Back to basics or back to the tree? (R.Lewis)

I Catches at length preliminary analyses

II Tagging and growth

III Length based cohort analysis and fishing patterns

IV Tagged fish recapture and VPAs

Some guideropes

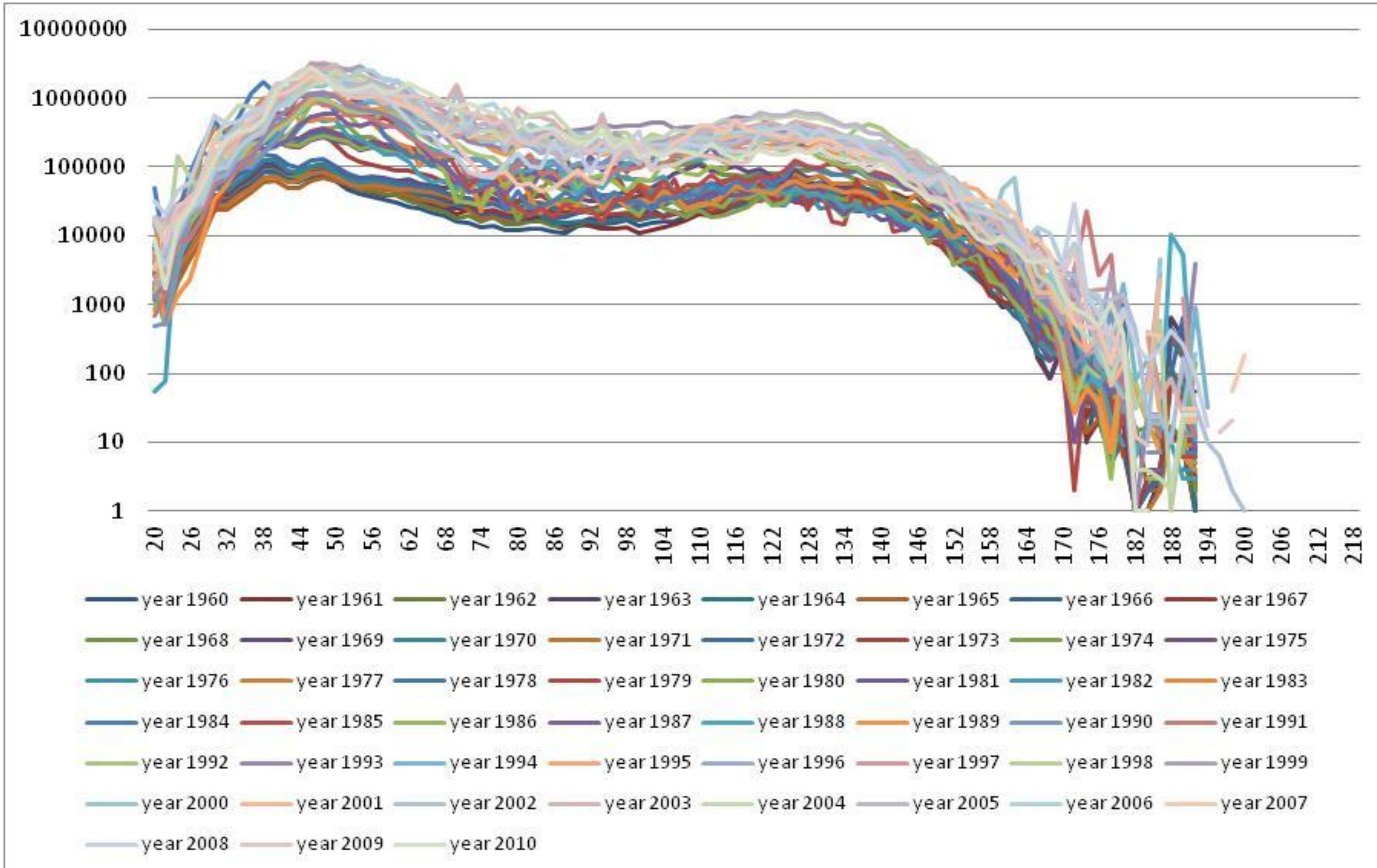
- The Kiss principle applied to specific parameters estimated on the basis of specific data
- Full recruitment beyond a critical length hypothesis
- « quasi » equilibrium situations
- Cross-checking and combination between catches at length and tagging results
- Food for thought >> assessment

I Catches at length analyses

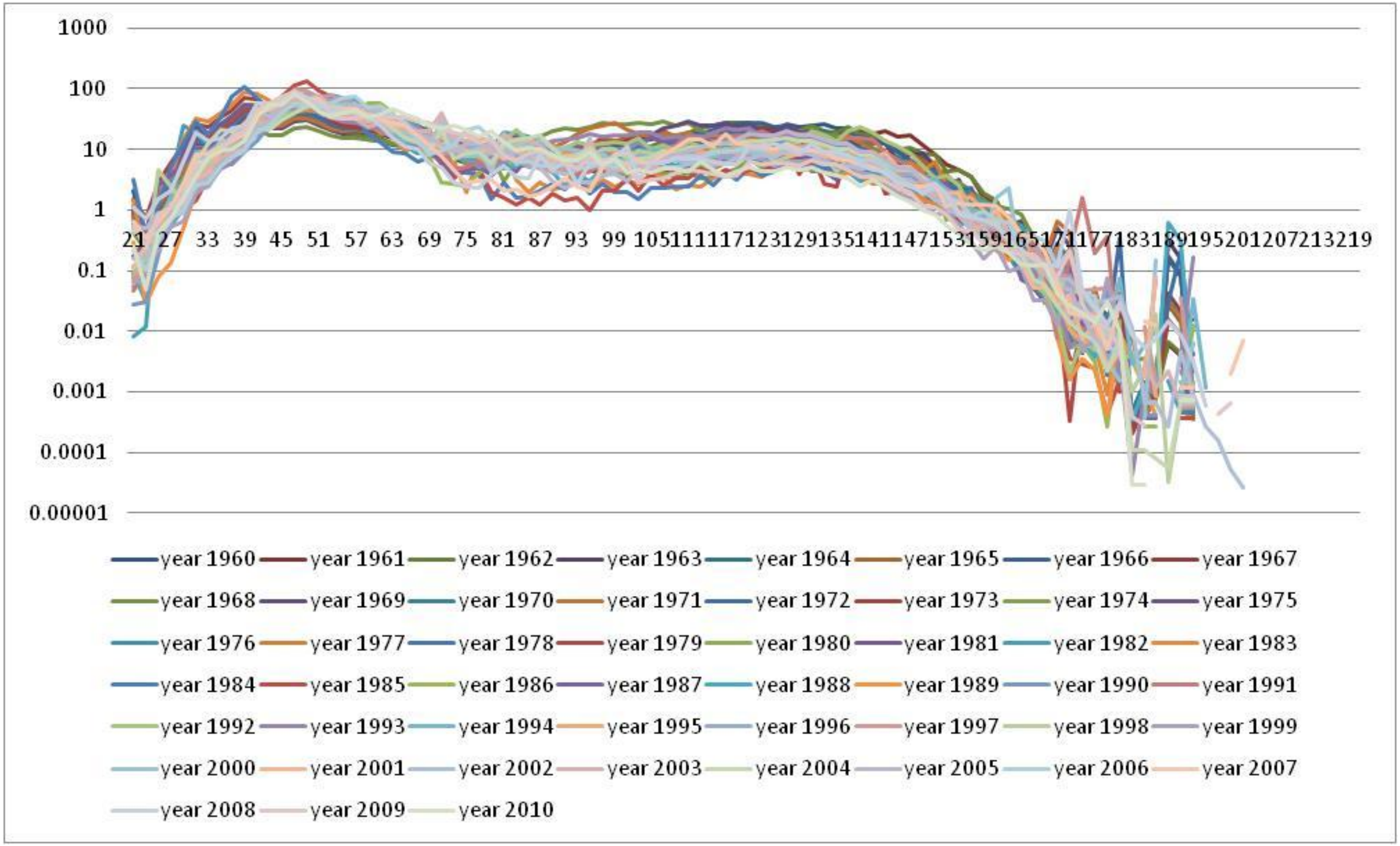
- Size ranges and total catches in number per year and per size ranges
- Catches at length for very large fish (>130)
- Why 130?
- Key parameters $L\infty$ and $\theta = Z/K$; θ threshold value(s)
- Moment based statistics : Beverton§Holt’s and Powell’s techniques

Yellow fin overall catches at length per year

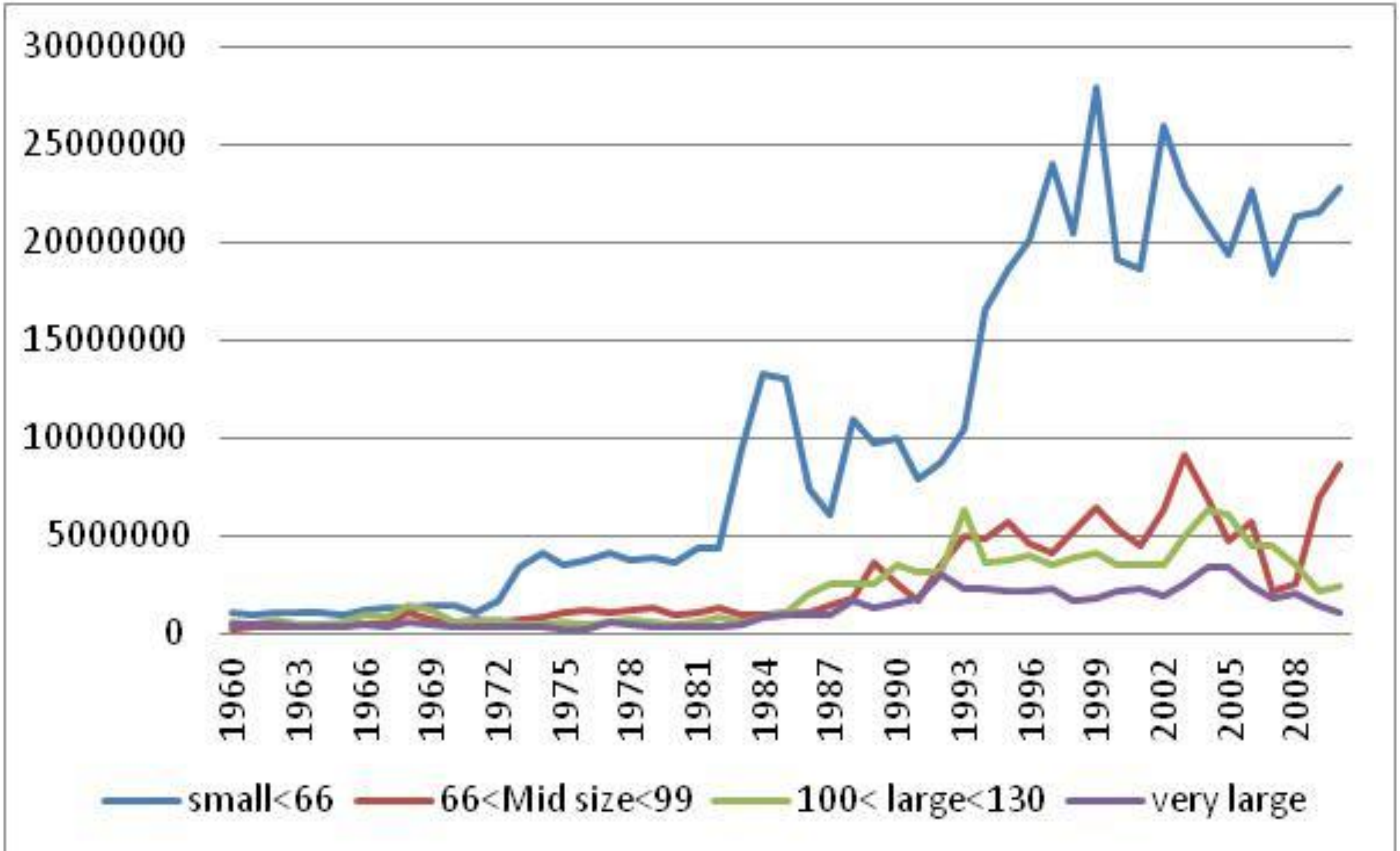
(logarithms)



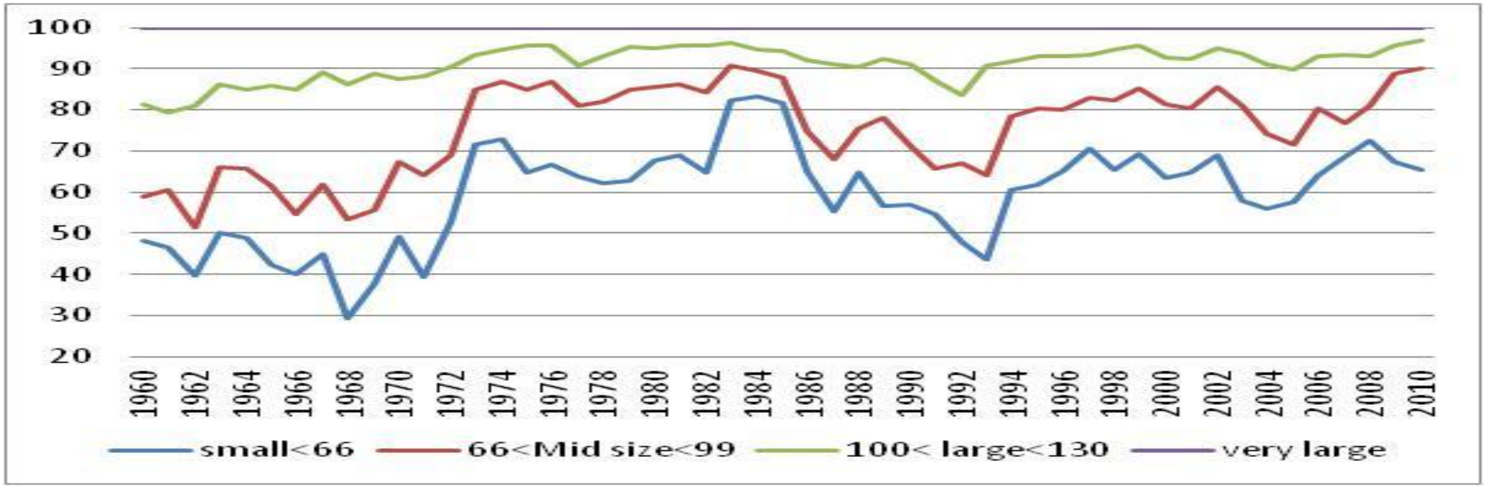
Relative frequencies (thousands)

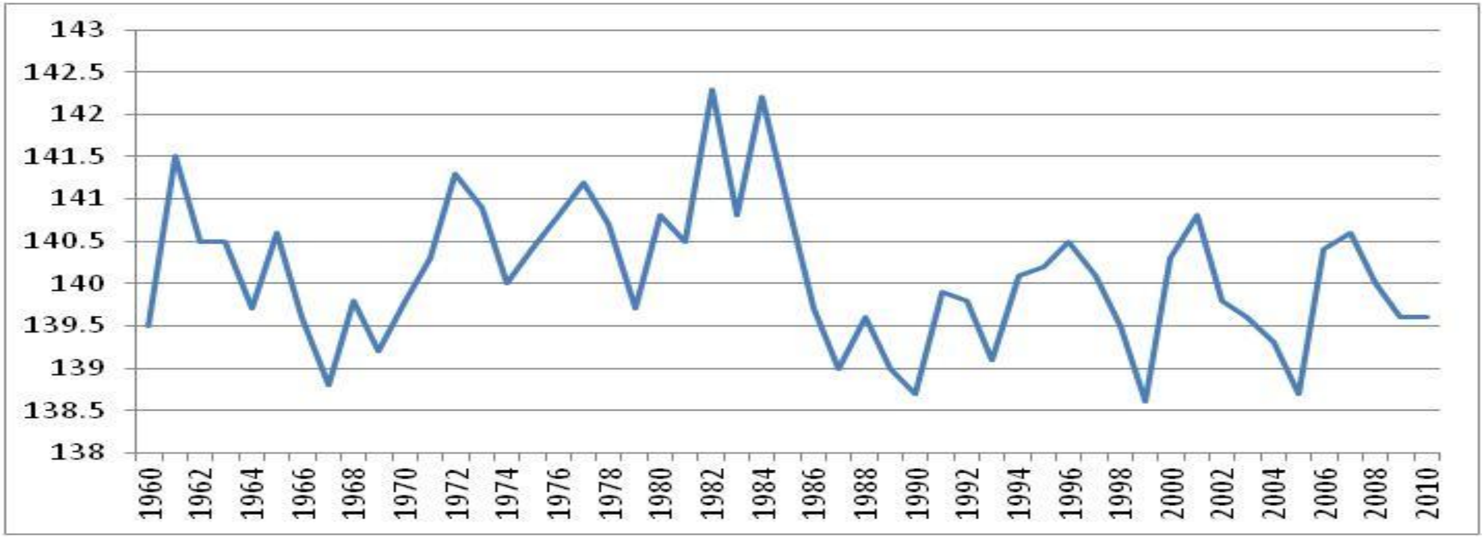


Time series of catches per size range



Cumulative percentages and average length of very large yellowfins





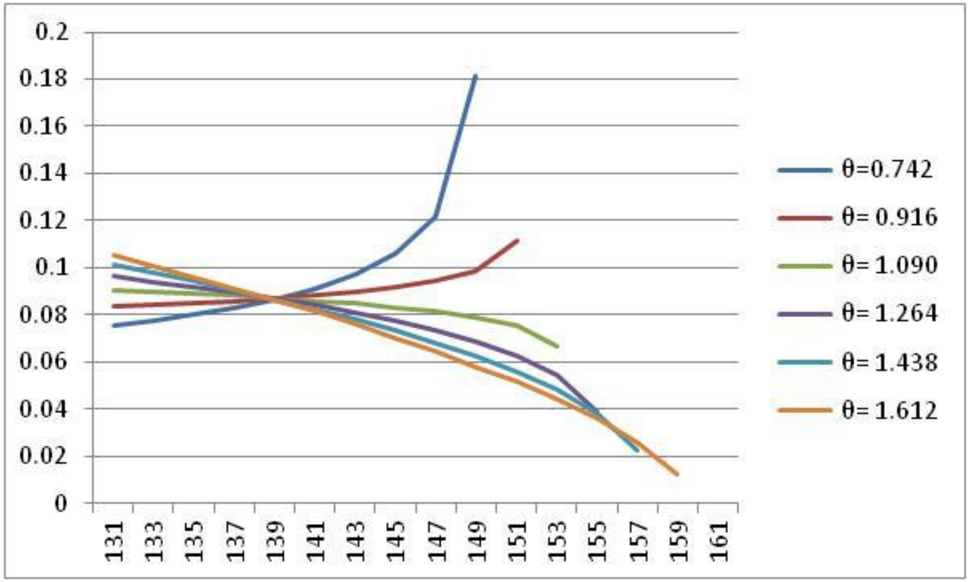
Catches at length above Lc (= 130 cms) under the hypotheses of
(1) full recruitement (constant F and M and of course Z)
(2) Von Bertalanffy growth curve (K,L∞)

c(l) = density for length l ; θ = Z/F

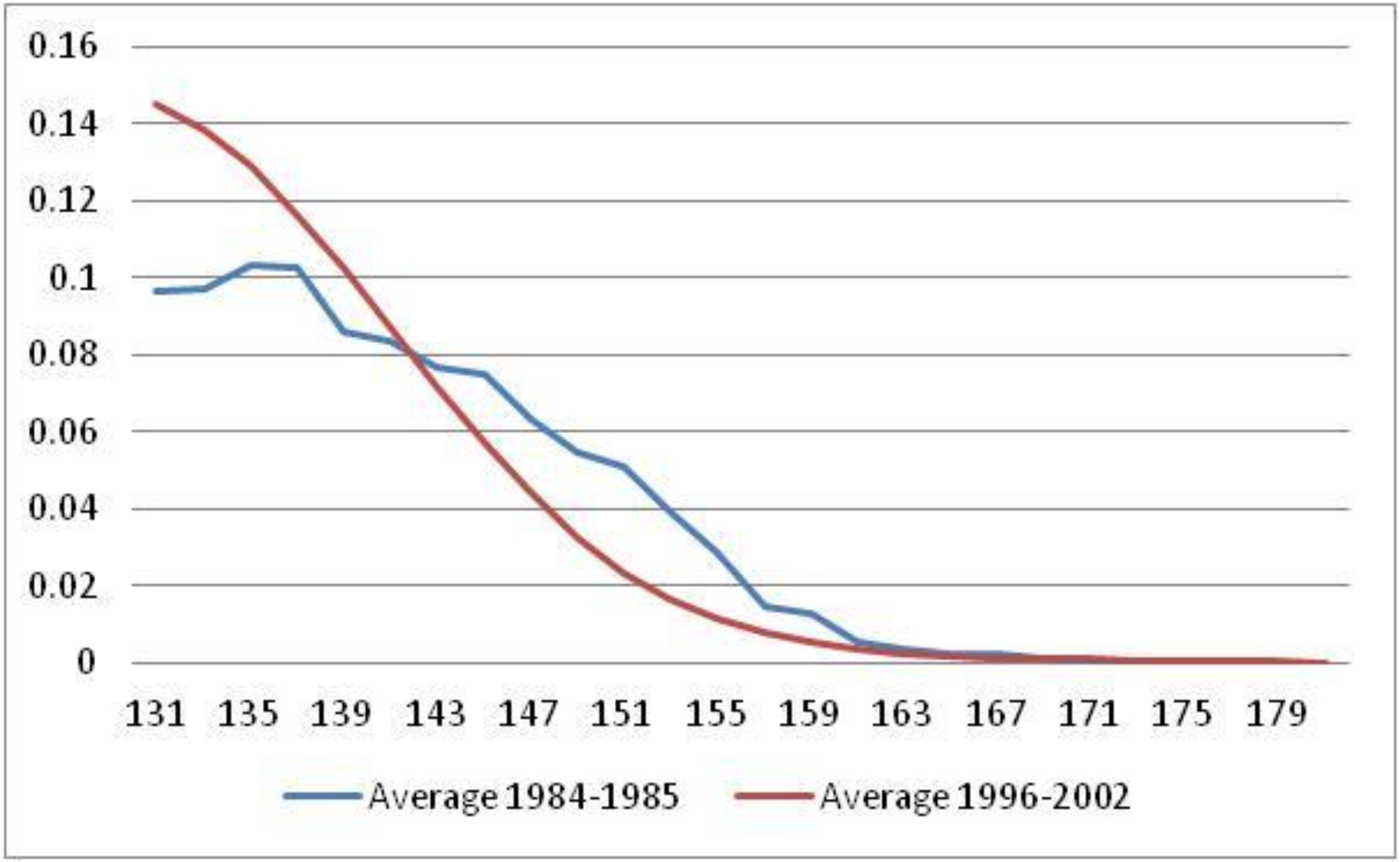
$$\boxed{\mathbf{c}(\ell) = \theta \frac{(\mathbf{L}\infty - \ell)^{\theta-1}}{(\mathbf{L}\infty - \mathbf{L_c})^{\theta}}}$$

$$\boxed{Fc(\ell) = 1 - \frac{(\mathbf{L}\infty - \ell)^{\theta}}{(\mathbf{L}\infty - \mathbf{L_c})^{\theta}}}$$

Examples and 1 as a major threshold value for θ



Comparisons between (1) 1984-1985 (2) 1996-2002 for purse seiners



Beyond the visual analysis: fitting curves using moments techniques

- **Bevertonš holt : The predicted average length for given K and L∞ should be equal to the observed one**

  Robust formula as for individual variability in growth parameters

- **Powell: observed means and variances should be equal to the observed one.**

Variability in individual L∞ can have a real influence, and must be taken into account unless Lc<<<<L ∞

Beverton $ Holt formulas

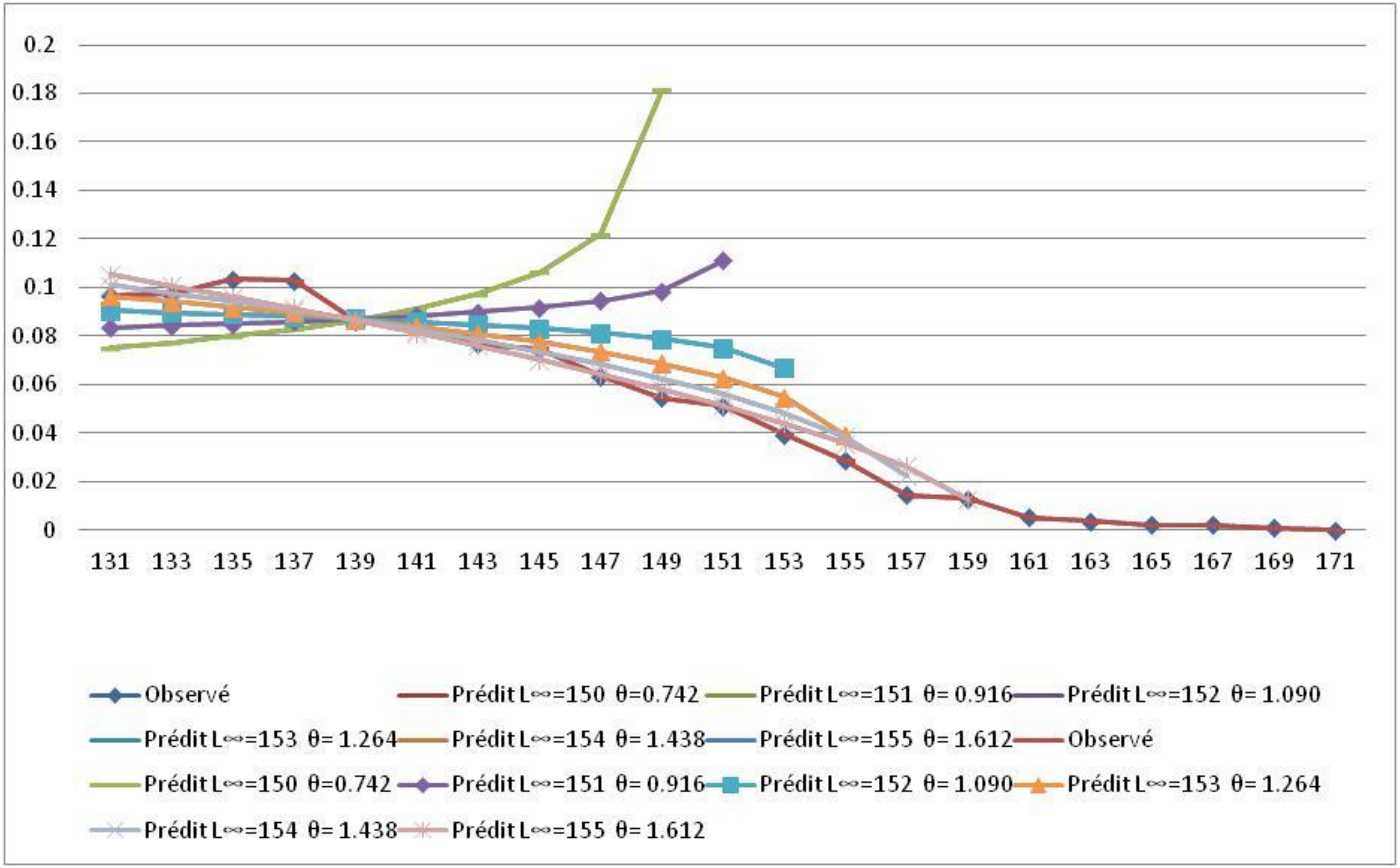
$$\boxed{\theta = \frac{Z}{K} = \frac{L\infty - \bar{\ell}}{\bar{\ell} - \ell^{+}}}$$

$$\boxed{Z = K\frac{L\infty - \bar{\ell}}{\bar{\ell} - \ell^{+}}}$$

Results from Beverton $ Holt formulas

Linf	Teta 1984-1985	Teta 1996-2002
150	**0.74**	1.23
152	**0.92**	1.45
154	1.09	1.68
156	1.26	1.90
158	1.44	2.12
160	1.51	2.34

Predicted histograms for various values for L∞ and the associated K according to B § H



Powell’s revised technique

	1983-1985		1996-2002	
σ indiv. L∞	L∞	θ	L∞	θ
0	161	1.7	166	3
1	161	1.7	166	3
2	160	1.6	166	3
3	160	1.6	165	2.9
4	159	1.5	164	2.8
5	157	1.4	162	2.6
6	156	1.2	160	2.4
7	153	1	157	2
8	146	0.4	151	1.3

Possible departure from the full recruitment hypothesis

If beyond Lc =130

- F/Z increases with l , real $L\infty$ < Powell's estimate, real θ > 160 Powell's estimate

- F/Z decreases with l , real $L\infty$ > Powell's estimate, real θ < 160 Powell's estimate

Main conclusions for section 2

- $150 < L\infty < 160$
- For the following calculations $L\infty = 155$
- Associated θ close to 1.2 in 1984-1985 , and 1.8 in 1996-2002 (if growth parameters have not changed this would imply that M was and remains predominant)
- Probably better for defining ranges than for point estimates
- Beware of the full recruitment hypothesis
- Catches at length per sex would significantly help
- As for growth one may wonder whether instead of attempts to use all data for fitting and life long groth curve it would not be enought to use tagging results for fish tagged at a lenght > 70 cms + length histograms beyond 130 cms, length modes for the smallest fish and some key results for defining the transition nrange between the two stanzas (This is real provocation)

III Tagging results and growth

- The key formula
- Only big Yf (last stanza)

- Histograms of individual apparent L∞ for a given value of K

- Overall relation ships between K and the corresponding average L∞

The basic formula

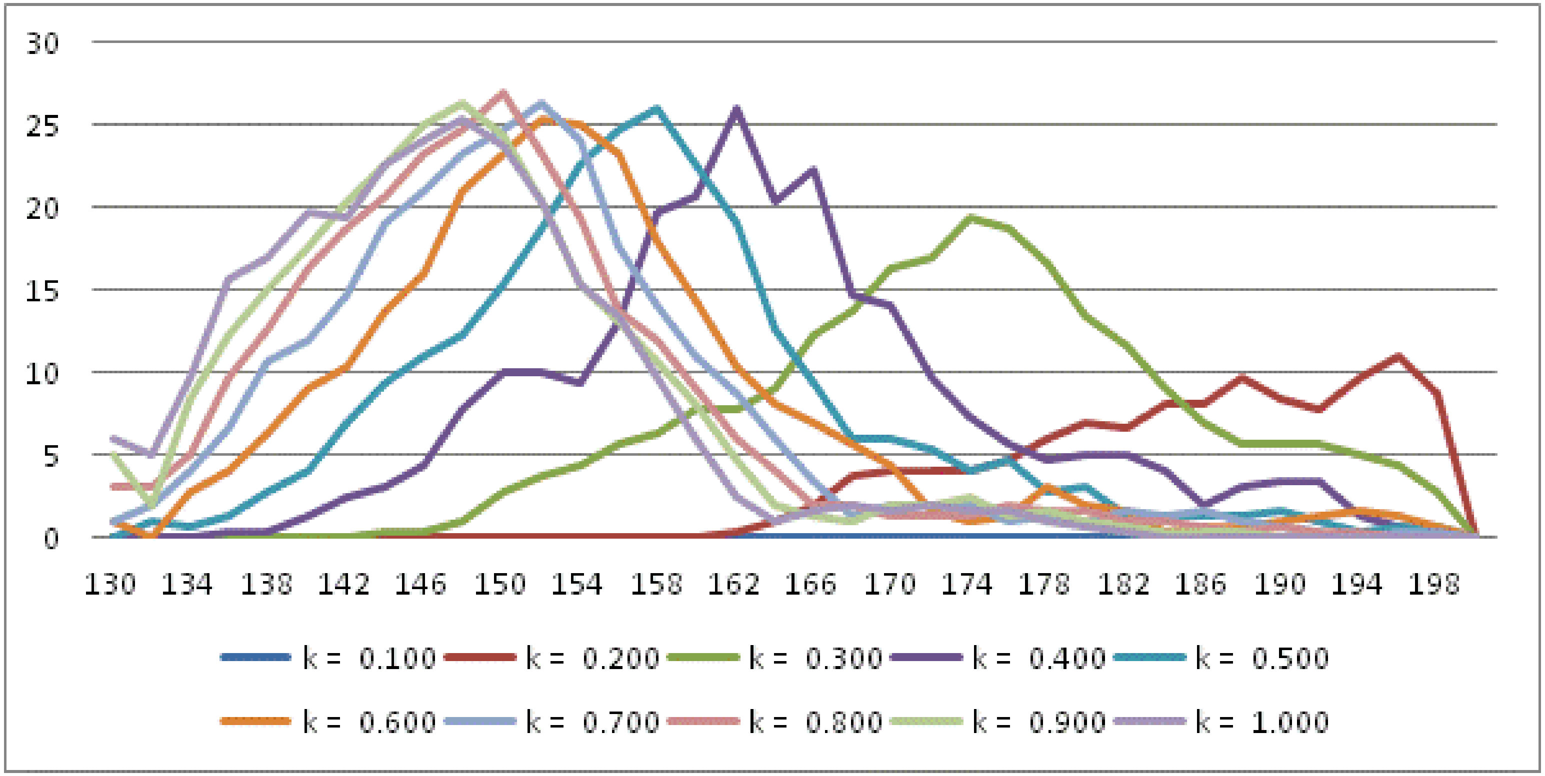
$$L\infty = \frac{l_2 - l_1 e^{-K\Delta}}{1 - e^{-K\Delta}}$$

l1 = length at tagging

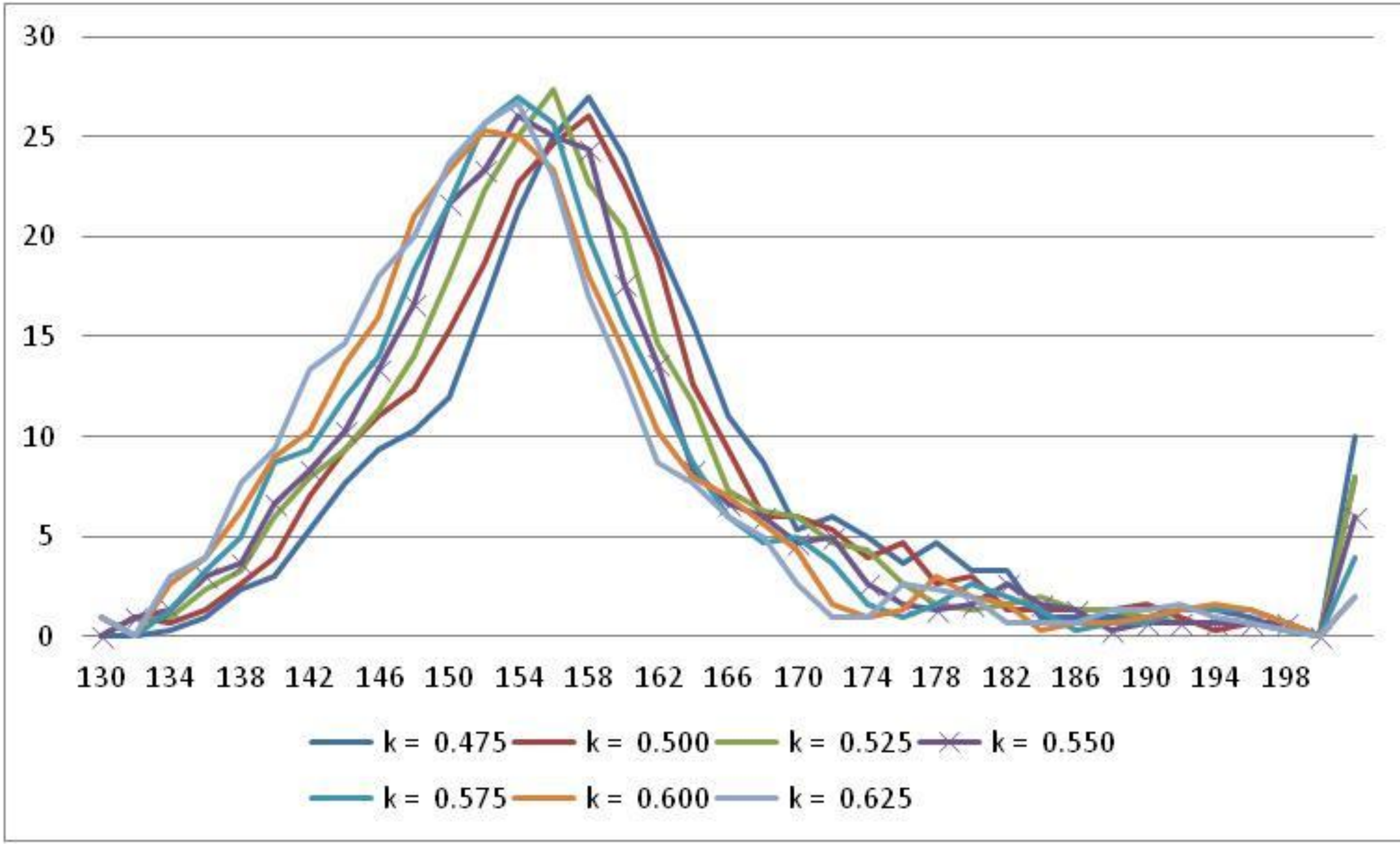
l2 = length at recapture

$$\Delta = time - at - liberty$$

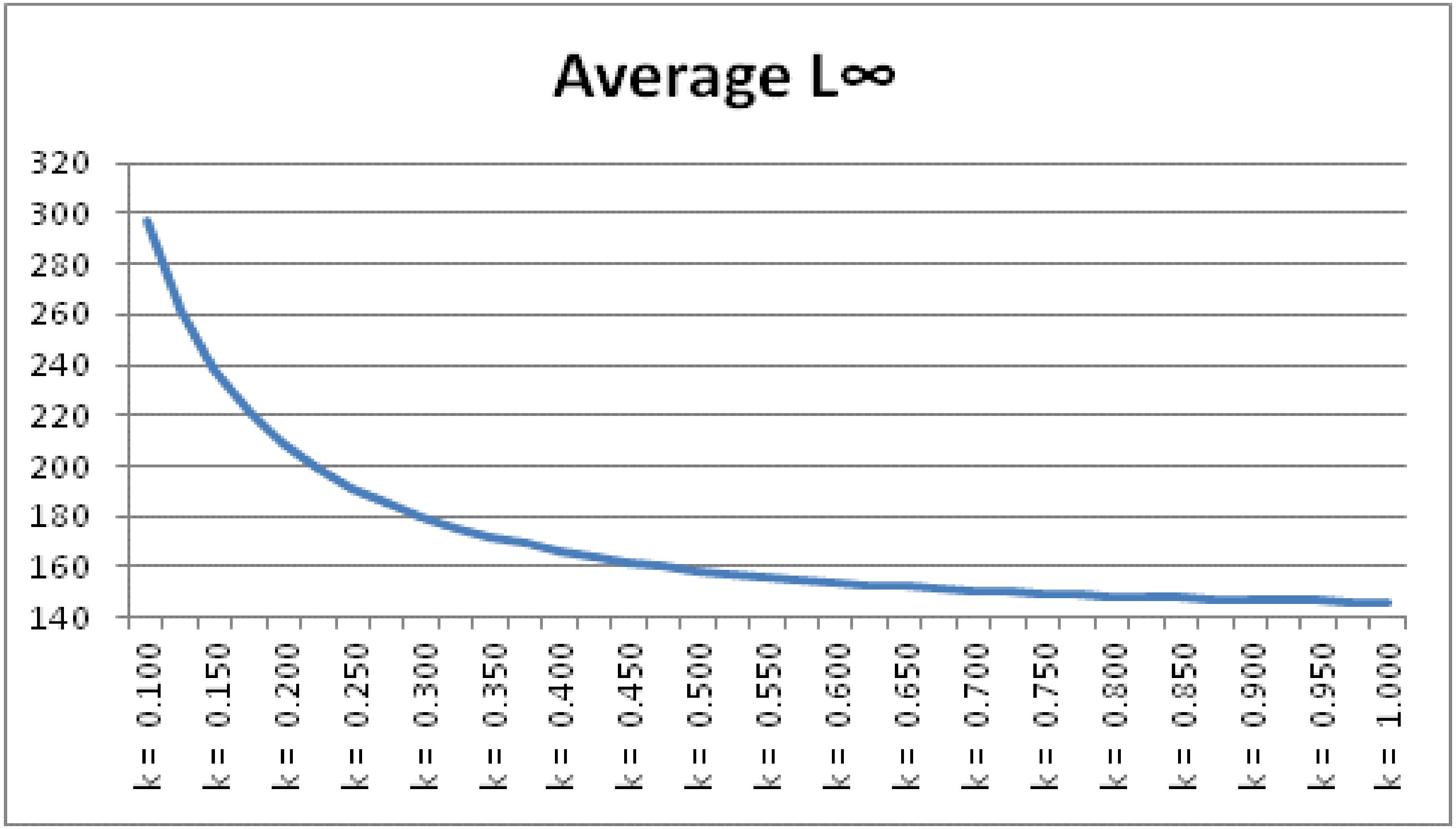
Distribution of individual apparent L∞ for a given value of K
Minimum tagging length 80cms Males + Females (Wide range for K)



Distribution of individual apparent L∞ for a given value of K Minimum tagging length 80cms Males + Females (narrow K range)



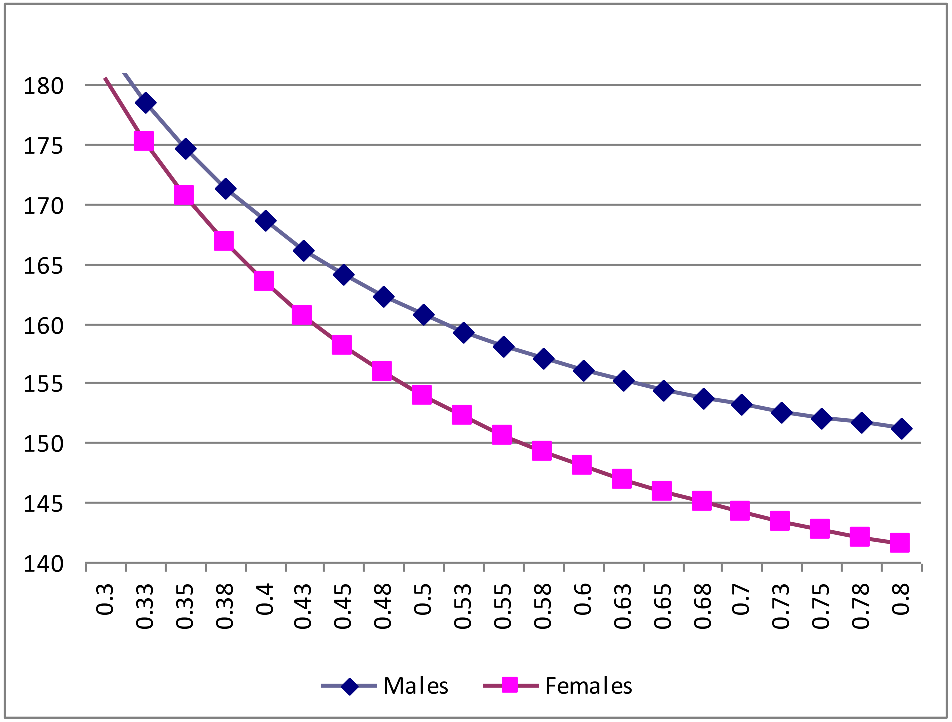
Average L∞ as a function of K



K,L∞ possible range

L∞	K	θ 84-85	Z 84-85	θ 1996-2002	Z 1996-2002
150	0.475	0.74 (impossible)		1.23	
155	0.575	1.2	0.7	1.74	1.2
160	0.725	1.6	1.2	2.3	2.8

Average L∞ as a function of K separting males and femalesltag>60



Conclusions:
Basic values for further calculations

- M 0.6 (at least for fish >130 cms)
- Z = 1.2 in 1996-2002 for fish > 130 cms
- $L\infty$ = 155
- K = 0.575

- Beware again of possibly non monotonous catchability at length q(l) beyond 130 cms

IV Jones length based cohort analysis

Basic catch equation over the length interval (l_i, l_{i+1})

Time for growing from $l_i \; to \; l_{i+1}: \Delta_i$

$$C_i = N_i \frac{F_i}{F_i + M_i}\left(1. - e^{-(F_i + M_i)\Delta_i}\right)$$

Assumed growth curve

- Above 80 cms : VB with $L\infty = 155$ $K = 0.575$
- Below 80 cms see A. Fonteneau for the two stanzas

Natural mortality

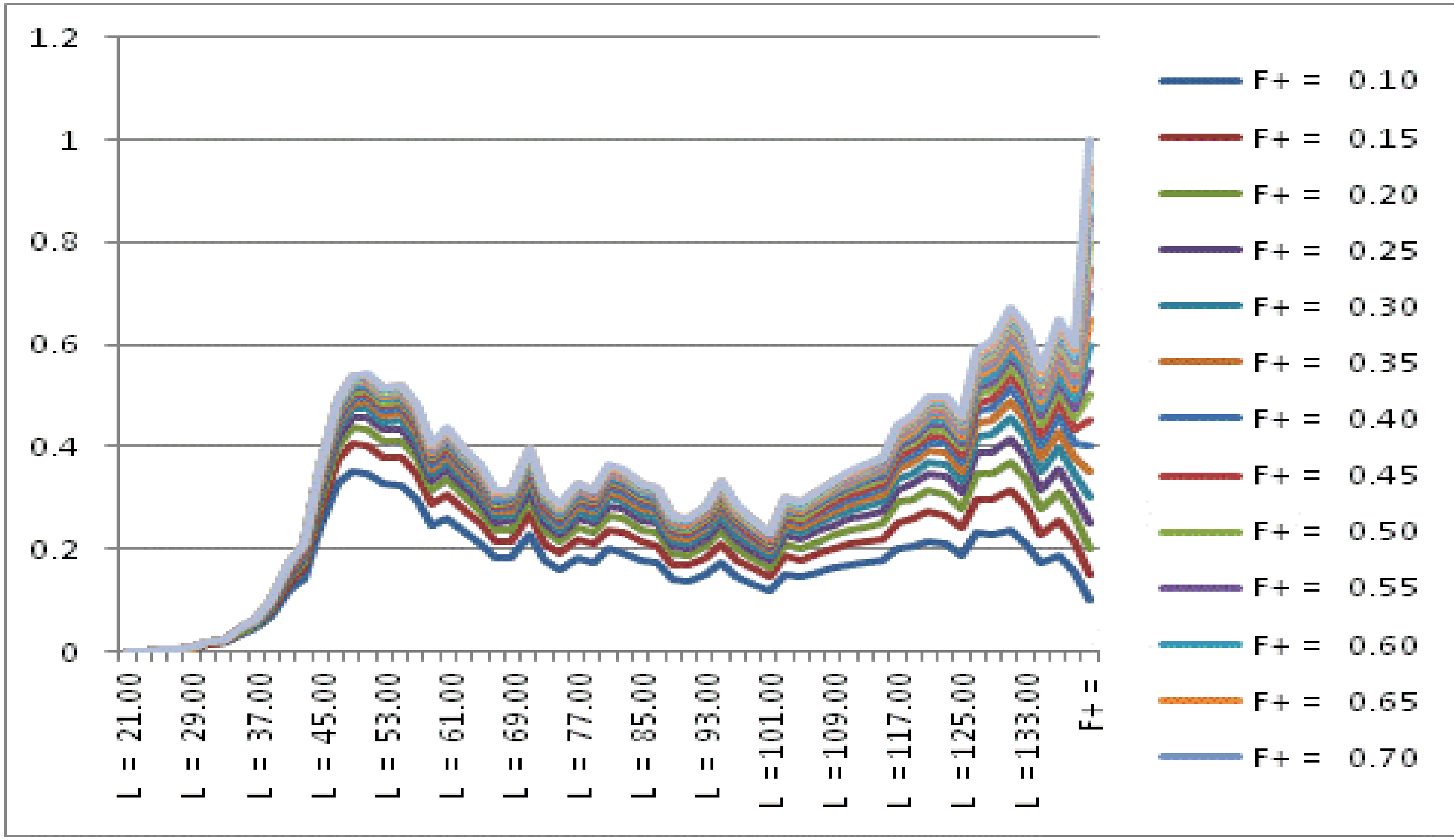
- Simplest hypothesis : constant M, with 0.6 as the reference value

- Possible changes with length

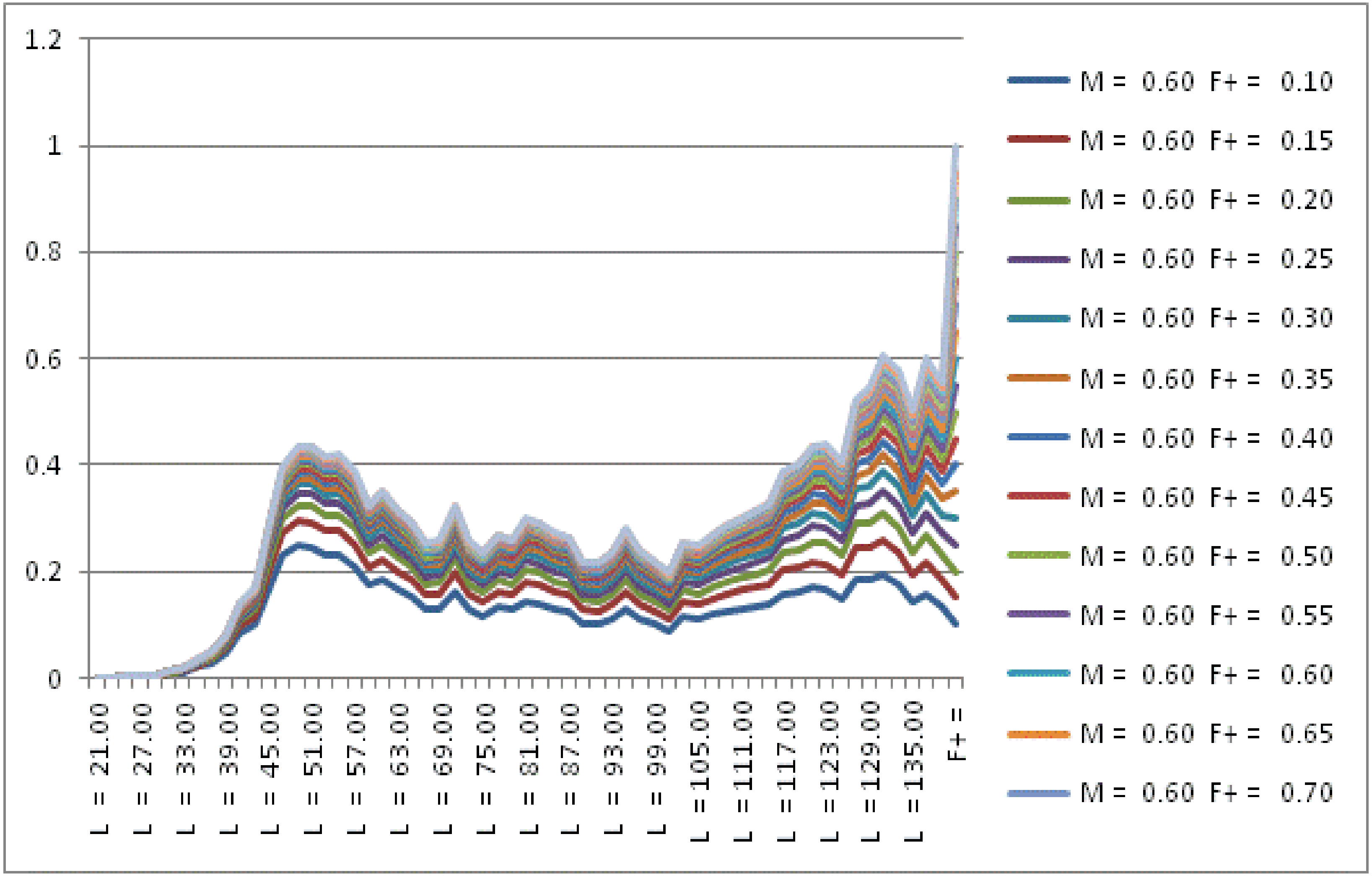
Linear decrease between 20 and 130 , constant above

Trials wtih $M_{20} = 2 \times M_{130}$ and $M_{20} = 3 \times M_{130}$

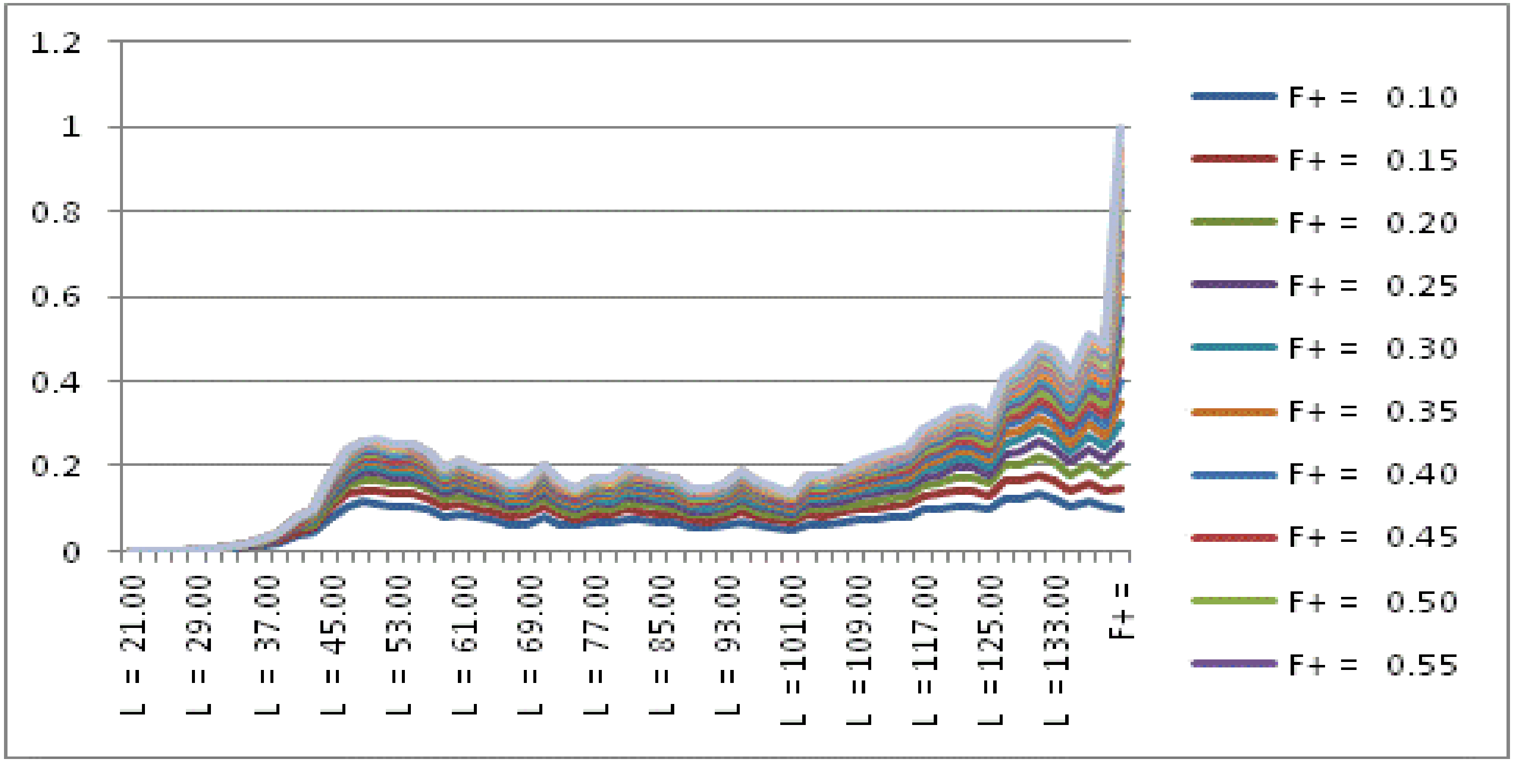
F at l vector for (constant)M = 0.5 ; various terminal F



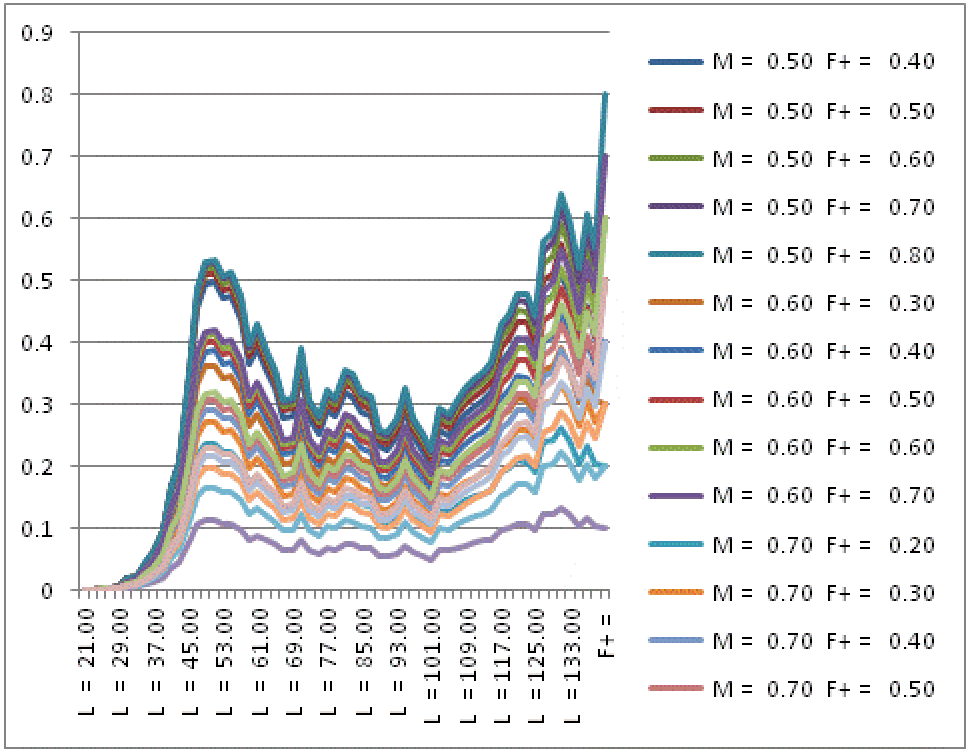
F at l vector for (constant M = 0.6) ; various terminal F



F at l vector for (constant M = 0.8) ; various terminal F

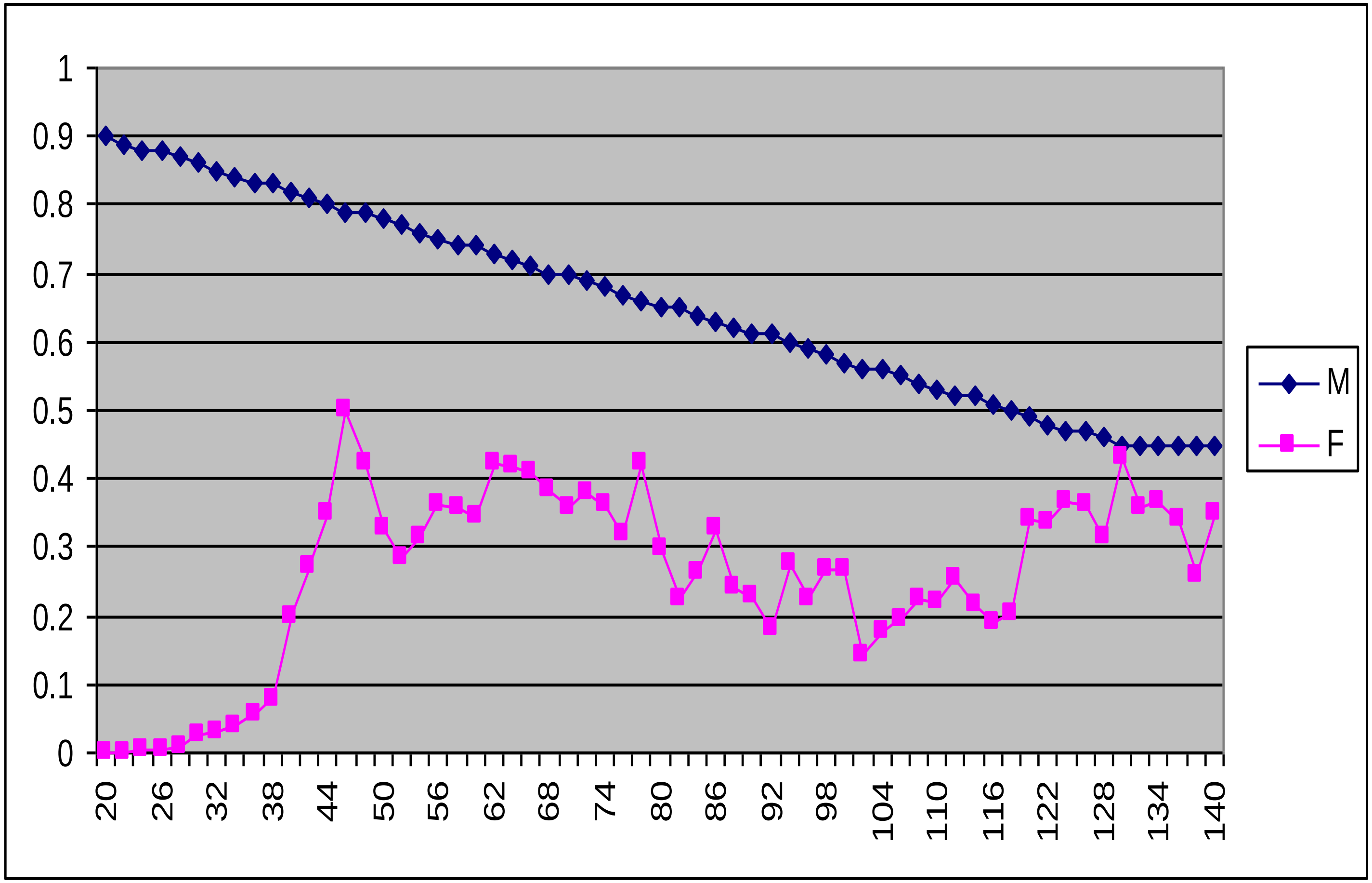


Various Ft M combinations compatible with the full recruitment beyond 130 cms and final Z between 0.9 and 1.3



M varying with length :

$M_{20} = 2 \times M_{130+}$, $F_t - 0.35\ M_{130+} = 0.45$



Conclusions from length base VPA/Cohort analyses

- Possible to find F at l vectors compatible with both (1)the full recruitment beyond 130 cms hypothesis, and (2) previously mentioned estimates of K,L∞ M and Z for large fish
- Key problem : the full recruitment hypothesis makes it possible to limit the range of plausible values for Z for large fish, but the partition between Z and M brings back to the value of M
- Still too many possibilities, even if in terms of conclusions for management the main conclusions are robust (F<Fmsy ; no immediate risk of recruitment failure)

V Tagging : recovery rates and length histograms for « recaptured fish

- Basic principle:
- Assuming a natural mortality vector, and a terminal Ft it is possible to calculate the probability that a fish tagged at a given length is caught by a fleet within a size range :

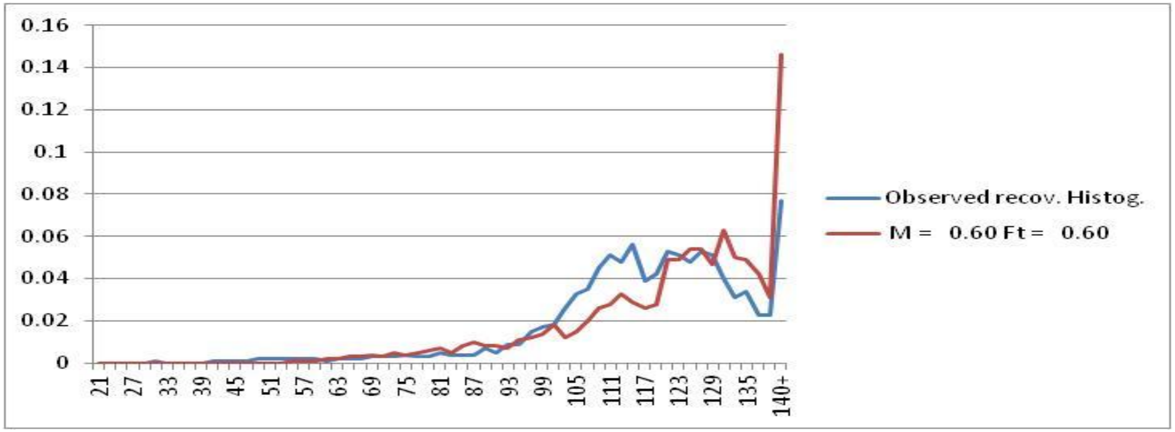
survival probability x probability for a survivor to be caught by the fleet within the length interval

- Implies 3 parameters (1) terminal F F_t (2) M_{130+} (3) M_{20}/M_{130+}
- Wise to set aside fish recaptured too early because of dilution problems within the stock
- Simple technique for choosing parameters : recovery rates + average length of the recaptured fish + fishing pattern beyond 130

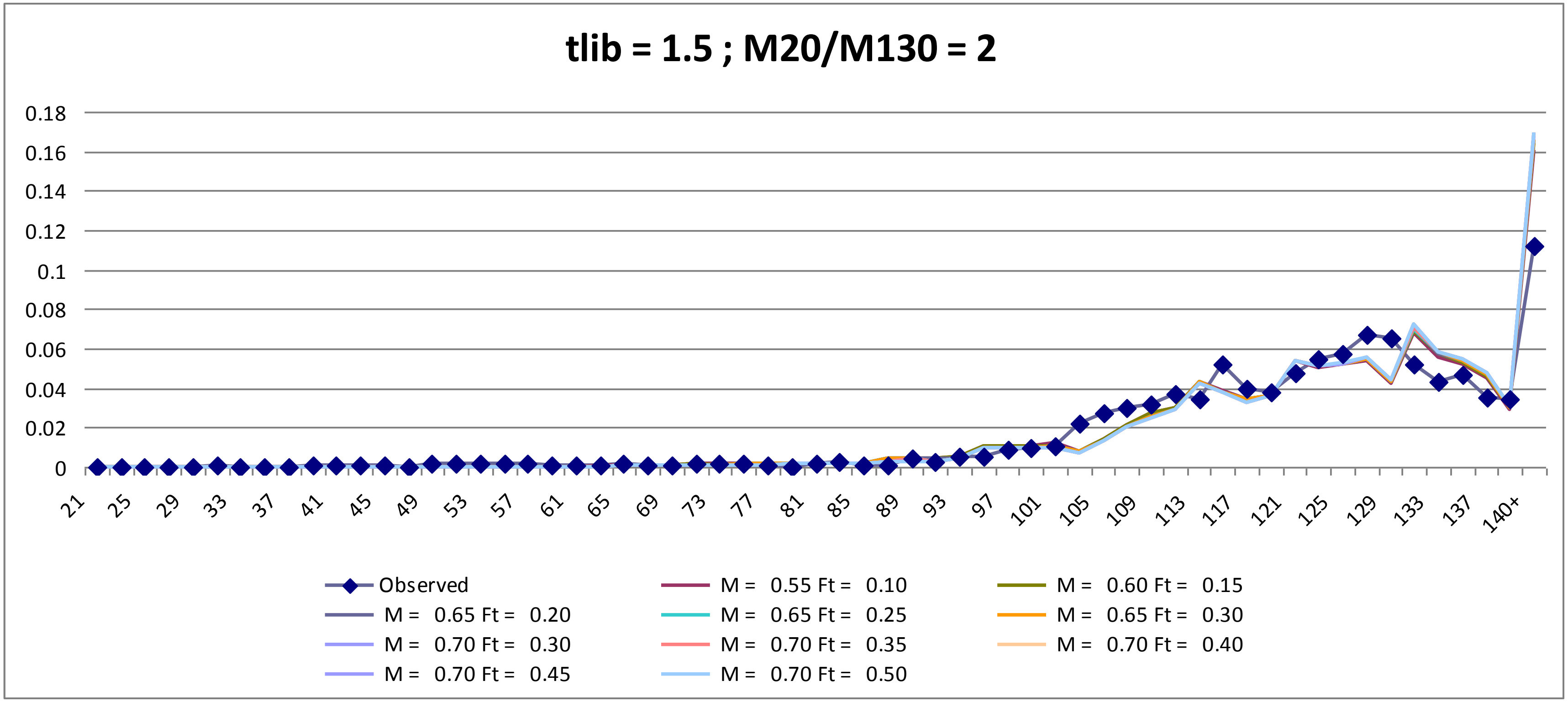
Observed and predicted recovery rate : compared histograms

(Ft = 0.6, M 130+ = 0.6 ; M20 = 1.2 with linear decrease between 40 and 130 cms)

Minimum freedom 1 year



Increased minimum delay between tagging and recapture = 1.5 Years



V Conclusions for section V

- Even a very simple model can lead to reasonable numbers and length histogram for recaptured fish
- *Why such a long delay (1.5 years) between tagging and recapture is required would require further analyses?*
- In fact difficult to discriminate between various combinations of the three parameters
- They would however lead to the same diagnosis in terms of stock status (current F below Fmax, no immediate risks of recruitment failure because of overfishing) : conclusions for managers can be much more robust than the estimation of a specific parameter
- **As previously mentioned results are given only for illustration purposes, and depend among others on the full recruitment hypothesis**

V Overall conclusions

- The same tools will be applied to Big eye
- Quick and (not so) dirty techniques can give at least preliminary estimates of the key parameters (growth , mortality for large fish) which are compatible with key observations in terms of catches at length and tagging results
- They can give an insight about which data and hypotheses are critical for estimating specific parameters
- Whenever more sophisticated techniques lead to radically different conclusions this needs to be explained : its is not because the computer is on that you need to turn your brain off!