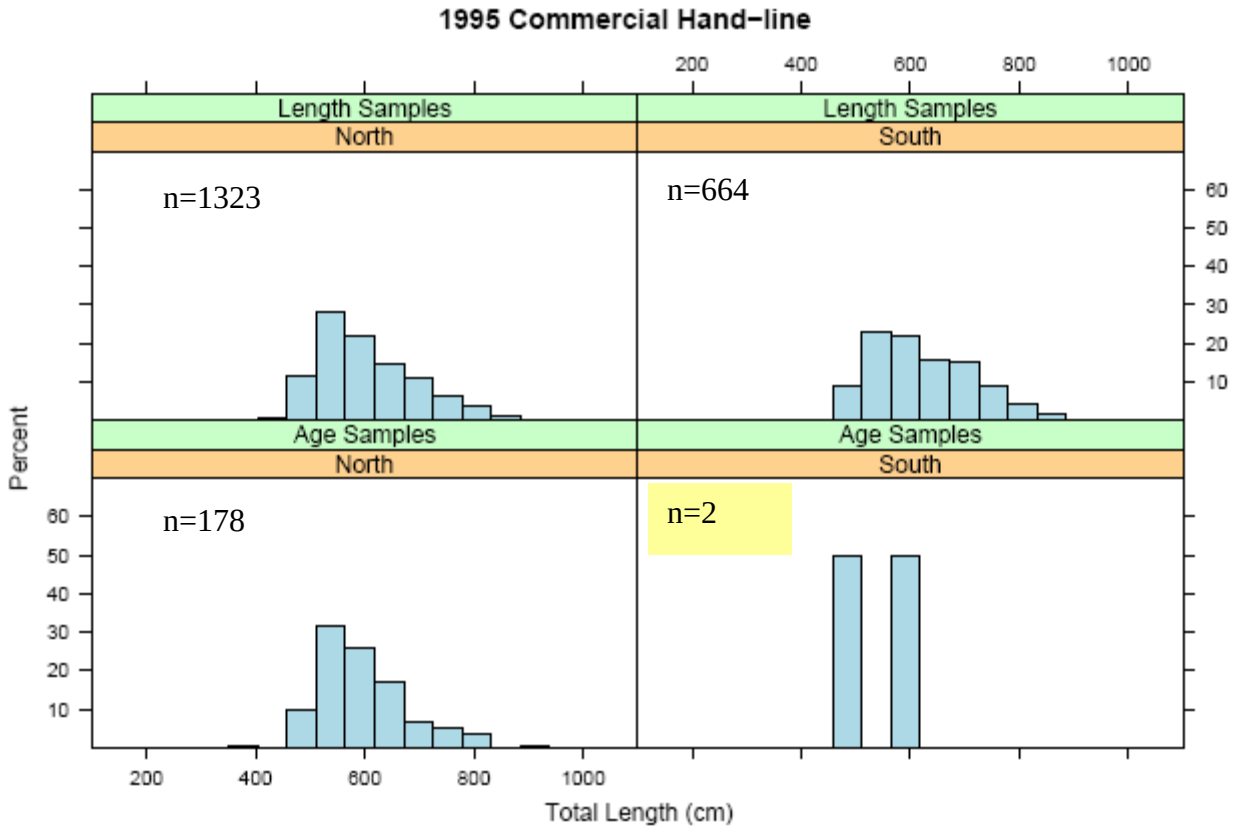


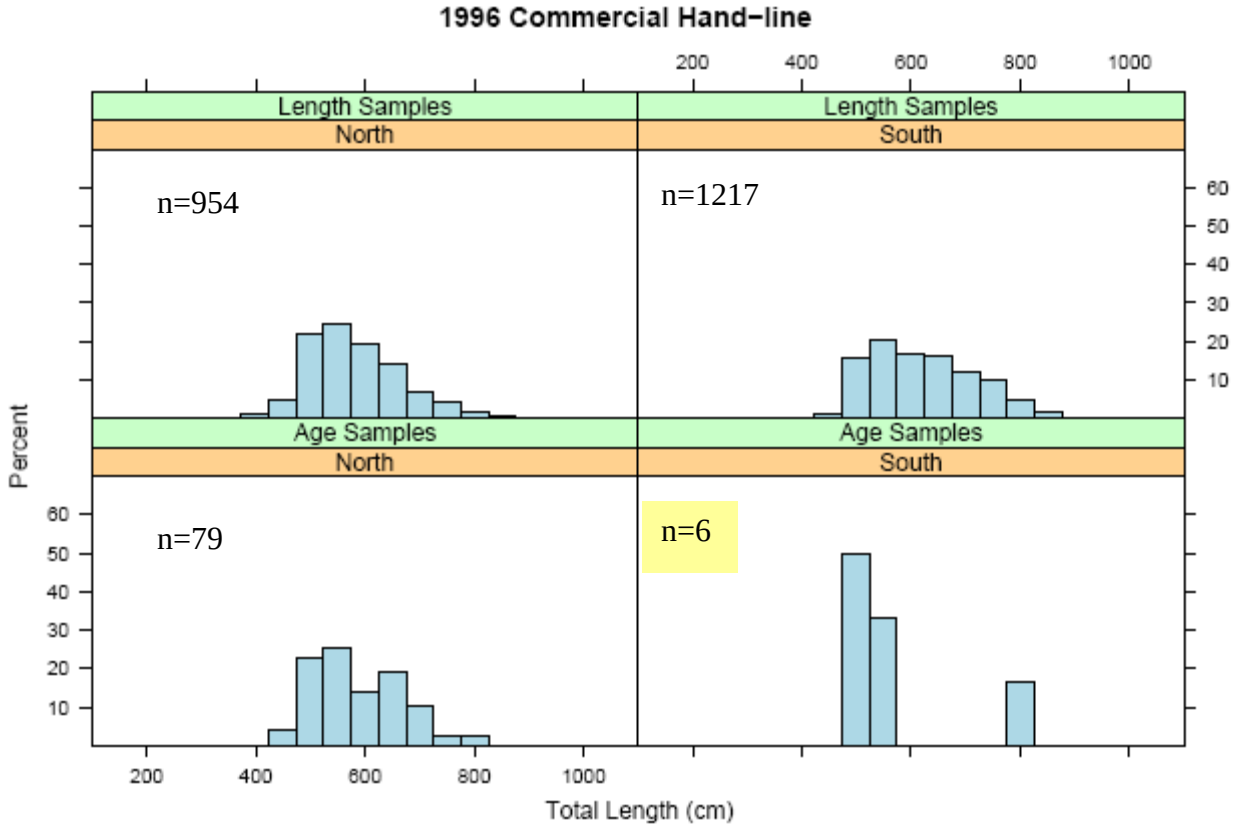
Figure 4. Commercial hand-line length frequency distributions by region and by sampling type: length or age based.

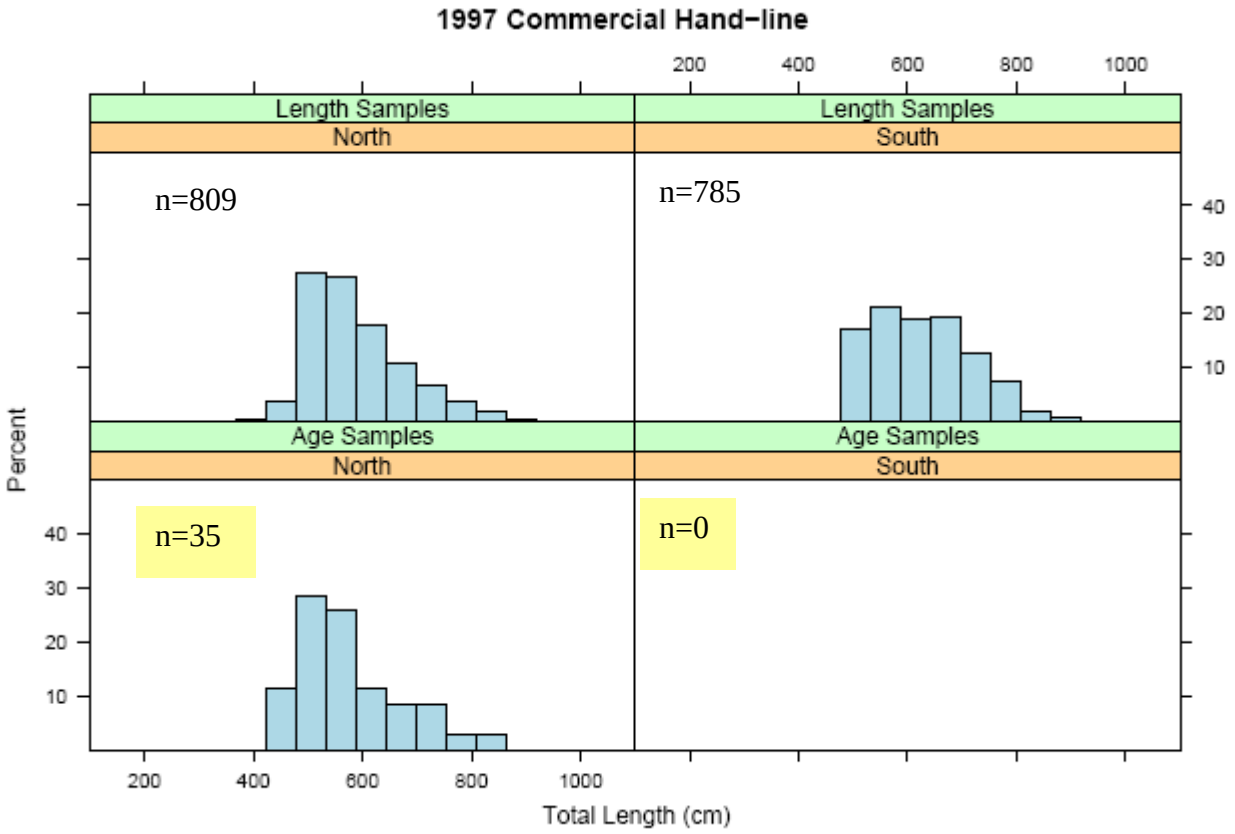


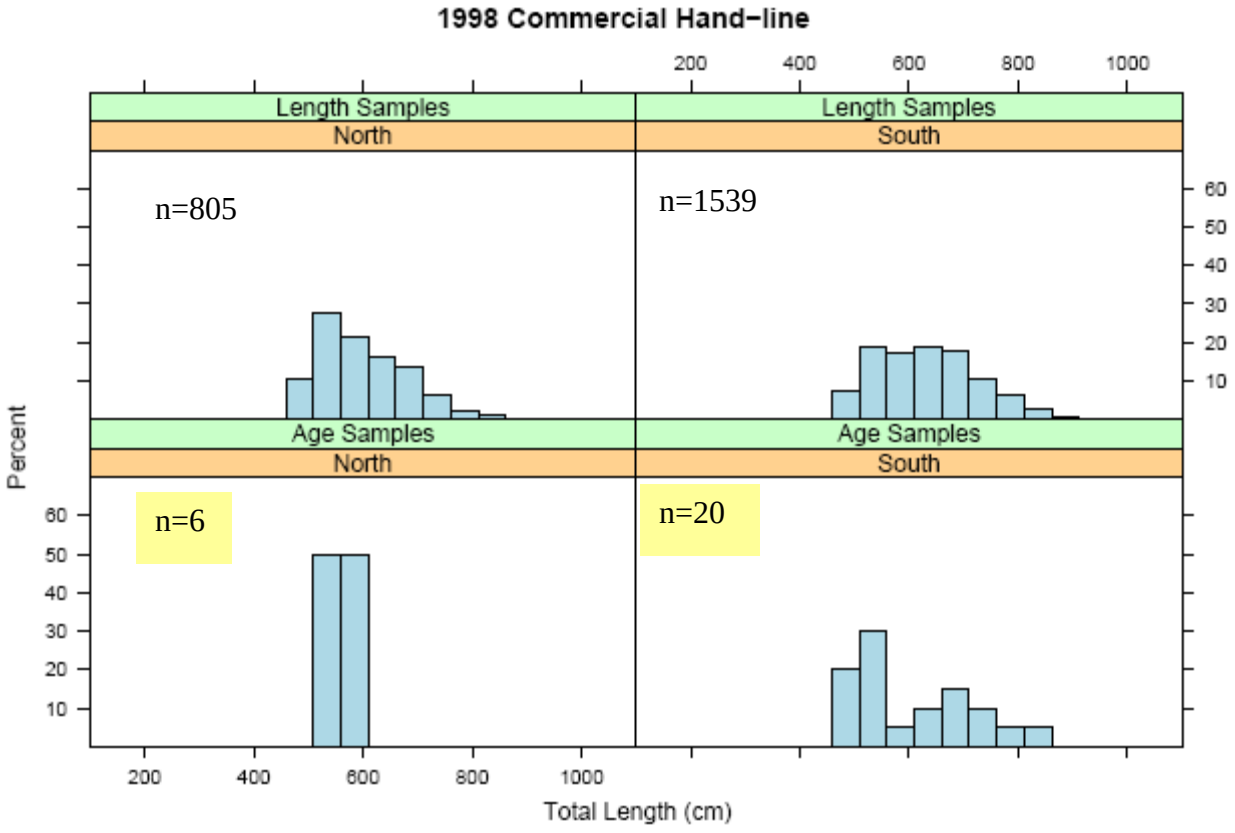

1993 Commercial Hand−line
Length Samples
North
South
n=739
n=950
Age Samples
n=80
n=12
Percent
Total Length (cm)

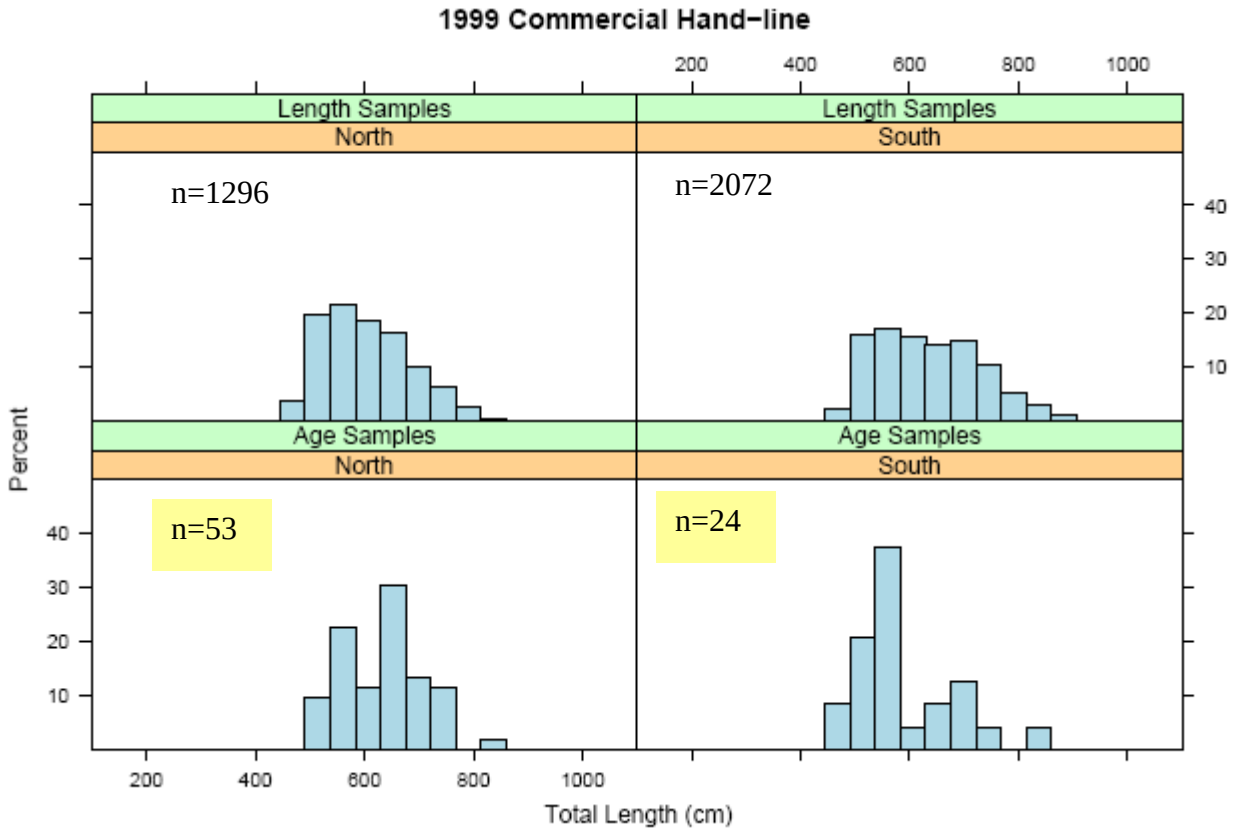

1994 Commercial Hand−line
Length Samples
North
South
n=624
n=1180
Age Samples
n=184
n=55
Percent
Total Length (cm)

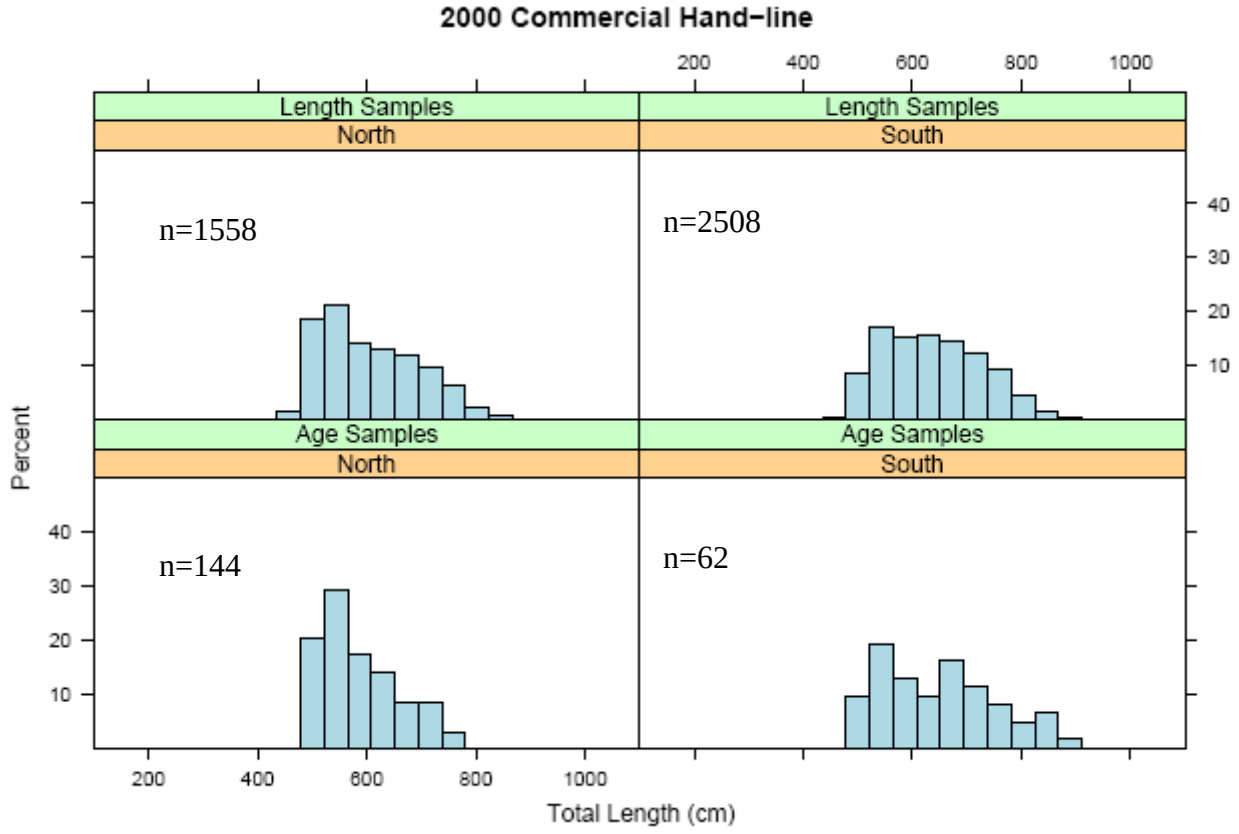

1995 Commercial Hand−line
Length Samples
North
South
Age Samples
n=1323
n=664
n=178
n=2
Percent
Total Length (cm)

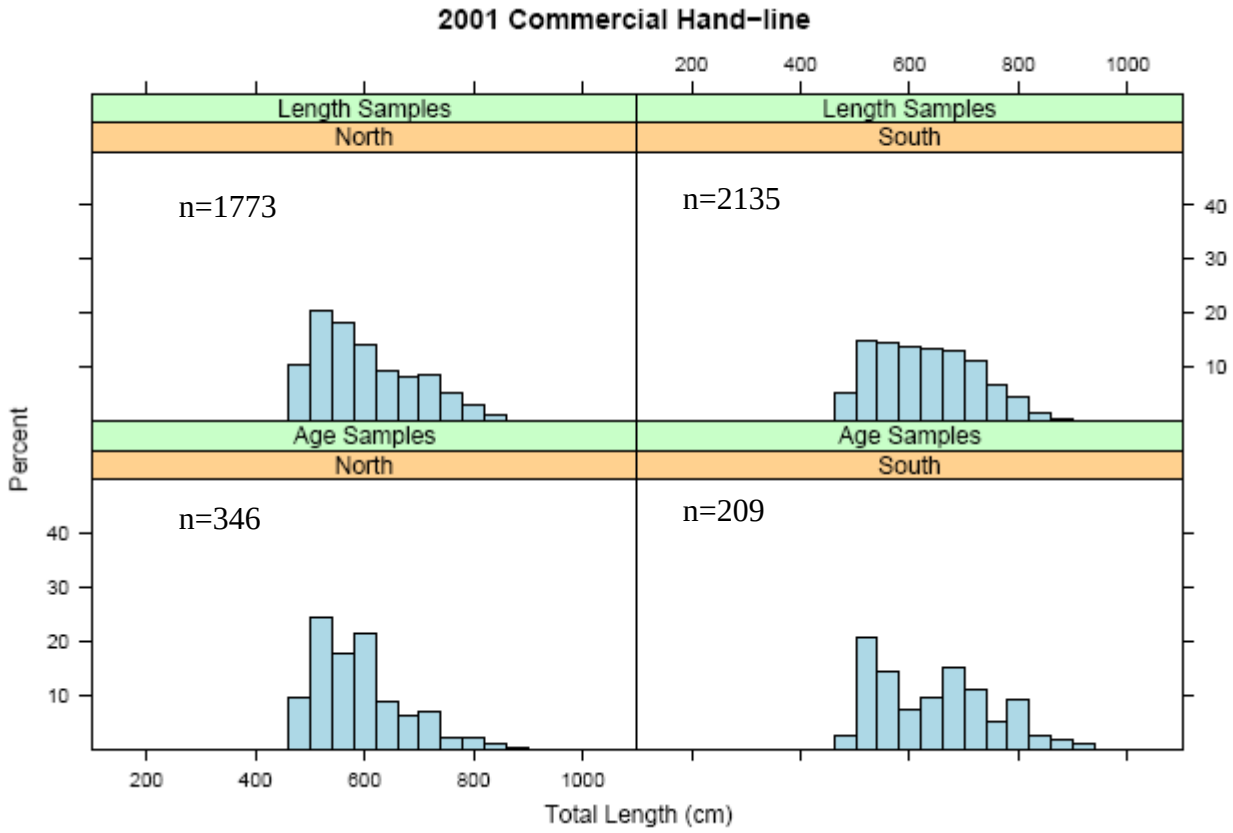

1996 Commercial Hand−line
Length Samples
North
South
Age Samples
n=954
n=1217
n=79
n=6
Percent
Total Length (cm)

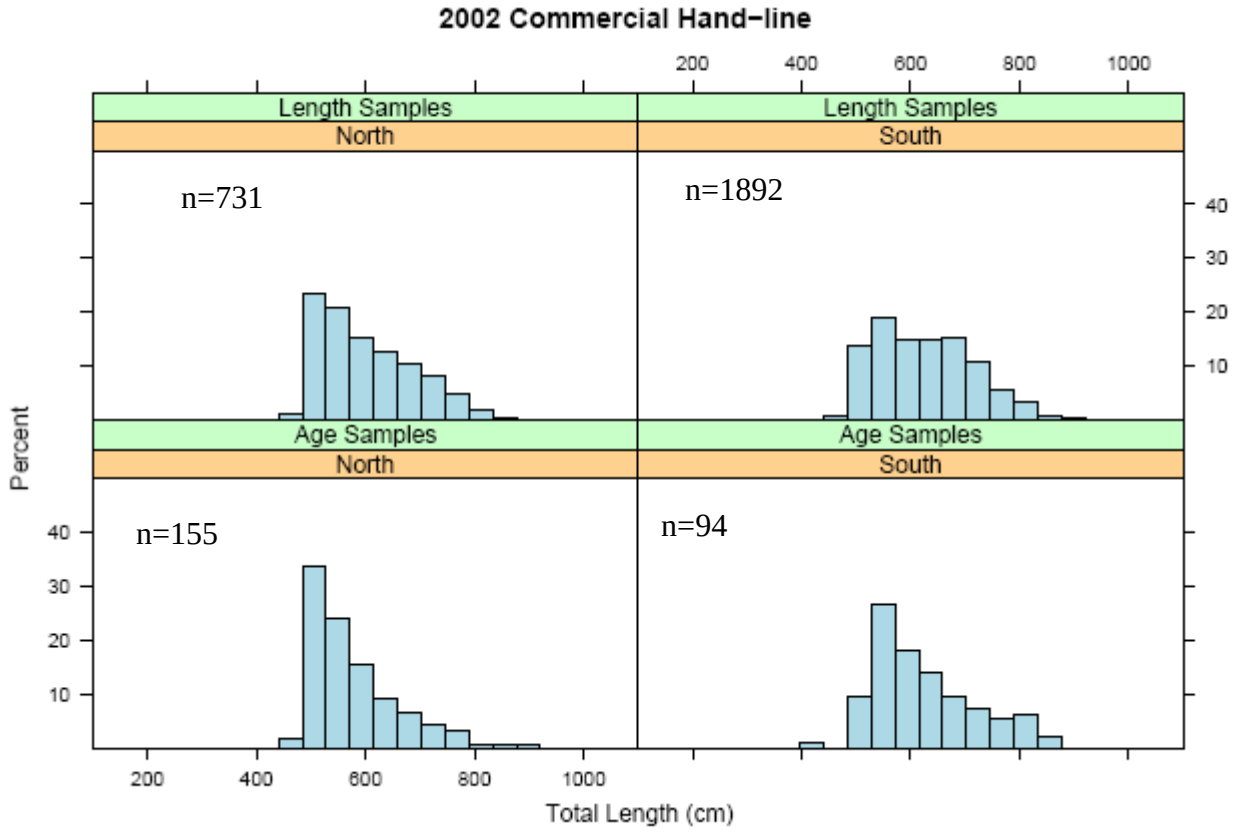

1997 Commercial Hand−line
Length Samples
North
South
n=809
n=785
Age Samples
n=35
n=0
Percent
Total Length (cm)

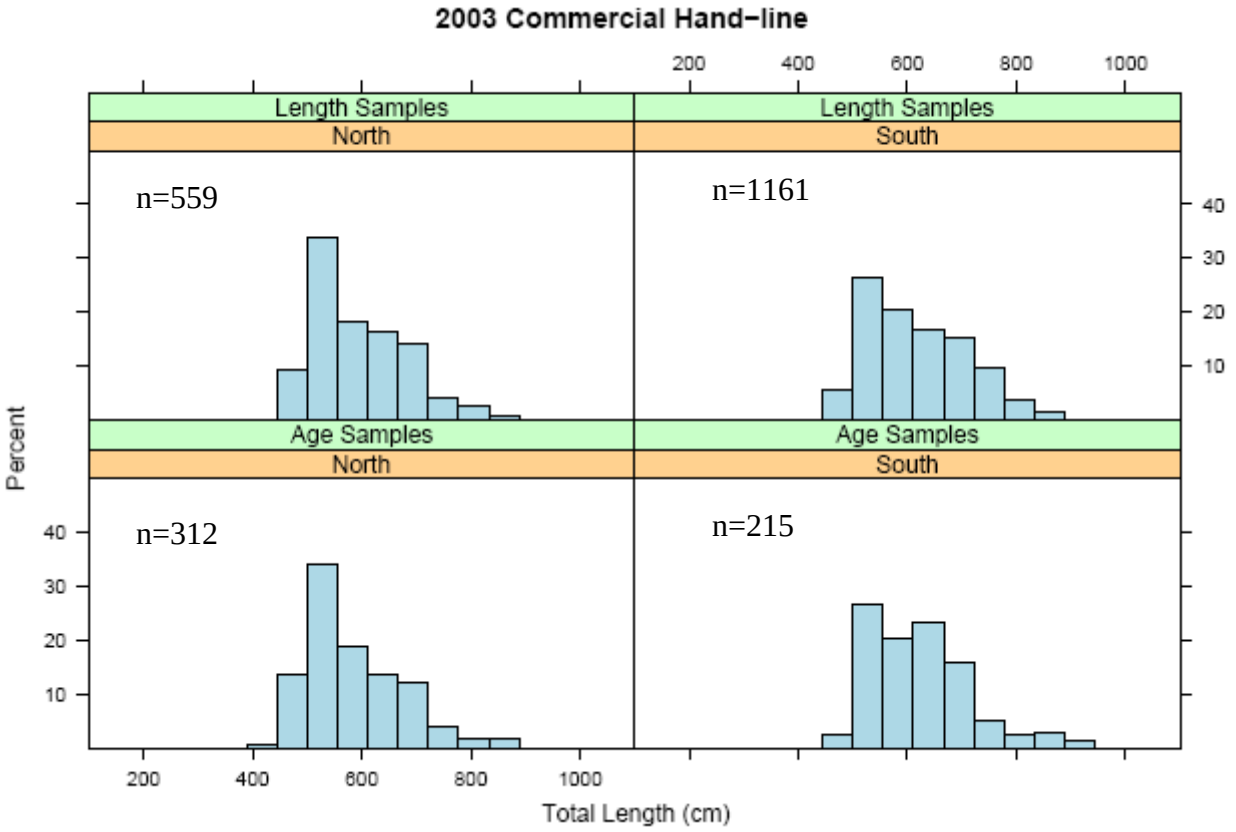

1998 Commercial Hand−line
Length Samples
North
South
n=805
n=1539
Age Samples
n=6
n=20
Percent
Total Length (cm)

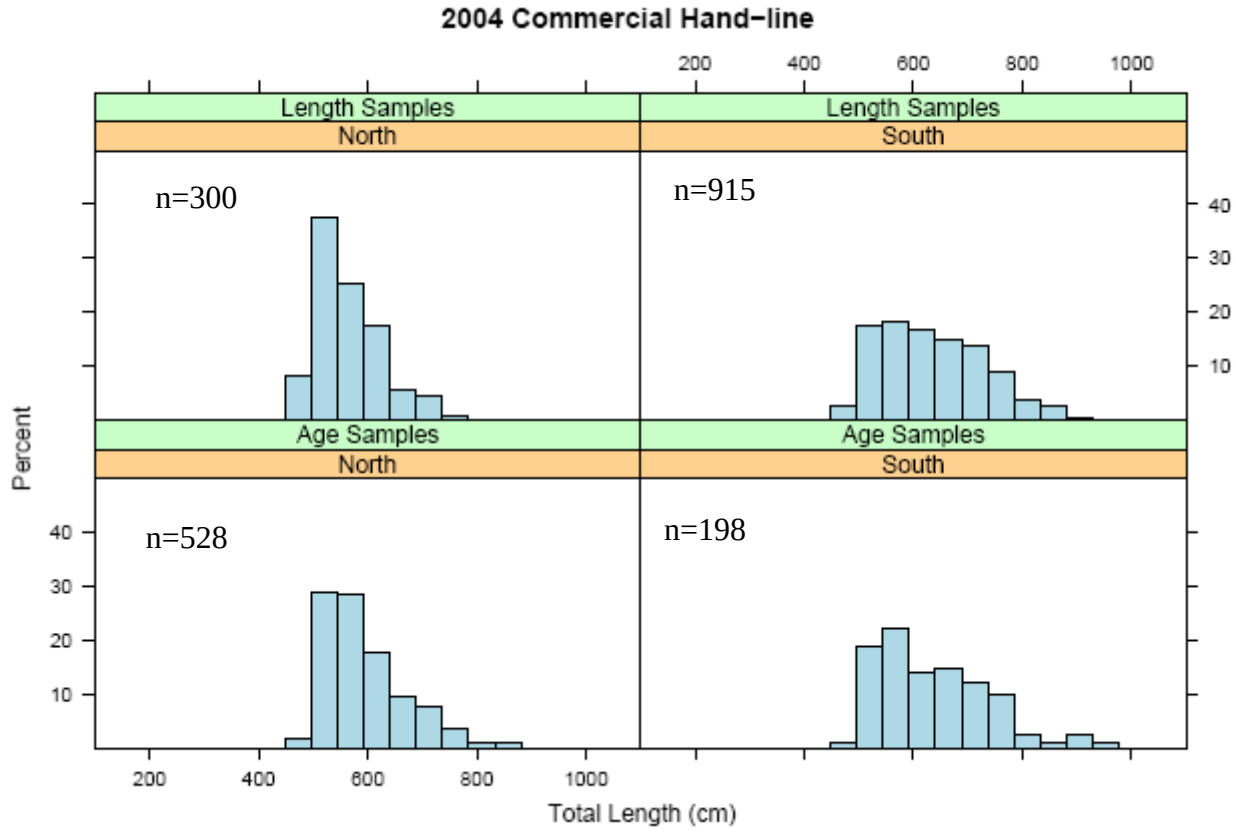

1999 Commercial Hand−line
Length Samples
North
South
n=1296
n=2072
Age Samples
n=53
n=24
Percent
Total Length (cm)


2000 Commercial Hand−line
Length Samples
North
South
n=1558
n=2508
Age Samples
n=144
n=62
Percent
Total Length (cm)


2001 Commercial Hand−line
Length Samples
North
South
Age Samples
n=1773
n=2135
n=346
n=209
Percent
Total Length (cm)


2002 Commercial Hand−line
Length Samples
North
South
Age Samples
n=731
n=1892
n=155
n=94
Percent
Total Length (cm)


2003 Commercial Hand−line
Length Samples
North
Length Samples
South
Age Samples
North
Age Samples
South
n=559
n=1161
n=312
n=215
Percent
Total Length (cm)


2004 Commercial Hand−line
Length Samples
North
Length Samples
South
Age Samples
North
Age Samples
South
n=300
n=915
n=528
n=198
Percent
Total Length (cm)

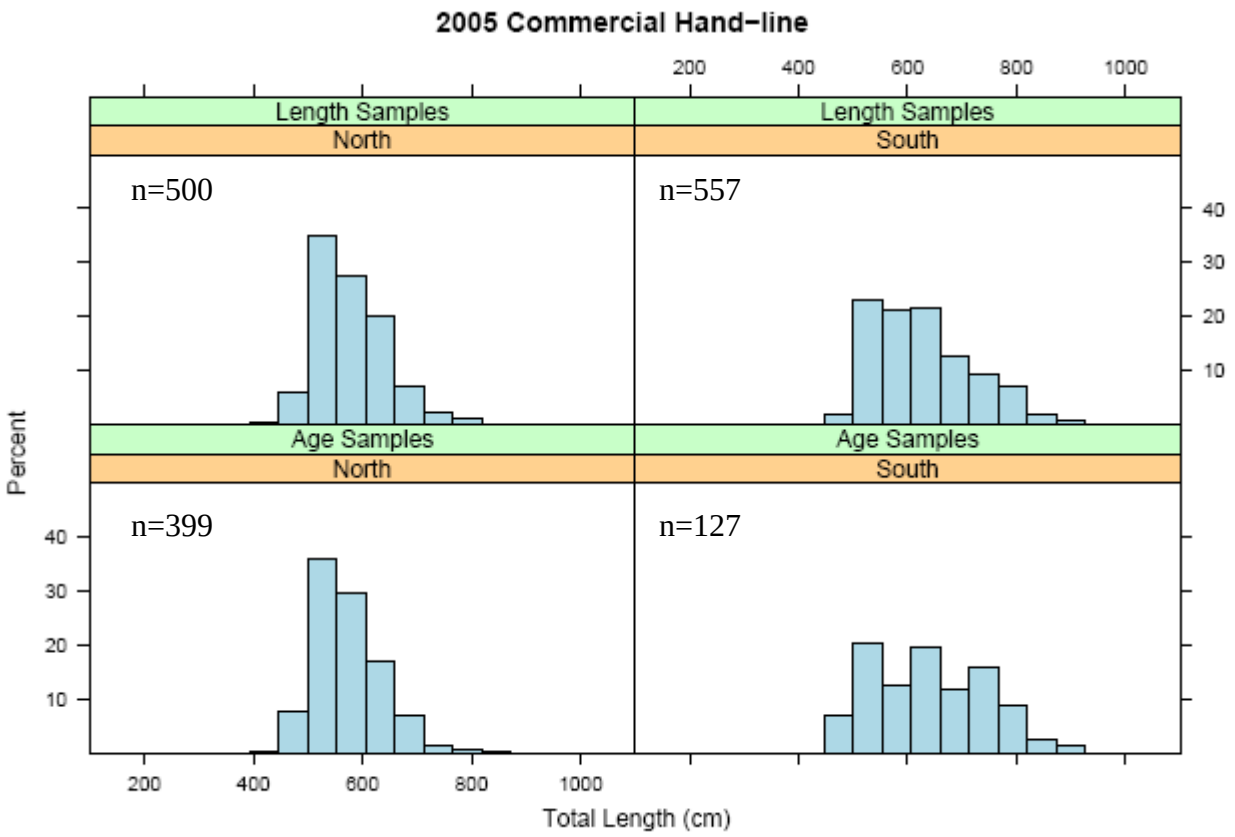
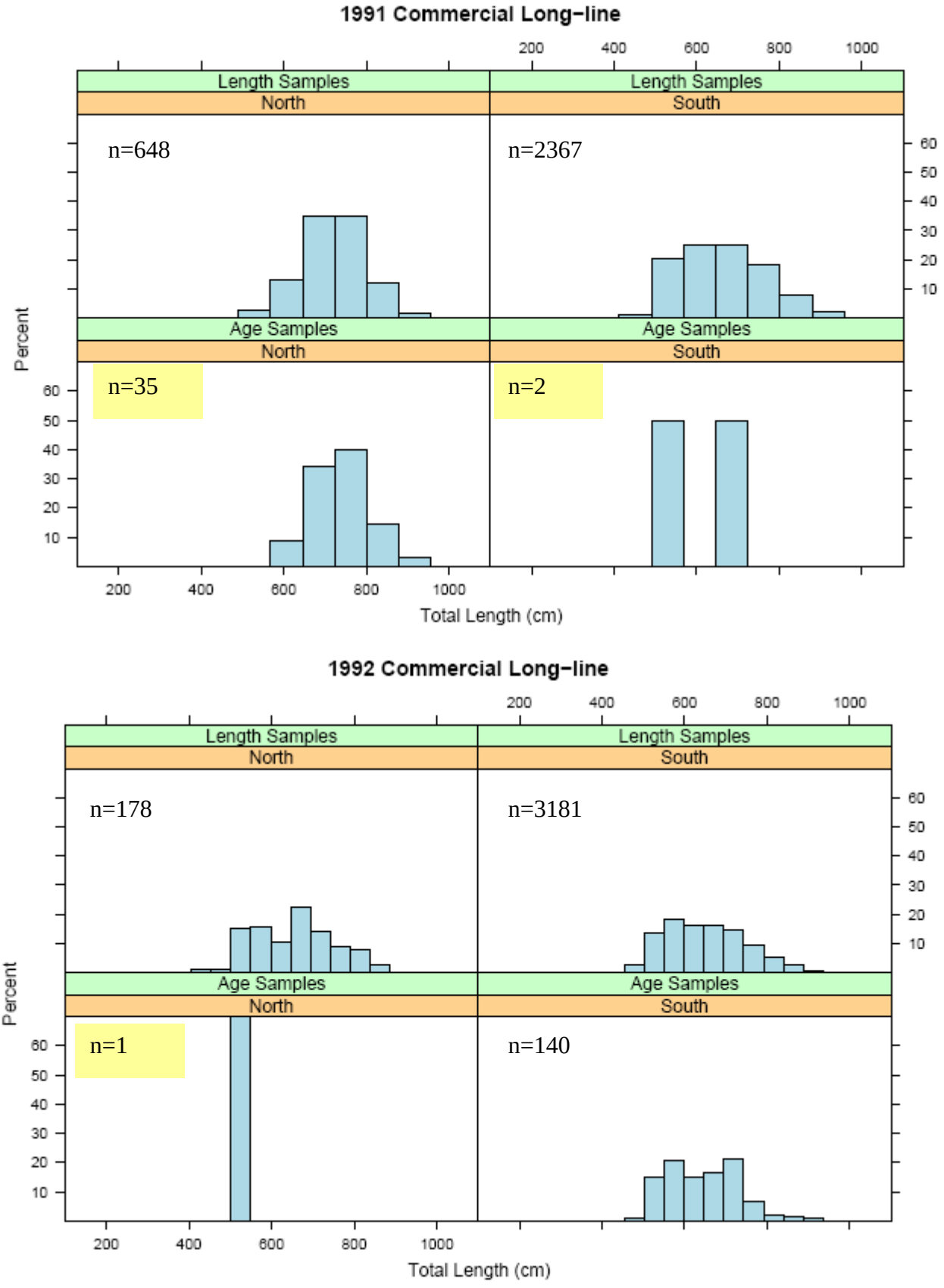
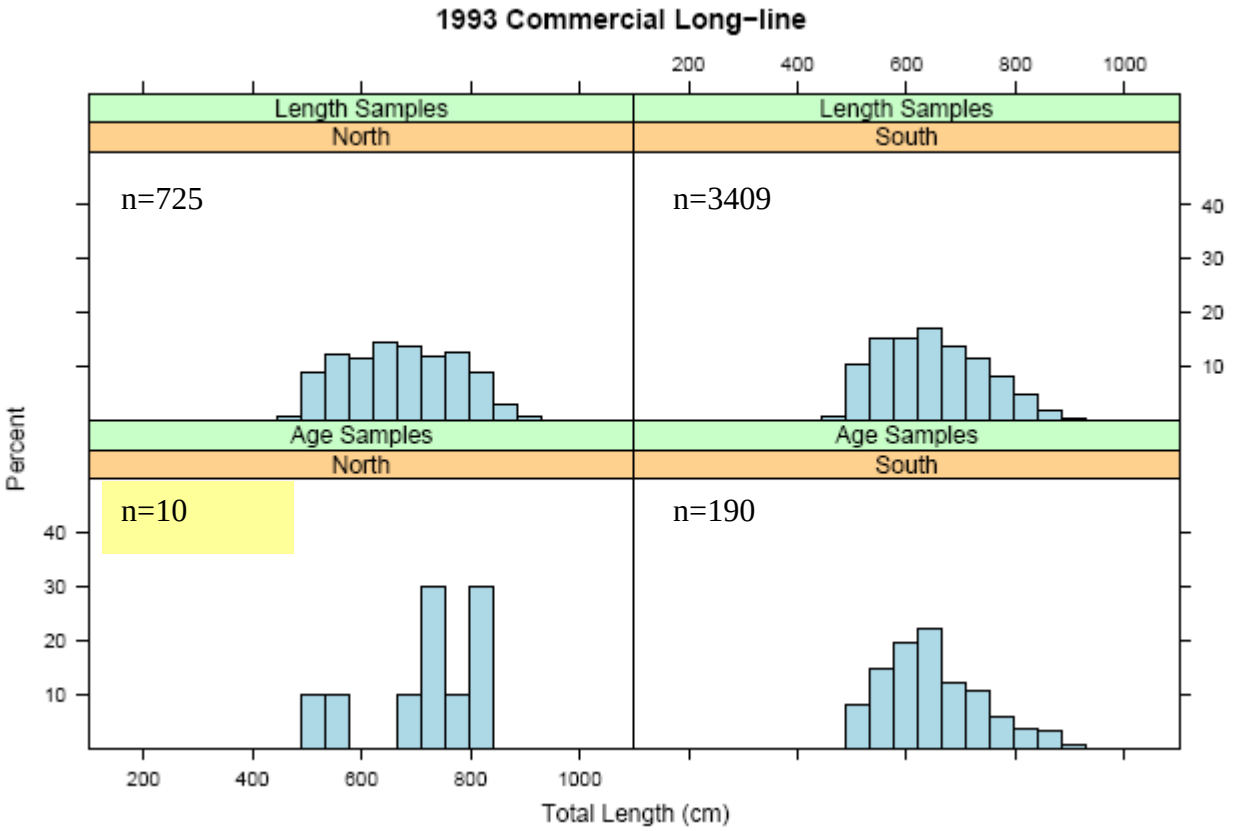
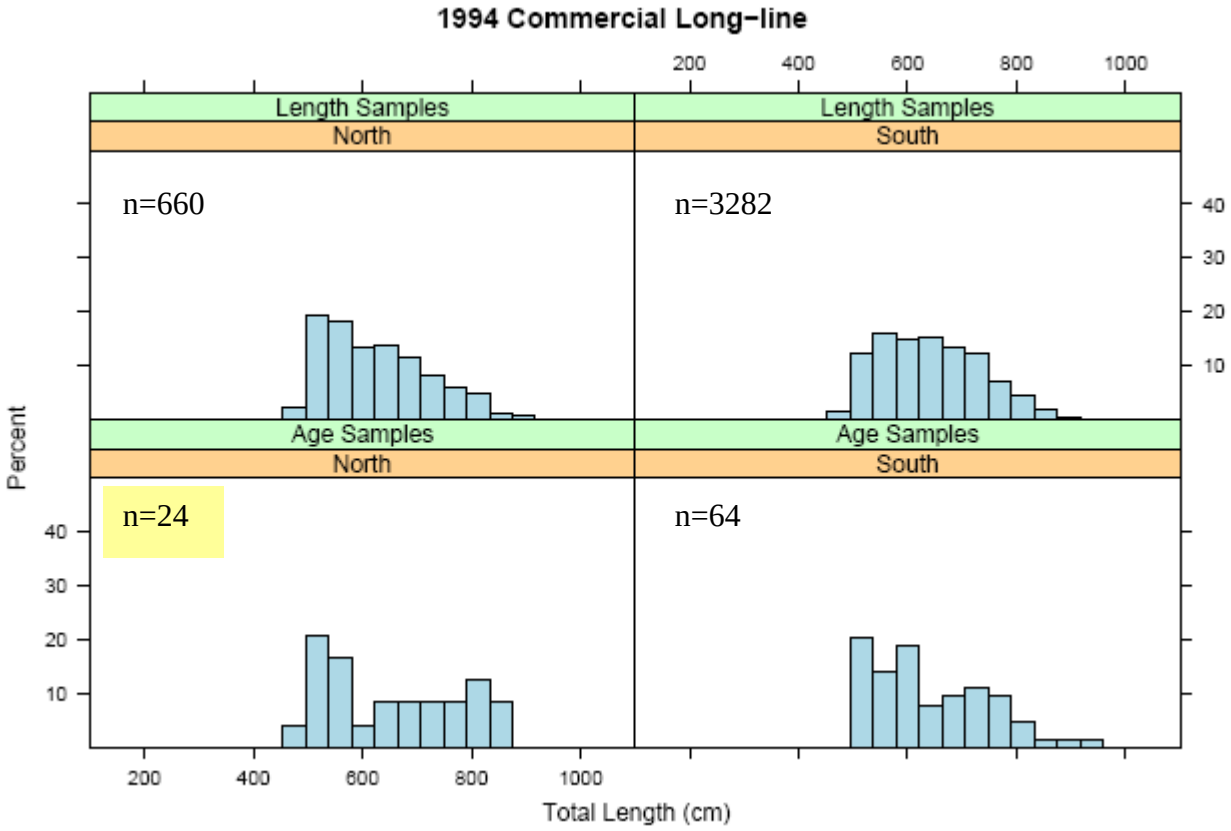
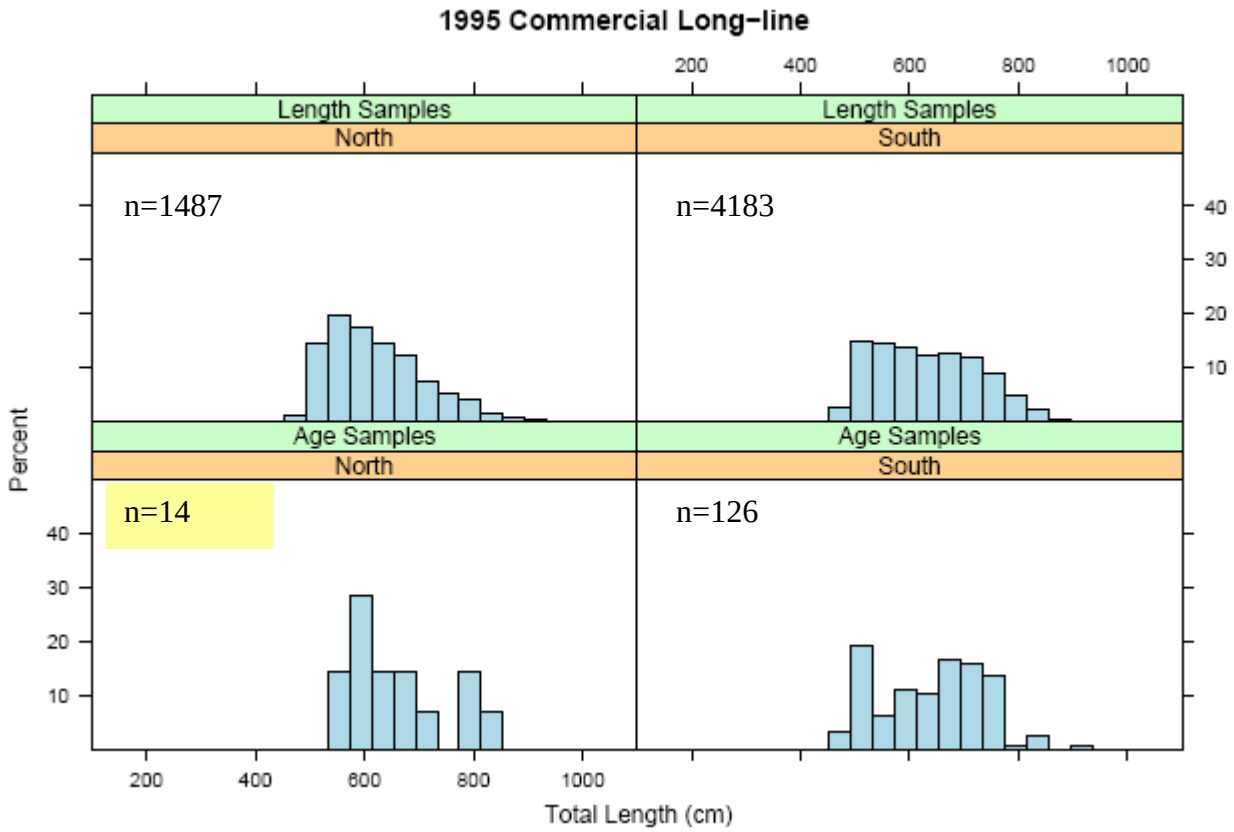

2005 Commercial Hand−line
Length Samples
North
n=500
Length Samples
South
n=557
Age Samples
North
n=399
Age Samples
South
n=127
Percent
Total Length (cm)
200
400
600
800
1000
10
20
30
40

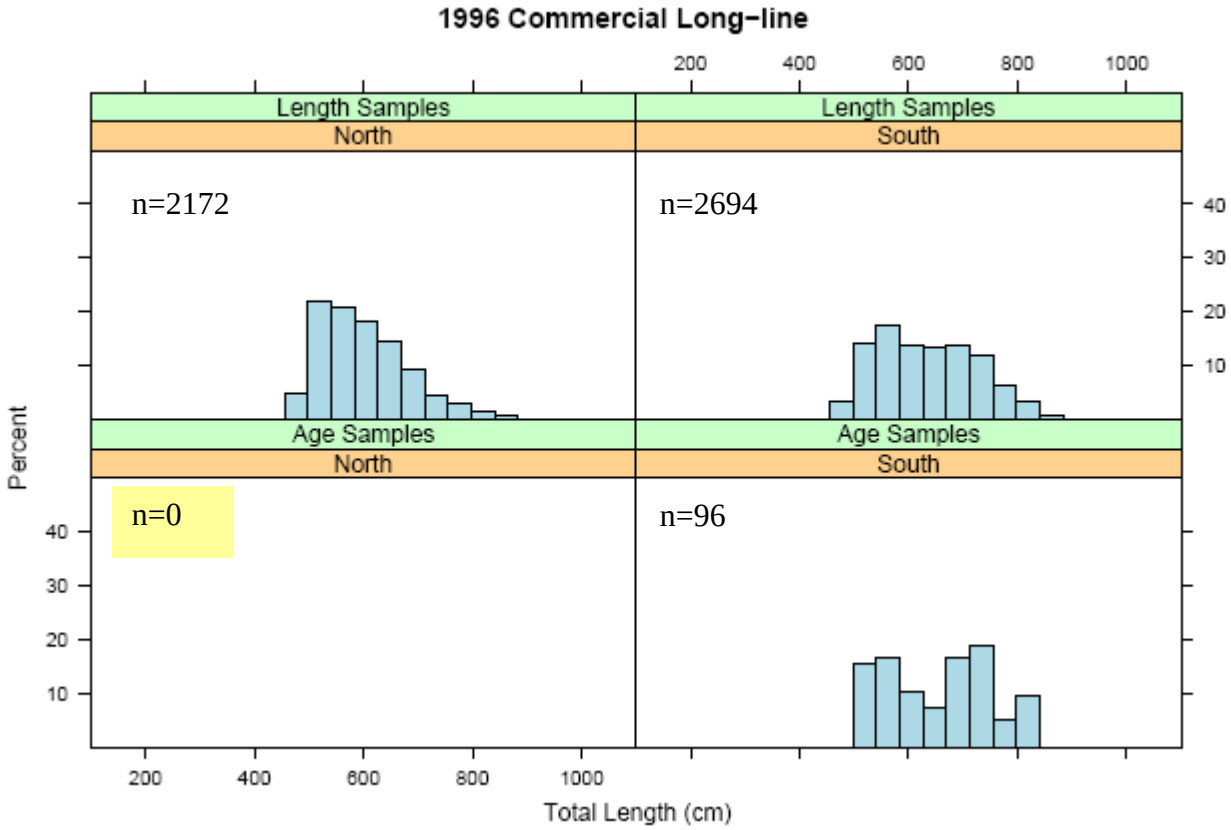
Figure 5. Commercial long-line length frequency distributions by region and by sampling type: length or age based.

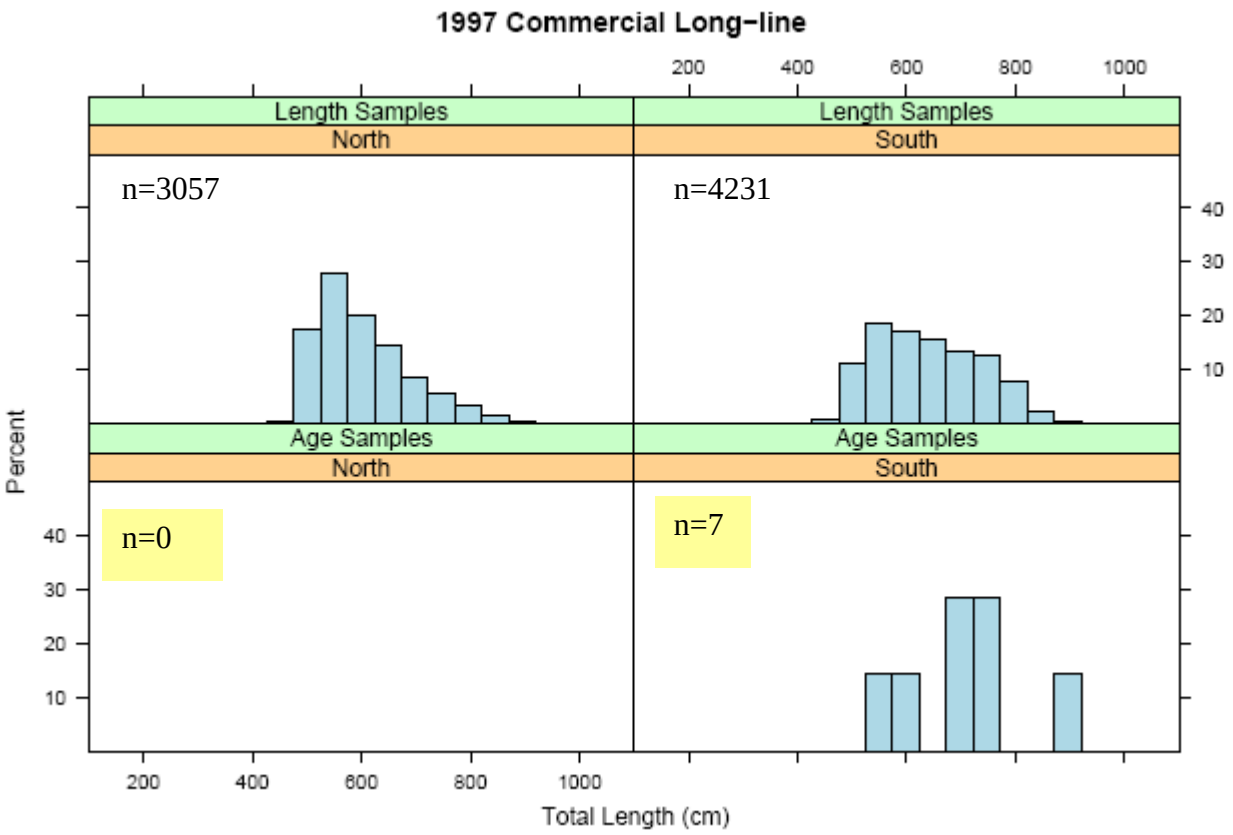


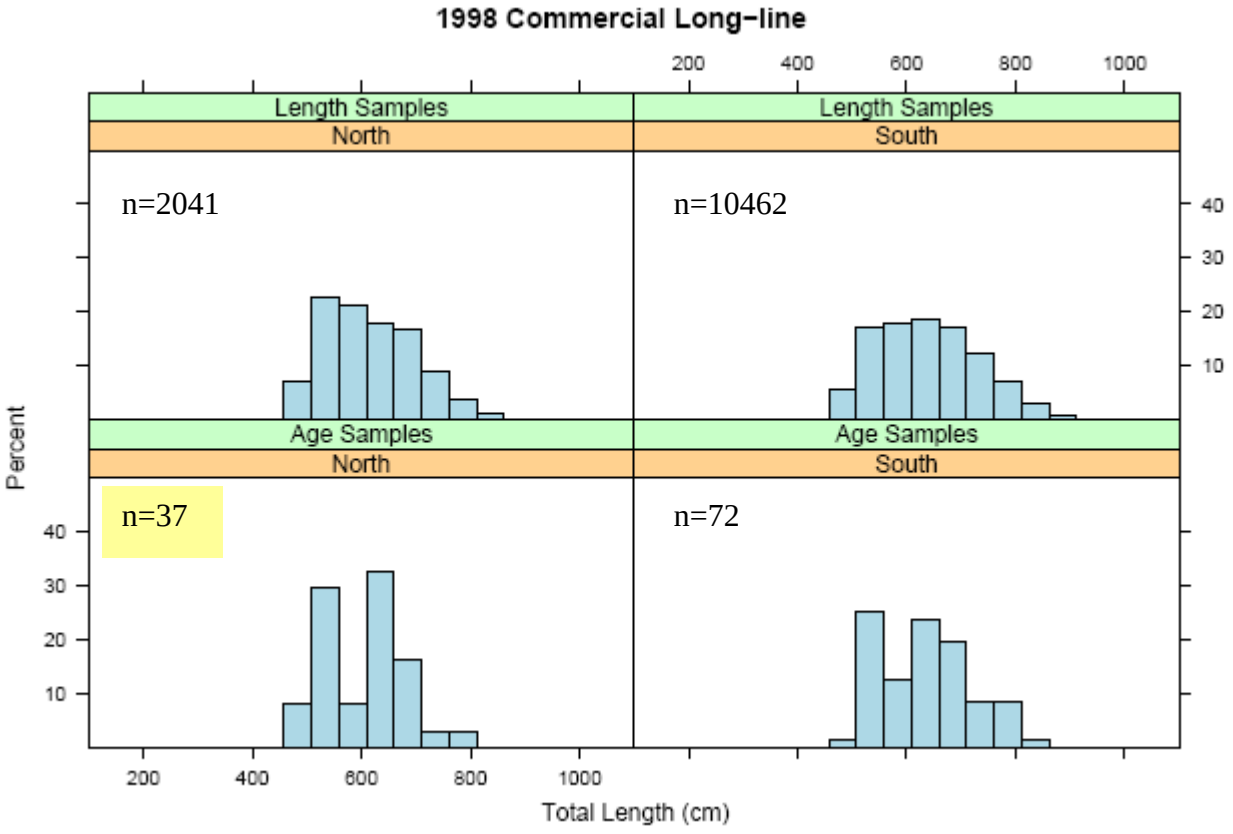

1993 Commercial Long−line
Length Samples
North
South
n=725
n=3409
Age Samples
n=10
n=190
Percent
Total Length (cm)

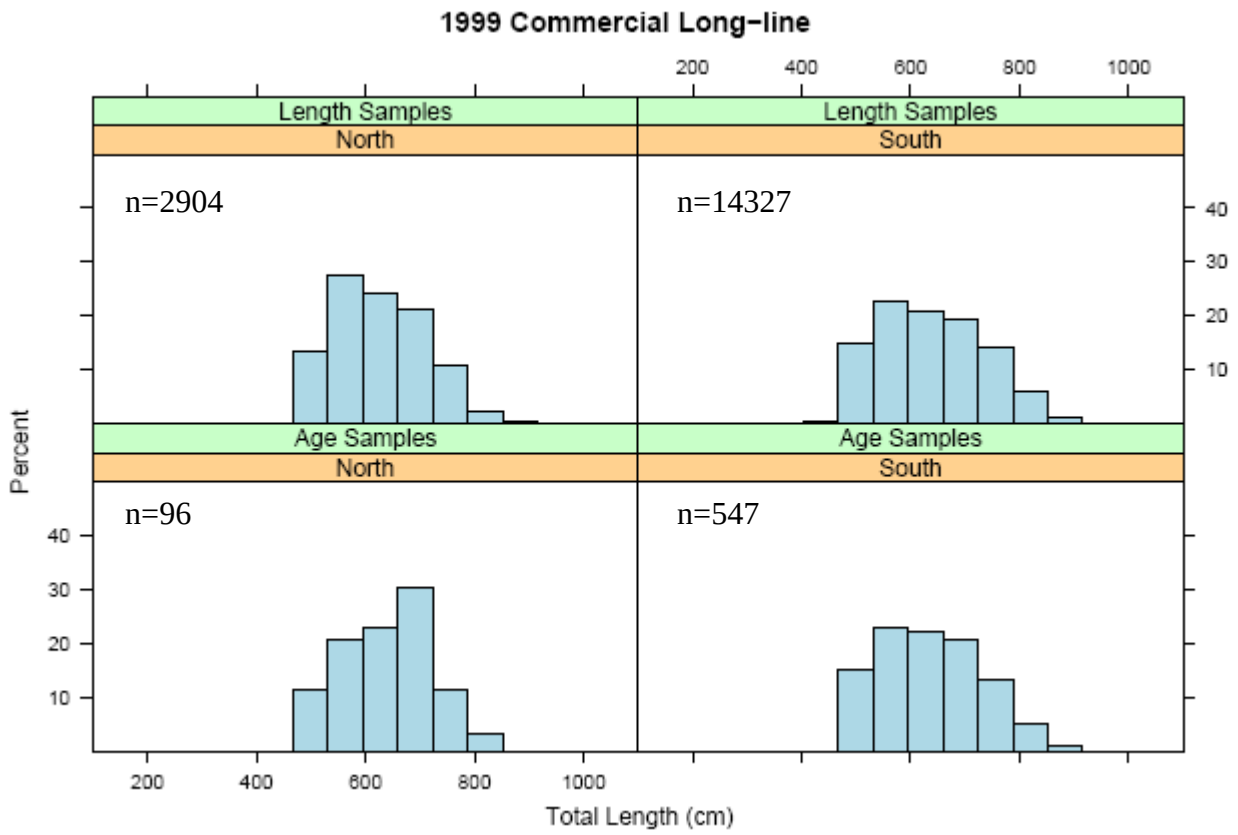

1994 Commercial Long−line
Length Samples
North
South
n=660
n=3282
Age Samples
n=24
n=64
Percent
Total Length (cm)

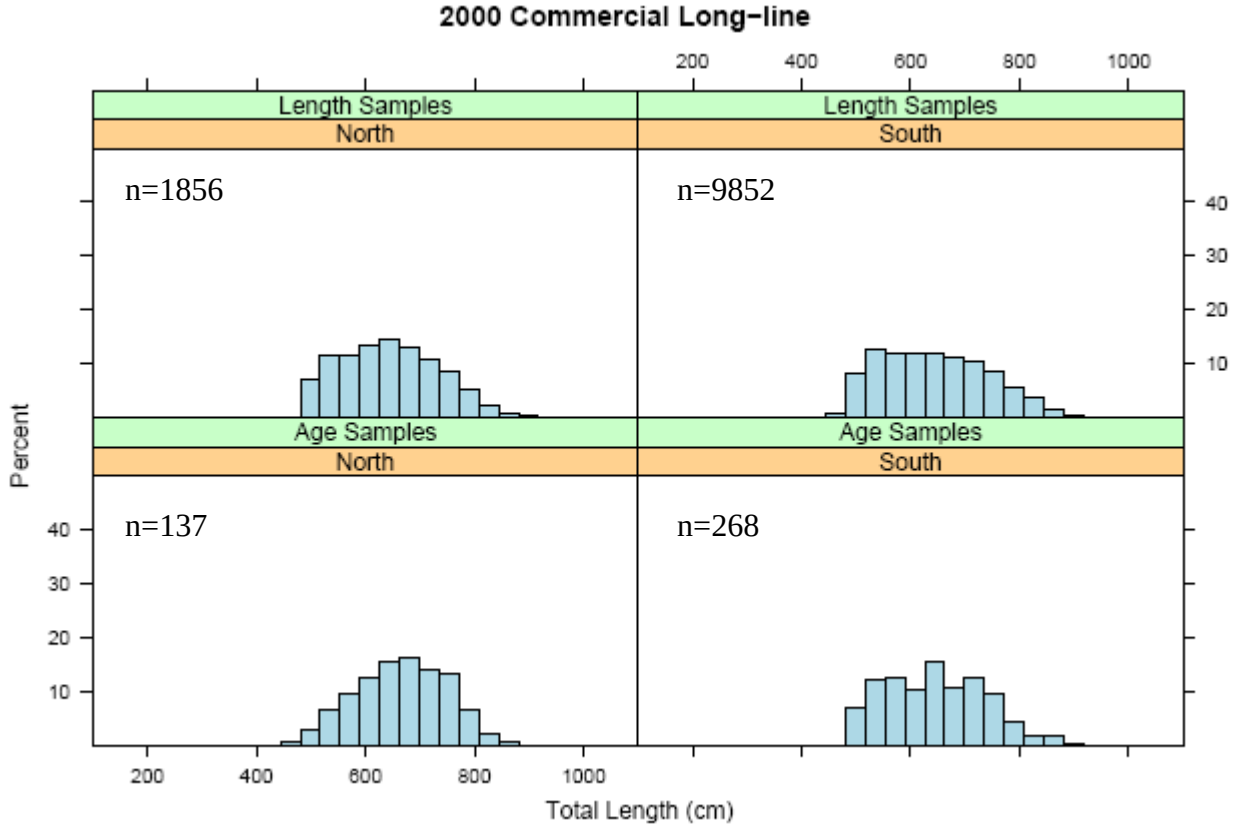

1995 Commercial Long-line
Length Samples
North
South
n=1487
n=4183
Age Samples
n=14
n=126
Percent
Total Length (cm)

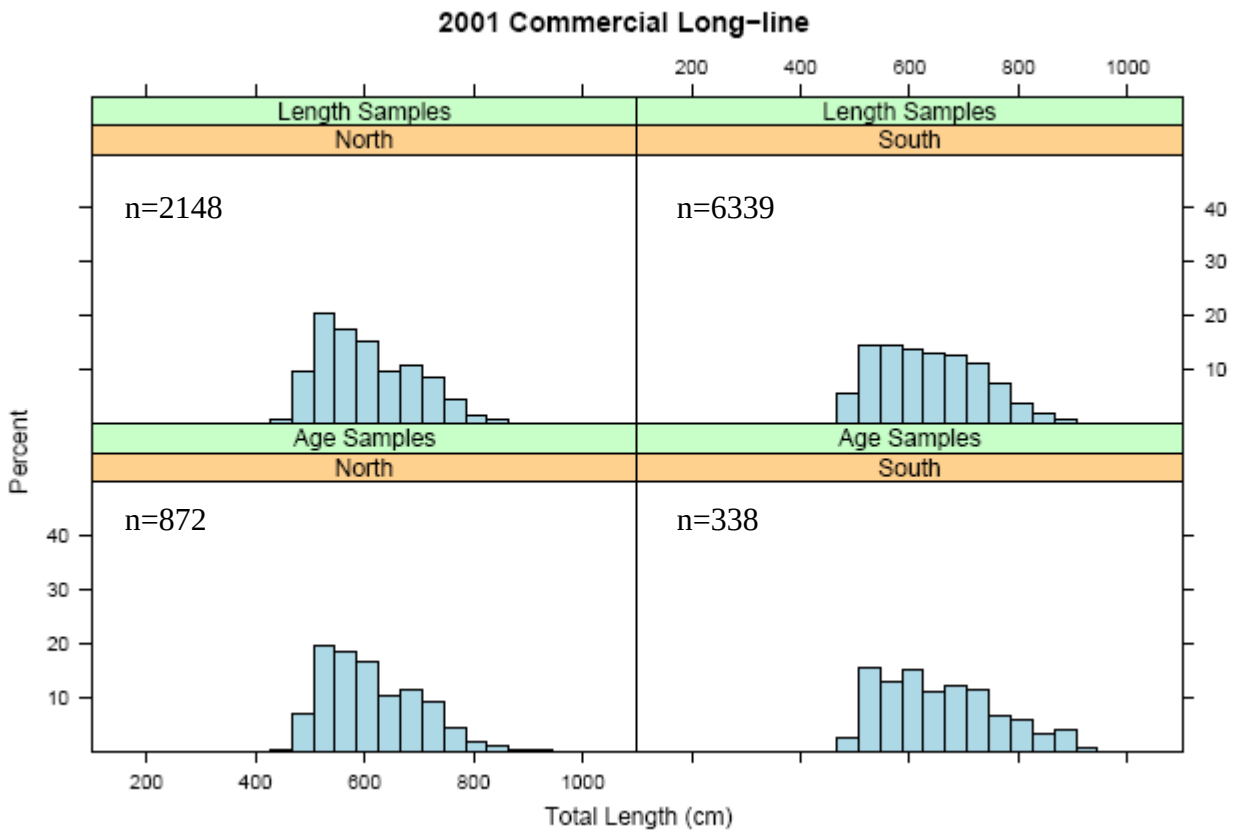

1996 Commercial Long-line
Length Samples
North
South
n=2172
n=2694
Age Samples
n=0
n=96
Percent
Total Length (cm)

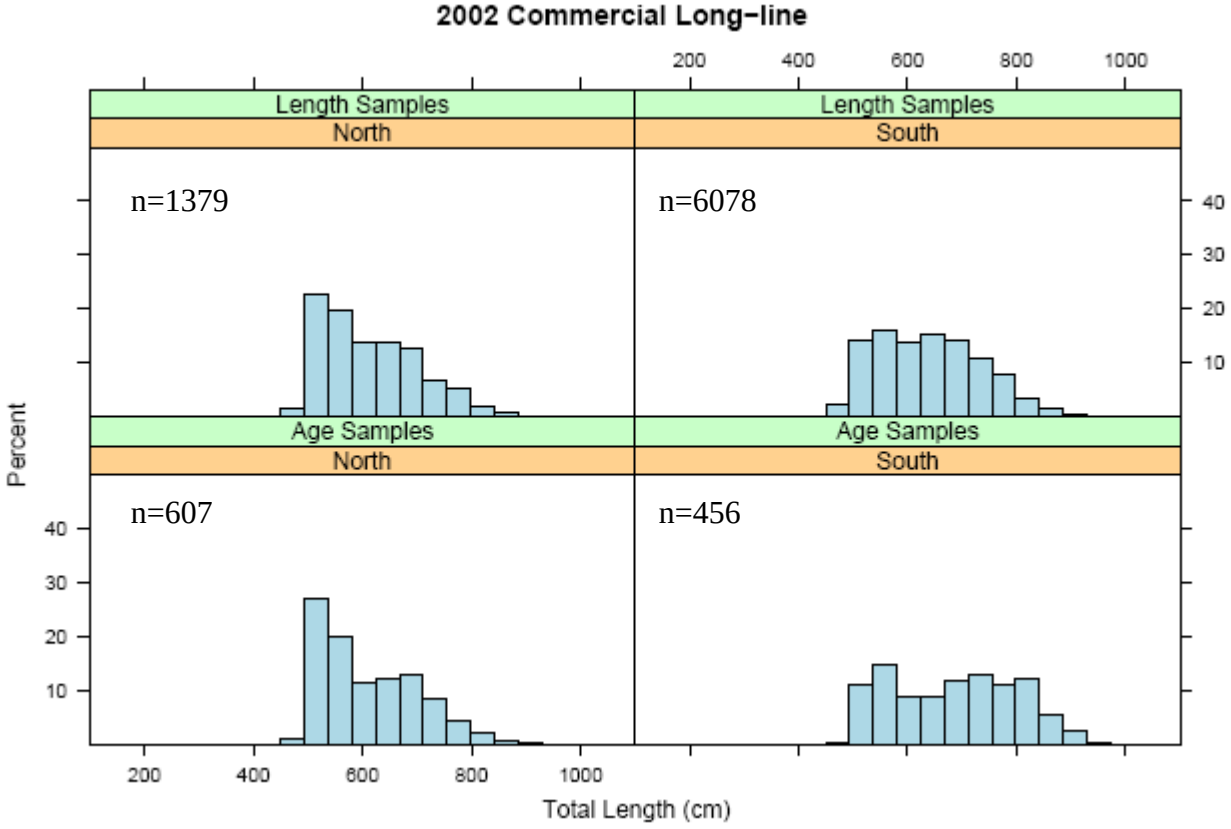

1997 Commercial Long−line
Length Samples
North
n=3057
Length Samples
South
n=4231
Age Samples
North
n=0
Age Samples
South
n=7
Percent
Total Length (cm)

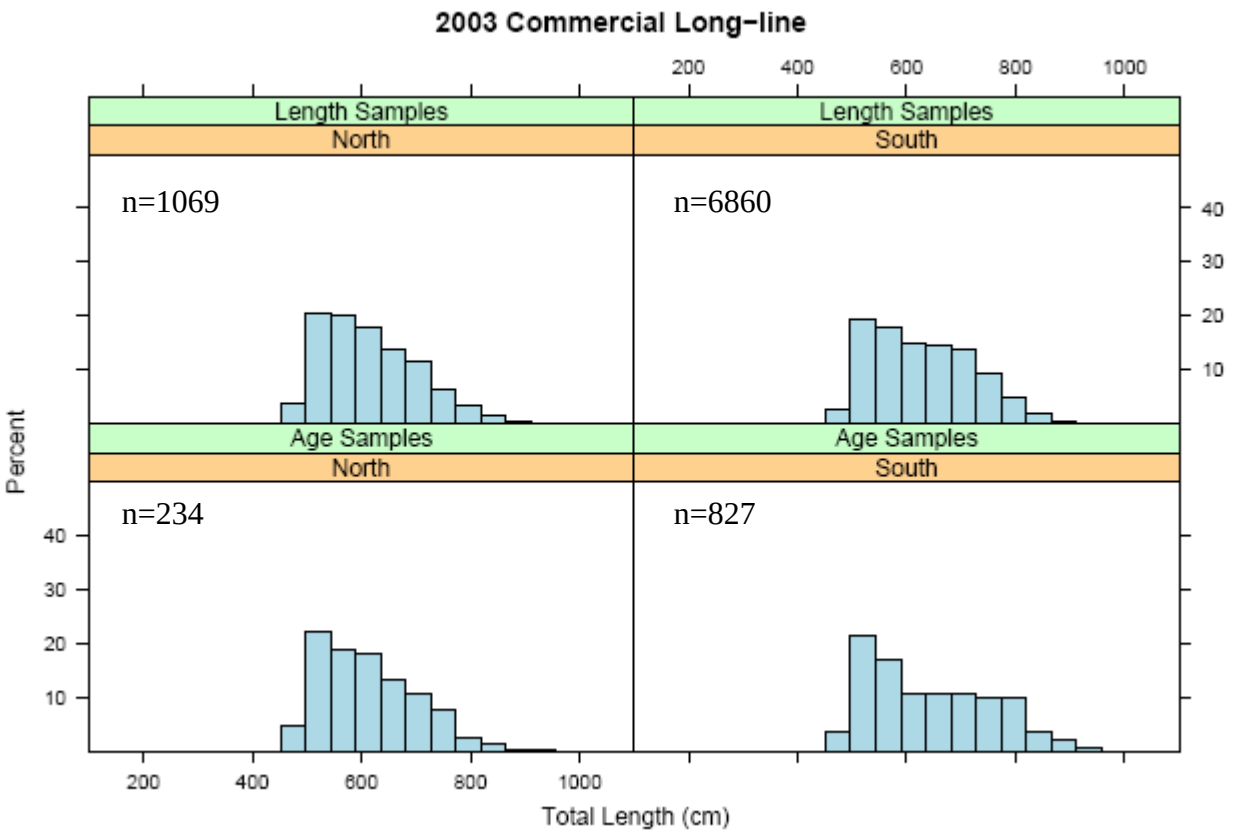

1998 Commercial Long−line
Length Samples
North
n=2041
Length Samples
South
n=10462
Age Samples
North
n=37
Age Samples
South
n=72
Percent
Total Length (cm)

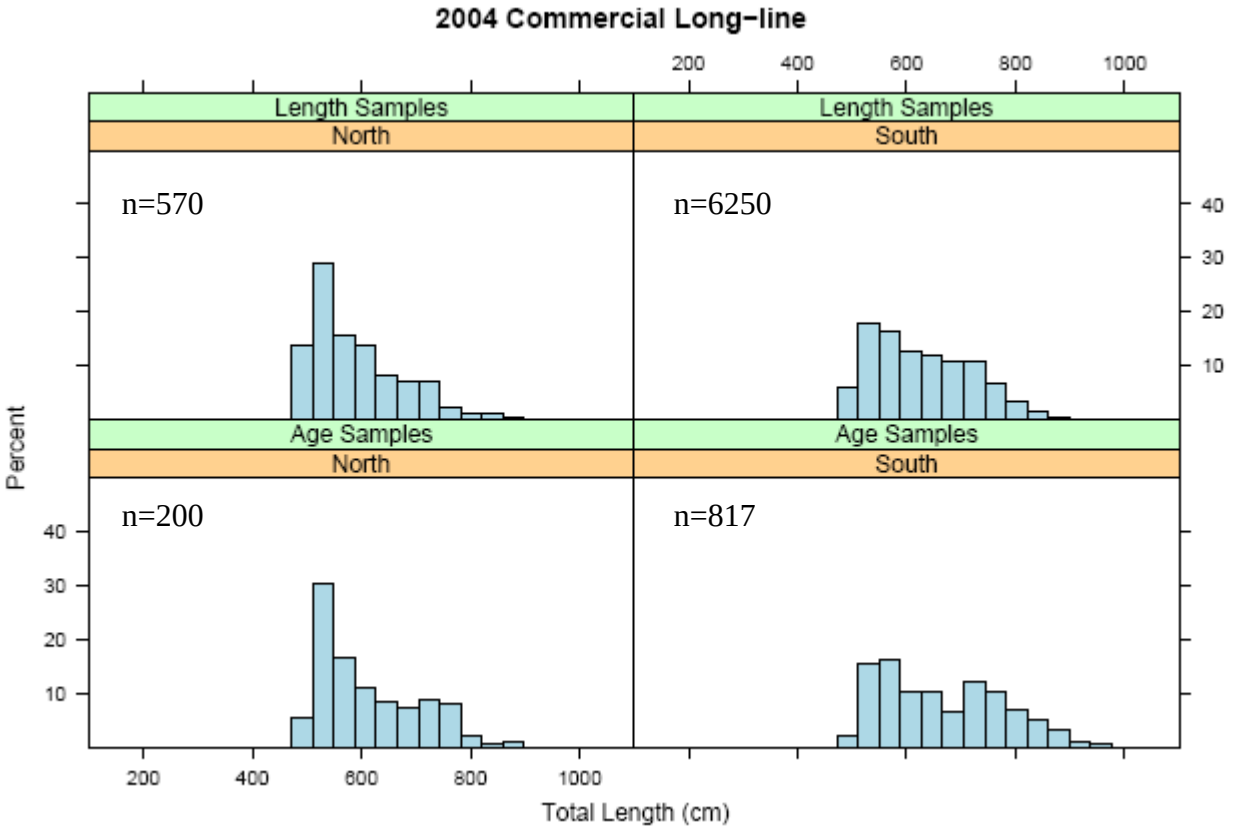

1999 Commercial Long−line
Length Samples
North
South
n=2904
n=14327
Age Samples
n=96
n=547
Percent
Total Length (cm)

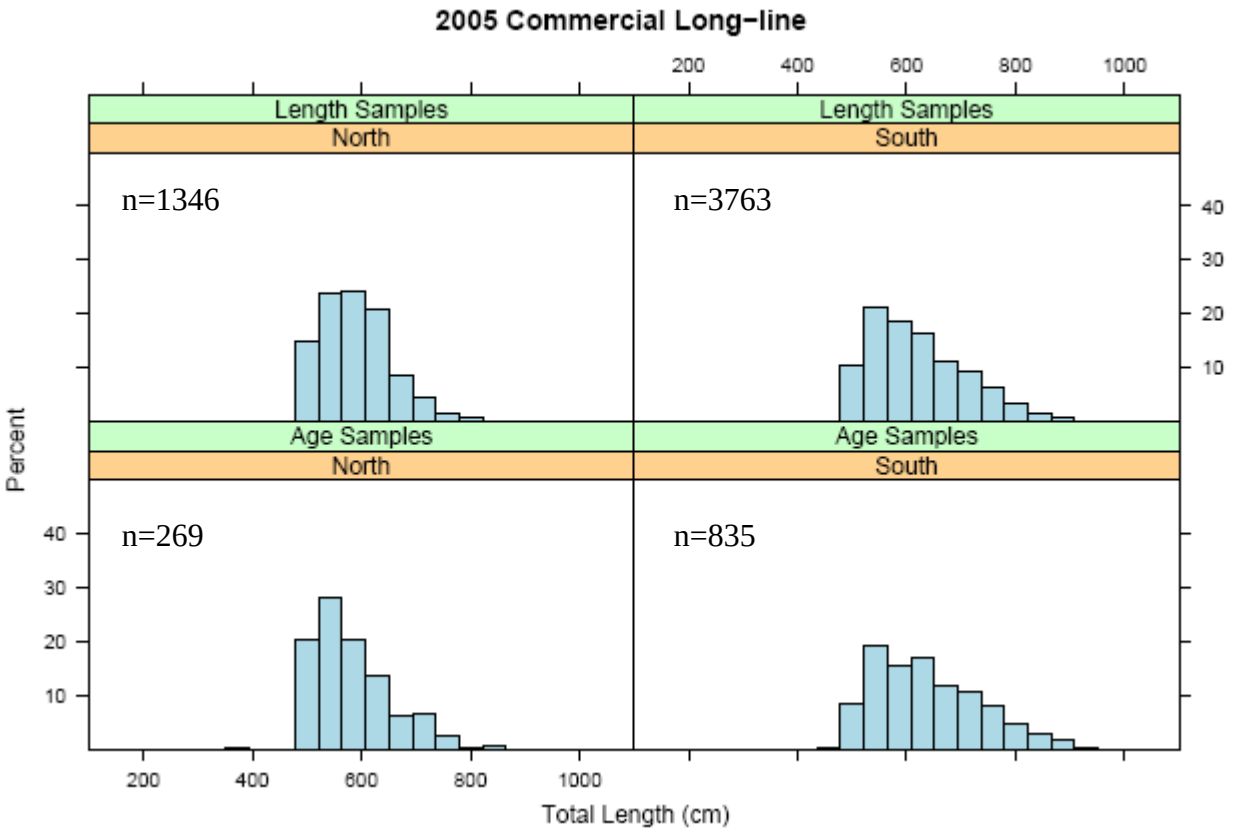

2000 Commercial Long−line
Length Samples
North
South
n=1856
n=9852
Age Samples
n=137
n=268
Percent
Total Length (cm)


2001 Commercial Long−line
Length Samples
North
South
n=2148
n=6339
Age Samples
n=872
n=338
Percent
Total Length (cm)


2002 Commercial Long−line
Length Samples
North
South
n=1379
n=6078
Age Samples
n=607
n=456
Percent
Total Length (cm)


2003 Commercial Long−line
Length Samples
North
South
n=1069
n=6860
Age Samples
n=234
n=827
Percent
Total Length (cm)


2004 Commercial Long−line
Length Samples
North
South
n=570
n=6250
Age Samples
n=200
n=817
Percent
Total Length (cm)


2005 Commercial Long−line
Length Samples
North
n=1346
Length Samples
South
n=3763
Age Samples
North
n=269
Age Samples
South
n=835
Percent
Total Length (cm)
200
400
600
800
1000
10
20
30
40