Population Dynamics

Royal Museum for Central Africa (RMCA Tervuren)

FishBase and Fish Taxonomy Training Session 2017

Introduction

Definition:

Population dynamics is the study of marginal and long-term changes in the numbers, individual lengths and weights, and age composition of individuals in one or several populations, and biological and environmental processes influencing those changes.

A population is affected by three dynamic rate functions:

1. **Natality or Birth rate [often recruitment; reaching a certain size or reproductive stage].**

2. **Mortality, which includes harvest mortality and natural mortality.**

3. **Growth rate, which measures the growth of individuals in size and length.**

Introduction

➔ Population dynamics is crucial for fisheries management purposes.

Relatively easy to obtain for most fish species:
- **maximum age and size.**
- **length-weight relationships.**

More difficult to obtain:
- **growth parameters.**
- **(natural) mortality estimates.**
- **Recruitment variability and recruitment time series.**

Introduction

These points were so important for tropical fisheries research that they provided a good reason to create a database in 1987. This database became FishBase.

> *"a summary of growth and mortality information for each species […] with the ultimate goal of covering 2,500 species."*

This vision however:

- Underestimated the number of species to be included in FishBase (now 33,500 species).
- Overestimated the number of species for which growth parameters and related information exist:
  - growth parameters for about 2000 species are reported in FishBase.
  - however, the treated species belong to 95% of the world's fisheries.

Similarly, the stocks for which over 750 time series of recruitment are included belong to the best-studied and most important single-species stocks in the world.

Recruitment (Natality)

© Andrew MacLeod

Recruitment (Natality)

* Recruitment fluctuations determine the annual catch levels of fisheries.

* Precise prediction of future recruitment is not possible, but broad generalizations are possible.

* The more recruitment time series are available from various parts of the world, the more precise and reliable will the generalizations be.

Recruitment (Natality)

FishBase

FishBase has incorporated the existing 'Stock Recruitement Database' of Ransom A. Myers (°1952-†2007).

www.mscs.dal.ca/~myers/welcome.html

Myers Lab

More information

Countries	Common names	Age/Size	References	Collaborators
FAO areas	Synonyms	Growth	Aquaculture	Pictures
Ecosystems	Metabolism	Length-weight	Aquaculture profile	Stamps, Coins
Occurrences	Predators	Length-length	Strains	Sounds
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Diet	Spawning	Larvae	Diseases	Gill area
Food items	Fecundity	Larval dynamics	Processing	Otoliths
Food consumption	Eggs	Recruitment	Mass conversion	Brains
Ration	Egg development	Abundance	Vision	

R.A. Myers et al's Recruitment Series for *Gadus morhua*

n = 32

Locality	C.V. (recr.)%	Recruitment series	
		Begin	End
NAFO 2J3KL	108.4	1850	1993
Iceland	47.0	1905	1998
NAFO 4TVn	50.4	1917	1993
Faroe Plateau	68.3	1924	1995
North East Arctic	86.3	1930	1991
North East Arctic	75.8	1930	1991
North East Arctic	108.5	1930	1991
North Sea	66.0	1930	1994
North East Arctic	80.8	1946	1993
NAFO 4X	34.9	1948	1994
NAFO 3NO	119.4	1953	1993
West Greenland (NAFO 1)	705.9	1955	1992
Greenland offshore component	710.1	1955	1992
NAFO 3M	190.8	1956	1984
NAFO 4VsW	56.2	1958	1993
NAFO 3Ps	36.5	1959	1993
NAFO 5Y	41.7	1960	1991
NAFO 5Y	189.0	1960	1997
NAFO 5Z	68.1	1960	1996
NAFO 5Z	134.4	1960	1997
NAFO 3Pn4RS	72.3	1961	1993
NAFO 3Pn4RS	171.2	1961	1997
Baltic Areas 22 and 24	84.5	1965	1992
Baltic Areas 25-32	63.7	1965	1995
ICES VIa	49.6	1966	1993
Irish Sea	57.7	1968	1995
Celtic Sea	94.8	1971	1994
Kattegat	64.9	1971	1992
Skagerrak	35.2	1971	1992
ICES VIId	127.5	1976	1994
NAFO 3M	488.0	1977	1990
Flemish Cap (NAFO Div. 3M)	586.2	1988	1997

FishBase gives a list with all stocks for which a recruitment series exist, if available.

A 'stock' consists of a group of individuals of a species which can be regarded as an entity for management or assessment purposes.

Recruitment (Natality)

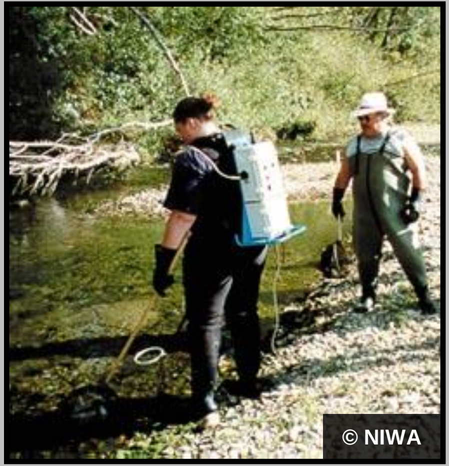
FishBase

Recruitment Series for *Gadus morhua*

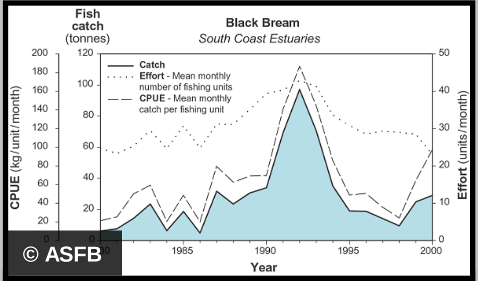
Time series graph (loading may take 2-3 mins.)
S-R Plot (loading may take 2-3 mins.)
Ransom A. Myers and colleagues
Dalhousie University, Halifax, N.S., Canada

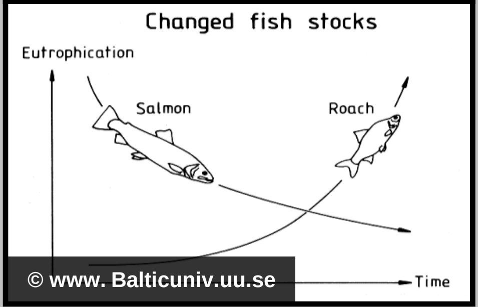
Common Name	Cod
Locality	Flemish Cap (NAFO Div. 3M) (47° N, 45° W)
Year	1988 - 1997
Country	
Method for deriving time series	SPA
Age group for estimating F	05-Mar
Age at recruitment	1 (full years)
C.V. (recr.)	586.2 %
Remarks	Natural mortality (1/y): 0.2. Spawning location: Shelf. Spawning/egg type: Oviparous, pelagic. Egg diameter: 1.4mm. Length at hatching: 3mm. Length at metamorphosis: 24mm. Change in length during larval phase: 21mm

Different methods are used to derive a time series of recruitment:



1/ direct counts.
2/ catch/effort data.
3/ electro-fishing.
4/ mark-recapture.
5/ sequential population analysis (SPA/APV).
6/ stock reconstruction.
7/ research survey.
8/ (see additional information).





Recruitment (Natality)

Recruitment Series for *Gadus morhua*

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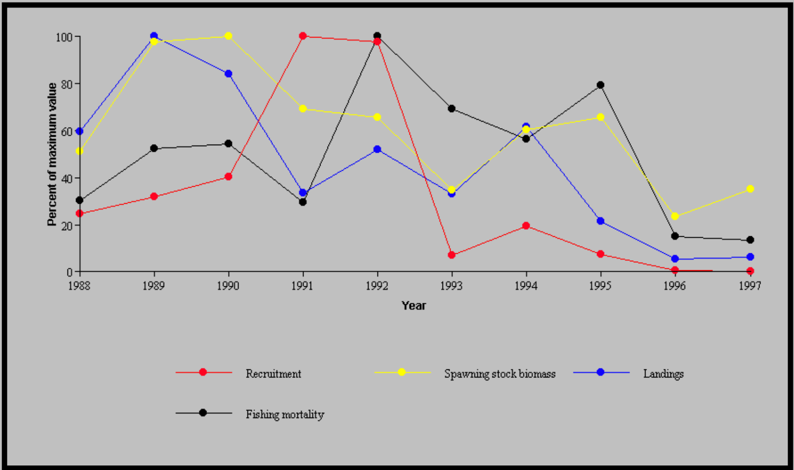
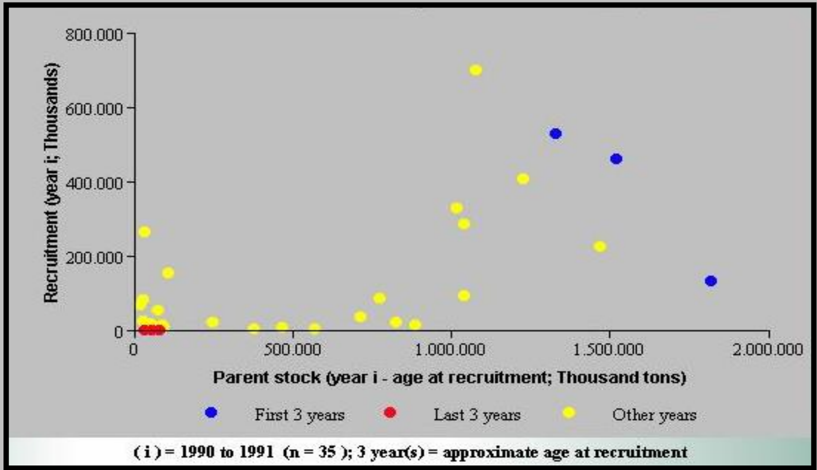
It is possible to make different graphs in FishBase based on the present data:



Time series graph

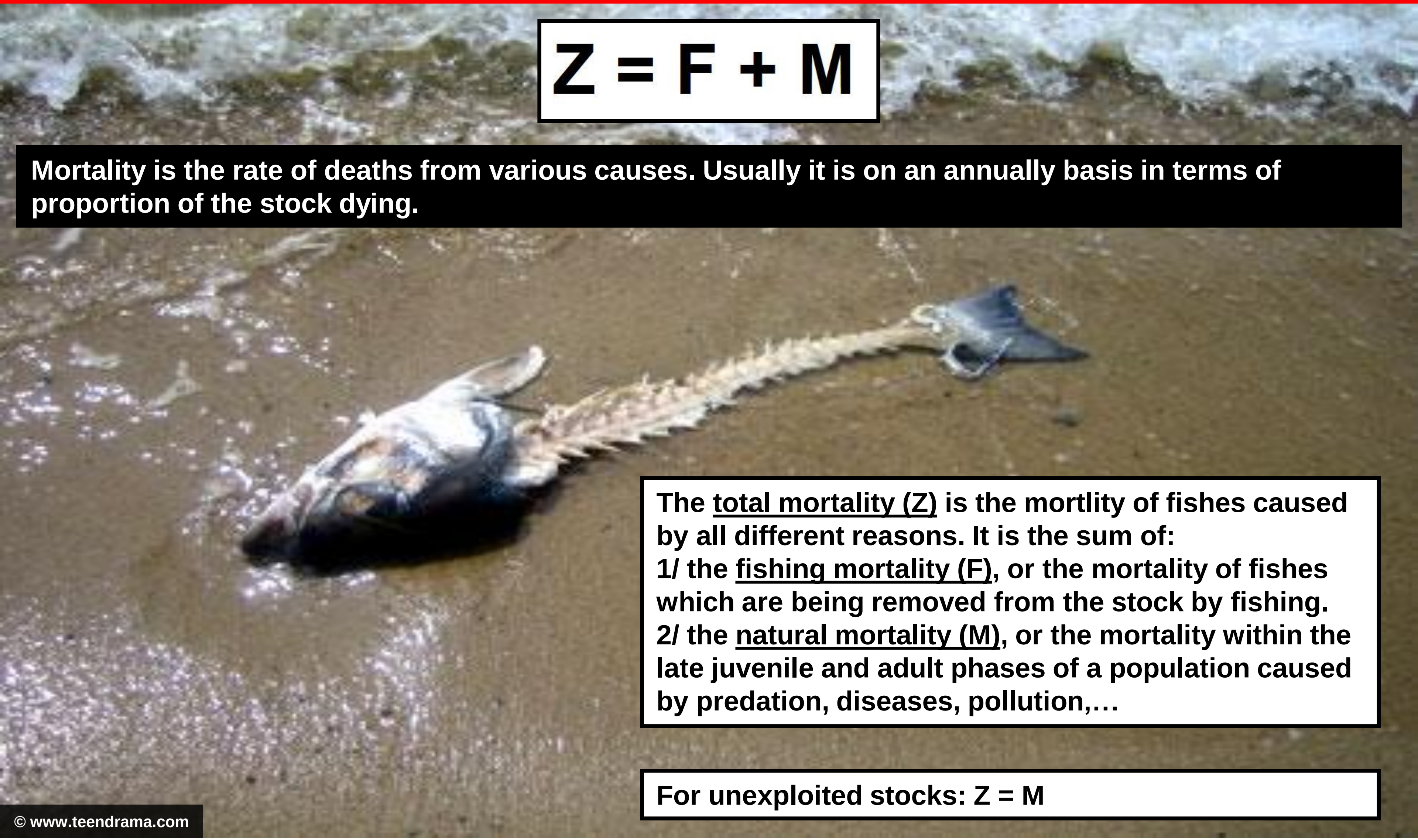


Stock-recruitment relationship

Mortality

Louisiana (U.S.A.) 2010:
A 'dead zone' is a hypoxic zone (lack of dissolved oxygen) located in an aquatic environment.
These zones have an increasingly important impact on fisheries and ecosystems.

Mortality



$$Z = F + M$$

Mortality is the rate of deaths from various causes. Usually it is on an annually basis in terms of proportion of the stock dying.

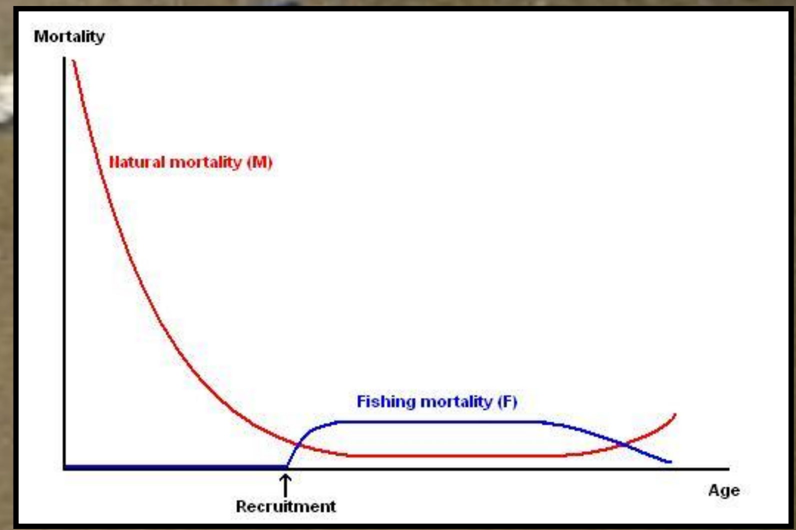
The <u>total mortality (Z)</u> is the mortlity of fishes caused by all different reasons. It is the sum of:
1/ the <u>fishing mortality (F)</u>, or the mortality of fishes which are being removed from the stock by fishing.
2/ the <u>natural mortality (M)</u>, or the mortality within the late juvenile and adult phases of a population caused by predation, diseases, pollution,…

For unexploited stocks: Z = M

Mortality

$$Z = F + M$$

The natural mortality (M) is estimated from the maximum length and the water temperature. It is one of the most difficult parameters to estimate from exploited stocks. Therefore estimates from empirical models are made: based on growth coefficients, length at first maturity, maximum size, or maximum age. The natural mortality rate is variable (e.g. in function of predator biomass).



The fishery mortality rate (F) can have a value of 0 for no fishing, up to very high values like 1,5 or 2, which indicates that the number of caught fish is 1,5 to 2 times the number of fish at the start of the fishing season.

Maximum age and size

More information

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List of Population Characteristics records for *Bagrus docmak*

n = 5

Sex	Wmax	Lmax (cm)	Tmax (y)	Country	Locality
unsexed	46.0 kg			Uganda	Murchison Falls, Victoria Nile, unknown
unsexed	5.3 kg	71		Chad	Mayo Kebbie, Chad
unsexed	15.0 kg	110			Lake Albert
unsexed	20.0 kg	115		Congo Dem Rp	Lake Edward , 1988
unsexed	33.0 kg	120			Nile river

Population Characteristics of *Bagrus docmak*

Main Ref.	13302	
Sex	unsexed	**Data Ref.** 13302
Wmax	20.0 kg total weight	
Lmax (cm)	115 FL	
Tmax (y)		
Locality	Lake Edward , 1988	
Country	Congo Dem Rp	
Comments		

Maximum age and size

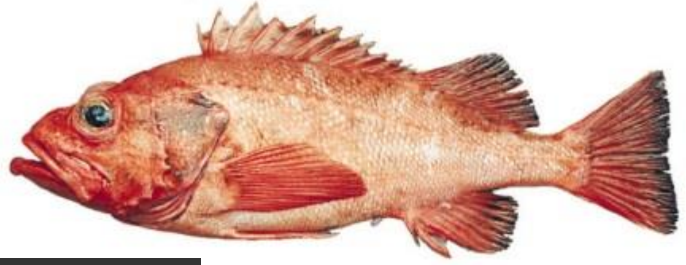
This page can be considered as the FishBase answer to the book ‘Guiness Book of Records’.

➔ The whale shark is the largest and heaviest fish.

Rhincodon typus Smith, 1828

Length: 20 m TL

Weight: 34.000 kg

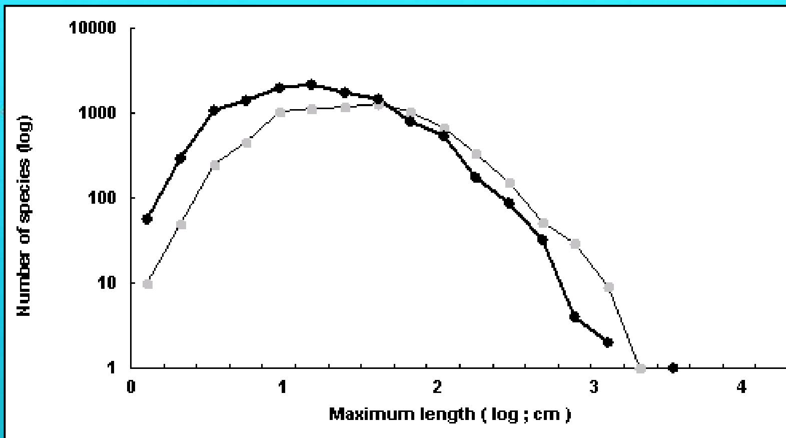


➔ The rougheye rockfish is the longest-living fish.

Sebastes aleutianus (Jordan & Evermann, 1898)

Age: 205 years

Maximum age and size



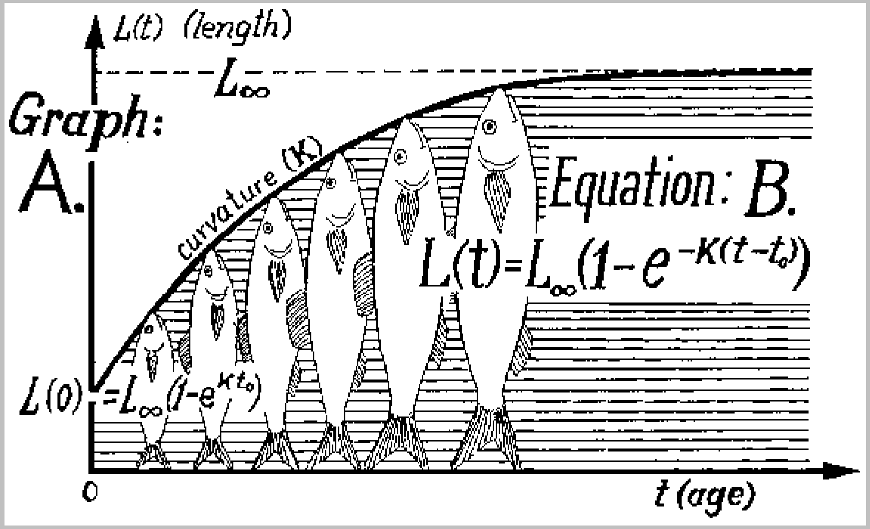
Length distribution of tropical fishes (●) vs. All other fishes in FishBase (●).

Growth rate

Growth rate

Growth parameters in FishBase are based on the von Bertalanffy Growth Function (VBGF). This is the most used growth model for aquatic animals. It is introduced by von Bertalanffy in 1938 and predicts the length of a fish as a function of its age.

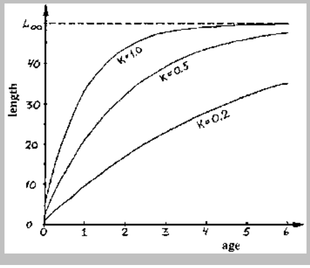
$$L_t = L_\infty(1 - e^{-K(t - t_0)})$$



L_t = the predicted mean length of a fish of a given population at age t.
L_∞ = the mean asymptotic length (the length a fish could reach at an infinitely high age).
K = the growth coefficient (with units of reciprocal time).
t_0 = the theoretical (and generally negative) age the fish would have at zero length, provided by an extrapolation of the VBGF.

K is often called a growth constant, but it can change when fish grow.

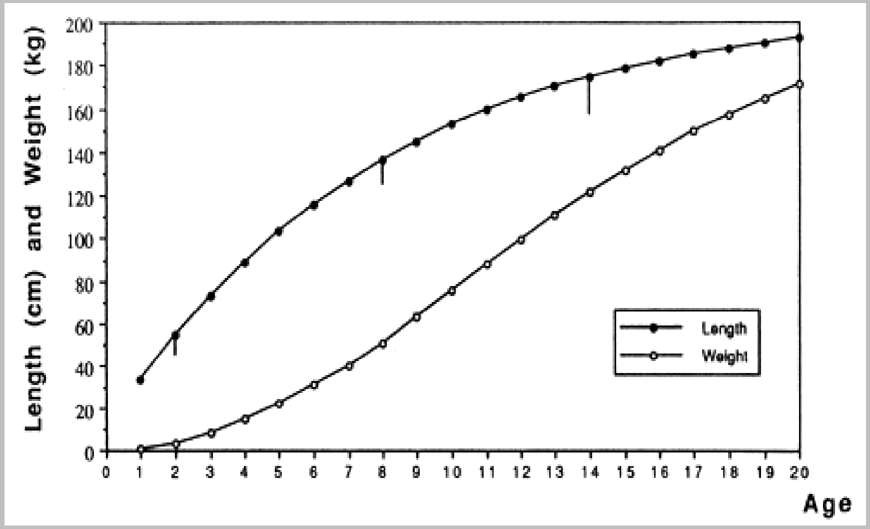
$$K = (dL / dt) / (L_\infty - L)$$



Growth rate

Similarly, the von Bertalanffy Growth Function (VBGF) can be made based on weight instead of length.

$$W_t = W_\infty (1 - e^{-K(t - t_0)})^b$$



W_t = the predicted mean weight of a fish of a given population at age t.
W_∞ = the mean asymptotic weight (the weight a fish could reach at an infinitely high age).
K = the growth coefficient (with units of reciprocal time).
t_0 = the theoretical (and generally negative) age the fish would have at zero length, provided by an extrapolation of the VBGF.
b = the exponent of the length-weight relationship.

$$W = a\ L^b$$

Growth rate

- Growth models which do not explicitly consider seasonal oscillations fail to capture an essential aspect of the growth process.
- Moreover, in a tropical environment differences in temperature between winter and summer as small as 2° C are sufficient enough to induce seasonal growth oscillations which, while not visually detectable, are still statistically significant.
- The growth model which fits best with seasonal growth oscillations is probably the growth model of Somer (1988):

$$L_t = L\ (1 - e^{-(K(t-t_0) + S_t - S_{t_0})})$$

L_t = the predicted mean length of a fish of a given population at age t.
K = the growth coefficient (with units of reciprocal time).
t_0 = the theoretical (and generally negative) age the fish would have at zero length, provided by an extrapolation of the VBGF.

Defined as in the standard VBGF.

t_s = the time between t=0 and the start of a sinusoid growth oscillation.

For visualisation, it helps to define WP (Winter Point), which expresses the period of time when the growth is slowest.

WP = ts + 0,5

The WP is often near 0,1 in the northern hemisphere (mid-February) and 0,6 in the southern hemisphere (mid-August), hence its name.

Growth rate

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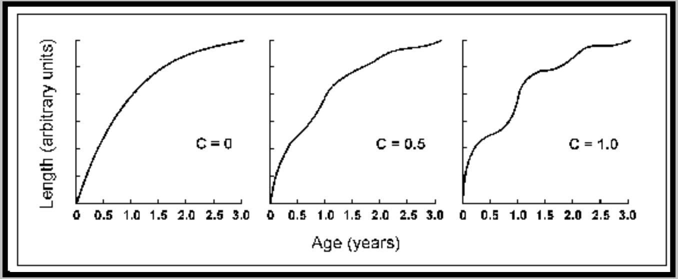
$$L_t = L\,(1 - e^{-(K(t-t_0) + S_t - S_{t_0})})$$

$$S_t = (C\frac{K}{2\pi})\,\sin^{\pi}(t - t_s)$$

$$S_{t_0} = (C\frac{K}{2\pi})\,\sin^{\pi}(t_0 - t_s)$$

C indicates the amplitude of the growth oscillations:

- When C=0, the equation reverts to the standard VBGF.
- When C=0,5, the seasonal growth oscillations are such that growth is increased by 50% at the peak of the growth season in summer and, briefly, reduced by 50% in winter.
- When C=1, growth increases by 100%; it doubles during summer and becomes 0 in the depth of winter.



Growth rate

Length-Weight relationship

$$W = a\ L^{b}$$

W = total fish weight (g).
L = total fish length(cm).

a = a condition factor, for comparing fish of the same species. It varies between species and may vary based on sex and season.

b = an exponent describing the growth.

Fulton's condition factor (K):

$$K = \frac{10^{N} W}{L^{3}}$$

Example: *Salmo trutta* Linnaeus, 1758

- K=1.60 – excellent condition
- K=1.40 – good condition
- K=1.20 – fair condition
- K=1.00 – poor condition
- K=0.80 – extremely poor condition

Growth rate

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W = total fish weight (g).
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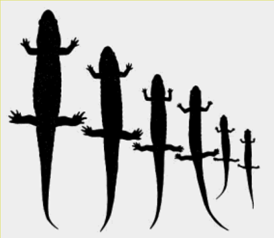
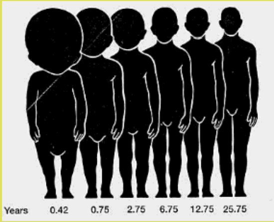
a = a condition factor, for comparing fish of the same species. It varies between species and may vary based on sex and season.

b = an exponent describing the growth. →

1/ b=3: the growth is isometric and the organism will grow uniformly; the fish has a consistent body form and specific gravity.



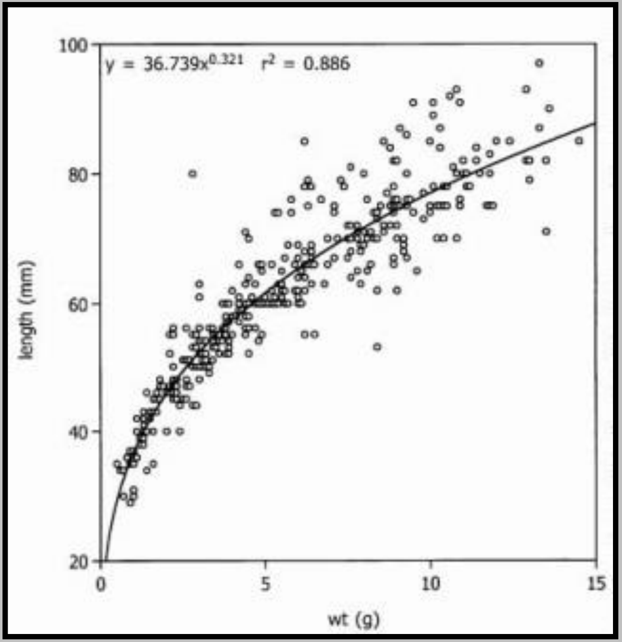
2/ b>3 ou b<3: the growth is allometric (positive or negative). There is a different growth of a part of the organism in relation to the growth of the whole organism or some other part of it.

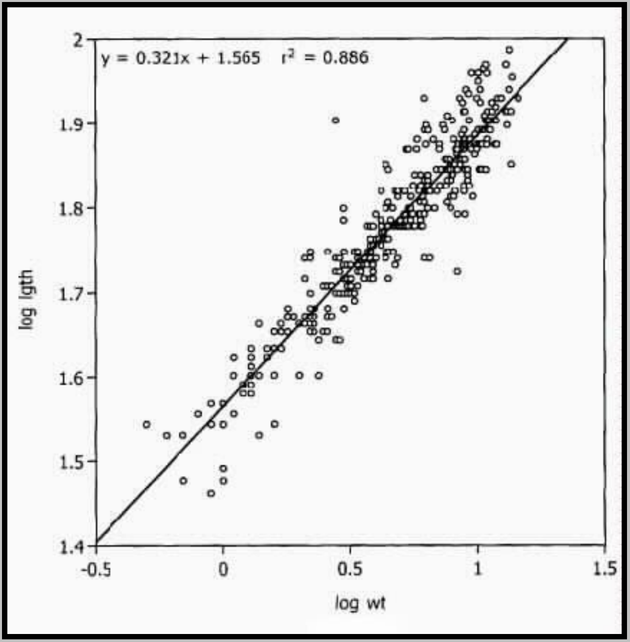


Growth rate

Length-Weight relationship

$W = a\ L^{b}$ → After log-transformation → $\log W = \log a + b \log L$





Length-Weight relationship

More information

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FishBase contains information on the relation between the length and weight in different populations.

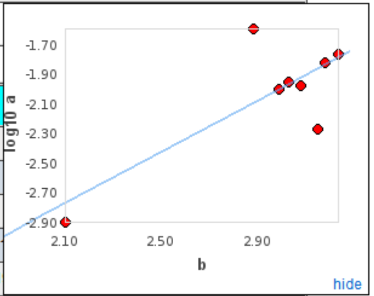
Length-Weight Parameters for *Bagrus docmak*

Length-weight (log *a* vs *b*) graph

[n=8]
Hide graph

Sort by ○ a ◉ b ○ Country ○ Locality

Score	a	b	Doubtful?	Sex	Length (cm)	Length type	r^2	SD b	SD log_{10} a	n	Country	
0.50	0.00126	2.100		male							Egypt	Assiut, 1993
0.50	0.02530	2.880		mixed								Lake Nasser
0.96	0.01000	2.987		unsexed	8.4 - 32.0	SL	0.956			123	Ghana	Volta River
0.97	0.01100	3.028		unsexed	27.5 - 48.2	FL	0.968			50	Congo Dem Rp	Lake Edward /
0.70	0.01040	3.076		unsexed	14.4 - 70.1	FL				139	Tanzania	Lake Victoria, 1
0.99	0.00529	3.149		unsexed	13.0 - 37.5	TL	0.988			16	Benin	Ouémé River Basin, 1999-2001
0.50	0.01510	3.180		mixed							Egypt	Assiut, 1993
0.50	0.01710	3.233		female							Egypt	Assiut, 1993



Refresh | Download selected data | Bayesian analysis

Preliminary parameter estimates are provided below, based on your selection of studies and weighted by the scores.
You may want to exclude or give less weight to studies that are far from the regression line in the graph.
Selected studies = 8, **geometric mean a** = 0.0089, **mean b** = 2.98, **SD log10(W)** = 0.0000, **SD log10(a)** = 0.3254 **SD b** = 0.2927

Estimate weight for given length: 0.0 (cm) = 0.00 (g) 95% range 0.00 - 0.00 (g)

Include Genus | Include Family

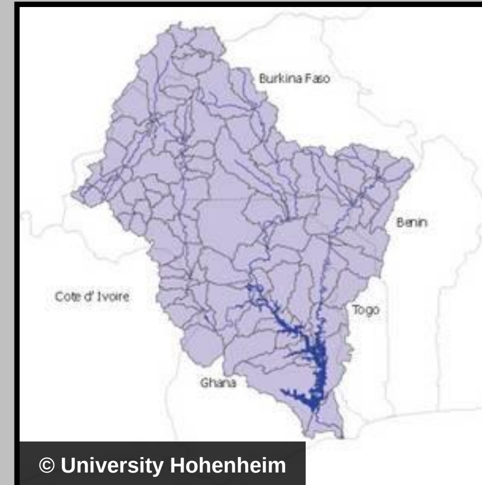
Search for more references on length-weight: Scirus

Back to Search | Back to Top

Length-Weight relationship

Length-Weight Relationship for *Bagrus docmak*

Main Ref. :	8992	
Data Ref. :	8992	
Length (cm) :	8.4 - 32.0 SL	
Number of fish :	123	
Sex of fish :	unsexed	
Method :	type I linear regression	
a :	0.01000	95% confidence limit:
b :	2.987	95% confidence limit:
r^2 :	0.956	
Estimate doubtful ? :		
Locality :	Volta River	
Country :	Ghana	
Comments :		
Calculated weight :	10 cm SL => 9.71 g Recalculate	



There are different methods to determine the values for a and b:

1/ linear regression type I (predictive) – linear regression of logW vs. logL.
2/ linear regression type II (functional)– linear regression of logW vs. logL.
3/ non-linear regression of W vs. L.
4/ algorithm of Pauly & Gayanilo (1996) – from length-frequency samples and their bulk weights.
5/ by setting b=3 and using a single pair of L-W values to calculate a.
6/ by setting b=3 and using the geometric mean of L and W values to calculate a.
7/ any other method (specified in the 'comments'-field).

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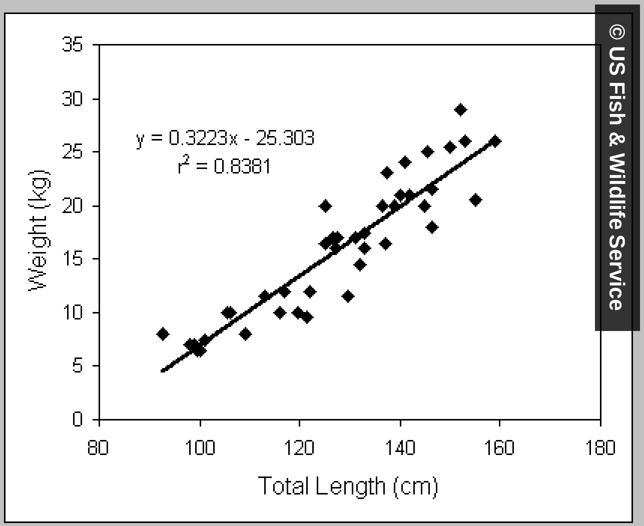


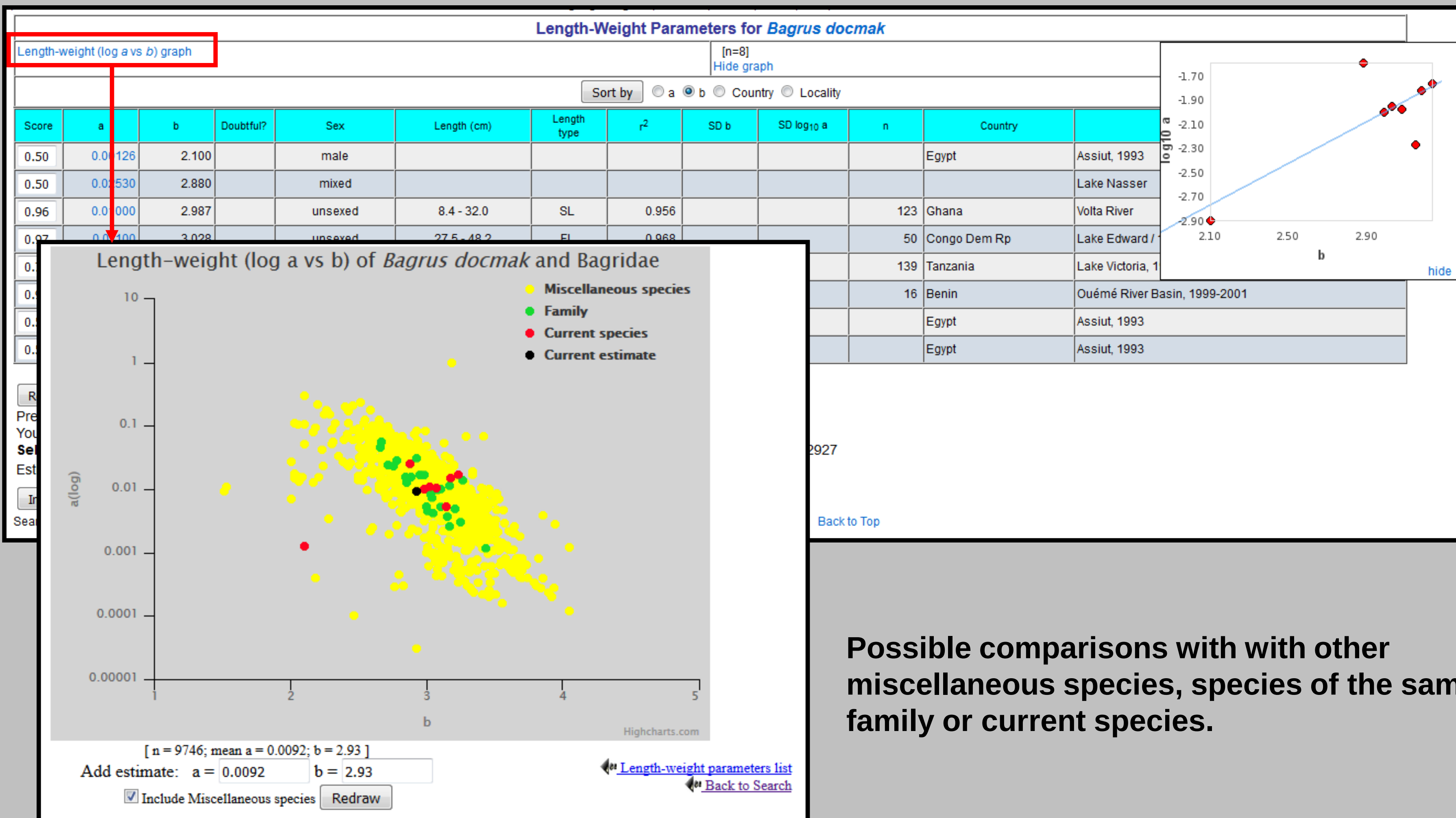
The length-weight relationship can be predicted. This prediction won't be perfect, so we need to be able to say how strong that relationship is, or how the line fits the data.

r = the correlation coefficient. It indicates the extend to which the pairs of numbers for the two variables lie on a straight line.

- **r = ±1: perfect linearity.**
- **r > 1: trend is upwards.**
- **r < 1: trend is downwards.**

If there is no linear trend, r is close to 0. A correlation of 0,9 is very strong.

Length-Weight relationship



Possible comparisons with with other miscellaneous species, species of the same family or current species.

Growth rate

FishBase

Length-Length relationship

More information

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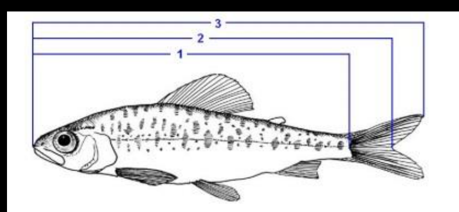
Length-length Parameters for *Bagrus docmak*

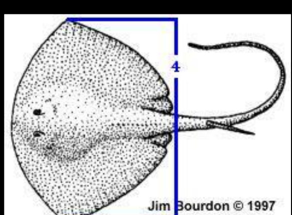
[n=4]

Unknown length	a	b	Known length	r	Length range (cm)	Sex of fish
TL	0.000	1.177	FL		-	unsexed
TL	1.507	1.194	SL		-	unsexed
TL	0.000	1.260	SL		-	unsexed
TL	0.233	1.271	SL	0.991	13 - 37.5	unsexed

Length-Length Relationship for *Bagrus docmak*

Sex of fish :	unsexed	
Regression :	TL = 1.507 + 1.194 x SL	
Number of fish :		r :
Length (cm) :	-	Data Ref. : 8992
Comments :		



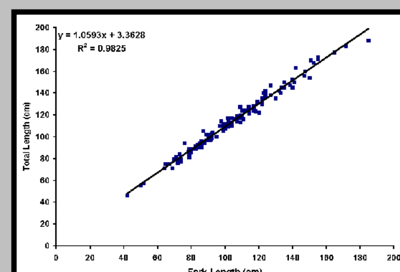


1. SL = standard length
2. FL = fork length
3. TL = total length
4. DW = disc width

Formulas for the convertion of one length type to another:

1/ Length type (2) = a + b * length type (1)

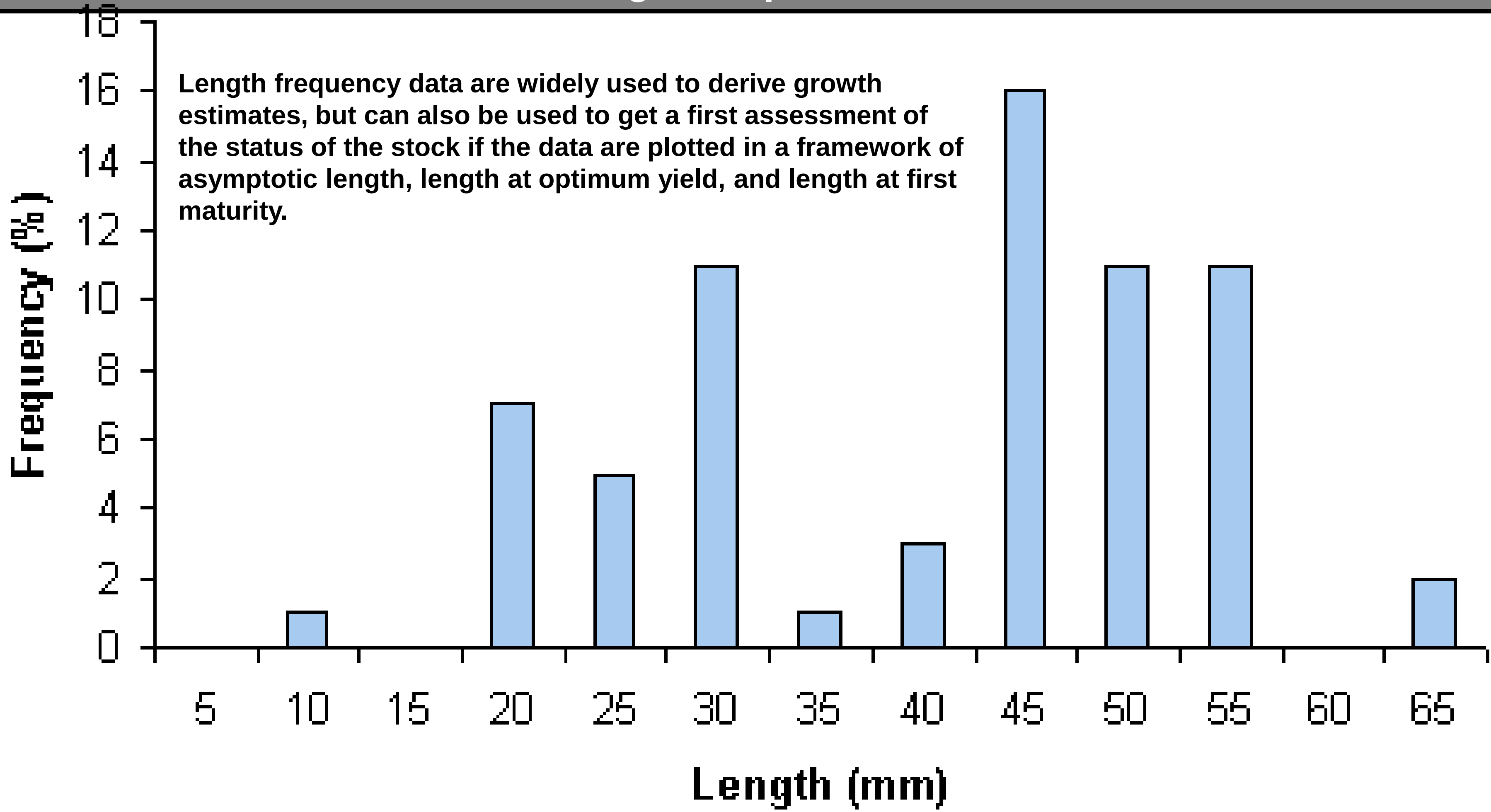
2/ Length type (2) = r * length type (1)



[Mostly estimated by a single specimen]

Length frequencies

Length frequency data are widely used to derive growth estimates, but can also be used to get a first assessment of the status of the stock if the data are plotted in a framework of asymptotic length, length at optimum yield, and length at first maturity.



Growth rate

FishBase

Length frequencies

More information

Countries	Common names	Age/Size	References	Collaborators
FAO areas	Synonyms	Growth	Aquaculture	Pictures
Ecosystems	Metabolism	Length-weight	Aquaculture profile	Stamps, Coins
Occurrences	Predators	Length-length	Strains	Sounds
Introductions	Ecotoxicology	Length-frequencies	Genetics	Ciguatera
Stocks	Reproduction	Morphometrics	Allele frequencies	Speed
Ecology	Maturity	Morphology	Heritability	Swim. type
Diet	Spawning	Larvae	Diseases	Gill area
Food items	Fecundity	Larval dynamics	Processing	Otoliths
Food consumption	Eggs	Recruitment	Mass conversion	Brains
Ration	Egg development	Abundance	Vision	

List of frequency studies for *Brycinus sadleri*

Locality	Year from - to	Sex	Gear	Frequency type
Lac Victoria, Kenya	1985 - 1985	unsexed/mixed	other	absolute number measured
Nyanza Gulf, Lake Victoria, Kenya	1985 - 1986	unsexed/mixed	trawls	raised to the catch

Back to Search

Length frequency of *Brycinus sadleri*

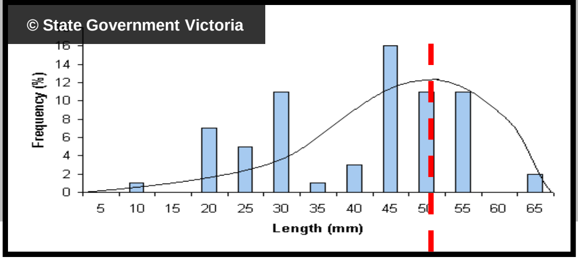
Main Ref:	Moreau, J., M.L.D. Palomares, F.S.B. Torres and D. Pauly, 1995				
Locality:	Lac Victoria Kenya				
Latitude:		Longitude:		Accuracy:	
Depth:		Temp:	28-	Sex:	unsexed/mixed
Gear:	other	Specific gear used:			
Lm (cm):		Lopt:	7.566	L(infinity) (cm):	13.7
Lc (cm):		F:		M:	1.59
Z:	1.76	E:		Unexploited:	☐
a:		b:		Ref:	
Length:	3.75 - 12.25 cm TL				
Frequency type:	absolute number measured			Data type	survey data
Year:	1985 - 1985				
LF Data					
Comments:					

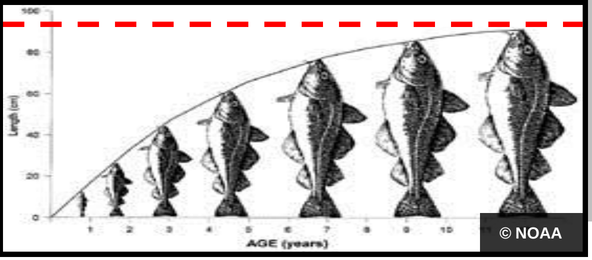
Parameters from Growth record:									
L (infinity)	13.7	K	0.46	Ref:	1472	M		Ref:	

L_m = length at first maturity.

L_{opt} = optimum length.
The length class where in an unfished population the product of survivors times average weight is maximum. At this length the biomass of the class is maximum.

$L_{infinity}$ = L_∞ = asymptotic length.
This is the mean length the fish of a given stock would attain if they were to grow for an infinitely long period.





Royal Museum for Central Africa (RMCA Tervuren)

FishBase and Fish Taxonomy Training Session 2017

Length frequencies

More information

Countries	Common names	Age/Size	References	Collaborators
FAO areas	Synonyms	Growth	Aquaculture	Pictures
Ecosystems	Metabolism	Length-weight	Aquaculture profile	Stamps, Coins
Occurrences	Predators	Length-length	Strains	Sounds
Introductions	Ecotoxicology	Length-frequencies	Genetics	Ciguatera
Stocks	Reproduction	Morphometrics	Allele frequencies	Speed
Ecology	Maturity	Morphology	Heritability	Swim. type
Diet	Spawning	Larvae	Diseases	Gill area
Food items	Fecundity	Larval dynamics	Processing	Otoliths
Food consumption	Eggs	Recruitment	Mass conversion	Brains
Ration	Egg development	Abundance	Vision	

List of frequency studies for *Brycinus sadleri*

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Lac Victoria, Kenya	1985 - 1985	unsexed/mixed	other	absolute number measured
Nyanza Gulf, Lake Victoria, Kenya	1985 - 1986	unsexed/mixed	trawls	raised to the catch

Back to Search

Length frequency of *Brycinus sadleri*

Main Ref:	Moreau, J., M.L.D. Palomares, F.S.B. Torres and D. Pauly, 1995				
Locality:	Lac Victoria Kenya				
Latitude:		Longitude:		Accuracy:	
Depth:		Temp:	28-	Sex:	unsexed/mixed
Gear:	other	Specific gear used:			
Lm (cm):		Lopt:	7.566	$L_{(infinity)}$ (cm):	13.7
Lc (cm):		F:		M:	1.59
Z:	1.76	E:		Unexploited:	☐
a:		b:		Ref:	
Length:	3.75 - 12.25 cm TL				
Frequency type:	absolute number measured			Data type	survey data
Year:	1985 - 1985				
LF Data					
Comments:					

Parameters from Growth record:							
$L_{(infinity)}$	13.7	K	0.46	Ref:	1472	M	Ref:

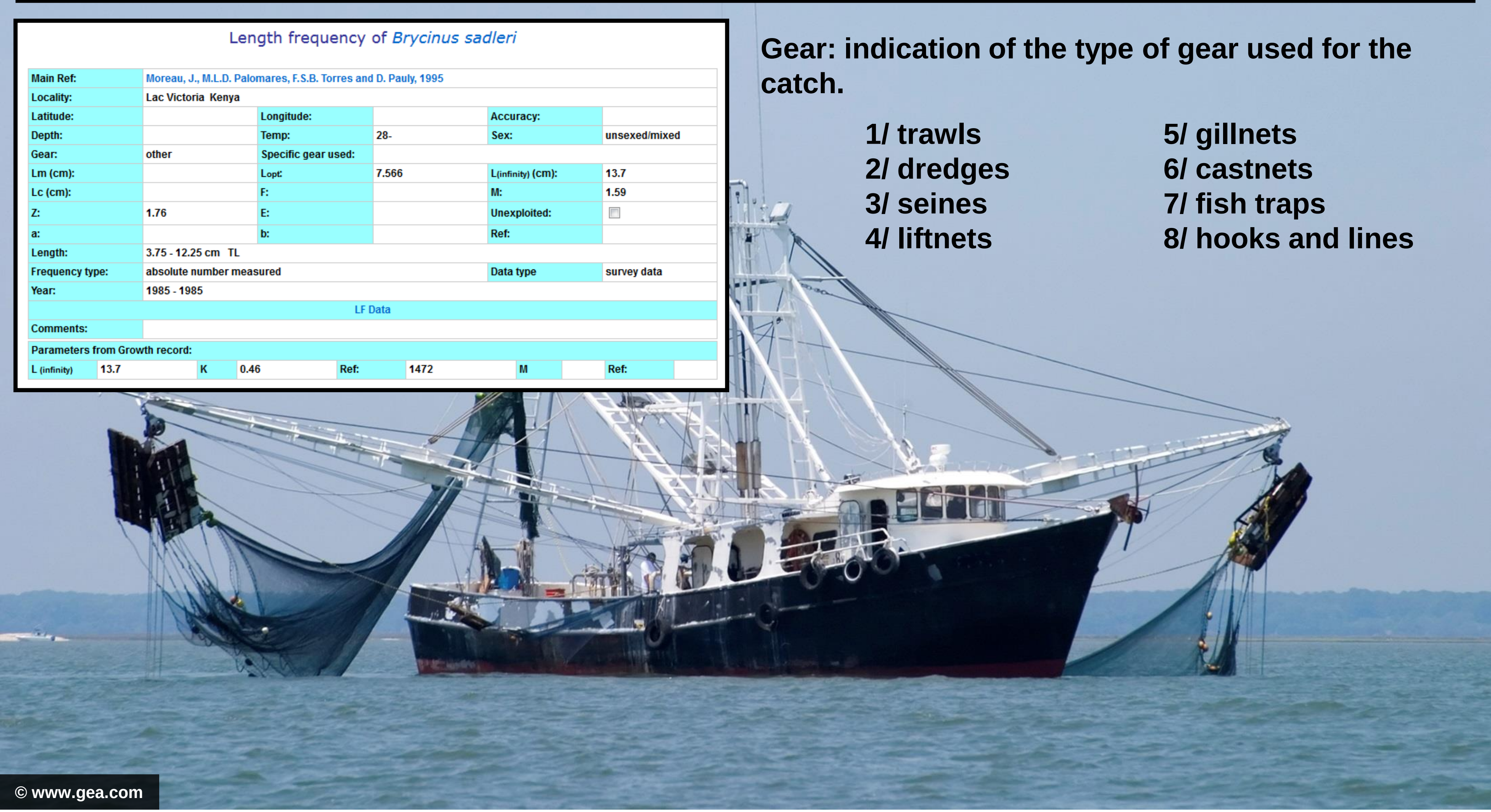
F = fishing mortality.
M = natural mortality.
Z = total mortality.

$$Z = F + M$$

a / b = the available length-weight constants.

$$W = a\ L^{b}$$

Length frequencies



Length frequency of *Brycinus sadleri*

Main Ref:	Moreau, J., M.L.D. Palomares, F.S.B. Torres and D. Pauly, 1995				
Locality:	Lac Victoria Kenya				
Latitude:		Longitude:		Accuracy:	
Depth:		Temp:	28-	Sex:	unsexed/mixed
Gear:	other	Specific gear used:			
Lm (cm):		Lopt:	7.566	L(infinity) (cm):	13.7
Lc (cm):		F:		M:	1.59
Z:	1.76	E:		Unexploited:	☐
a:		b:		Ref:	
Length:	3.75 - 12.25 cm TL				
Frequency type:	absolute number measured			Data type	survey data
Year:	1985 - 1985				
LF Data					
Comments:					

Parameters from Growth record:

L (infinity)	13.7	K	0.46	Ref:	1472	M		Ref:	

Gear: indication of the type of gear used for the catch.

1/ trawls
2/ dredges
3/ seines
4/ liftnets
5/ gillnets
6/ castnets
7/ fish traps
8/ hooks and lines

Growth rate

FishBase

Length frequencies

Length frequency of *Brycinus sadleri*

Main Ref:	Moreau, J., M.L.D. Palomares, F.S.B. Torres and D. Pauly, 1995				
Locality:	Lac Victoria Kenya				
Latitude:		Longitude:		Accuracy:	
Depth:		Temp:	28-	Sex:	unsexed/mixed
Gear:	other	Specific gear used:			
Lm (cm):		Lopt:	7.566	L(infinity) (cm):	13.7
Lc (cm):		F:		M:	1.59
Z:	1.76	E:		Unexploited:	☐
a:		b:		Ref:	
Length:	3.75 - 12.25 cm TL				
Frequency type:	absolute number measured			Data type	survey data
Year:	1985 - 1985				
		LF Data			
Comments:					

Parameters from Growth record:									
L (infinity)	13.7	K	0.46	Ref:	1472	M		Ref:	

Frequency Distribution

LF Code 399	Sampling										Summation
MidLength	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard
3.75	1.0	0.0	0.0	0.0	0.0	0.0	1.0	3.0	1.0	1.0	7.0
4.25	11.0	1.0	6.0	1.0	1.0	0.0	3.0	25.0	0.0	14.0	62.0
4.75	44.0	20.0	31.0	11.0	9.0	10.0	17.0	40.0	2.0	24.0	208.0
5.25	69.0	116.0	55.0	32.0	18.0	29.0	32.0	50.0	12.0	28.0	441.0
5.75	22.0	150.0	112.0	37.0	10.0	83.0	62.0	55.0	15.0	51.0	597.0
6.25	10.0	148.0	102.0	82.0	57.0	83.0	62.0	18.0	27.0	24.0	613.0
6.75	1.0	65.0	24.0	61.0	65.0	49.0	24.0	8.0	37.0	14.0	348.0
7.25	9.0	6.0	5.0	24.0	35.0	44.0	19.0	33.0	91.0	6.0	272.0
7.75	53.0	7.0	40.0	8.0	24.0	29.0	11.0	61.0	96.0	24.0	353.0
8.25	52.0	36.0	80.0	6.0	43.0	5.0	19.0	43.0	12.0	38.0	334.0
8.75	78.0	50.0	48.0	28.0	38.0	21.0	33.0	22.0	17.0	55.0	390.0
9.25	31.0	48.0	44.0	48.0	26.0	31.0	34.0	4.0	25.0	29.0	320.0
9.75	18.0	21.0	20.0	22.0	7.0	40.0	60.0	2.0	61.0	20.0	271.0
10.25	9.0	7.0	6.0	10.0	7.0	22.0	27.0	1.0	80.0	3.0	172.0
10.75	9.0	3.0	7.0	3.0	5.0	14.0	17.0	1.0	60.0	1.0	120.0
11.25	0.0	1.0	2.0	3.0	3.0	7.0	5.0	0.0	27.0	0.0	48.0
11.75	0.0	4.0	0.0	3.0	2.0	5.0	4.0	0.0	4.0	0.0	22.0
12.25	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	5.0	0.0	7.0

Raw data for the length frequencies of the studied population are present in FishBase.

Length-Frequency Wizard

FishBase

Tools

E-book | Field guide | Length-frequency wizard | Life-history tool | Point map | Classification Tree | Catch-MSY |

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)
(Designed by Rainer Froese in 2004)

Step 1: Introduction

In the following you will be guided through an analysis of length-frequency data, resulting in an estimation of the degree of exploitation, and an indication of how much more could be caught with a different fishing strategy. For advanced users we also provide an approach to estimate Linf, Z/K, Z, annual reproductive rate (alpha), intrinsic rate of population increase (rmax), population doubling time (td), and fishing mortality associated with maximum sustainable yield (Fmsy).
We assume that you have a set of length frequency data for this species and that you have a good idea about the maximum length (largest fish caught during the last 5 - 10 years) of your population. Note that this analysis is based on the assumption that the size distribution in your sample is similar to that of the population as a whole (see Note). In every step you can click on the 'Background' button for definitions of parameters and equations.
In the next step you will be asked to enter your Length Frequency data (go to 'Length frequencies', 'L-F Data' if you want to use data from FishBase).

Proceed | Exit | Background

Note: It is assumed here (1) that the L-F sample covers a wide range of lengths, (2) that gear selection is accounted for and (3) that the sizes of monthly samples are more or less equal if the total sample is accumulated over more than one month. Accumulated samples should include altogether at least 500 specimens. If L-F data stem from a single sample it should include at least 1000 specimens. A good sample would be accumulated over 6 or more months and include over 1500 specimens.

Frequency Distribution

LF Code 399	Sampling										Summation
MidLength	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard	LF Wizard
3.75	1.0	0.0	0.0	0.0	0.0	0.0	1.0	3.0	1.0	1.0	7.0
4.25	11.0	1.0	6.0	1.0	1.0	0.0	3.0	25.0	0.0	14.0	62.0
4.75	44.0	20.0	31.0	11.0	9.0	10.0	17.0	40.0	2.0	24.0	208.0
5.25	69.0	116.0	55.0	32.0	18.0	29.0	32.0	50.0	12.0	28.0	441.0
5.75	22.0	150.0	112.0	37.0	10.0	83.0	62.0	55.0	15.0	51.0	597.0
6.25	10.0	148.0	102.0	82.0	57.0	83.0	62.0	18.0	27.0	24.0	613.0
6.75	1.0	65.0	24.0	61.0	65.0	49.0	24.0	8.0	37.0	14.0	348.0
7.25	9.0	6.0	5.0	24.0	35.0	44.0	19.0	33.0	91.0	6.0	272.0
7.75	53.0	7.0	40.0	8.0	24.0	29.0	11.0	61.0	96.0	24.0	353.0
8.25	52.0	36.0	80.0	6.0	43.0	5.0	19.0	43.0	12.0	38.0	334.0
8.75	78.0	50.0	48.0	28.0	38.0	21.0	33.0	22.0	17.0	55.0	390.0
9.25	31.0	48.0	44.0	48.0	26.0	31.0	34.0	4.0	25.0	29.0	320.0
9.75	18.0	21.0	20.0	22.0	7.0	40.0	60.0	2.0	61.0	20.0	271.0
10.25	9.0	7.0	6.0	10.0	7.0	22.0	27.0	1.0	80.0	3.0	172.0
10.75	9.0	3.0	7.0	3.0	5.0	14.0	17.0	1.0	60.0	1.0	120.0
11.25	0.0	1.0	2.0	3.0	3.0	7.0	5.0	0.0	27.0	0.0	48.0
11.75	0.0	4.0	0.0	3.0	2.0	5.0	4.0	0.0	4.0	0.0	22.0
12.25	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	5.0	0.0	7.0

Length-Frequency Wizard

FishBase

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

Step 2: Data Entry

The maximum reported length for this species is 17 cm SL . The 'Max. age & size' table may contain additional maximum length values for different areas. Please enter the maximum length known for your population and the respective length type (TL = total length, SL = standard length, FL = fork length).

Maximum length: 17.0 (cm)

Length type: TL

Please enter the mid-ranges of your length classes and the number of fish counted therein. Separate entries by a space and use point as decimal symbol (see example). [1]

Proceed | Back | Exit | Background | Upload to FishBase

Length (cm)	Frequency (n)
5.25	0
5.75	0
6.25	0
6.75	0
7.25	0
7.75	1
8.25	0
8.75	3
9.25	5
9.75	4
10.25	7
10.75	4
11.25	10
11.75	4
12.25	6
12.75	1
13.25	0
13.75	0
14.25	0
14.75	0
15.25	0

Example

52.5 12.0
57.5 14.0
62.5 23.0

Proceed | Back | Exit | Background

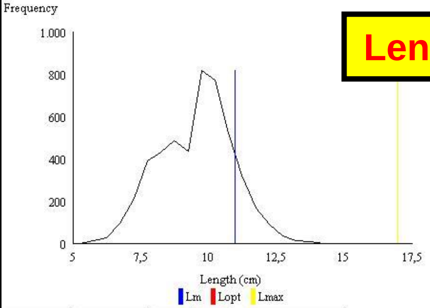
Note: For the calculation of natural mortality in Step 7 we need the length type in TL. For some species such as tunas the difference between TL and FL is small, and thus FL data can be treated as TL. Otherwise see our ' L-L relationship' table for conversions of length types.

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

Step 3: Length Frequency Graph

On the graph below you see a plot of your length frequency data with vertical lines indicating maximum length (Lmax), length at first maturity (Lm), and length with optimum yield (Lopt). Survey data from an unfished population will usually show the highest peak of juvenile fishes at the left, followed by values fluctuating around a nearly straight line from the peak to maximum length on the X-axis, with a large proportion of mature and old fishes. Data from heavily exploited stocks will fluctuate around an exponentially declining curve from the first peak towards a value on the X-axis left of maximum length, and thus with only a small portion of mature and very few--if any--old fishes. In your sample **3.4%** of the specimens had a chance to reproduce before being caught.
To avoid growth and recruitment overfishing, fisheries should strive to catch less juveniles, increase the number of fish that could spawn before being caught, and strive to only catch fish near the length with maximum yield (Lopt). The graph below can help to monitor progress towards such goals in subsequent years.
You can change the value for Lmax and recalculate Lopt. You can also replace the value for length at first maturity with a better estimate (preferably for females) and recalculate the number of mature specimens in the catch. Additional maturity values may be available in the 'Maturity' table.

Maximum length (Lmax):	17.0 (cm) TL	Recalculate
Length with optimum yield (Lopt):	10.8 (cm)	
Length at first maturity (Lm):	11.2 (cm)	Recalculate
Number of specimens in sample:	4,901	
Number of mature specimens:	169 (3.4%)	
Number of specimens with optimum yield (Lopt +/- 10%):	2,711 (55.3%)	
Number of Mega-spawners in catch (> Lopt + 10%):	74 (1.5%)	
Smallest fully selected length class (L'):	10 (cm)	Recalculate
Mean length (>= L') in sample (Lmean):	10.6 cm	



Length-frequency graph

Redraw | Proceed | Back | Exit | Background

Note: If the first two peaks of your L-F sample are clear and well separated and likely to represent subsequent cohorts (fishes that are one year apart), you can use the length-difference between these peaks to estimate growth.

Linf:	18.0 cm	(asymptotic length estimated from Lmax)
L 1:	8.75 cm	(length associated with first peak; X value of mouse-over)
L 2:	9.75 cm	(length associated with second peak; X value of mouse-over)
delta t:	1 years	(time difference between L 1 and L 2, usually 1 year)
K:	1/year	Calculate

If your L-F sample is aggregated from several individual samples you may want to do this calculation for every sub-sample and then take the mean value of K. You may change the value for delta t if the time between the peaks is different from 1; for example, delta t could be 0.5 if fish spawn twice per year, or 3 if you can identify the young-of-the year and a peak representing an outstanding year class of 3 years earlier. Note that this is only a preliminary estimate of K which you may want to compare with other estimates available for this species, or for closely related species of similar size.

Length-Frequency Wizard

FishBase

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

FishBase

Step 4: Length-Weight Relationship

In this step we calculate the weight of the fish in your Length-Frequency sample. We use a length-weight relationship of the form W=**a***L^**b** from FishBase with the same length-type as in your sample, if available. You can replace the values for **a** and **b** if you have better estimates (length in cm, weight in g). Additional length-weight estimates for this species may be available in the 'Length-weight' table. If no length-weight relationship is available set b=3.0 and a=0.1 for short and round fishes, a=0.01 for normal fishes, and a=0.001 for eel-like fishes. In the following analysis the values for yield will then be only approximations, but peak in biomass, yield increase in percent, and preliminary exploitation rate will be correct.

a = 0.01920

b = 2.68100

Proceed | Back | Exit | Background

Note: Values for L-W are required for proceeding.

Length-weight relationship

Actual yield data

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

FishBase

Step 5: Actual Yield

Below we show your Length-Frequency data with actual yields in metric tons. The total yield of your sample is **0.20 tons**. Note that the **62.5 cm** length class produced the highest yield (**0.06 tons**) in your sample.

Proceed | Back | Exit | Background

n = 6 (Number of Length Classes)

Length (cm)	Frequency	Yield (tons)
52.5	12	0.017156
52.5	12	0.017156
57.5	14	0.026505
57.5	14	0.026505
62.5	23	0.056326
62.5	23	0.056326

Proceed | Back | Exit | Background

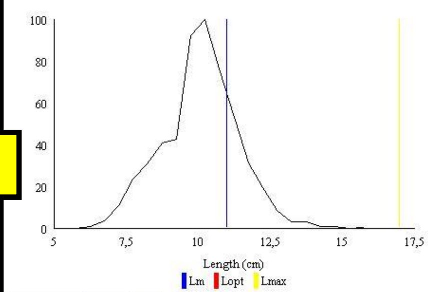
Note: If your frequency is not in absolute numbers, then the yield w... relative yield'.

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

Step 6: Yield Graph

Below we show a graph of the yield (biomass) in your sample. Note that small fish usually do not contribute much to the yield. In an unfished or well-managed stock the peak of the yield curve will be close to Lopt. The greater the distance between the peak and Lopt, the larger the degree of growth and potentially recruitment overfishing. In your sample the yield peaks at **10.25 cm** length. This graph can be used to monitor the development of a fishery over several years.

Yield (% of largest value)



Proceed | Back | Exit | Background

Length-yield graph

Length-Frequency Wizard

FishBase

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

Step 7: Growth and Natural Mortality

To estimate exploitation rate from your data and the potential gain from a different fishing strategy you need to know the growth (Linf, K) and natural mortality (M) of your stock. Below we show values from FishBase, if available. You can replace these with your own values or use the Life-history tool to improve our estimates.

Lmax: 17 cm TL

Linf: 18.0 cm TL [Recalculate]

K: 0.82 1/year [Recalculate]

M: 1.59 1/year [Recalculate]

The subsequent calculation of preliminary exploitation rate (E) depends on a good estimate of Lopt (which we recalculate here from the growth and mortality values above) and the observed length class with maximum yield. You can replace our estimates below with your own.

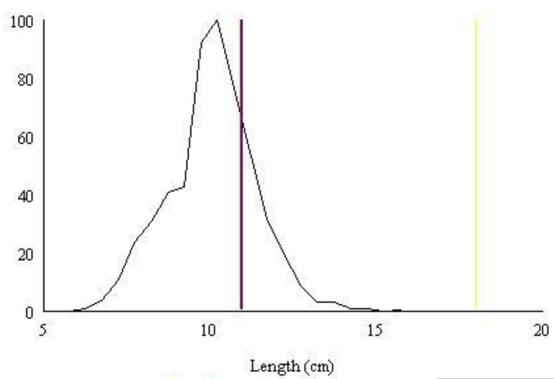
Lopt length class: 10.9 cm TL

Length class with maximum yield: 11 cm

Age at first maturity: 1.0 years

[Proceed] [Back] [Exit] [Background]

Yield (% of largest value)



Growth and natural mortality

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

FishBa

Step 8: Preliminary Exploitation Rate

The length class 62.5 cm with the highest yield in your L-F sample can be used to obtain a preliminary estimate of total mortality (Z) in your stock. Fishing mortality (F) is then obtained from F=Z-M, and the exploitation rate of E=F/Z=**1.97** means that about **20%** of each generation of fish in your sample died from fishing. Exploitation rates of E>0.5 are considered unsustainable for most species and fisheries that include juveniles and adults. Note that if F is close to zero or negative then either your stock is unfished or your L-F sample is not suitable for this analysis.

Preliminary total mortality (Z): -1.39

Preliminary fishing mortality (F): -2.73

Preliminary exploitation rate (E): 1.97

Exploitation rate

We also provide the Beverton and Holt estimation of Z from Z = K * (Linf - Lmean) / (Lmean - L') (see Step 3):

B & H total mortality (Z): -9.36

B & H fishing mortality (F): -10.70

B & H exploitation rate (E): 1.14

[Proceed] [Back] [Exit] [Background]

For advanced users we also provide an approach to estimate Linf, Z/K, Z, annual reproductive rate (alpha), intrinsic rate of population increase (rmax), population doubling time (td), and fishing mortality associated with maximum sustainable yield (Fmsy). [Advanced L-F Wizard]

Length-Frequency Wizard

FishBase

Fishing strategy

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

Step 9: Fishing Strategy Background

Normally you can achieve much higher yields from your stock if you only catch fish with lengths around Lopt. This means you will not catch juveniles in order to let them realize their growth and spawning potential, and you will not catch very big adults, in order to benefit from their high fecundity and their good genes (reaching a large size and high age is an indicator of excellent 'fitness'). In the next steps we will calculate the gain in yield if such fishing strategy is applied. Note that such analysis does not make sense for new, unfished, or well managed stocks (peak of yield >= Lopt) or Length Frequency samples that do not represent properly the size structure of the stock.
Change Z below if you want to use the B & H estimate of Z = -9.36

Proceed | Back | Exit | Background

The following parameters will be used for the subsequent calculations:

Linf:	18.0	cm SL
K:	0.65	1/year
M:	1.34	1/year
Z:	-1.39	1/year
Lopt:	10.7	cm

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

FishBase

Step 10: Calculation of Potential Yield

In this step we calculate the potential yield if you only catch fish around Lopt at an average length of **10.7 cm**, which corresponds to an age of **1.4 years**. Thus, the column 'Potential Freq.' contains the number of fish in each length class that will survive to reach **1.4 years**, and the column 'Potential Yield' contains the contribution of the respective length class to the total potential yield. Note that the numbers in 'Potential Freq.' are lower than the numbers in 'Frequency', due to natural mortality. However, the survivors should nevertheless produce a higher yield.

Proceed | Back | Exit | Background

n = 6 (Number of Length Classes)

Length (cm)	Frequency	Actual Yield (tons)	Potential Freq.	Potential Yield (tons)
52.5	12.0	0.017156	0.0	0.000000
52.5	12.0	0.017156	0.0	0.000000
57.5	14.0	0.026505	0.0	0.000000
57.5	14.0	0.026505	0.0	0.000000
62.5	23.0	0.056326	0.0	0.000000
62.5	23.0	0.056326	0.0	0.000000

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Potential yield calculation

Length-Frequency Analysis Wizard (*Limnothrissa miodon*)

FishBase

Step 11: Comparison of Actual Yield with Potential Yield

Below you see the comparison between the actual yield represented by your Length Frequency sample, and the potential yield if these fish had been allowed to survive to a length around Lopt. If your Length Frequency sample was representative of the stock, then the difference in yield expressed in percent will give you a first estimate of how much more protein and income can be derived from your fishery. Also, most fish had a chance to reproduce before being caught and **86 'mega-spawners'** were allowed to survive. This should stabilize recruitment and further increase catches in subsequent years. Note, however, that it will take approximately **1.4 years** until the higher yield is achieved, and that especially in the first years after implementing the new fishing strategy yields may be significantly lower and fishers may need external support during that period.

Actual yield:	0.199972 tons
Potential yield:	0.000000 tons
Difference:	-0.200 tons (see Note if negative)
Difference:	-100.0 %

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Note: If the difference between Actual yield and Potential yield is negative, then most likely your L-F sample is not representative of the stock (see Note in Step 1). Other reasons could be that your population is unfished, that your growth or mortality estimates are unrealistic, or that fish are already caught at Lopt.

Below we repeat all relevant parameters of this analysis for easy documentation (just print this page).

Linf:	18.0	**Lm:**	11.2
K:	0.65	**tm:**	1.21
Ø:	2.32	**Lopt:**	10.70
to:	-0.29	**M:**	1.34
Z:	-1.39	**F:**	-2.73
E:	1.97		

Actual yield & Potential yield

Growth

FishBase

Growth

More information

Countries	Common names	Age/Size	References	Collaborators
FAO areas	Synonyms	Growth	Aquaculture	Pictures
Ecosystems	Metabolism	Length-weight	Aquaculture profile	Stamps, Coins
Occurrences	Predators	Length-length	Strains	Sounds
Introductions	Ecotoxicology	Length-frequencies	Genetics	Ciguatera
Stocks	Reproduction	Morphometrics	Allele frequencies	Speed
Ecology	Maturity	Morphology	Heritability	Swim. type
Diet	Spawning	Larvae	Diseases	Gill area
Food items	Fecundity	Larval dynamics	Processing	Otoliths
Food consumption	Eggs	Recruitment	Mass conversion	Brains
Ration	Egg development	Abundance	Vision	

Growth parameters for *Oreochromis esculentus*

Maximum Length 50cm SL — n = 20

Note that studies where Loo is very different (+/- 1/3) from Lmax are doubtful.

Auximetric graph [n = 20]
Lm vs Linf graph [n = 3]
Reproductive graph [n = 3]
M vs K graph [n = 1]
M vs Linf graph [n = 1]
Longevity vs 3/K graph [n = 1]

ø = 3.12
L inf = 12.9 cm SL
K = 8.0

Median record no. 11
102Ref. 102

Distributions

	Loo (cm)	Length Type	K (1/y)	to (years)	Sex	M (1/y)	Temp° C	Lm	Ø'	Country	Locality	Questionable	Captive
	6.4	TL	0.96				22.5		1.59		aquarium	No	Yes
	8.0	TL	1.02				22.5		1.81		aquarium	No	Yes
	9.0	TL	1.89				22.5		2.18		aquarium	No	Yes
	9.5	TL	1.02				22.5		1.96		aquarium	No	Yes
	10.1	TL	3.80				22.5		2.59		large aquarium	No	Yes
	10.5	TL	2.03				22.5		2.35		aquarium	No	Yes
	12.2	TL	0.91				22.5		2.13		aquarium	No	Yes
	12.4	TL	2.87				22.5		2.64		aquarium	No	Yes
	12.5	TL	2.22				22.5		2.54		aquarium	No	Yes
	12.8	TL	3.29				22.5		2.73		small aquarium	No	Yes
	12.9	SL	7.96						3.12	Tanzania	ponds	No	Yes
	16.3	TL	0.79				22.5		2.32		aquarium	No	Yes
	25.1	TL	0.43				22.5		2.43		aquarium	No	Yes
✓	25.2	SL	0.35						2.35	Zimbabwe	Luapula Moero	No	No
✓	26.7	SL	0.45				25.5		2.51	Tanzania	Lake Victoria	No	No
	30.8	TL	0.26				22.5		2.38		aquarium	No	Yes
✓	32.0	TL	0.50			1.75	25.0	22.0	2.71	Kenya	Lake Victoria, Kavirondo Gulf	No	No
✓	32.4	TL	0.31				25.0	26.0	2.51	Tanzania	Lake Victoria, Mwanza Area	No	No
	33.5	TL	0.31				25.0		2.54	Kenya	Lake Victoria, outside Kavirondo Gulf	Yes	No
✓	33.8	TL	0.32				25.0	25.0	2.56	Uganda	Lake Victoria, Jinja Area	No	No

Distributions | Show Genus | Show Family

Growth of *Oreochromis esculentus*

Auximetric graph   Lm vs Linf graph   M vs Linf graph
Lm vs Linf graph   M vs K graph
(loading of graphs may take 2-3 min.)

Main Ref. :	787 **Data Ref. :**787			
Data Type :	scale annual rings			
Sex :	unsexed			
L infinity (cm) :	32.0 TL			**95% confidence limit:**
K (1/y) :	0.50 Ford/Walford plot	**n:**	**r²:**	**95% confidence limit:**
to (y) :				**95% confidence limit:**
Winf. :	616.00 g	other(see comments) **b used** :3.000	**Ø' :** 2.71	
C :				
M (1/y) :	1.750 **M Ref. :**1795 M doubtful?	**n:**	**r²:**	**95% confidence limit:**
	plot of Z on effort			
Lm (cm) :	22.0	0.69	Unsexed TL	**Lm Ref. :** 787
Locality :	Lake Victoria, Kavirondo Gulf			
Country :	Kenya			
Environment:	open waters			
Temp. :	25.0 **Temp. Ref. :**			
Comment :	Winf from Ref. 115			

Growth

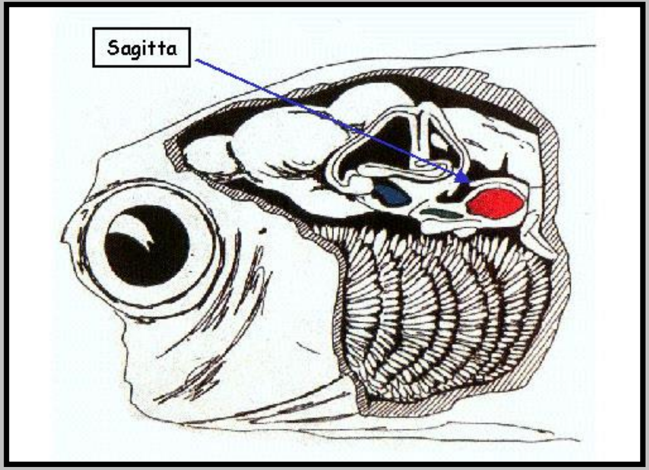
Growth of *Oreochromis esculentus*

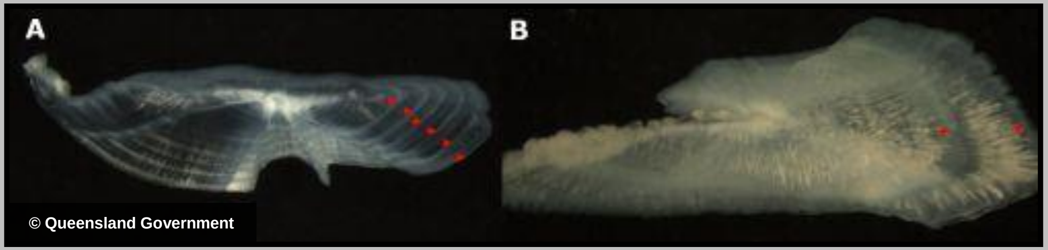
Auximetric graph   Lm vs Linf graph   M vs Linf graph
Lm vs Linf graph   M vs K graph
(*loading of graphs may take 2-3 min.*)

Main Ref. :	787 **Data Ref. :** 787				
Data Type :	scale annual rings				
Sex :	unsexed				
L infinity (cm) :	32.0 TL			**95% confidence limit:**	
K (1/y) :	0.50 Ford/Walford plot	**n:**	**r^2:**	**95% confidence limit:**	
to (y) :				**95% confidence limit:**	
Winf. :	616.00 g	other(see comments) **b used** :3.000	**Ø' :** 2.71		
C :					
M (1/y) :	1.750 **M Ref. :**1795 M doubtful?	**n:**	**r^2:**	**95% confidence limit:**	
	plot of Z on effort				
Lm (cm) :	22.0	0.69	Unsexed	TL	**Lm Ref. :** 787
Locality :	Lake Victoria, Kavirondo Gulf				
Country :	Kenya				
Environment:	open waters				
Temp. :	25.0 **Temp. Ref. :**				
Comment :	Winf from Ref. 115				

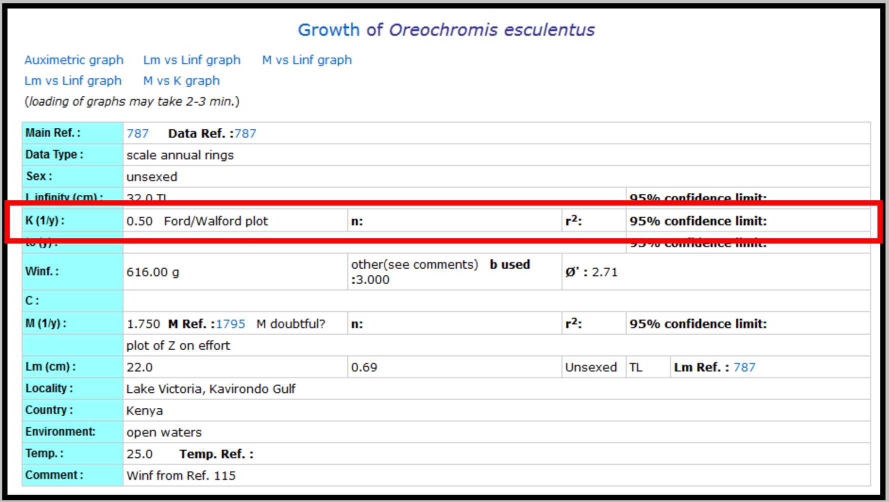
There are different source data used for the growth estimation:

1/ otolith annuli.
2/ scale annuli.
3/ other annual rings.
4/ daily otolith rings.
5/ tagging / recapture.
6/ length-frequency data.
7/ direct observations.
8/ several data types.
9/ other possibilities.





Growth



Growth of *Oreochromis esculentus*

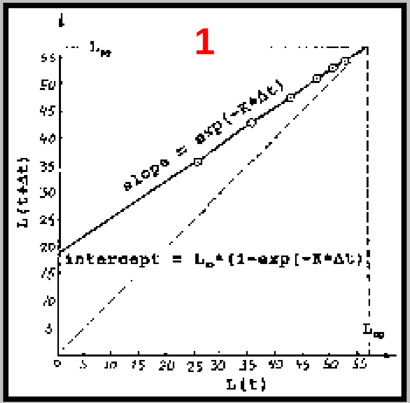
Auximetric graph Lm vs Linf graph M vs Linf graph
Lm vs Linf graph M vs K graph
(*loading of graphs may take 2-3 min.*)

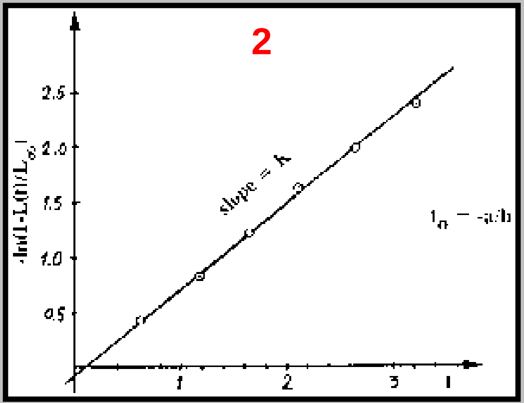
Main Ref.:	787 **Data Ref.**: 787				
Data Type:	scale annual rings				
Sex:	unsexed				
L infinity (cm):	32.0 TL			95% confidence limit:	
K (1/y):	0.50 Ford/Walford plot	n:	r²:	95% confidence limit:	
to (y):				95% confidence limit:	
Winf.:	616.00 g	other(see comments) **b used** :3.000	ø' : 2.71		
C:					
M (1/y):	1.750 **M Ref.**: 1795 M doubtful?	n:	r²:	95% confidence limit:	
	plot of Z on effort				
Lm (cm):	22.0	0.69	Unsexed	TL	**Lm Ref.**: 787
Locality:	Lake Victoria, Kavirondo Gulf				
Country:	Kenya				
Environment:	open waters				
Temp.:	25.0 **Temp. Ref.**:				
Comment:	Winf from Ref. 115				

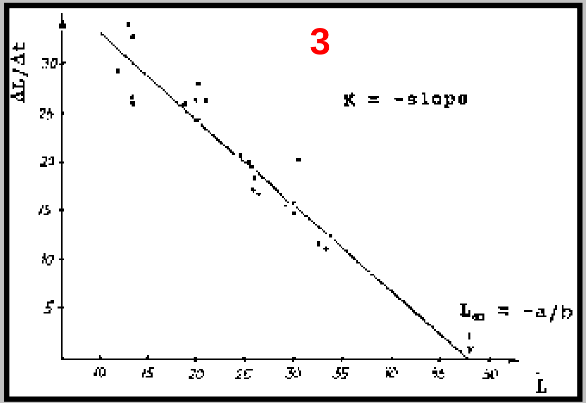
There are different methods to estimate a given set of growth parameters:

1/ Ford-Walford plot.
2/ von Bertalanffy / Beverton plot.
3/ Gulland & Holt plot.
4/ nonlinear regression.
5/ ELEFAN.
6/ other methods.

See Bougis (1976), Ricker (1980), Gulland (1983), Pauly (1984, 1997), Gayanilo & Pauly (1997) and other publications for the description of these methods, their underlying hypotheses, conformity of the data and their biases.







Growth

Growth of *Oreochromis esculentus*

Auximetric graph Lm vs Linf graph M vs Linf graph
Lm vs Linf graph M vs K graph
(*loading of graphs may take 2-3 min.*)

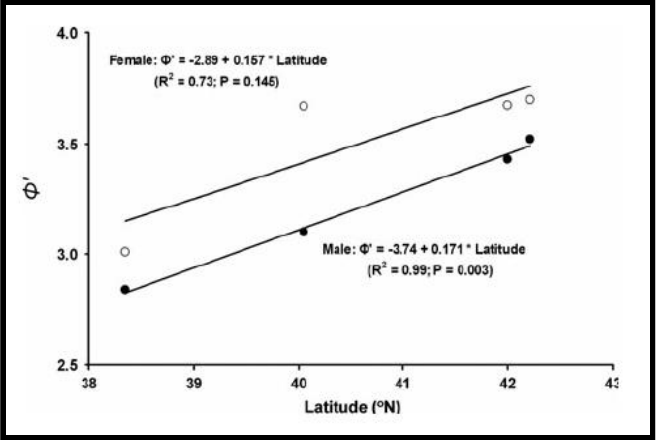
Main Ref. :	787 **Data Ref. :**787				
Data Type :	scale annual rings				
Sex :	unsexed				
L infinity (cm) :	32.0 TL			**95% confidence limit:**	
K (1/y) :	0.50 Ford/Walford plot	**n:**	**r^2:**	**95% confidence limit:**	
to (y) :				**95% confidence limit:**	
Winf. :	616.00 g	other(see comments) **b used** :3.000	**Ø' :** 2.71		
C :					
M (1/y) :	1.750 **M Ref. :**1795 M doubtful?	**n:**	**r^2:**	**95% confidence limit:**	
	plot of Z on effort				
Lm (cm) :	22.0	0.69	Unsexed	TL	**Lm Ref. :** 787
Locality :	Lake Victoria, Kavirondo Gulf				
Country :	Kenya				
Environment:	open waters				
Temp. :	25.0 **Temp. Ref. :**				
Comment :	Winf from Ref. 115				

Conversion of W_∞ from L_∞ based on following choices:

1/ as given in MainRef. or Ref. for growth.
2/ computed using L/W relationship of the same stock.
3/ computed using L/W relationship of an other stock from the same species.
4/ computed using L/W relationship of a similar species.
5/ other (see Comments).

ø' = growth performance index.
It is for comparison with the ø' index of other stocks from the same species, or from a closely allied species.

$$ø' = \log_{10}K + 2 \log_{10}L_\infty$$



Growth

FishBase

Growth

Growth of *Oreochromis esculentus*

Auximetric graph   Lm vs Linf graph   M vs Linf graph

Lm vs Linf graph   M vs K graph

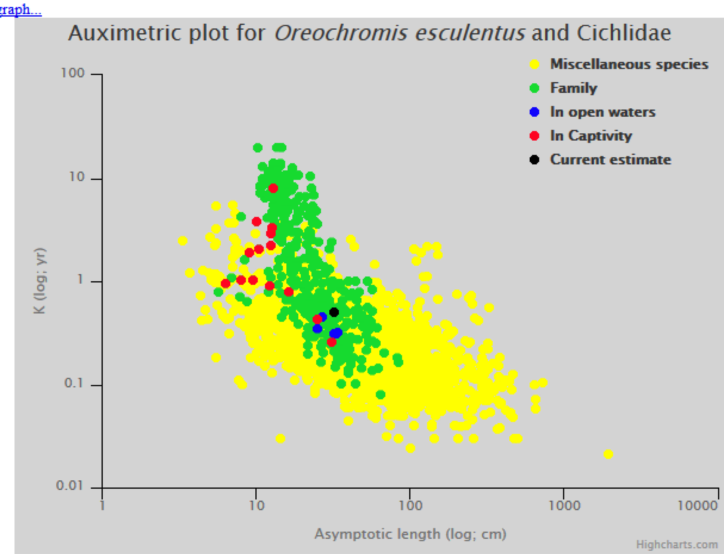
(loading of graphs may take 2-3 min.)

Main Ref. :	787 **Data Ref. :**787				
Data Type :	scale annual rings				
Sex :	unsexed				
L infinity (cm) :	32.0 TL			**95% confidence limit:**	
K (1/y) :	0.50 Ford/Walford plot	**n:**	**r^2:**	**95% confidence limit:**	
to (y) :				**95% confidence limit:**	
Winf. :	616.00 g	other(see comments) **b used** :3.000	**Ø' :** 2.71		
C :					
M (1/y) :	1.750 **M Ref. :**1795 M doubtful?	**n:**	**r^2:**	**95% confidence limit:**	
	plot of Z on effort				
Lm (cm) :	22.0	0.69	Unsexed	TL	**Lm Ref. :** 787
Locality :	Lake Victoria, Kavirondo Gulf				
Country :	Kenya				
Environment:	open waters				
Temp. :	25.0 **Temp. Ref. :**				
Comment :	Winf from Ref. 115				

FishBase makes it possible to reproduce an auximetric plot of growth parameters (K vs. L_∞, on logaritmic basis).

- **Possible comparisons with other miscellaneous species, species of the same family, or current species.**
- **Possibility to change the growth parameters and redraw the plot.**

About this graph...



[n = 20; mean K = 0.96; Linf = 16.14]

In Captivity [n = 14]; In Open Waters [n = 6]

Add estimate: K = 0.50 Linf = 32.0 Redraw

Growth parameters list

Back to Search

Growth

FishBase

Growth

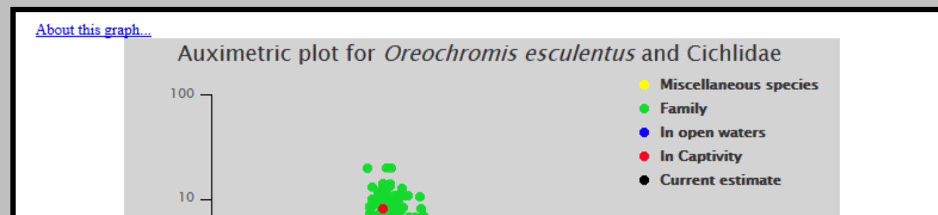
Growth of *Oreochromis esculentus*

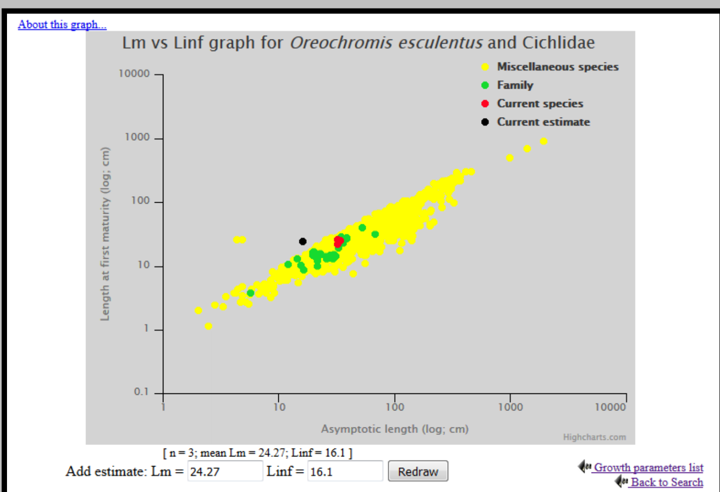
Auximetric graph | Lm vs Linf graph | M vs Linf graph
Lm vs Linf graph | M vs K graph
(loading of graphs may take 2-3 min.)

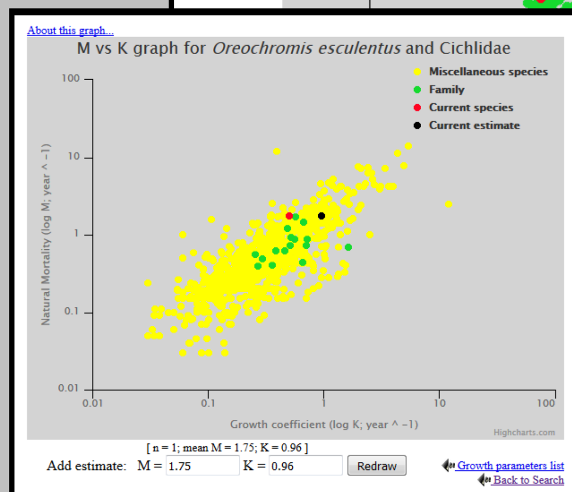
Main Ref. :	787 **Data Ref. :** 787				
Data Type :	scale annual rings				
Sex :	unsexed				
L infinity (cm) :	32.0 TL			**95% confidence limit:**	
K (1/y) :	0.50 Ford/Walford plot	**n:**	**r²:**	**95% confidence limit:**	
to (y) :				**95% confidence limit:**	
Winf. :	616.00 g	other(see comments) **b used** :3.000	**Ø' :** 2.71		
C :					
M (1/y) :	1.750 **M Ref. :** 1795 M doubtful?	**n:**	**r²:**	**95% confidence limit:**	
	plot of Z on effort				
Lm (cm) :	22.0	0.69	Unsexed	TL	**Lm Ref. :** 787
Locality :	Lake Victoria, Kavirondo Gulf				
Country :	Kenya				
Environment:	open waters				
Temp. :	25.0 **Temp. Ref. :**				
Comment :	Winf from Ref. 115				

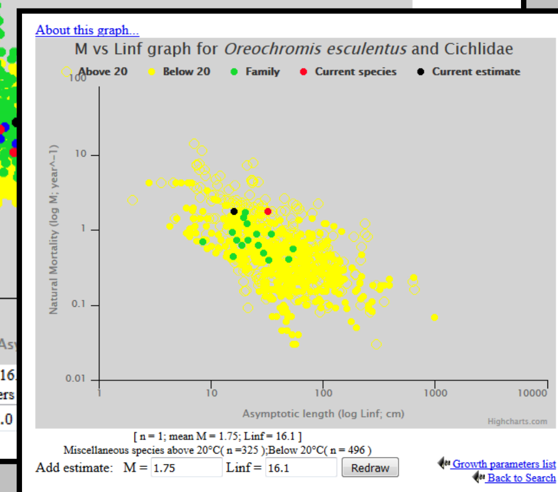
FishBase makes it possible to reproduce an auximetric plot of growth parameters (K vs. L_∞, on logaritmic basis).

- **Possible comparisons with other miscellaneous species, species of the same family, or current species.**
- **Possibility to change the growth parameters and redraw the plot.**









Life-History Tool

FishBase

The Life-History Tool contains the different parameters on population dynamics and life history of a certain species, such as growth, length at first maturity,…

It uses the best available data in FishBase as default for the various equations, but users can replace these with their own estimates and can recalculate the parameters.

Tools

E-book | Field guide | Length-frequency wizard | Life-history tool | Point map | Classification Tree | Catch-MSY |

Life History Data on *Oreochromis esculentus*
Singida tilapia

Family:	Cichlidae Cichlids	
Max. length (Lmax):	50.0 cm SL	
L infinity (Linf):	= 32.2 cm TL	Recalculate
K:	0.45 /year Ø' = 2.67 Median Ø' value with related Linf. and K.	Recalculate Growth & mortality data
to:	-0.36 years Estimated from Linf and K.	
Natural mortality (M):	0.91 s.e. 0.60 - 1.38 /year Estimated from Linf., K and annual mean temp. = 25.5 °C	Recalculate
Life span (approx.):	6.3 years Estimated from Linf., K and to. Max. age & size data	
Generation time:	1.8 years Estimated from Lopt, Linf., K and to.	
Age at first maturity (tm):	1.6 years Estimated from Lm, Linf., K and to.	
L maturity (Lm):	18.9 s.e. 14.1 - 25.3 cm TL Estimated from Linf. Maturity data	
L max. yield (Lopt):	19.8 s.e. 16.8 - 23.4 cm TL Estimated from Linf.	
Length-weight:	32.2 cm TL => 668.3 g (wet weight) W = 0.0194 * L ^ 3.00900	Recalculate Length-weight data
Nitrogen & protein:	Weight 669 (g) => whole-body nitrogen (N) 18.2 (g) => whole-body crude protein 113.6 (g)	Recalculate
Reproductive guild:	bearers: external brooders Reproduction	
Fecundity:	[no value (min.)-no value (max.)] Estimated as geometric mean. Fecundity	

Relative Yield per Recruit (Y'/R):	0.0277	Estimate Y'/R from M/K, Lc/Linf and E. Lc= 12.9 cm TL E= 0.50 /year Emsy 0.65 /year Eopt 0.57 /year Fmsy 1.69 /year Fopt 1.21 /year	Recalculate
Exploitation:	Z= F= E=	Estimate Z, F, E from Lc, Lmean, Linf, K, M Lc = 12.9 cm TL Lmean = cm TL	Recalculate
Resilience / productivity:	High; decline threshold 0.99 Vulnerable to extinction if decline in biomass or numbers exceeds threshold over the longer of 10 years or 3 generations.		
Intrinsic rate of increase (rm):	3.38 /year	Lr = 12.9 cm TL Estimated from Fmsy at Lc = length of recruitment (Lr).	Recalculate
Main food:	mainly plants/detritus (troph. 2-2.19)		
Trophic level:	2.5 +/- s.e. 0.17 Estimated from food data. Food		
Food consumption (Q/B):	20.7 times the body weight per year	Enter Winf, temperature, aspect ratio (A), and food type to estimate Q/B Winf = 668.3 g Temp. = 25.5 °C A = 1.32 Detrivore Herbivore Omnivore Carnivore	Recalculate
Estimate growth			

Note: The estimates are derived from default values taken from FishBase and will thus not be appropriate for every population. You can change these values and recalculate the life history parameters.

Back to Search
Species summary

More info:

- FAO Fisheries Technical Paper 306: Introduction to tropical fish stock assessment.
- Christensen, V. & J. MacLean (2011) Ecosystem approach to fisheries. Cambridge University Press, Cambridge. 325 p.
- Pauly, 1997 (adaption française par J. Moreau) Méthodes pour l'évaluation des ressources halieutiques. Editions CEPADUES, Toulouse. 288 p.