Science, Service, Stewardship

Silk Snapper – Re - Analysis of size-frequency

CFMC Presentation
2009

Photo from: www.incognitolighttackle.com/photos.htm

NOAA FISHERIES SERVICE

Todd Gedamke (SEFSC)

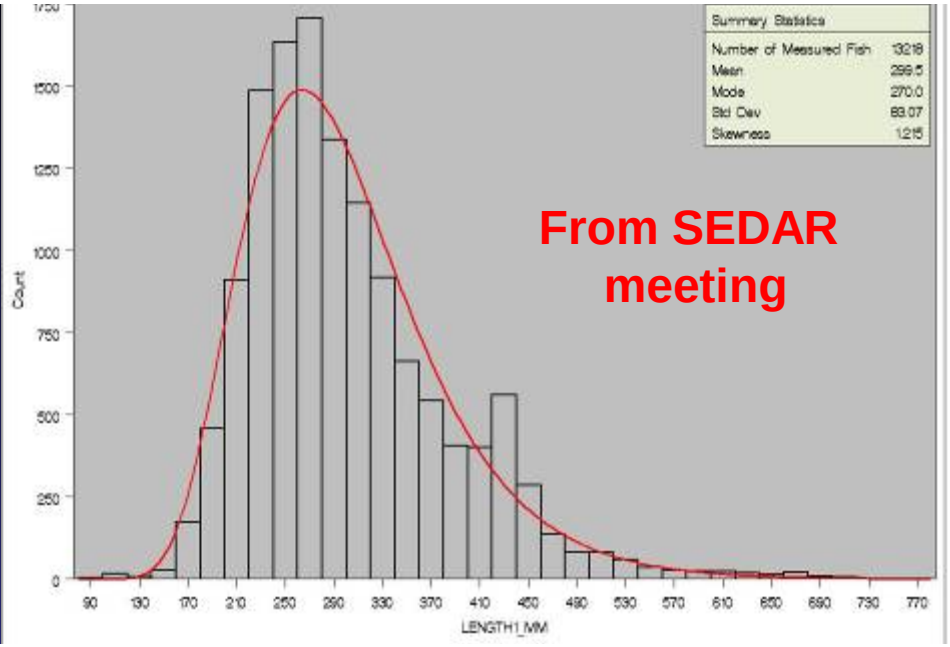
Beverton-Holt mean length mortality estimator

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c}$$

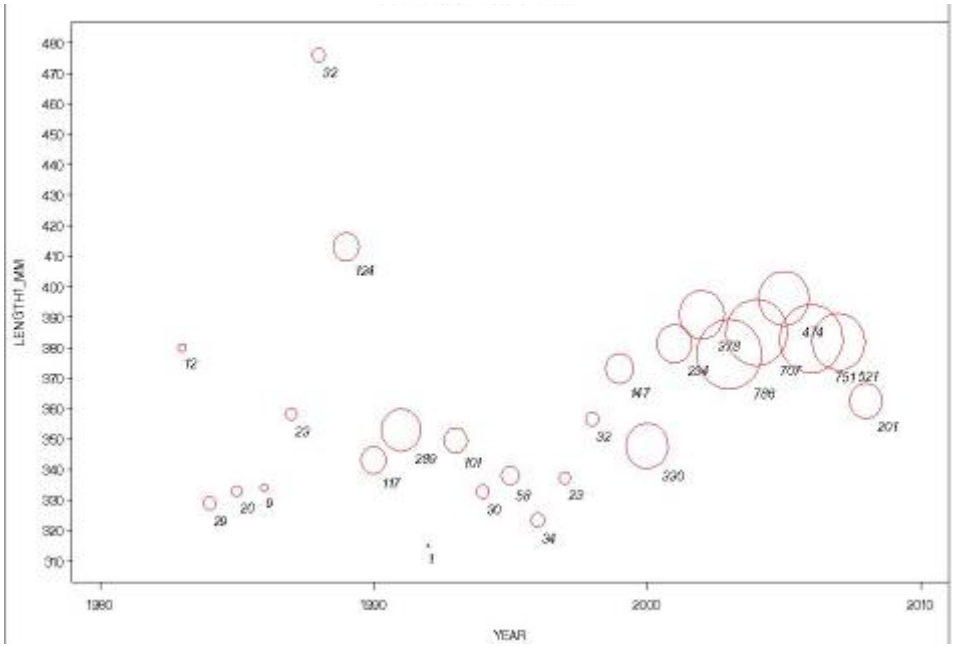
5 assumptions:

1. Asymptotic growth, K and L_∞ known & constant over time.
2. No individual variability in growth.
3. Constant & continuous recruitment over time.
4. Mortality constant with age.
5. Mortality constant over time → Population in equilibrium (mean length reflects mortality)

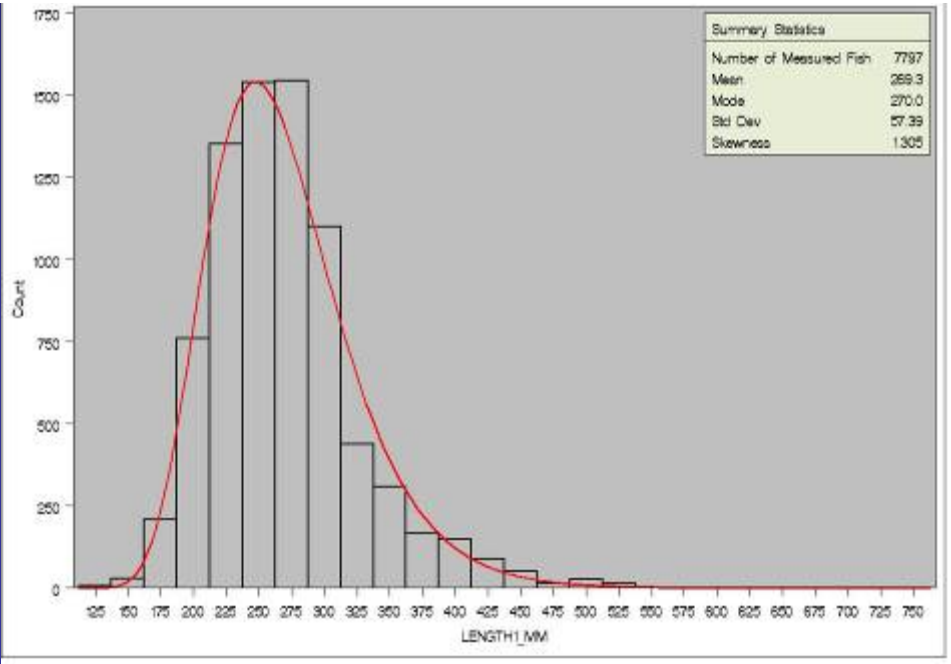
Silk Snapper – Hook and Line – Code 610 – Puerto Rico

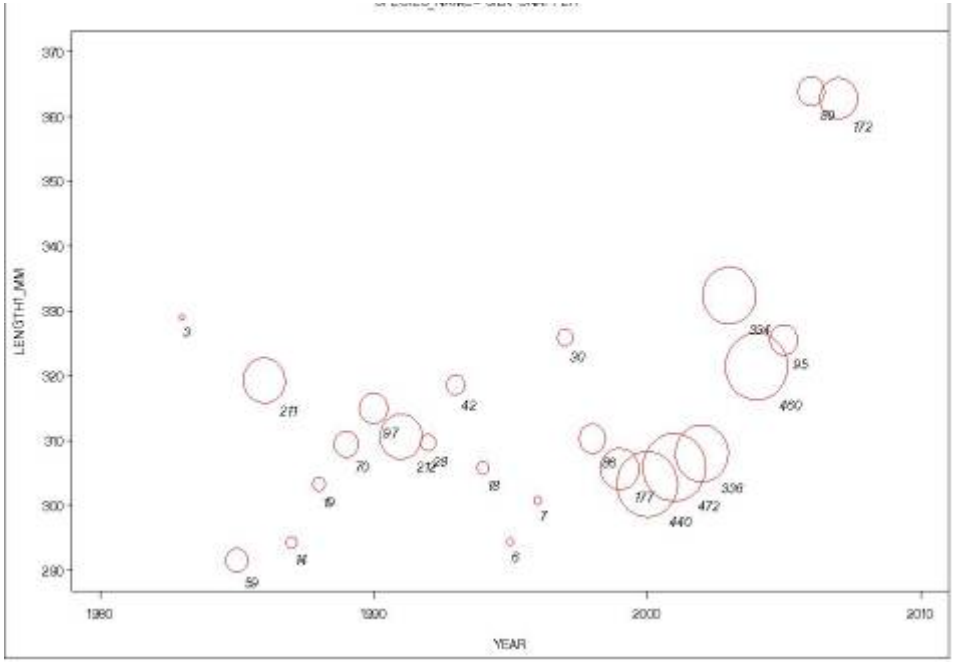


From SEDAR meeting

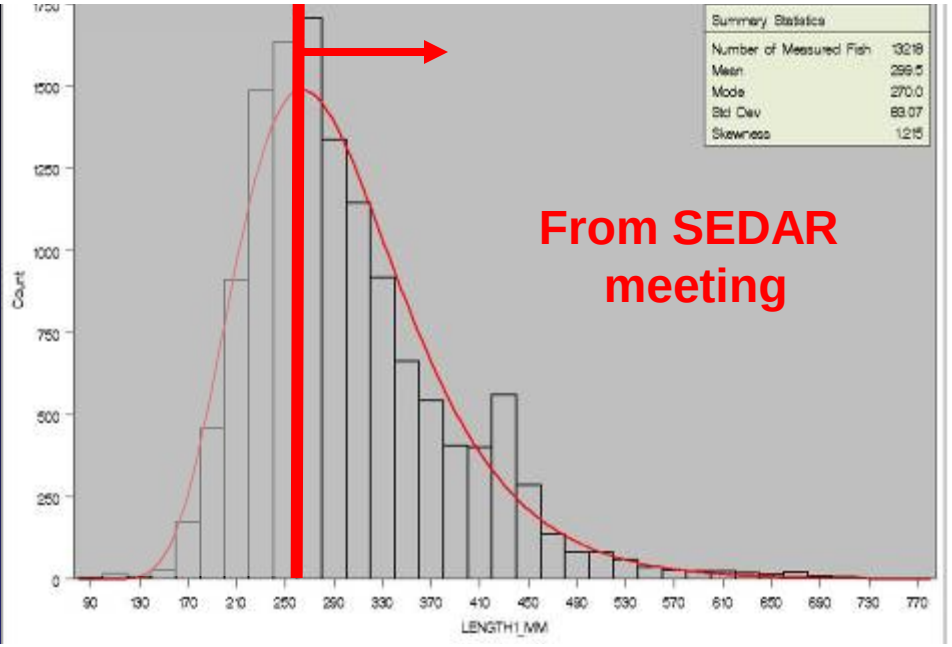


Silk Snapper – Traps – Code 345 – Puerto Rico

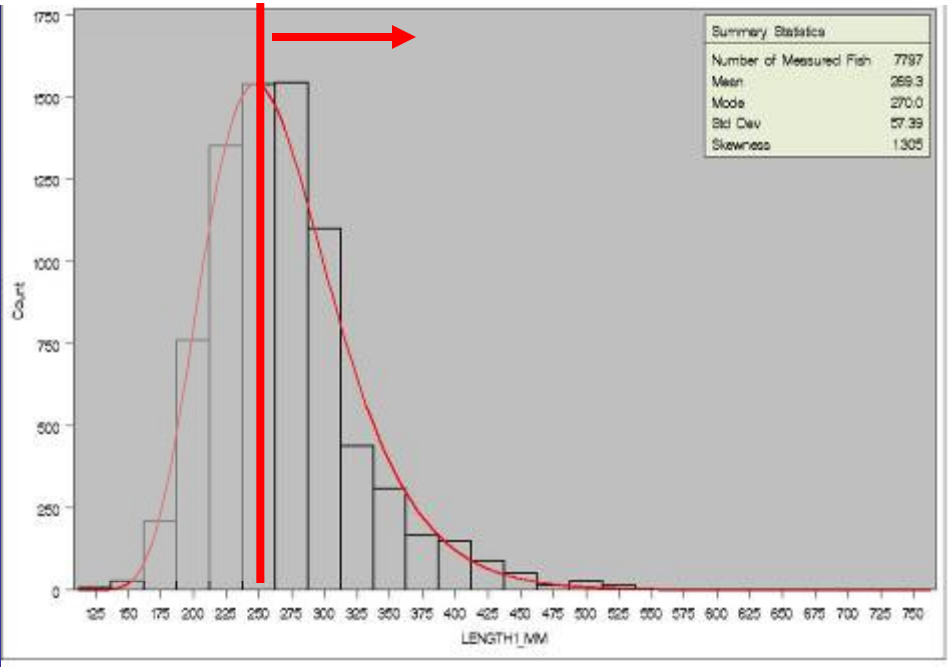




Silk Snapper – Hook and Line – Code 610 – Puerto Rico

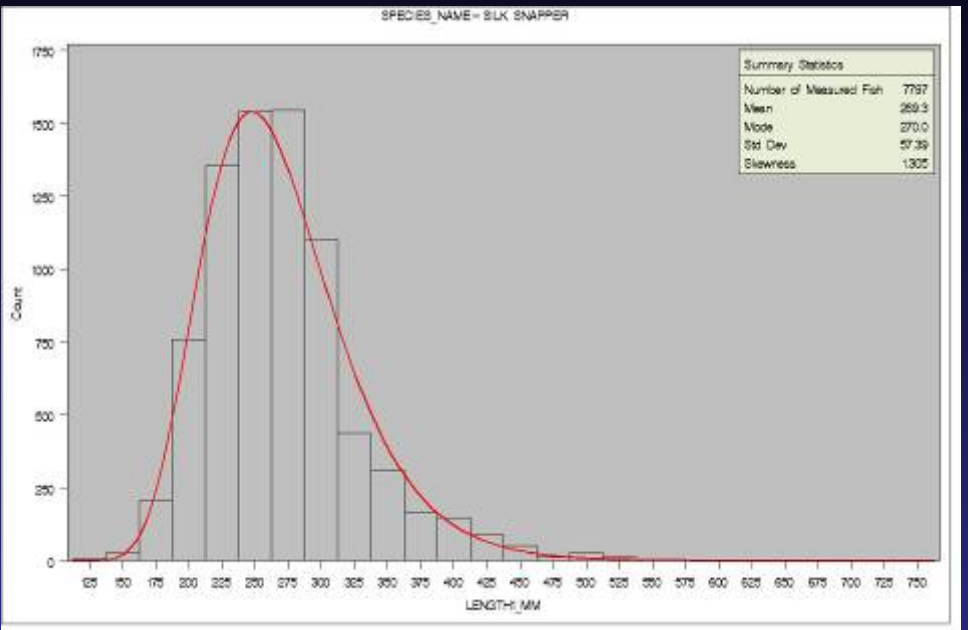


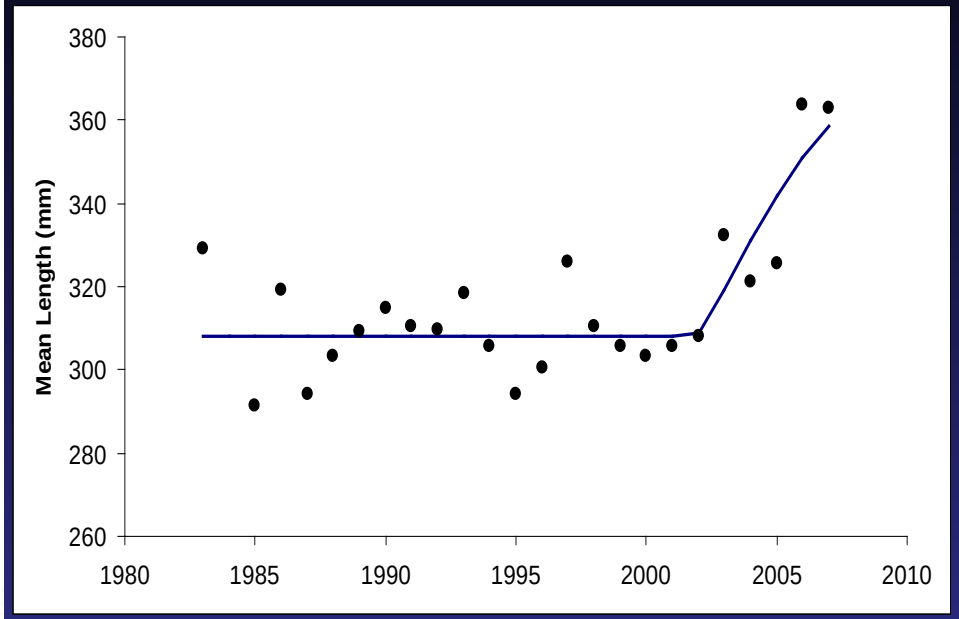
Silk Snapper – Traps – Code 345 – Puerto Rico

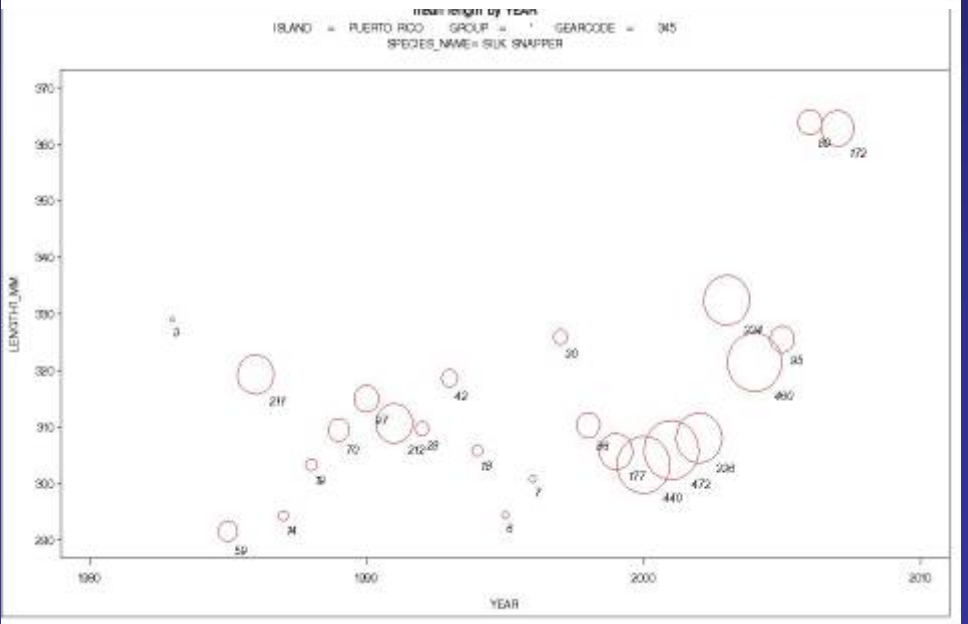


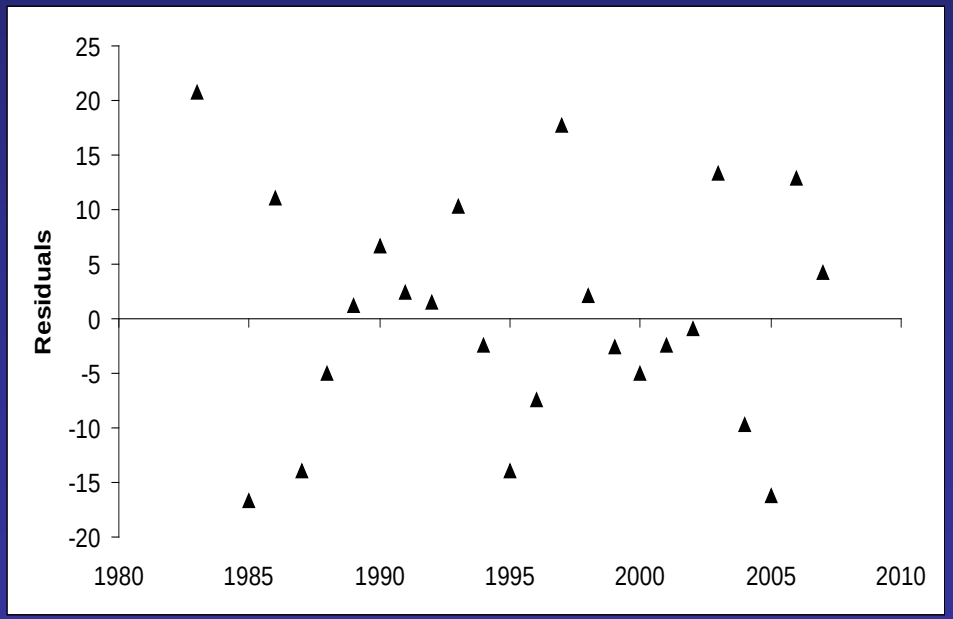
Silk Snapper

Z = 1.12 → 0.31 in 2001.8

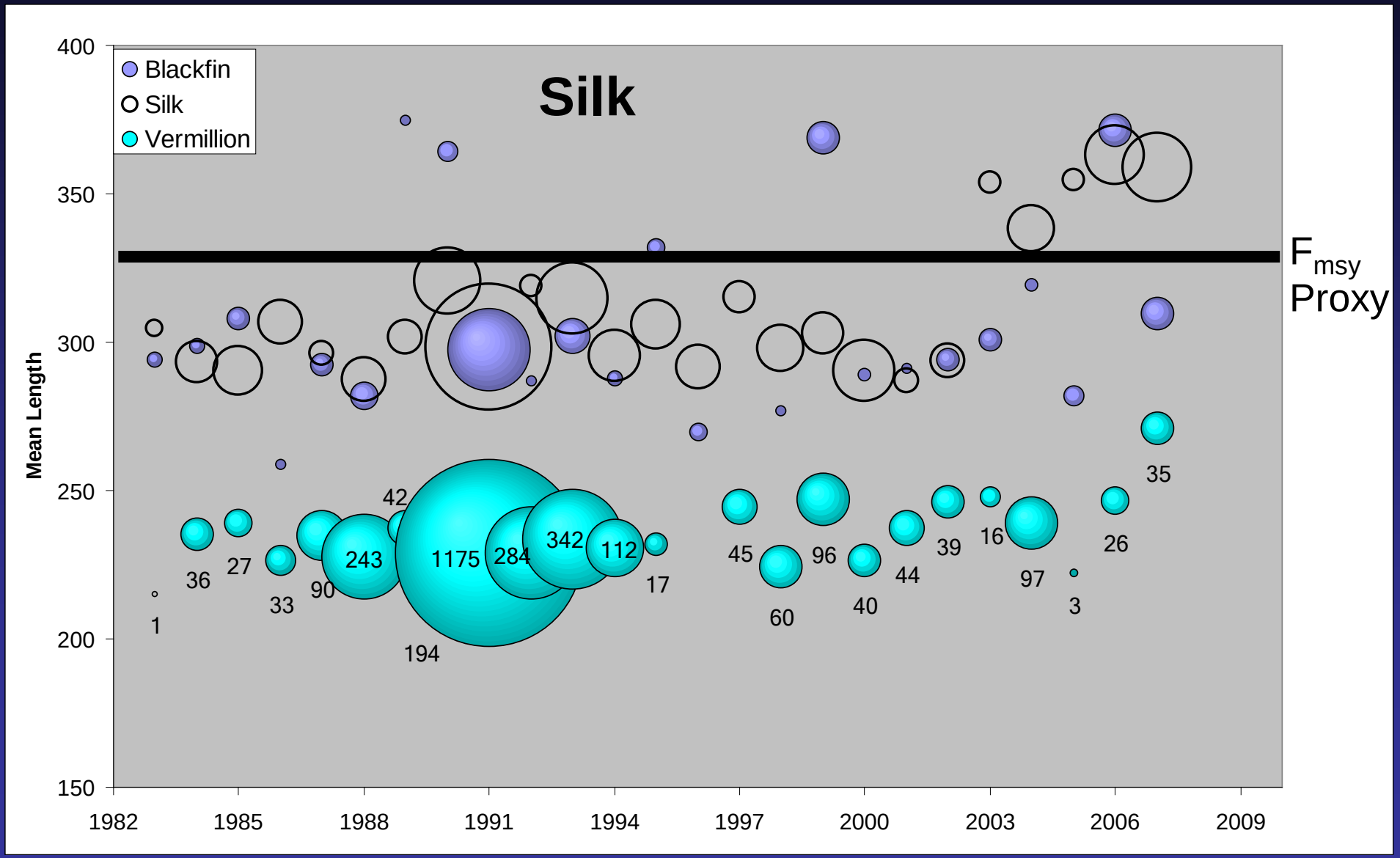




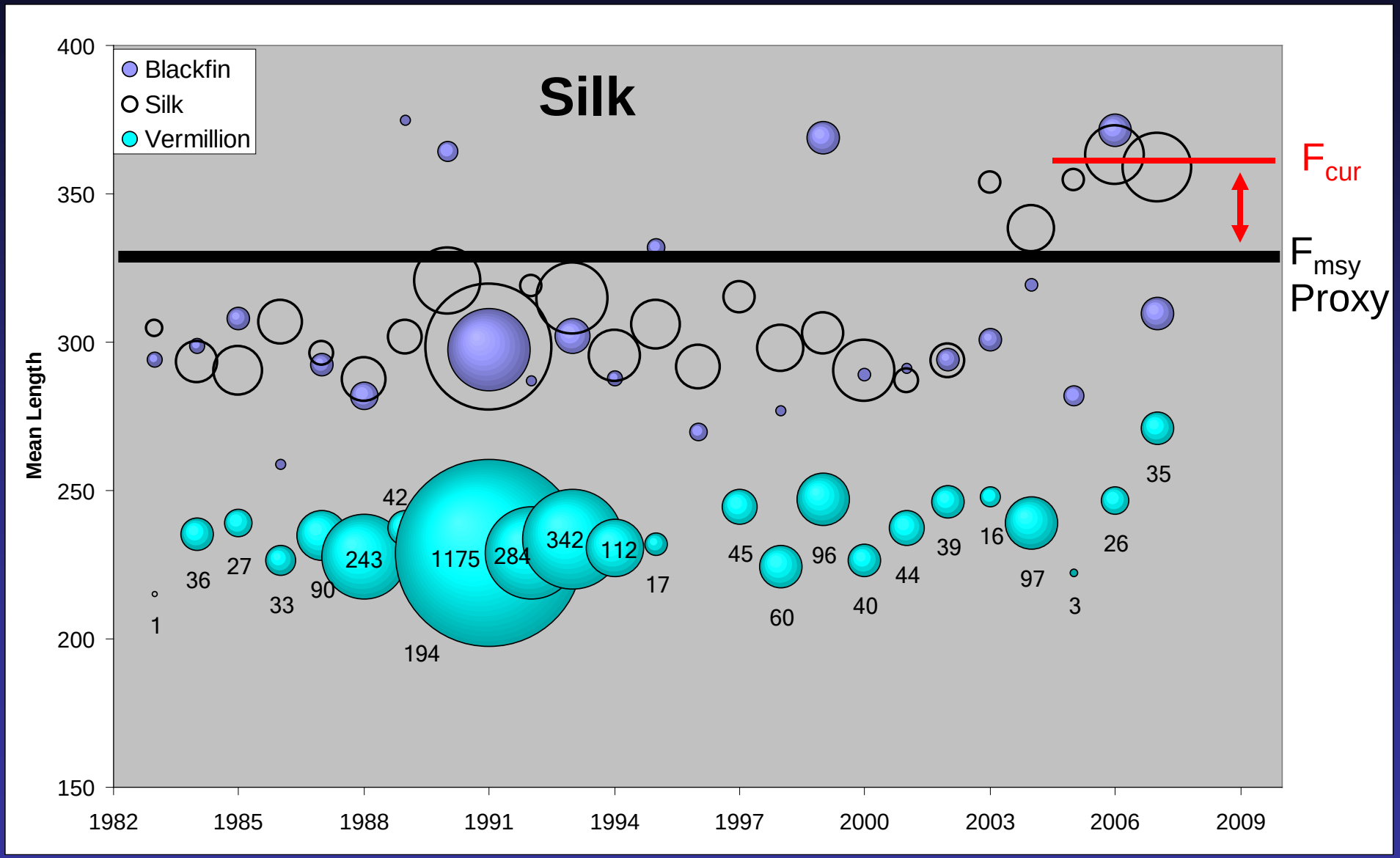




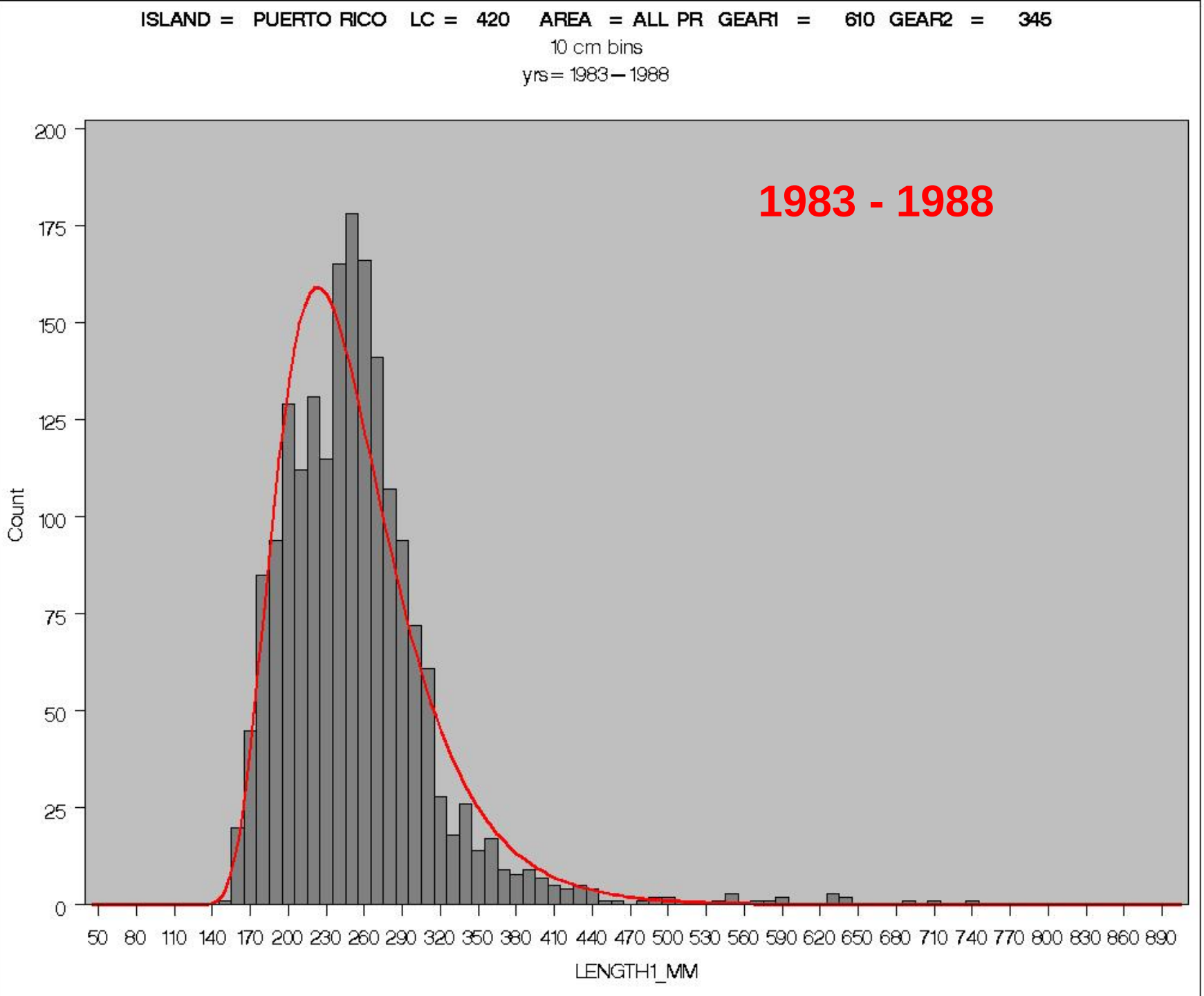
2009 - 2010 Analysis

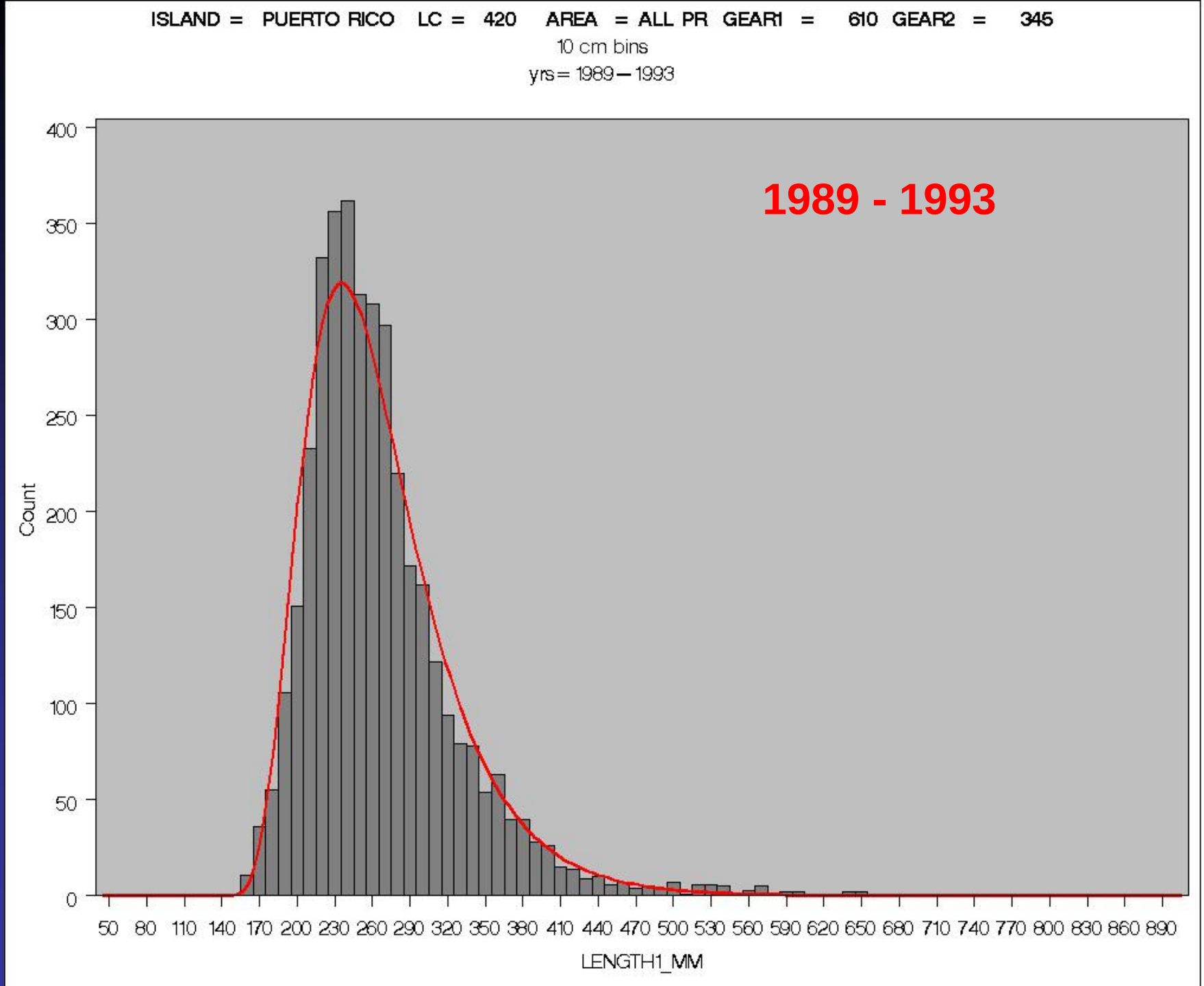


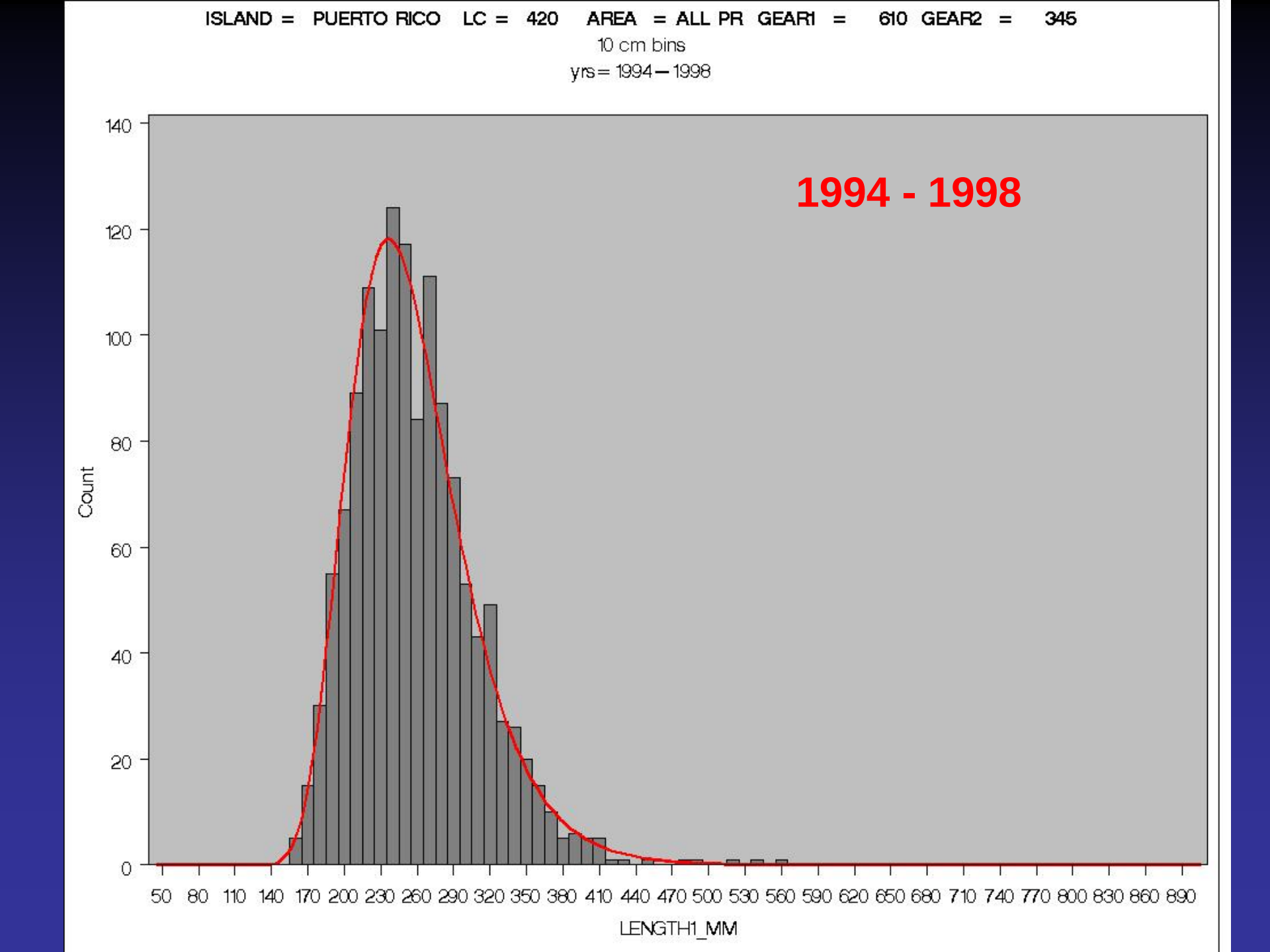
2009 - 2010 Analysis

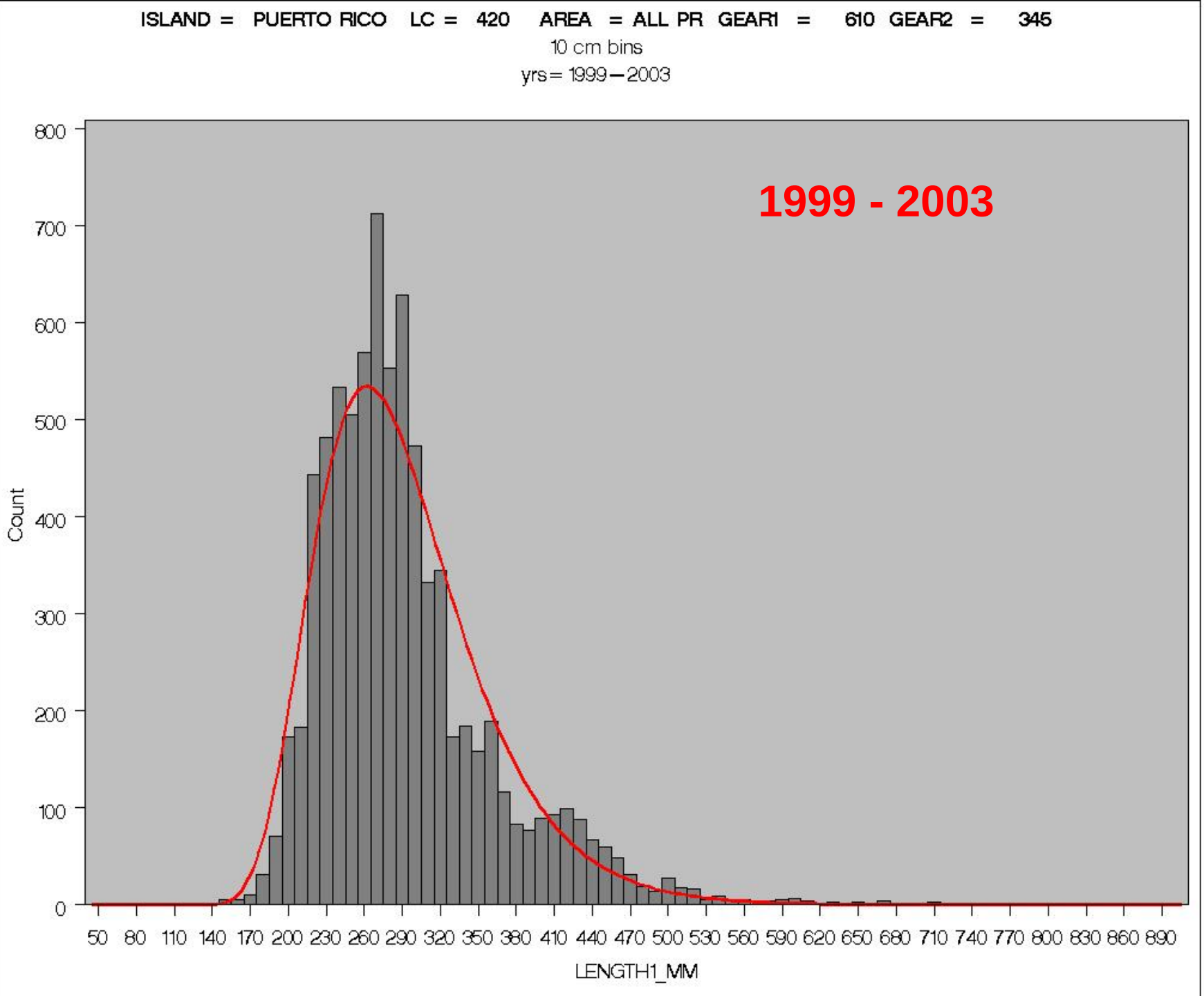


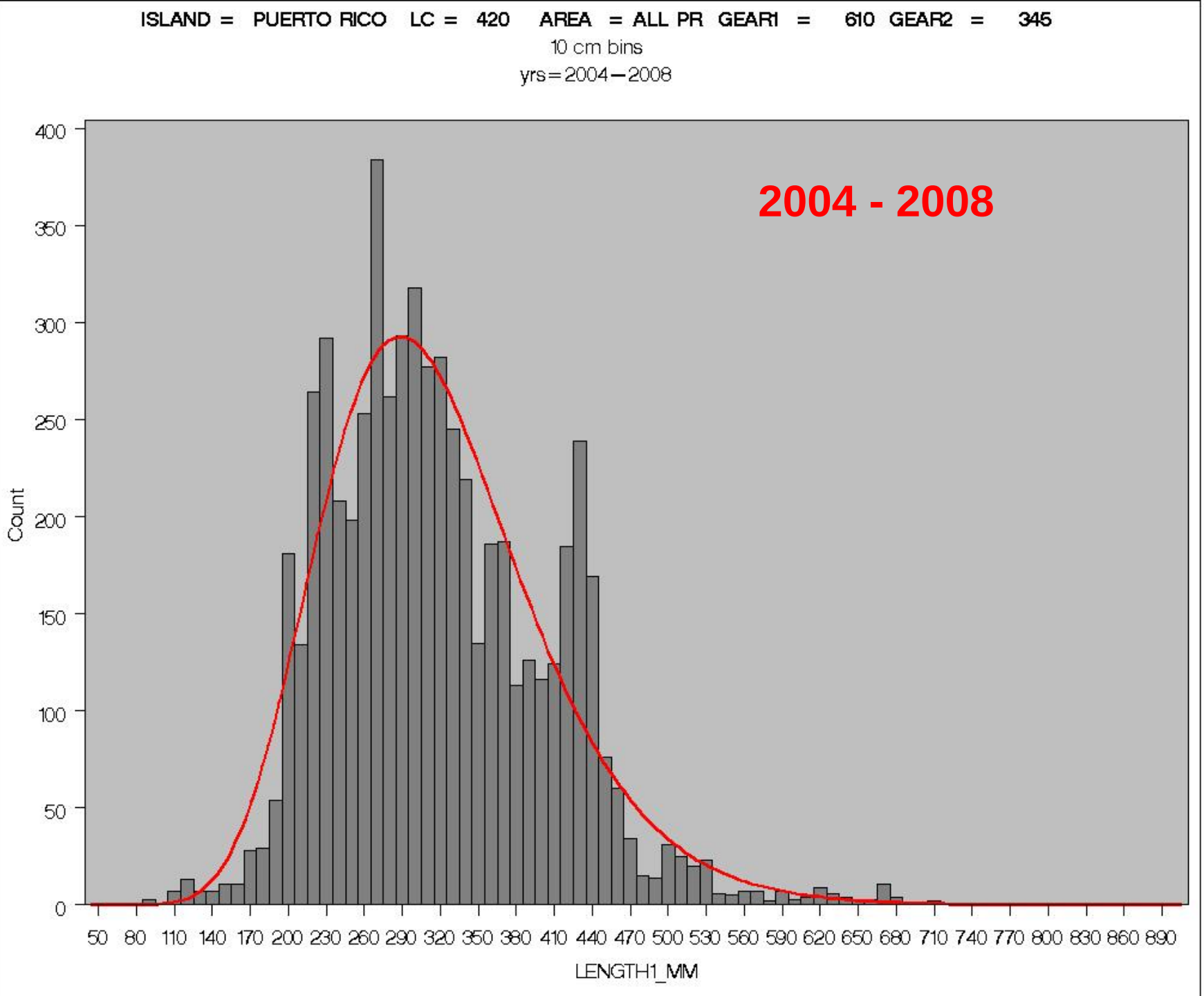
Detailed inspection of size composition over time


ISLAND = PUERTO RICO LC = 420 AREA = ALL PR GEAR1 = 610 GEAR2 = 345
10 cm bins
yrs = 1983 – 1988
1983 - 1988
Count
0
25
50
75
100
125
150
175
200
50 80 110 140 170 200 230 260 290 320 350 380 410 440 470 500 530 560 590 620 650 680 710 740 770 800 830 860 890
LENGTH1_MM


ISLAND = PUERTO RICO LC = 420 AREA = ALL PR GEAR1 = 610 GEAR2 = 345
10 cm bins
yrs = 1989 – 1993
1989 - 1993
Count
0
50
100
150
200
250
300
350
400
50 80 110 140 170 200 230 260 290 320 350 380 410 440 470 500 530 560 590 620 650 680 710 740 770 800 830 860 890
LENGTH1_MM

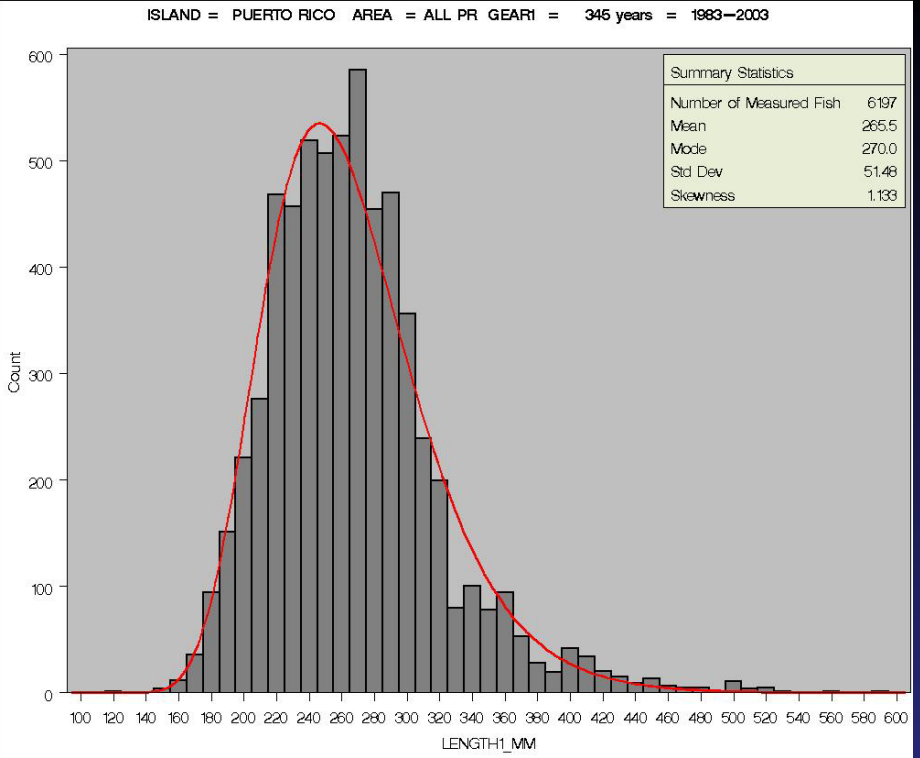

ISLAND = PUERTO RICO LC = 420 AREA = ALL PR GEAR1 = 610 GEAR2 = 345
10 cm bins
yrs = 1994 – 1998
1994 - 1998
Count
0
20
40
60
80
100
120
140
50 80 110 140 170 200 230 260 290 320 350 380 410 440 470 500 530 560 590 620 650 680 710 740 770 800 830 860 890
LENGTH1_MM


ISLAND = PUERTO RICO LC = 420 AREA = ALL PR GEAR1 = 610 GEAR2 = 345
10 cm bins
yrs= 1999–2003
1999 - 2003
Count
0
100
200
300
400
500
600
700
800
50 80 110 140 170 200 230 260 290 320 350 380 410 440 470 500 530 560 590 620 650 680 710 740 770 800 830 860 890
LENGTH1_MM

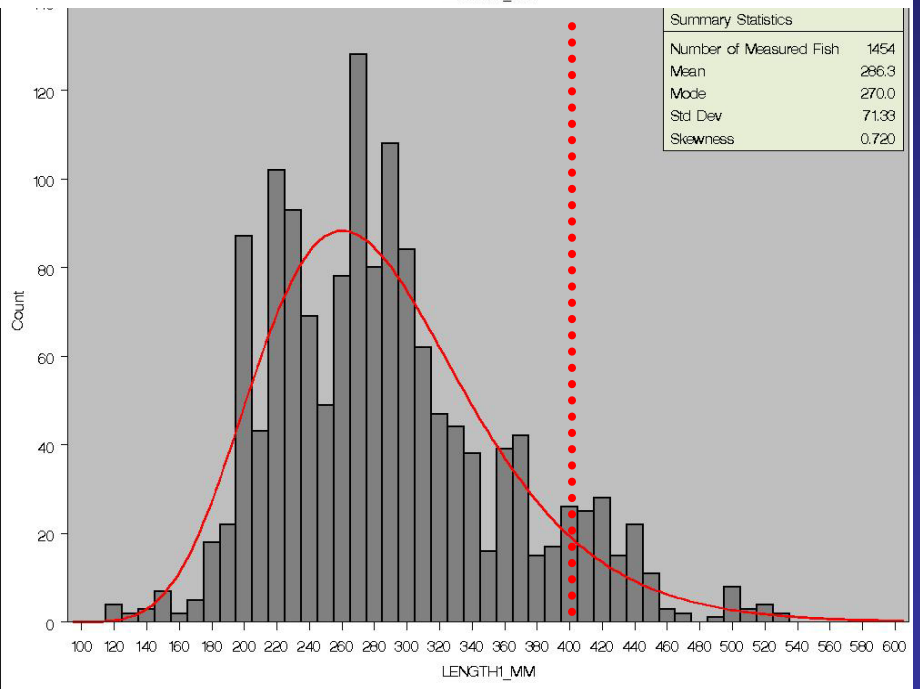

ISLAND = PUERTO RICO LC = 420 AREA = ALL PR GEAR1 = 610 GEAR2 = 345
10 cm bins
yrs=2004–2008
2004 - 2008
Count
0
50
100
150
200
250
300
350
400
50 80 110 140 170 200 230 260 290 320 350 380 410 440 470 500 530 560 590 620 650 680 710 740 770 800 830 860 890
LENGTH1_MM

Same signal found in all gear/area scenarios

Traps – All Island

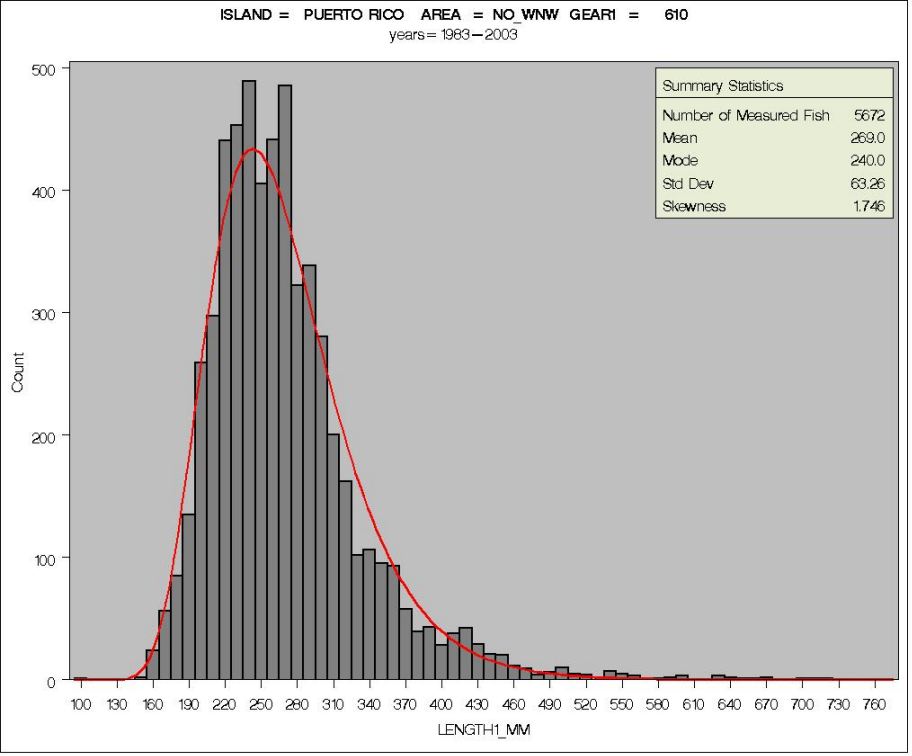


1983-2003

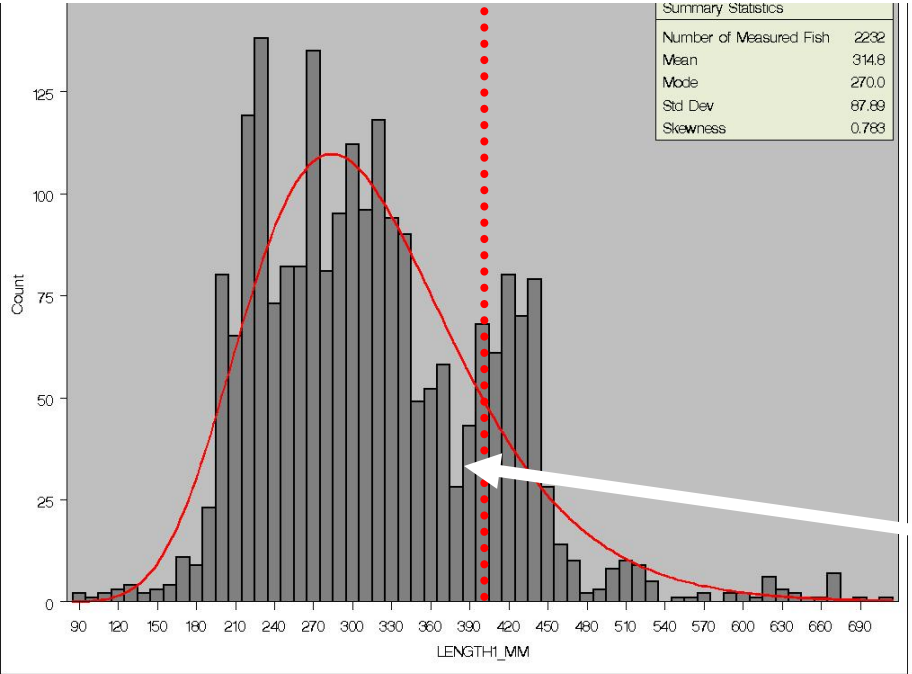


2004-2008

Hook and Line – No WNW



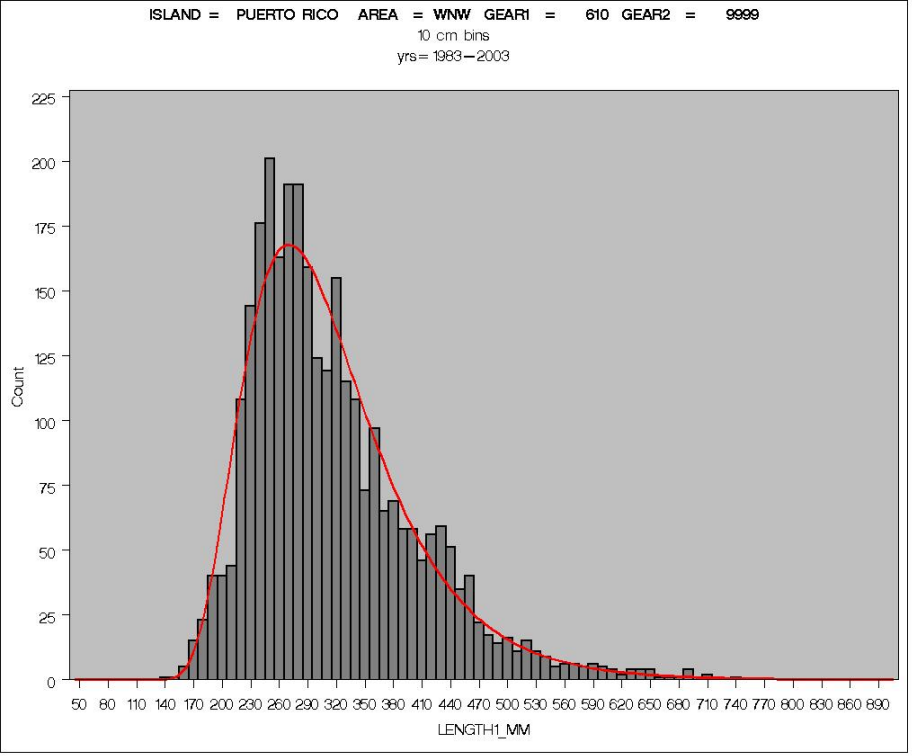
1983-2003



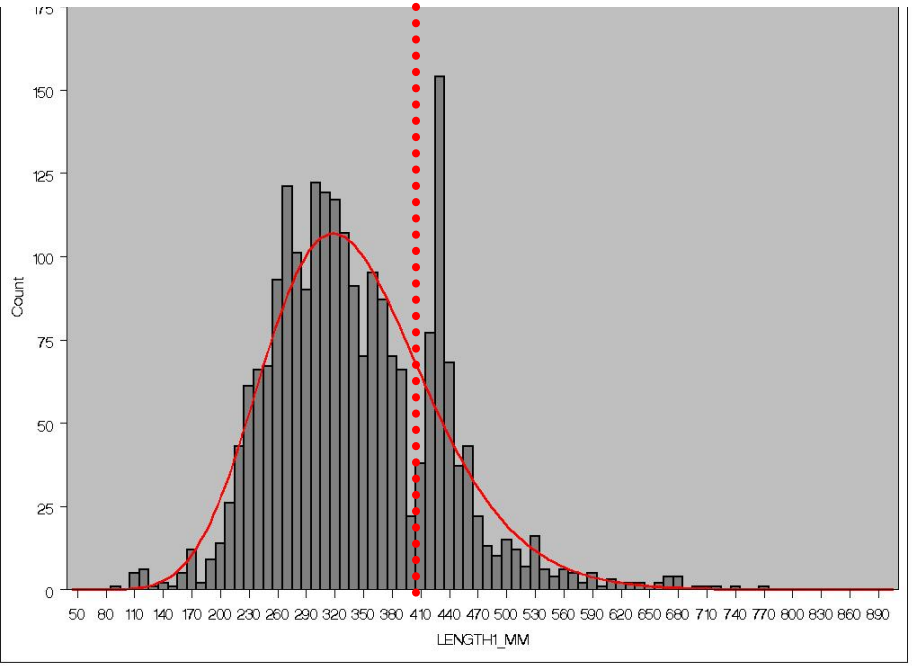
2004-2008

Note: dip before min size

Hook and Line –WNW only



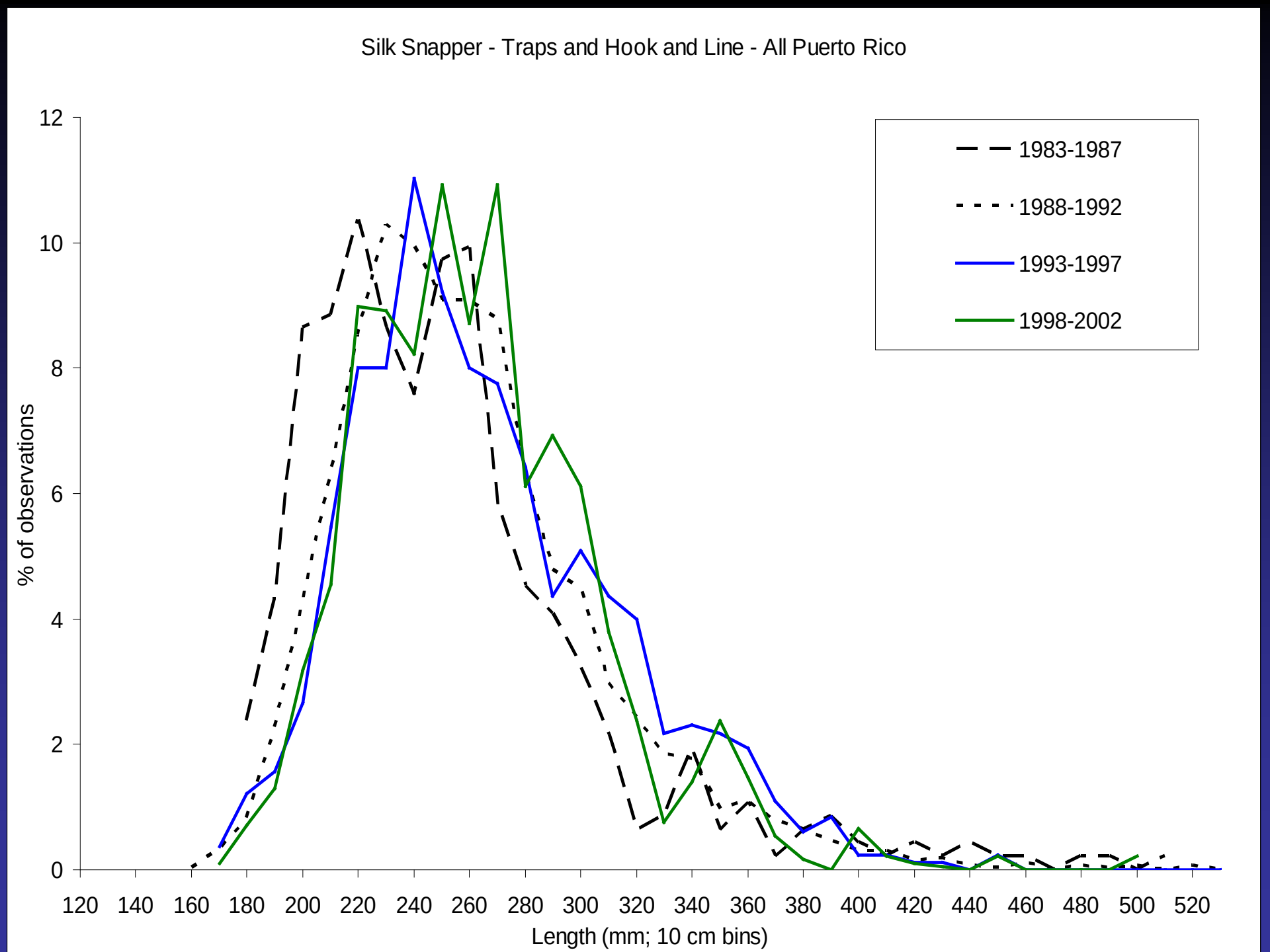
1983-2003

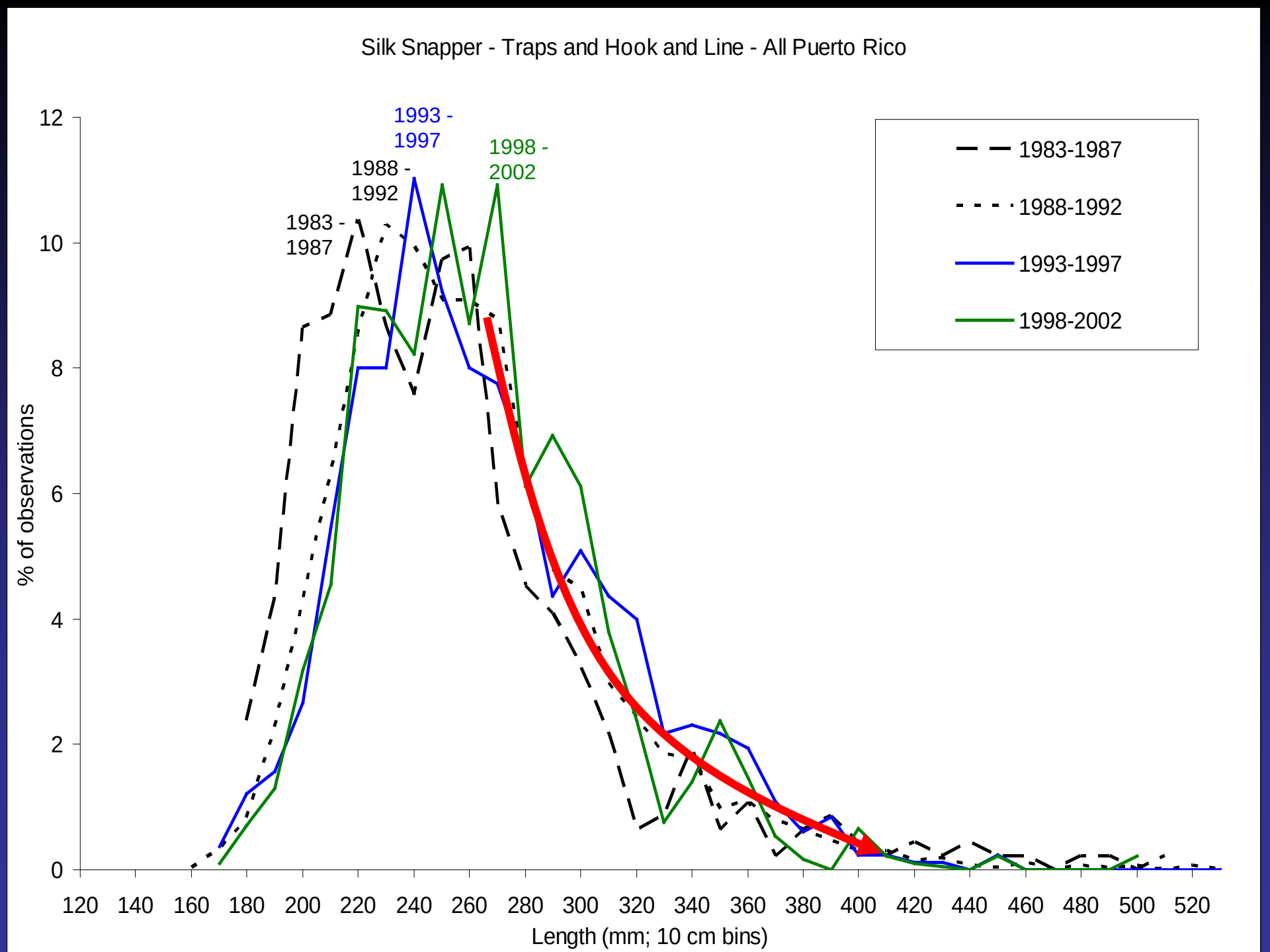


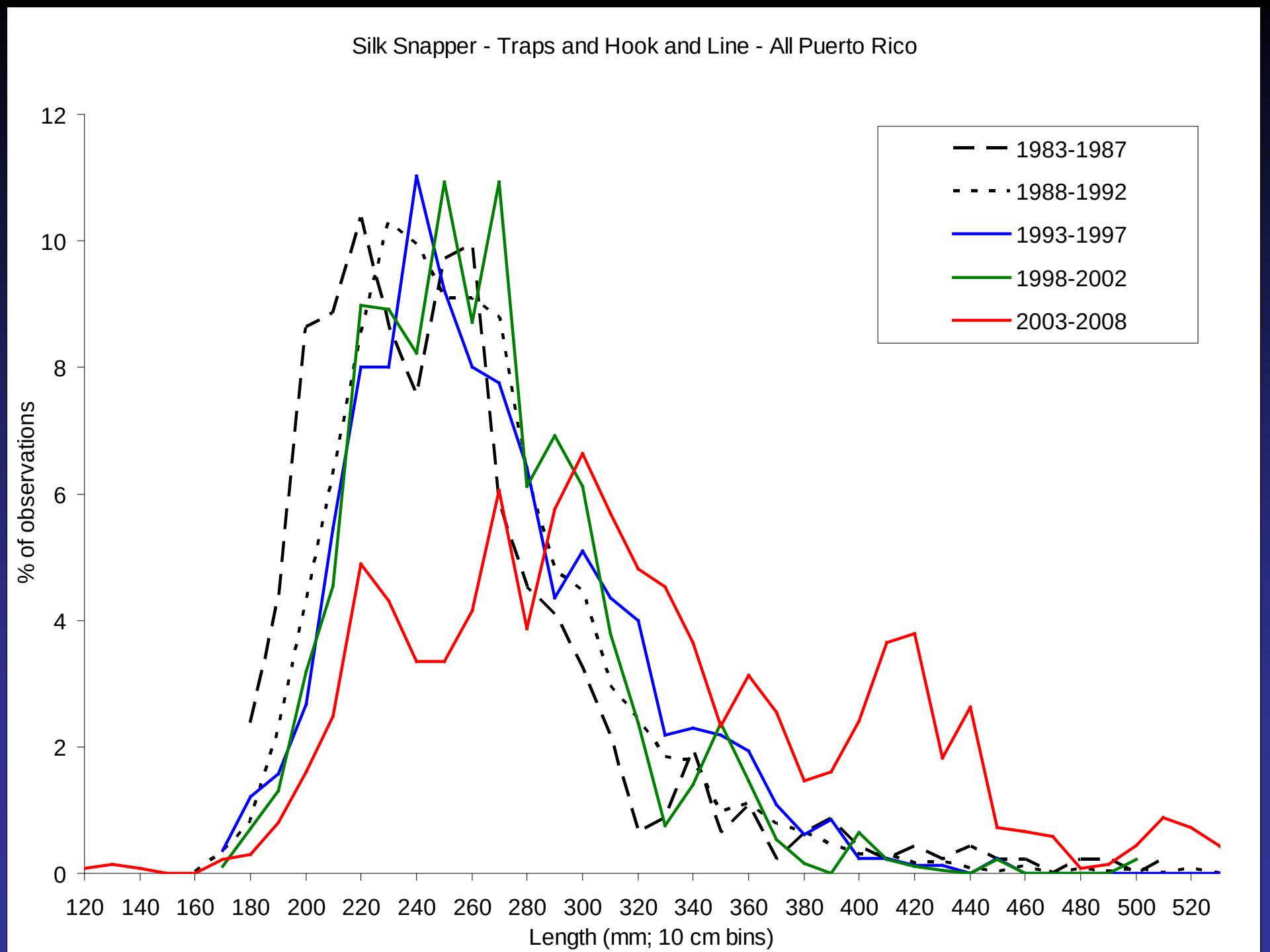
2004-2008

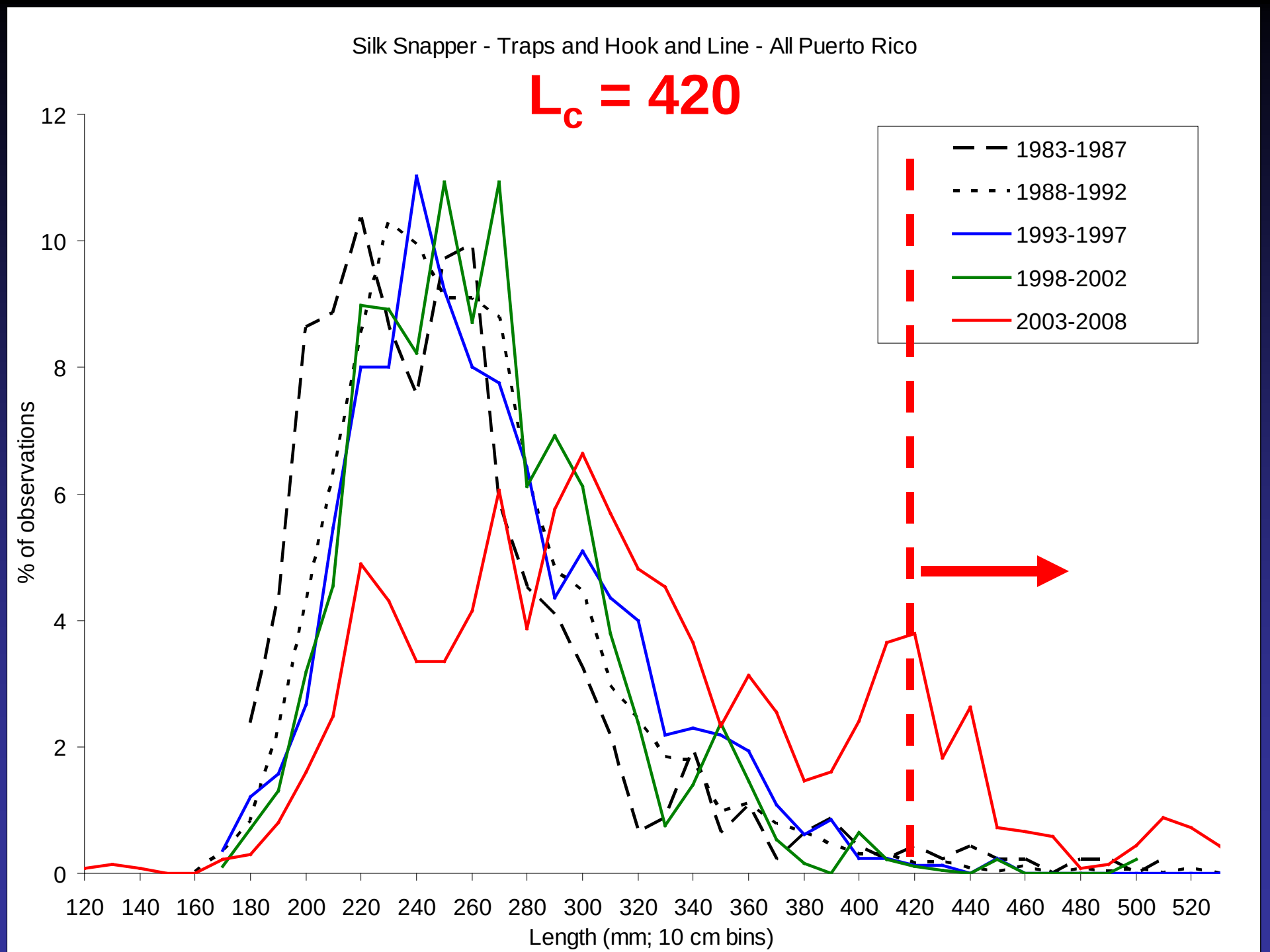
Size-Composition relatively constant 1983-2004

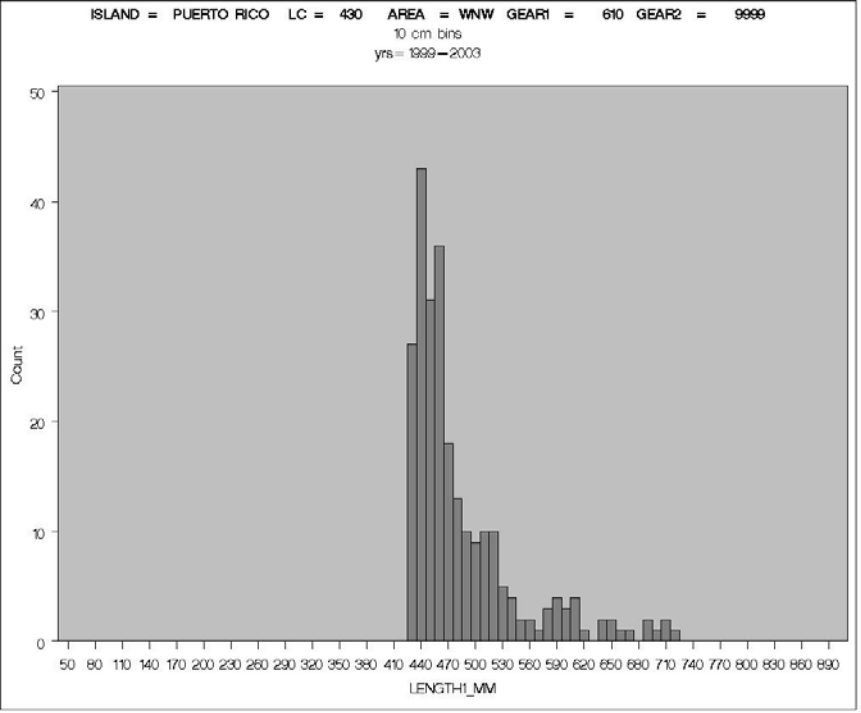
Selection of L_c

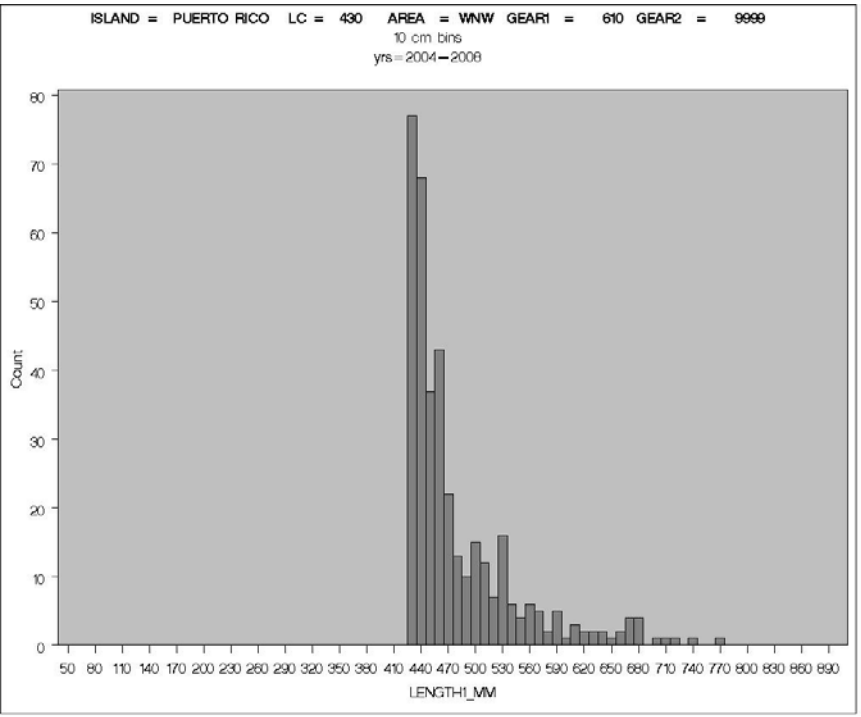

Silk Snapper - Traps and Hook and Line - All Puerto Rico
% of observations
Length (mm; 10 cm bins)
0
2
4
6
8
10
12
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
1983-1987
1988-1992
1993-1997
1998-2002


Silk Snapper - Traps and Hook and Line - All Puerto Rico
1993 - 1997
1998 - 2002
1988 - 1992
1983 - 1987
1983-1987
1988-1992
1993-1997
1998-2002
% of observations
Length (mm; 10 cm bins)
0
2
4
6
8
10
12
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520


Silk Snapper - Traps and Hook and Line - All Puerto Rico
% of observations
Length (mm; 10 cm bins)
0
2
4
6
8
10
12
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
1983-1987
1988-1992
1993-1997
1998-2002
2003-2008


Silk Snapper - Traps and Hook and Line - All Puerto Rico
$L_c = 420$
1983-1987
1988-1992
1993-1997
1998-2002
2003-2008
% of observations
0
2
4
6
8
10
12
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
Length (mm; 10 cm bins)





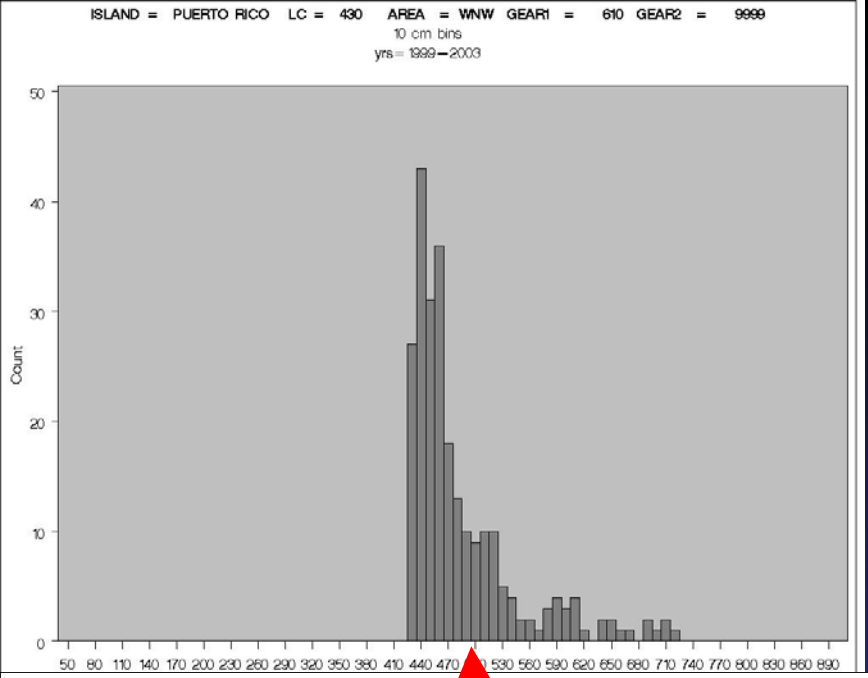
Hook and Line – WNW Only
Minimum Size of 420 mm

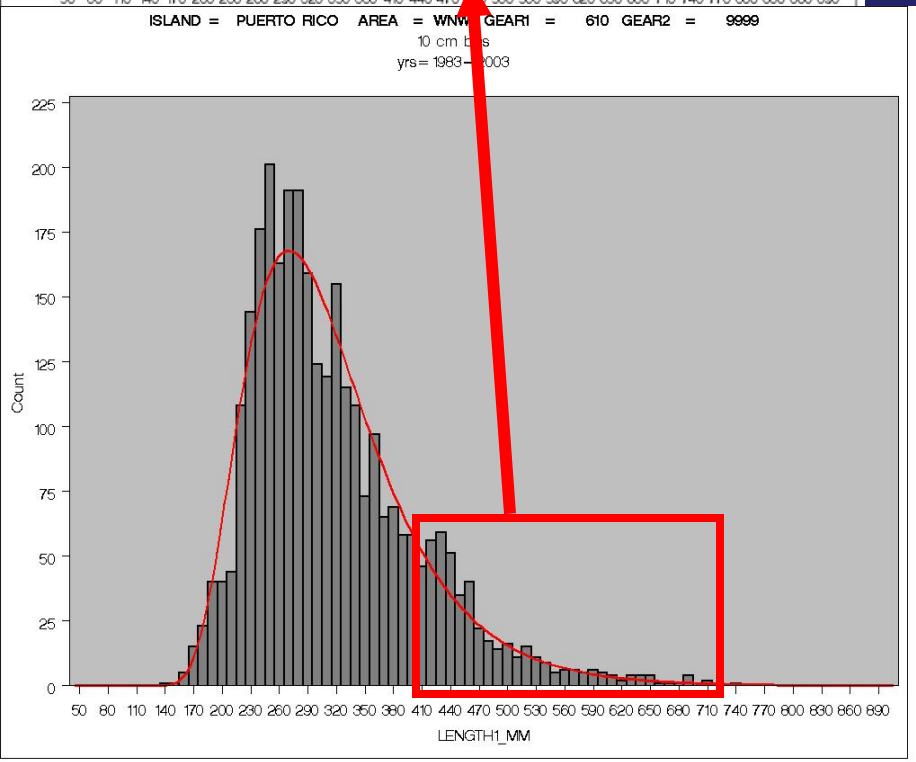
1983-2003

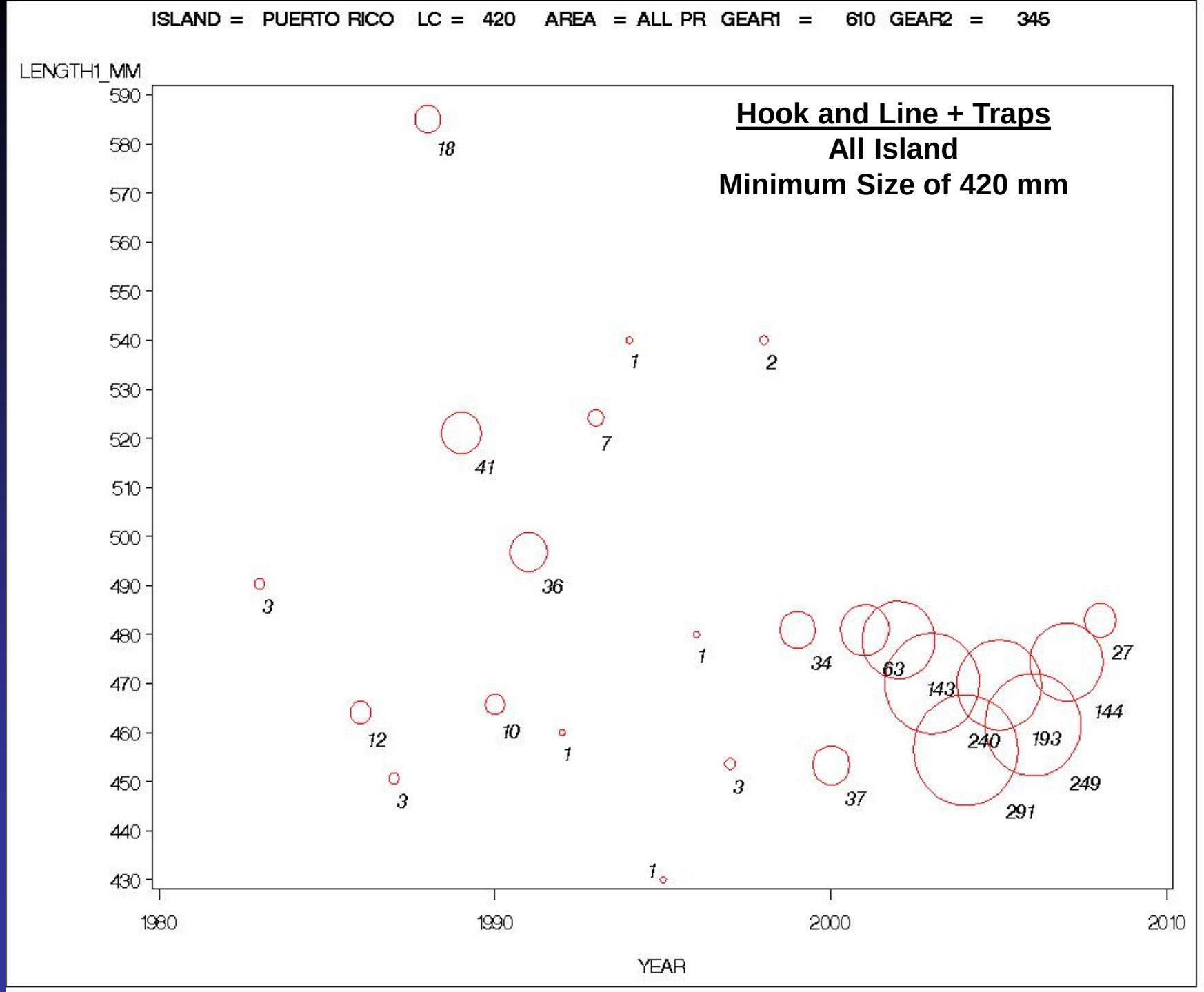
2004-2008

Hook and Line – WNW Only
Minimum Size of 420 mm

1983-2003

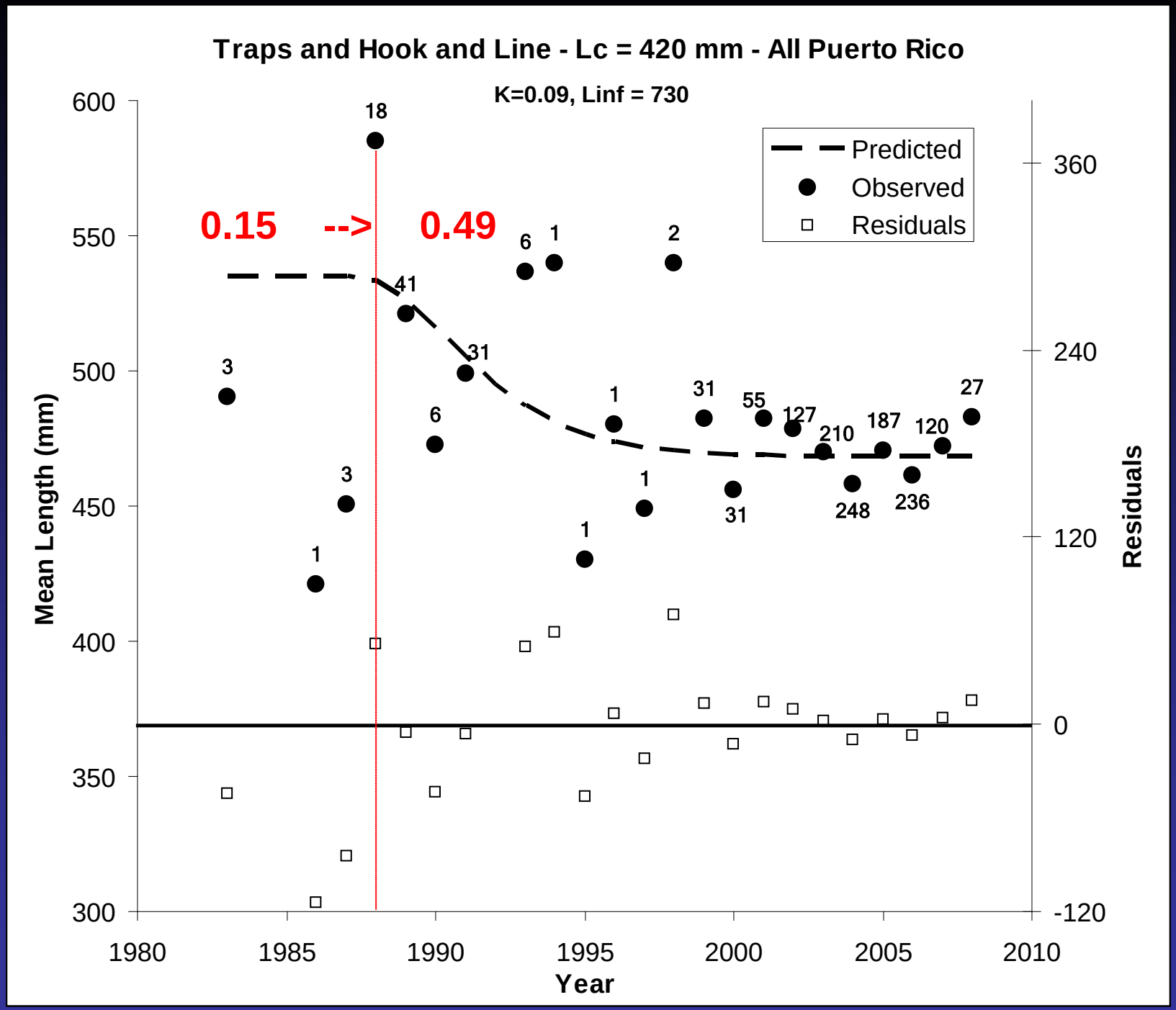


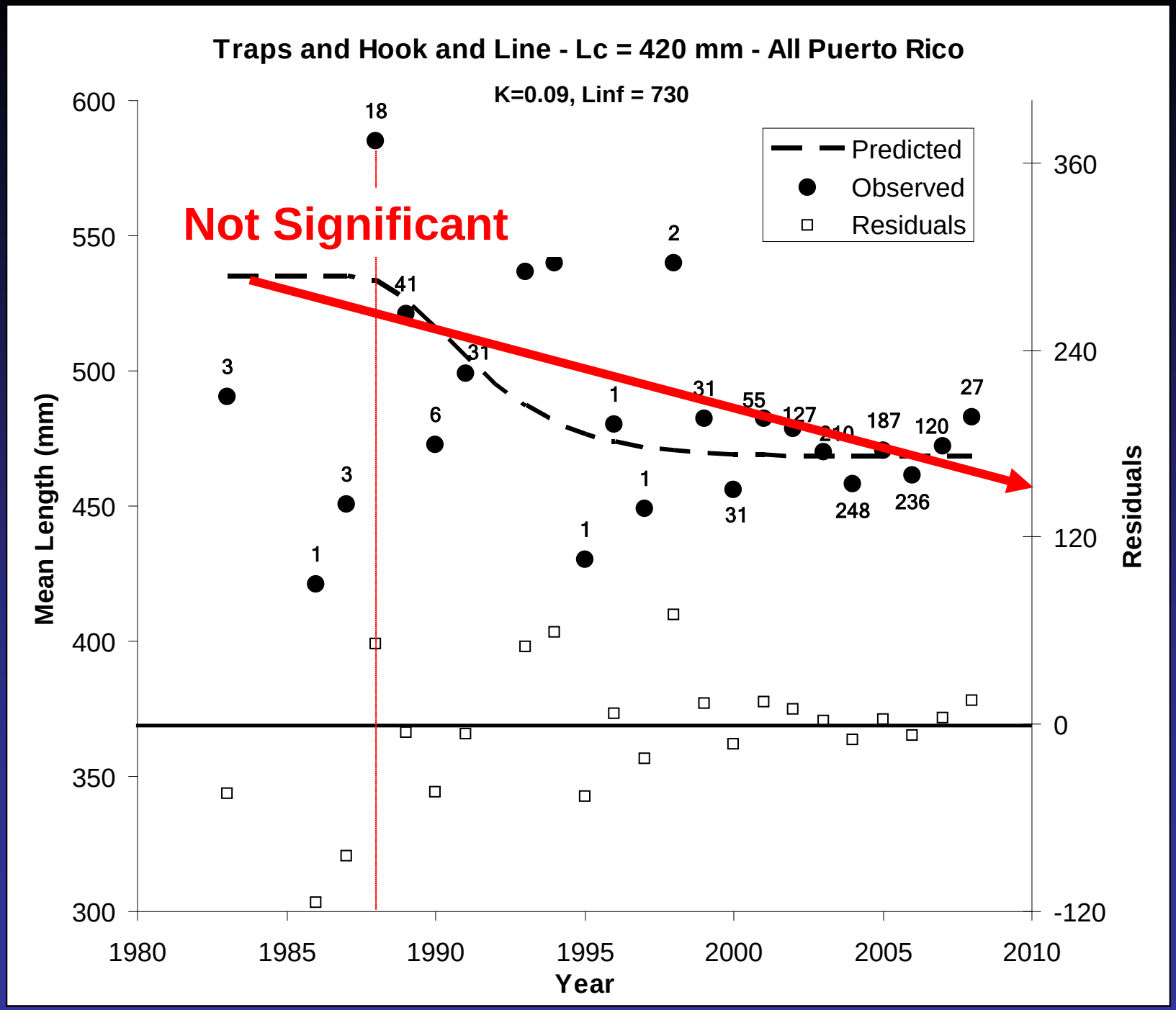



ISLAND = PUERTO RICO LC = 420 AREA = ALL PR GEAR1 = 610 GEAR2 = 345
LENGTH1_MM
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
1980
1990
2000
2010
YEAR
Hook and Line + Traps
All Island
Minimum Size of 420 mm
18
1
2
7
41
36
3
1
34
63
143
27
144
240
193
249
291
12
10
1
3
37
3
1

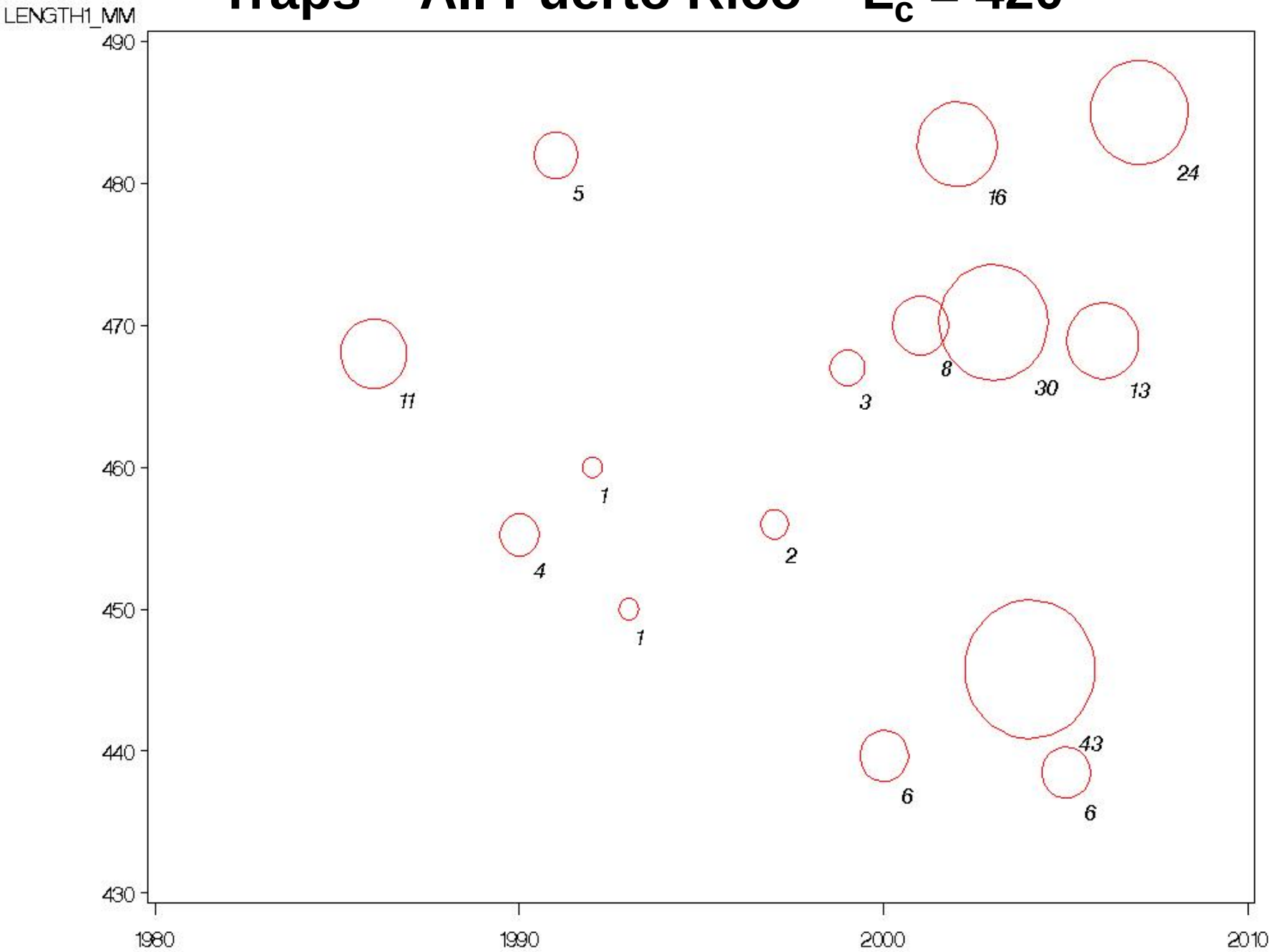
Applying Gedamke and Hoenig Method

(Detecting changes in Mortality)

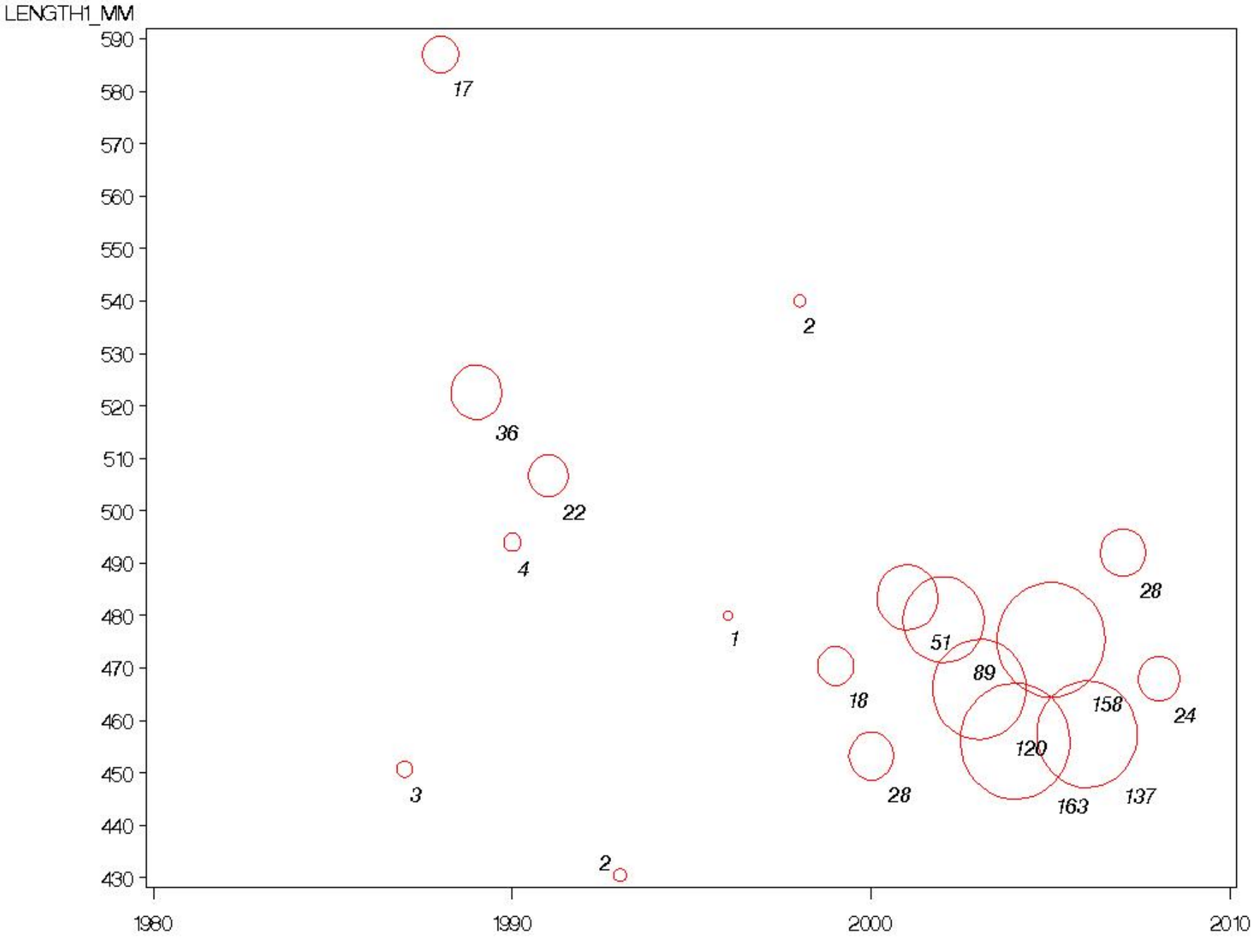

Traps and Hook and Line - Lc = 420 mm - All Puerto Rico
K=0.09, Linf = 730
0.15 --> 0.49
Predicted
Observed
Residuals
Mean Length (mm)
Residuals
Year
600
550
500
450
400
350
300
360
240
120
0
-120
1980
1985
1990
1995
2000
2005
2010
18
6
1
2
41
3
31
3
6
1
31
55
127
210
187
120
27
1
1
1
31
248
236


Traps and Hook and Line - Lc = 420 mm - All Puerto Rico
K=0.09, Linf = 730
Not Significant
Predicted
Observed
Residuals
Mean Length (mm)
Residuals
Year
600
550
500
450
400
350
300
360
240
120
0
-120
1980
1985
1990
1995
2000
2005
2010
18
2
41
3
31
6
1
31
55
127
187
120
27
3
1
1
1
31
248
236

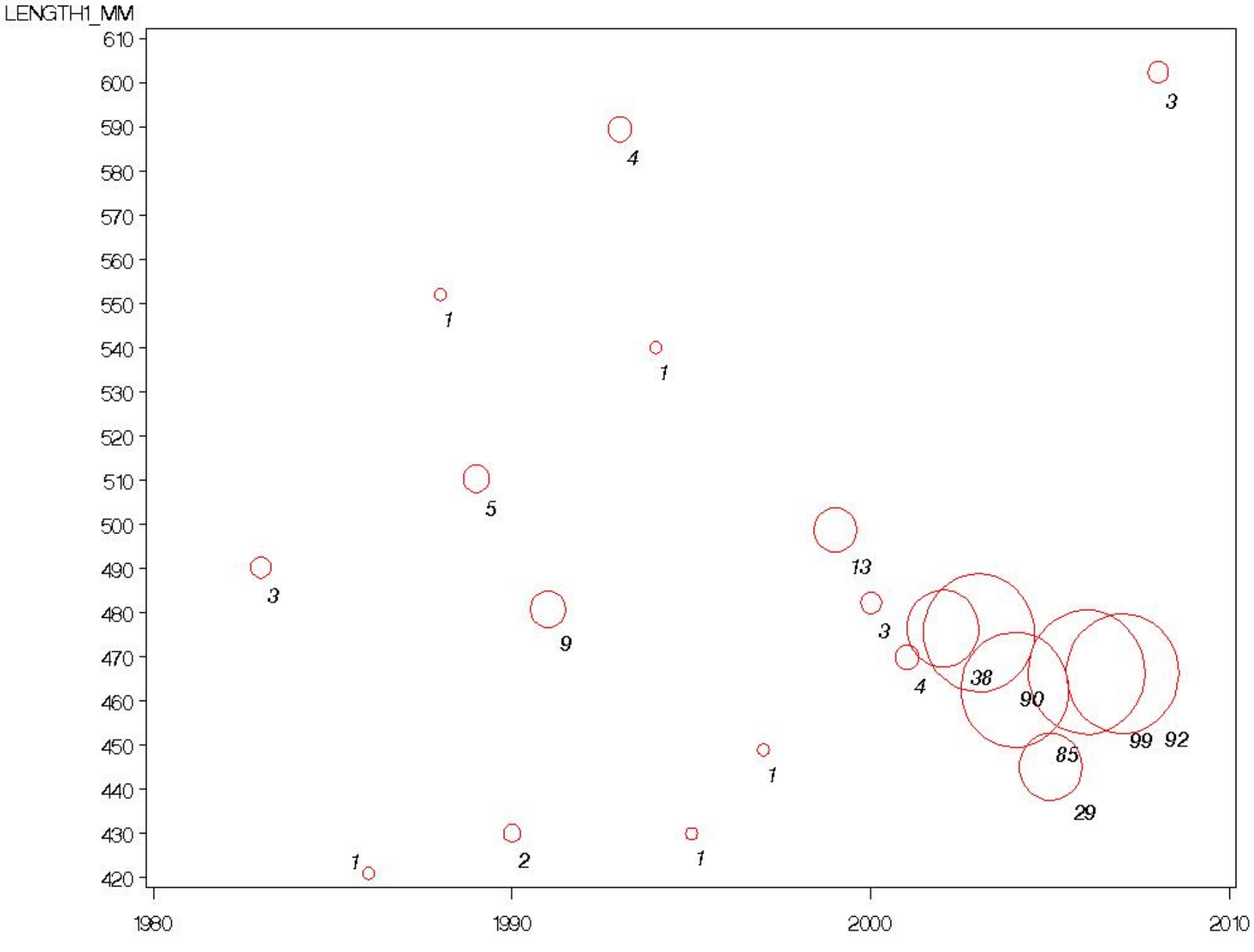
Traps – All Puerto Rico – L_c = 420



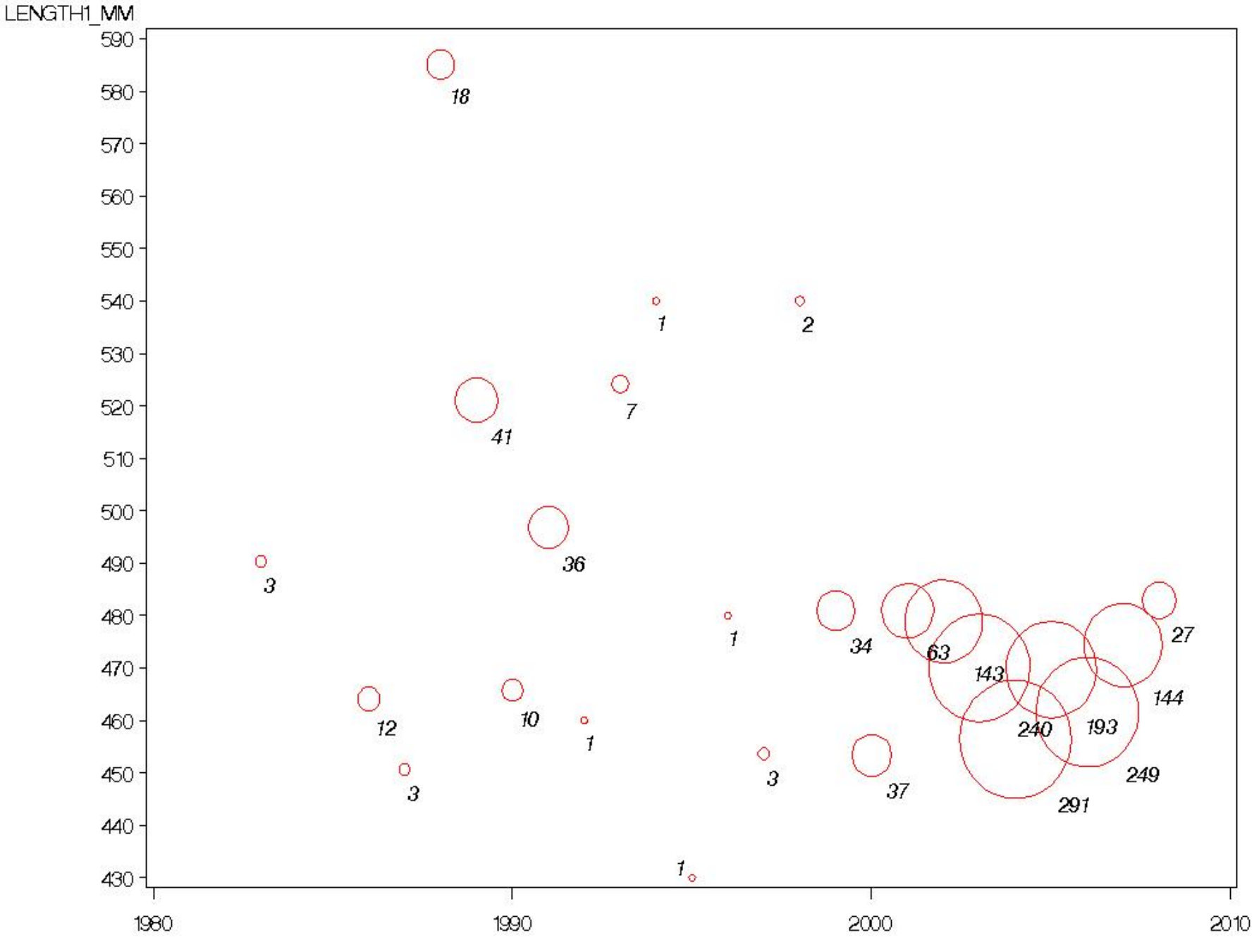
Hook and Line – WNW Only – L_c = 420

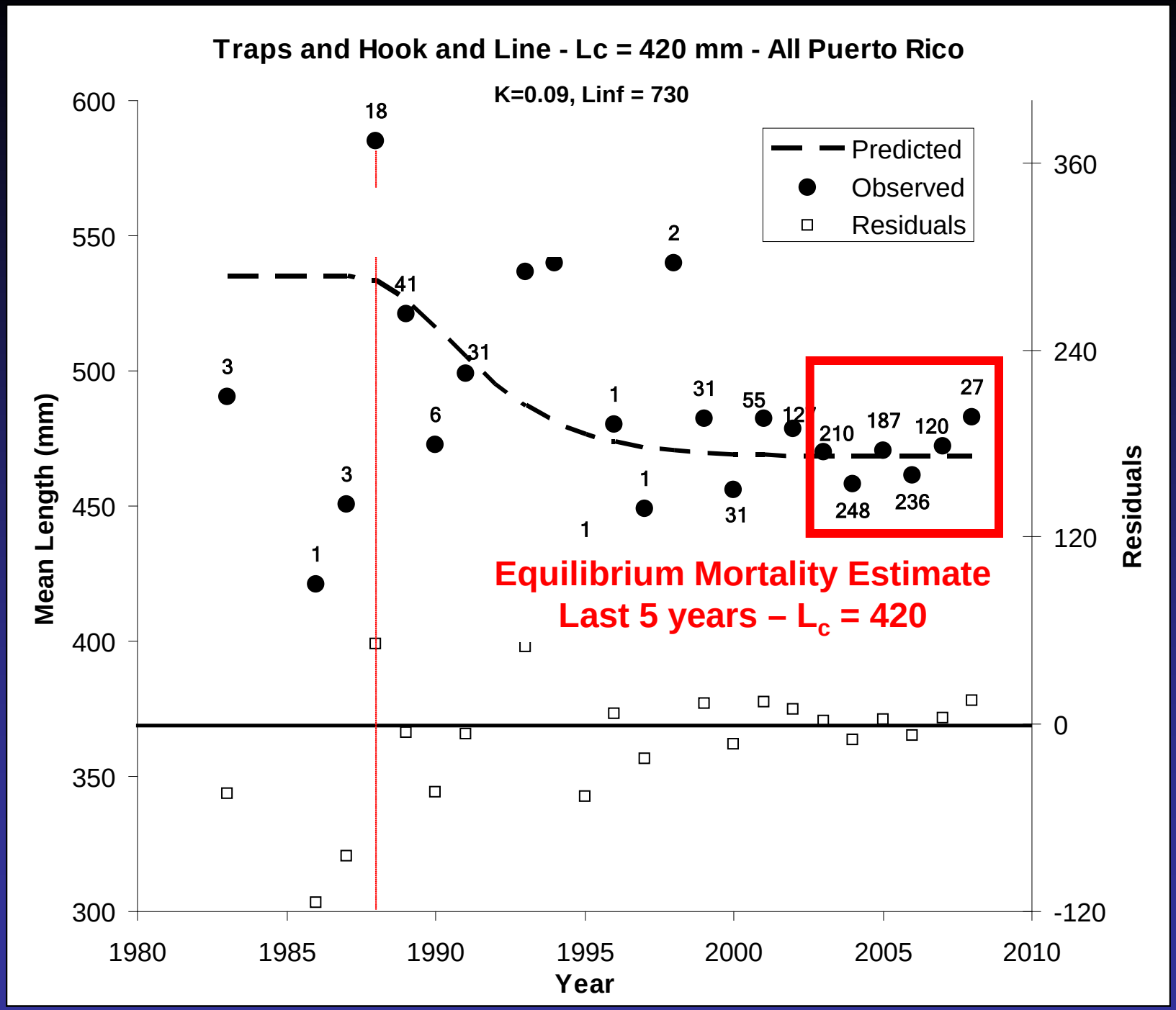


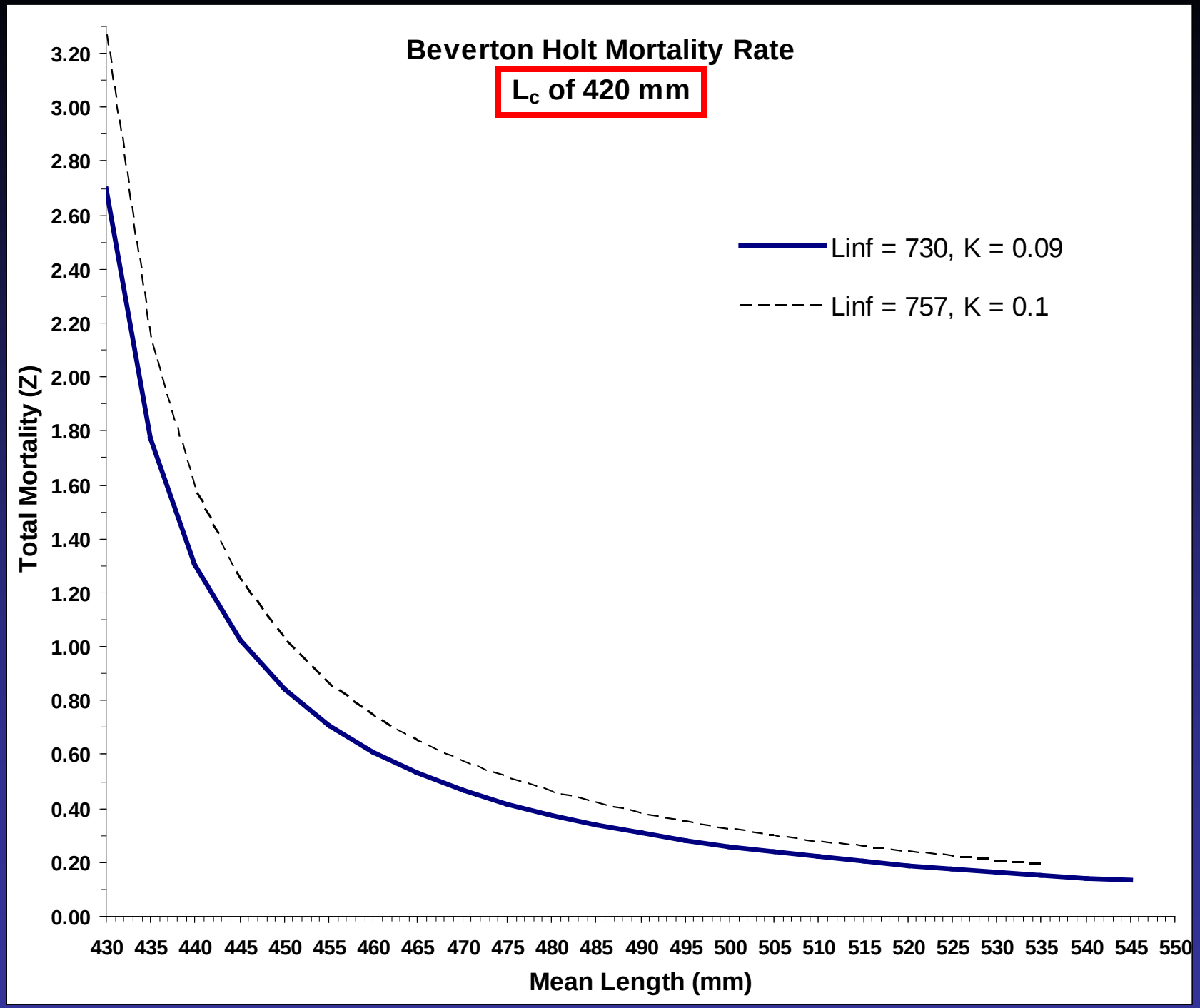
Hook and Line – No WNW – L_c= 420

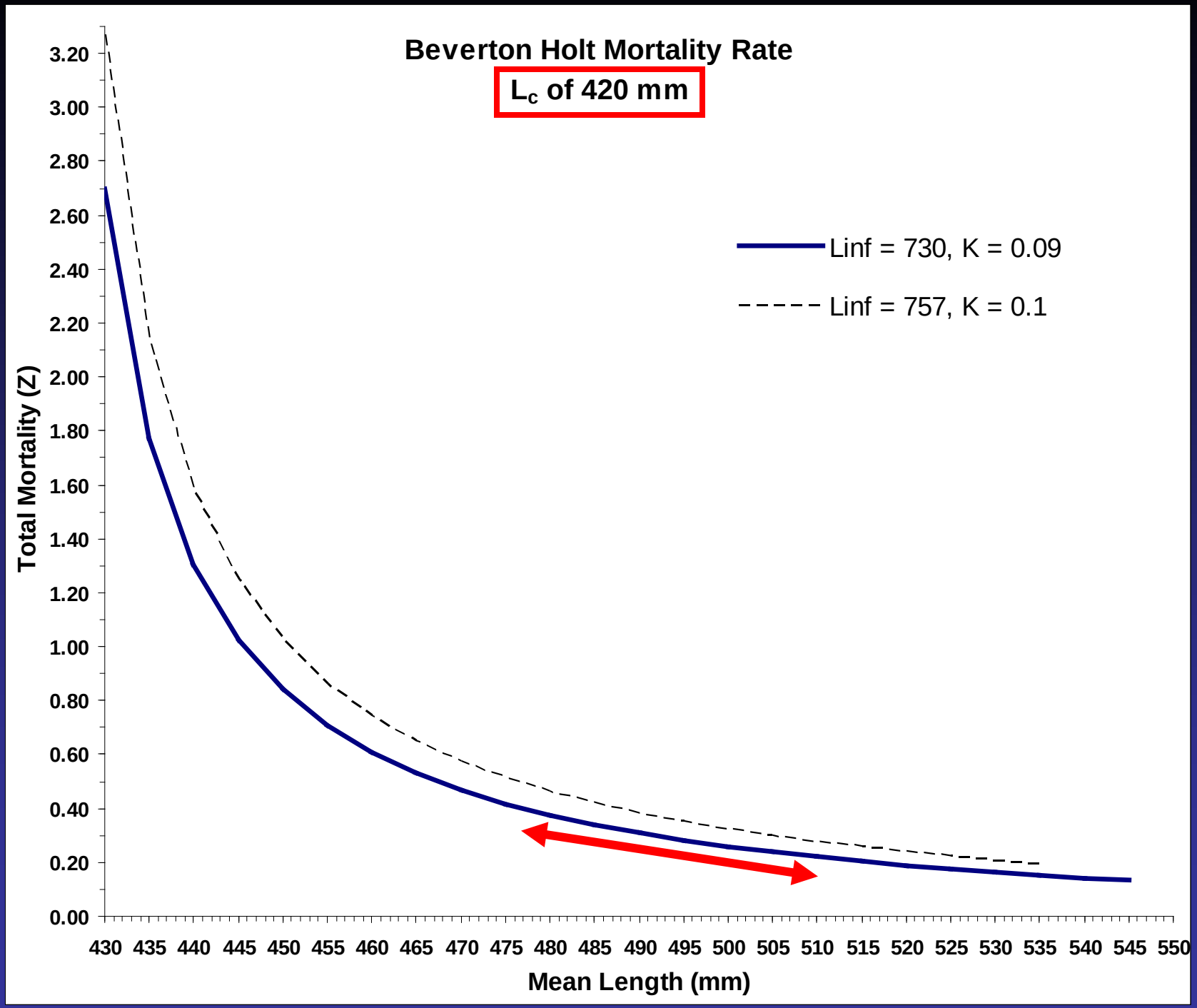


Hook and Line and Traps - All PR – L_c = 420




Traps and Hook and Line - Lc = 420 mm - All Puerto Rico
K=0.09, Linf = 730
Predicted
Observed
Residuals
Mean Length (mm)
Residuals
Year
600
550
500
450
400
350
300
360
240
120
0
-120
1980
1985
1990
1995
2000
2005
2010
18
41
2
3
31
6
1
31
55
127
210
187
120
27
3
1
3
1
1
31
248
236
Equilibrium Mortality Estimate
Last 5 years – Lc = 420


Beverton Holt Mortality Rate
L_c of 420 mm
Linf = 730, K = 0.09
Linf = 757, K = 0.1
Total Mortality (Z)
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550
Mean Length (mm)

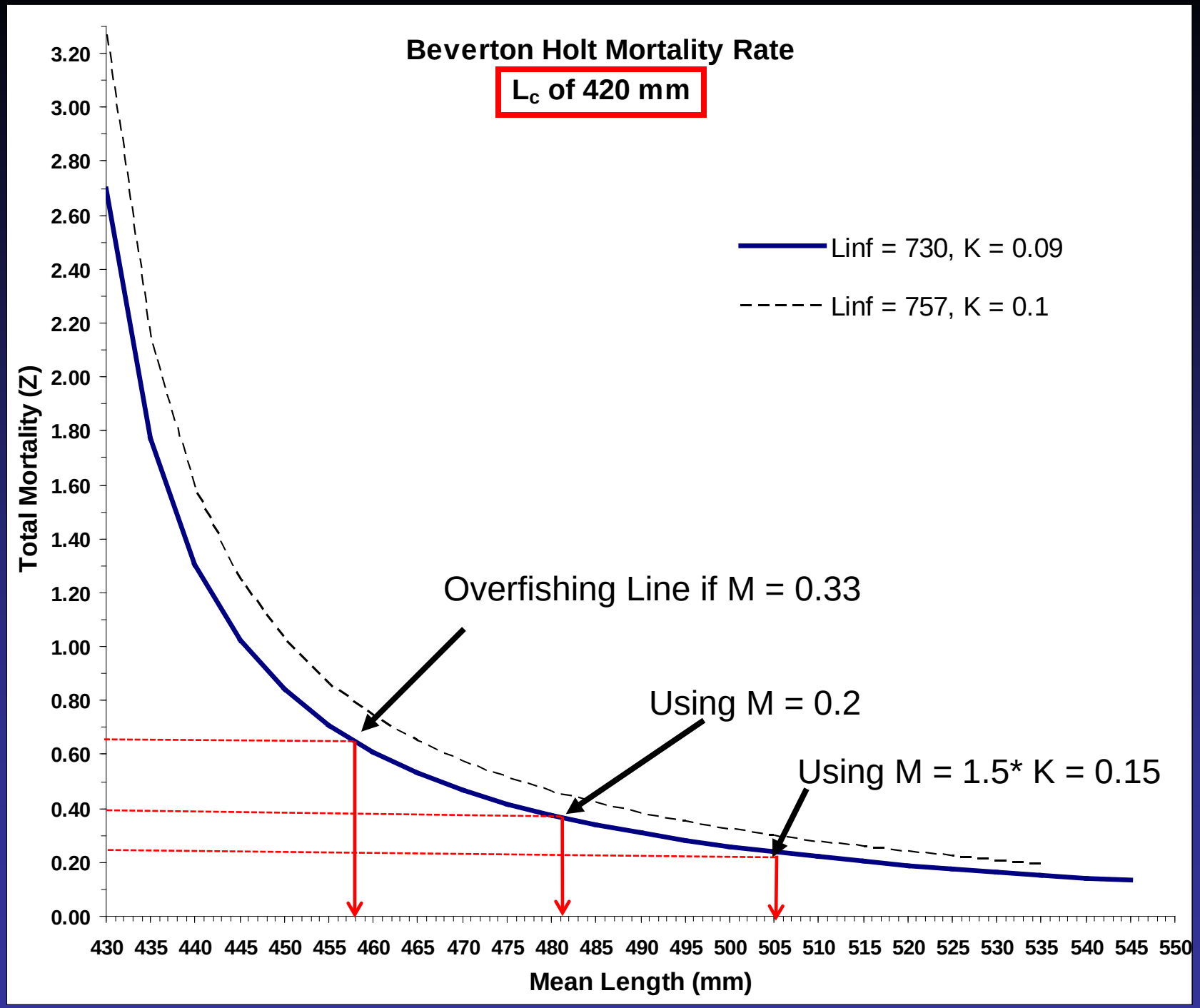

Beverton Holt Mortality Rate
L_c of 420 mm
Linf = 730, K = 0.09
Linf = 757, K = 0.1
Total Mortality (Z)
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550
Mean Length (mm)

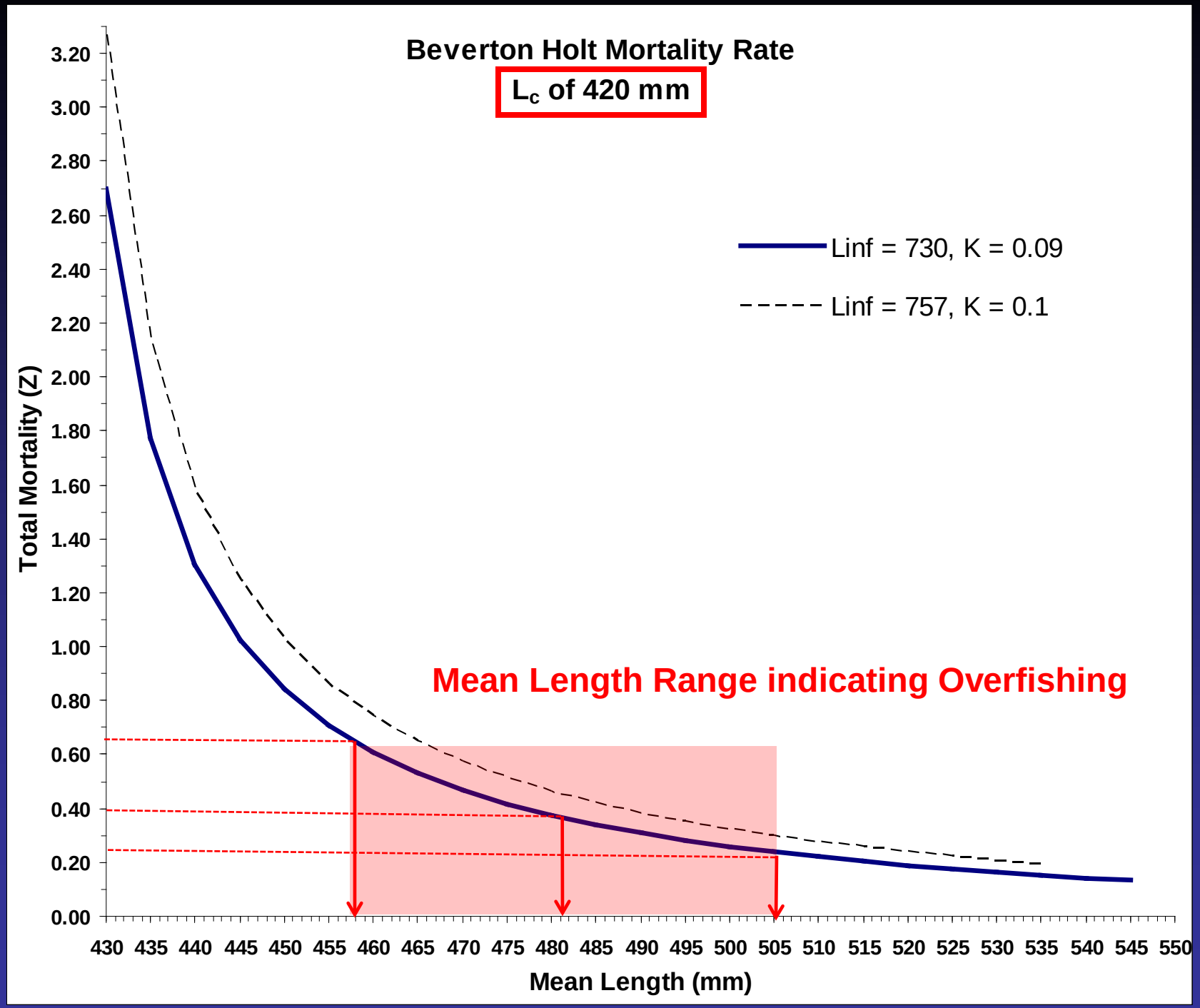
Natural Mortality Estimates

Results similar for available growth parameters (L_{inf} = 730, K= 0.09 and L_{inf} = 757, K = 0.1)

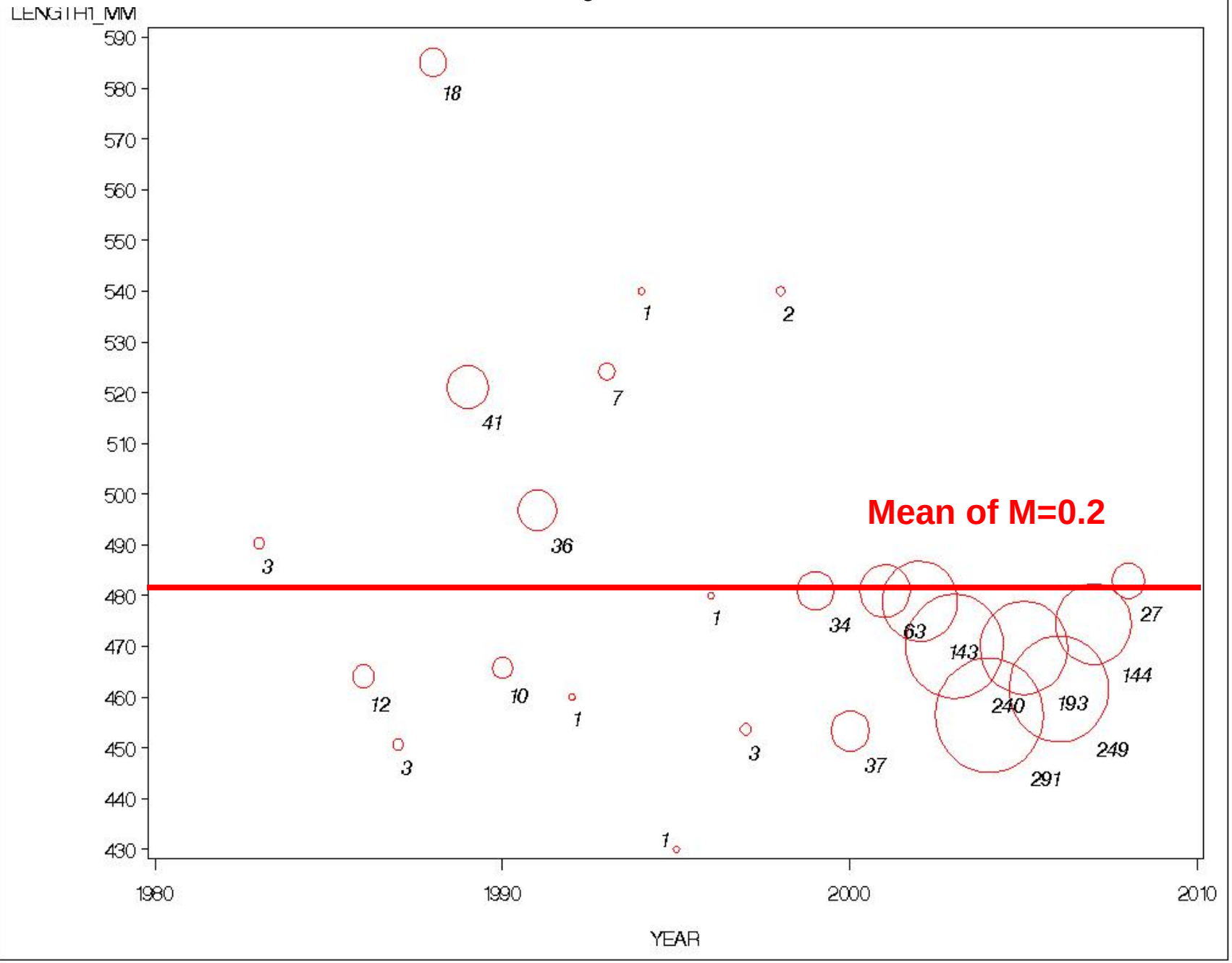
Hoenig (max. age 20)	Pauly (water temp) (26.5 C)	Chen & Watanabe (adult M)	Jensen (tmat) (8 yrs)	Jensen (K) (0.1)	Ault 2008 (Age Max) (9 yrs)
0.21	0.16	0.16	0.21	0.15	0.33

Mean of 0.2 yr^{-1}

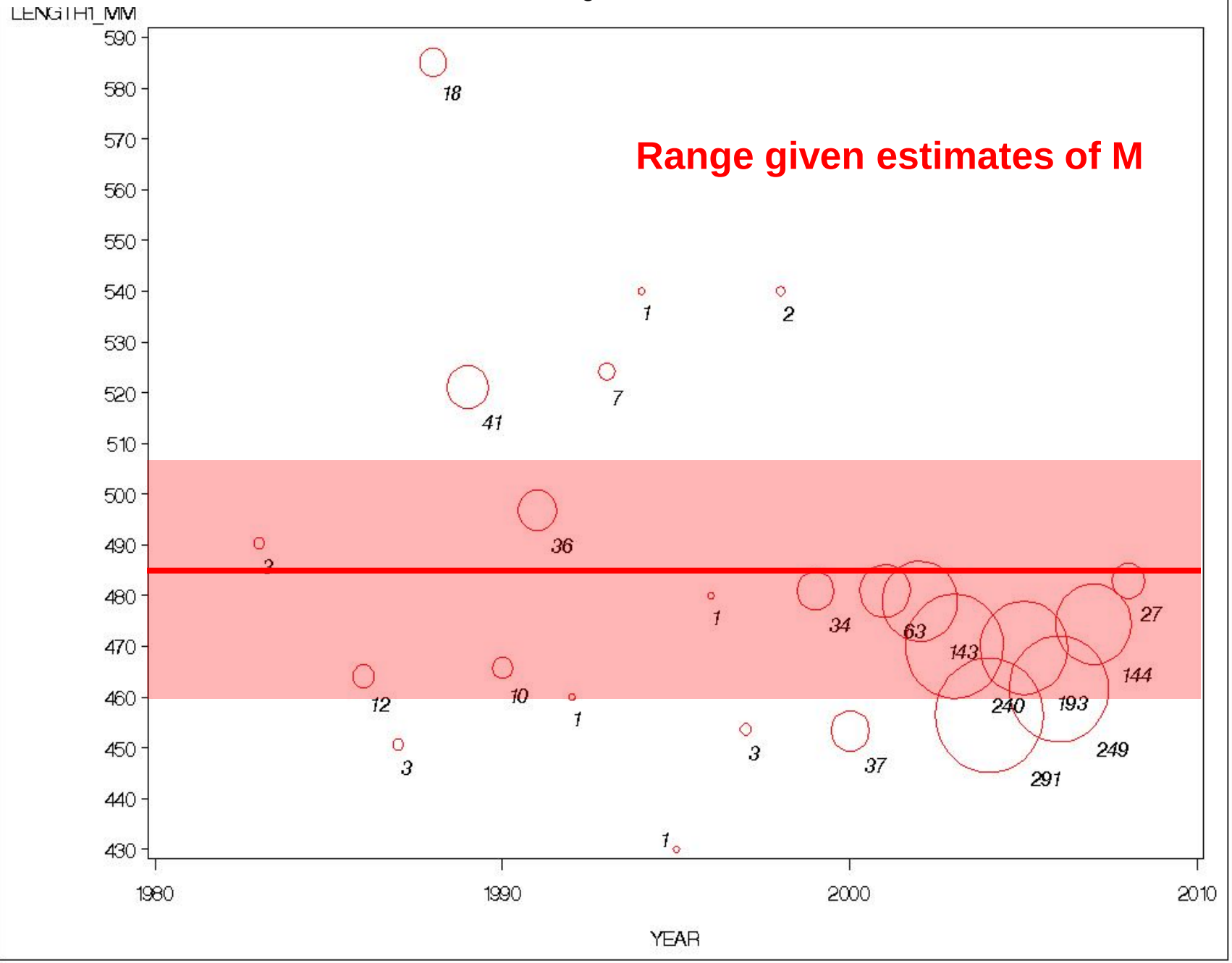

Beverton Holt Mortality Rate
L_c of 420 mm
Linf = 730, K = 0.09
Linf = 757, K = 0.1
Overfishing Line if M = 0.33
Using M = 0.2
Using M = 1.5* K = 0.15
Total Mortality (Z)
Mean Length (mm)
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550


Beverton Holt Mortality Rate
L_c of 420 mm
Linf = 730, K = 0.09
Linf = 757, K = 0.1
Mean Length Range indicating Overfishing
Total Mortality (Z)
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550
Mean Length (mm)

Mean lengths over time - L_c = 420 – Hook/Line and Traps



Mean lengths over time - L_c = 420 – Hook/Line and Traps



Results of Base Case Scenario (L_c = 420)
Mean Lengths Generated from all measured fish >= 2004

GEAR1	GEAR2	AREA	N	lc	Mean Length	uclm	lclm	K	Linf	BH - Z	uclm bh-z	lclm bhz
Hook and Line		NO_WNW	308	420	465	472	458	0.09	730	0.53	0.45	0.65
Hook and Line		NO_WNW	308	420	465	472	458	0.1	757	0.65	0.55	0.79
Hook and Line		WNW	510	420	465	470	460	0.09	730	0.53	0.47	0.61
Hook and Line		WNW	510	420	465	470	460	0.1	757	0.65	0.57	0.75
Hook and Line	Traps	ALL PR	904	420	464	468	460	0.09	730	0.54	0.49	0.60
Hook and Line	Traps	ALL PR	904	420	464	468	460	0.1	757	0.66	0.60	0.73
Traps		ALL PR	86	420	460	471	449	0.09	730	0.61	0.46	0.89
Traps		ALL PR	86	420	460	471	449	0.1	757	0.75	0.56	1.08

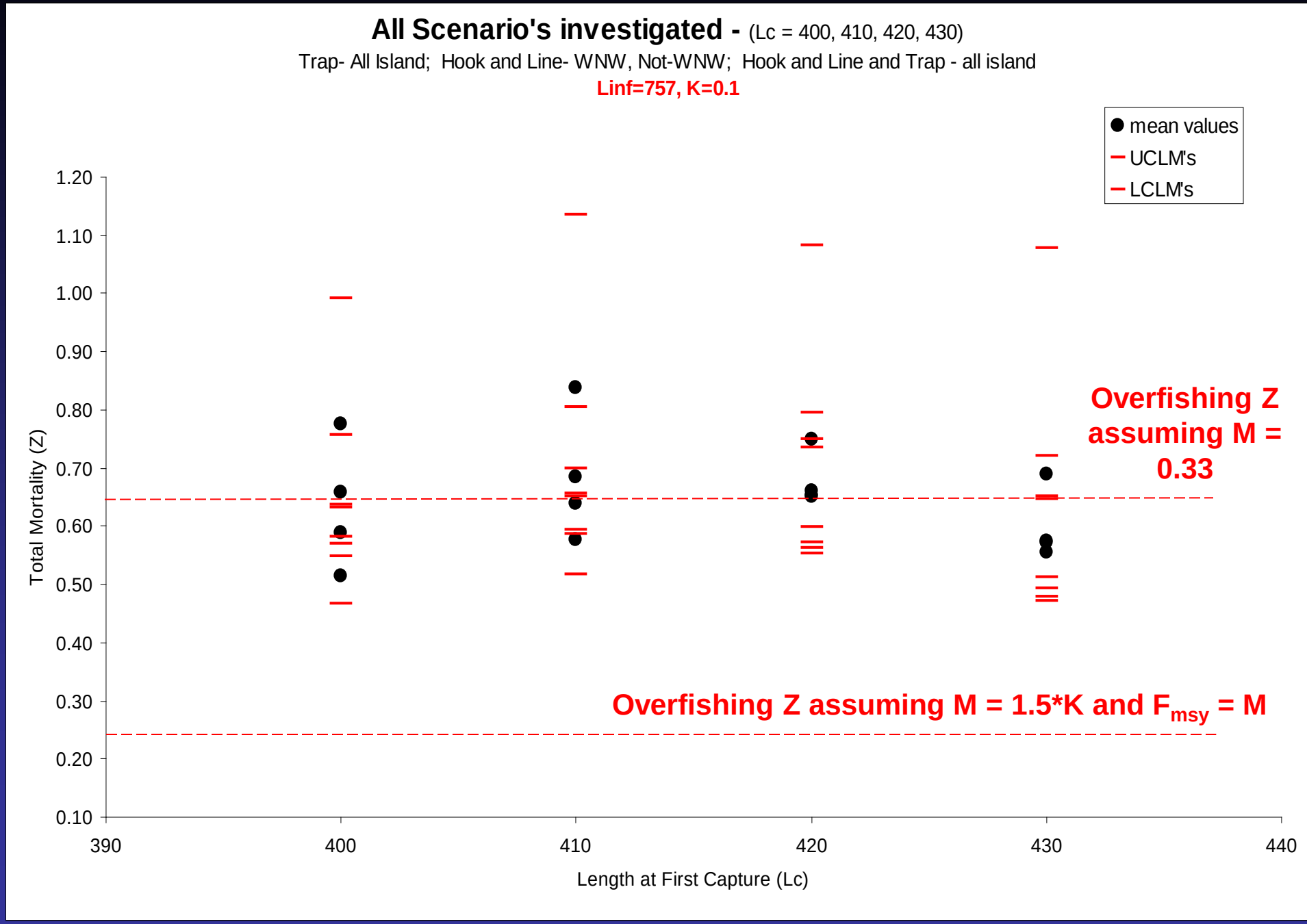
Hook and Line Only

Range of Z estimates from Mean Length = 0.53 → 0.66

Range from Confidence intervals = 0.45 → 0.79

Sensitivity Analysis

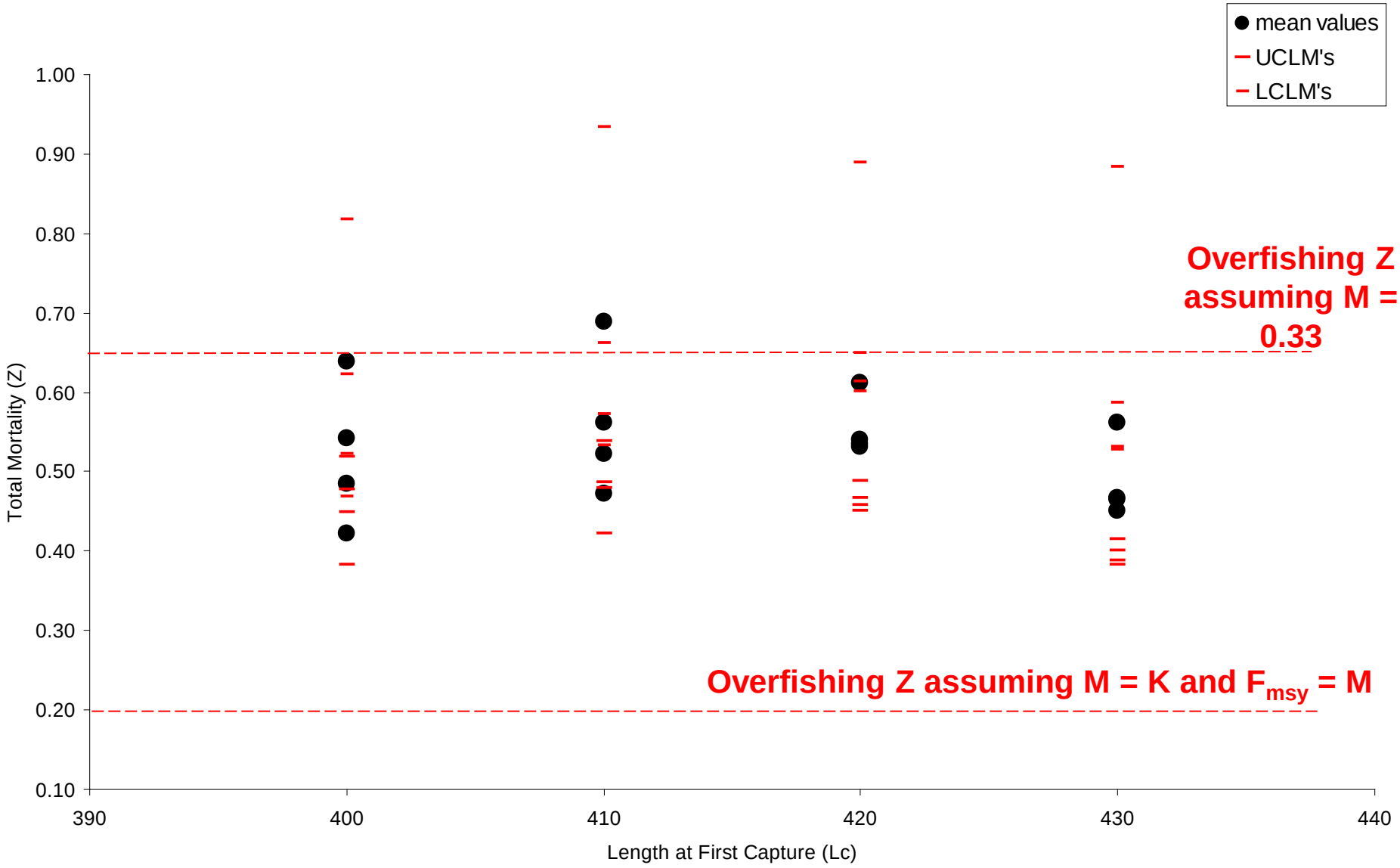
(selection of L_c, growth parameters, and uncertainty in Mean Lengths (95% CI's used)


All Scenario's investigated - (Lc = 400, 410, 420, 430)
Trap- All Island; Hook and Line- WNW, Not-WNW; Hook and Line and Trap - all island
Linf=757, K=0.1
mean values
UCLM's
LCLM's
Total Mortality (Z)
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Overfishing Z assuming M = 0.33
Overfishing Z assuming M = 1.5*K and F msy = M
390
400
410
420
430
440
Length at First Capture (Lc)

All Scenario's investigated - (Lc = 400, 410, 420, 430)

Trap- All Island; Hook and Line- WNW, Not-WNW; Hook and Line and Trap - all island

Linf=730, K=0.09



Conclusions

- **Change in size-composition of TIP data resulted from the minimum size regulation. Most fish (>90%) were still below the 16” min size and could not be used in length based time series analysis (i.e. lower sample sizes for entire time series)**
  - **Note: effect of management measures on fishery-dependent data**
  - **Minimum size regulation not appropriate for this fishery**
  - **DNER move to a closed season is likely to be more effective**

- **The size-composition appears to have changed little from 1983 to 2002, implying that this historic level of F might not had a significant impact on the stock and may have been sustainable.**

- **The revised analyses suggests that the current F is higher than the F=M proxy for F_{msy}, however lower sample sizes results in considerable uncertainty and inability to provide a defensible current status determination or F_{cur}/F_{msy} scalar.**

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