



Magister en Ciencias mención Pesquerías

# Evaluación y Manejo de Pesquerías Limitadas en Datos

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**Día 2: Modelos de evaluación de stock basado en datos de tallas (LBI, LBSPR, LBB, LBPA)**

◆ **Clase 3:** Métodos basados en datos de frecuencia de tallas

# Modelos basados en tallas

## Length-based indicators (LBI)

**Indicadores basados en la talla:**

- Distribuciones de frecuencia de tallas de muestras obtenidas de las capturas, o cruceros.
- Parámetros de historia de vida (crecimiento, longitud de madurez, longitud de primera captura, mortalidad natural).

**ICES MSY framework** utiliza esta información para elaborar indicadores para:

1. La conservación de los individuos grandes (i.e., el potencial reproductivo)
2. Conservación de peces inmaduros
3. Rendimiento máximo sostenible (RMS)

(<https://www.seafish.org/responsible-sourcing/fisheries-management/sustainable-fisheries-assessment-and-management-guides/data-limited-fisheries/> ]

ICES WKDLSSLS <https://www.ices.dk/community/groups/Pages/WKDLSSLS.aspx>

SEAFISH <https://www.seafish.org>

# LBI

- Conservación de individuos grandes, mega desovantes  $L_{mega}$ , inmaduros  $L_{25\%}$ , y rendimiento óptimo :

Indicador	Referencia	Razón	Valor esperado
$L_{95\%}$	$L_\infty$	$L_{95\%}/L_\infty$	$> 0.8$
$L_{max5\%}$	$L_\infty$	$L_{max5\%}/L_\infty$	$> 0.8$
$P_{mega}$	$0.3 - 0.4$	$P_{mega}$	$> 0.3$
$L_{25\%}$	$L_m$	$L_{25\%}/L_m$	$> 1$
$L_c$	$L_m$	$L_c/L_m$	$> 1$
$L_{mean}$	$L_{opt}$	$L_{mean}/L_{opt}$	$\sim 1$
$L_{maxy}$	$L_{opt}$	$L_{maxy}/L_{opt}$	$\sim 1$
$L_{mean}$	$L_{F=M}$	$L_{mean}/L_{F=M}$	$\geq 1$

# Notas LBI

$$L_{opt} = 3/(3 + M/K)L_\infty$$

$$L_{F=M} = (1 - a)L_c + aL_\infty$$

donde:

$$a = 1/(2(M/K)) + 1$$

- Cuando  $M/K = 1.5$ :

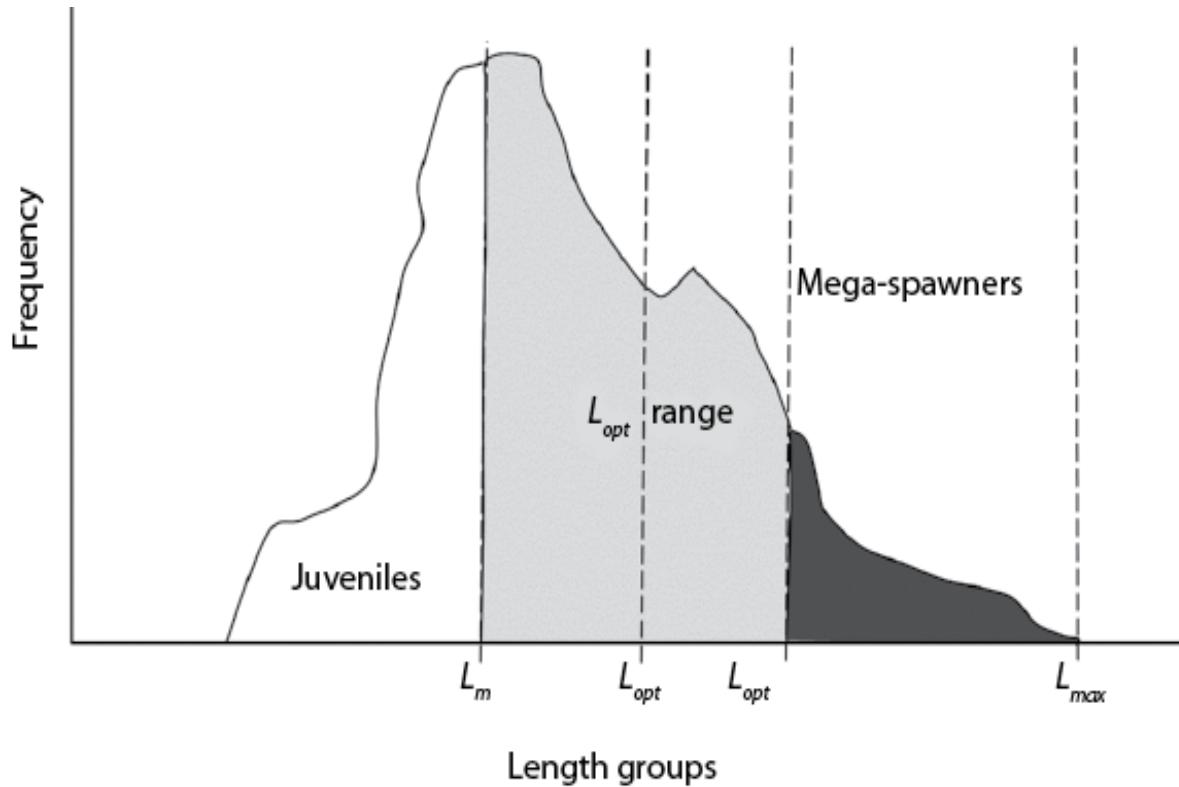
$$L_{opt} = 2/3L_\infty$$

$$L_{F=M} = 0.75L_c + 0.25L_\infty$$

ICES. 2018. Report of the Workshop on Length-Based Indicators and Reference Points for Elasmobranchs (WKSHARK4), 6 -9 February 2018, Ifremer, Nantes (France). 112 pp.

# Notas LBI (Cont.)

- Indicadores de conservación de individuos más grandes:



Tesfaye, G., Wolff, M. 2015. Revista de Biología Tropical 63, 755-770 <https://doi.org/10.15517/rbt.v63i3.16715>

# Notas LBI (Cont.)

- Indicadores de conservación de individuos más grandes:

$L_{95\%}$ : Percentil 95%, principalmente estadístico.

$L_{max5\%}$ : Longitud media del 5% de los individuos más grandes en las capturas (Probst et al. 2013; Miethe et al. 2019)

Probst, W.N., Kloppmann, M., Kraus, G. 2013. Indicator-based status assessment of commercial fish species in the North Sea according to the EU Marine Strategy Framework Directive (MSFD), ICES Journal of Marine Science 70, 694–706. <https://doi.org/10.1093/icesjms/fst010>

Miethe, T., Reecht, Y., Dobby, H. 2019. Reference points for the length-based indicator  $L_{max5\%}$  for use in the assessment of data-limited stocks, ICES Journal of Marine Science 76, 2125–2139. <https://doi.org/10.1093/icesjms/fsz158>

# Notas LBI (Cont.)

- Protección de mega reproductores

$$P_{mat} = \sum_{L_m}^{L_{max}} P_l$$

$$P_{opt} = \sum_{0.9L_{opt}}^{1.1L_{opt}} P_l$$

$$P_{opt} = \sum_{1.1L_{opt}}^{L_{max}} P_l$$

Cope, J.M., Punt, A.E. 2009. Length-Based reference points for data-limited situations: Applications and restrictions. *Marine and Coastal Fisheries* 1, 169-186. <https://doi.org/10.1577/C08-025.1>

# Software disponibles

- Análisis de datos de frecuencia de tallas y parámetros de historia de vida:

TropFishR

- Parámetros de historia de vida

FishLife

Mildenberger, T.K., Taylor, M.H. and Wolff, M. 2017. TropFishR: an R package for fisheries analysis with length-frequency data. *Methods Ecol Evol*, 8: 1520-1527. <https://doi.org/10.1111/2041-210X.12791>

Thorson, J. T., Munch, S. B., Cope, J. M., & Gao, J. (2017). Predicting life history parameters for all fishes worldwide. *Ecological Applications*, 27(8), 2262–2276. <https://doi.org/10.1002/eap.1606>

# Aplicación Shiny

[https://scott.shinyapps.io/LBIndicator\\_shiny/](https://scott.shinyapps.io/LBIndicator_shiny/)

Código: [ICES-tools-dev/LBIndicator\\_shiny](#)

Otras: [ICES-tools-dev/ICES\\_MSY](#)

# Aplicación

[https://scott.shinyapps.io/LBIndicator\\_shiny/](https://scott.shinyapps.io/LBIndicator_shiny/)



To use the LBI Application you will need: 1) a length frequency distribution 2) weight at length data, and 3) estimates of the life history parameters. The following paragraphs outline the steps to use the LBI Application. Each heading refers to a tab on the menu.

## Upload Data

The first step is to upload two CSV (comma separated variable) files containing the length frequency distribution and mean weight at length. The file must be in CSV format and contain only numeric values except for the header row which can contain labels. Multiple years of data should be placed in separate columns.

Length frequency data must have the midpoints of the length classes (the length bins) in the first column, and numeric values for all counts (i.e., all columns are the same length). Length measurements should be raw numbers, each column representing a different year.

Two example stocks have been included. Click the 'I want to look at sample data' radio button to make see the exact format.

## Plot length frequency distribution

Slide the bar according to the bin width that you want to aggregate the data. Both length frequency distribution and weight at length data frames are modified concurrently. Only the LFD is displayed

## LBI plot

Enter the life history parameters for your stock. The application will automatically generate the LBI indicators and reference points.

## LBI table

The last 3 years of LBI indicators are generated in a table relative to reference points. The shading of the cell indicates the relative status.

## Downloads

All figures and tables can be downloaded as a .docx report or as individual .png images.

# Potencial reproductivo basado en talla

$$SPR = \frac{\text{Potencial Reproductivo Explotado}}{\text{Potencial Reproductivo Inexplorado}}$$

SPR puede ser calculado a la talla, considerando la razón  $M/K$ ,  $F/M$ , y  $L_m/L_\infty$

$$SPR = \frac{\sum(1 - L_x)^{M/K(F/M-1)} L_x^3}{\sum(1 - L_x)^{M/K} L_x^3}$$

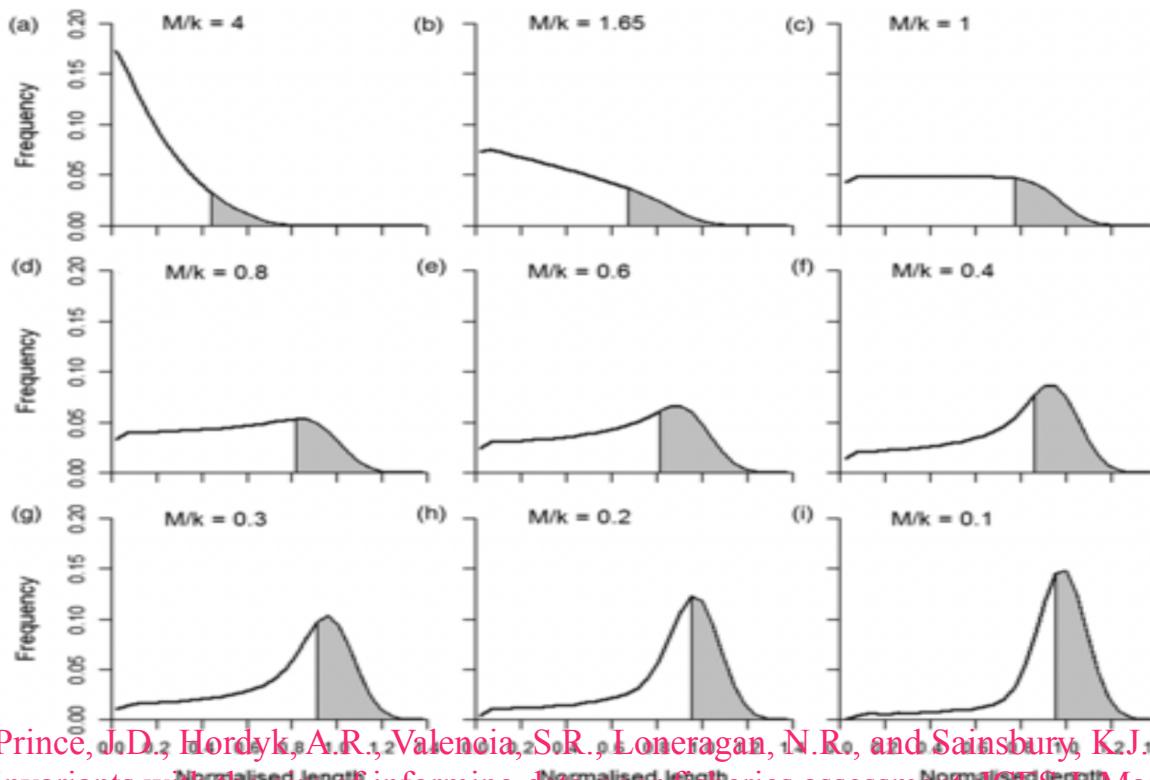
$L_x$ : longitud esperada (estandarizada) a la edad  $x$ .

Hordyk, A.R., Ono, K., Sainsbury, K.J., Loneragan, N., and Prince, J.D. 2015a. Some explorations of the life history ratios to describe length composition, spawning-per-recruit, and the spawning potential ratio. ICES J. Mar. Sci. 72: 204 - 216. <https://doi.org/10.1093/icesjms/fst235>

Hordyk, A.R., Ono, K., Valencia, S.R., Loneragan, N.R., and Prince, J.D. 2015b. A novel length-based empirical estimation method of spawning potential ratio (SPR), and tests of its performance, for small-scale, data-poor fisheries. ICES J. Mar. Sci. 72: 217 – 231.

# Invariantes de Beverton-Holt

- Cuando:  $L_m/L_\infty \sim 0.66$  y  $M/K \sim 15$



Prince, J.D., Hordyk, A.R., Valencia, S.R., Loneragan, N.R., and Sainsbury, K.J. 2015. Revisiting the concept of Beverton–Holt life-history invariants with the aim of informing data-poor fisheries assessment. *ICES J. Mar. Sci.* 72: 194 - 203. <https://doi.org/10.1093/icesjms/fsu011>

# LBSPR y selectividad

- Length-based GTG (growth-type-group), concepto asociado con el **fenómeno de Rosa Lee**; i.e., "La población de más edad está sesgada por peces de crecimiento más lento, ya que los peces de crecimiento más rápido murieron a una edad más temprana."
- GTG LB-SPR estima consistentemente valores más bajos de  $F/M$  comparado con  $LB - SPR$

Hordyk, A., Ono, K., Prince, J.D., and Walters, C.J. 2016. A simple length-structured model based on life history ratios and incorporating size-dependent selectivity: application to spawning potential ratios for data-poor stocks. *Can. J. Fish. Aquat. Sci.* 13: 1– 13.  
<https://doi.org/10.1139/cjfas-2015-0422>

# LBSPR: Length-Based Spawning Potential Ratio

## Vignettes LBSPR

<http://barefootecologist.com.au/lbspr>

### LBSPR R Shiny App



### Instructions

To use the LBSPR Application you will need: 1) length composition data from your fishery (either raw measurements or counts), and 2) estimates of the life history parameters. The following paragraphs outline the steps to use the LBSPR Application. Each heading refers to a tab on the menu.

#### Upload Data

The first step is to upload a CSV (comma separated variable) file containing length data. The file must be in CSV format and contain only numeric values except for the header row which can contain labels. Multiple years of data should be placed in separate columns.

Length frequency data must have the midpoints of the length classes (the length bins) in the first column, and numeric values for all counts (i.e., all columns are the same length). Length measurements should be raw numbers, each column representing a different year.

A number of example data files have been included. Download the CSV files to see the contents of these files

#### Fit Model

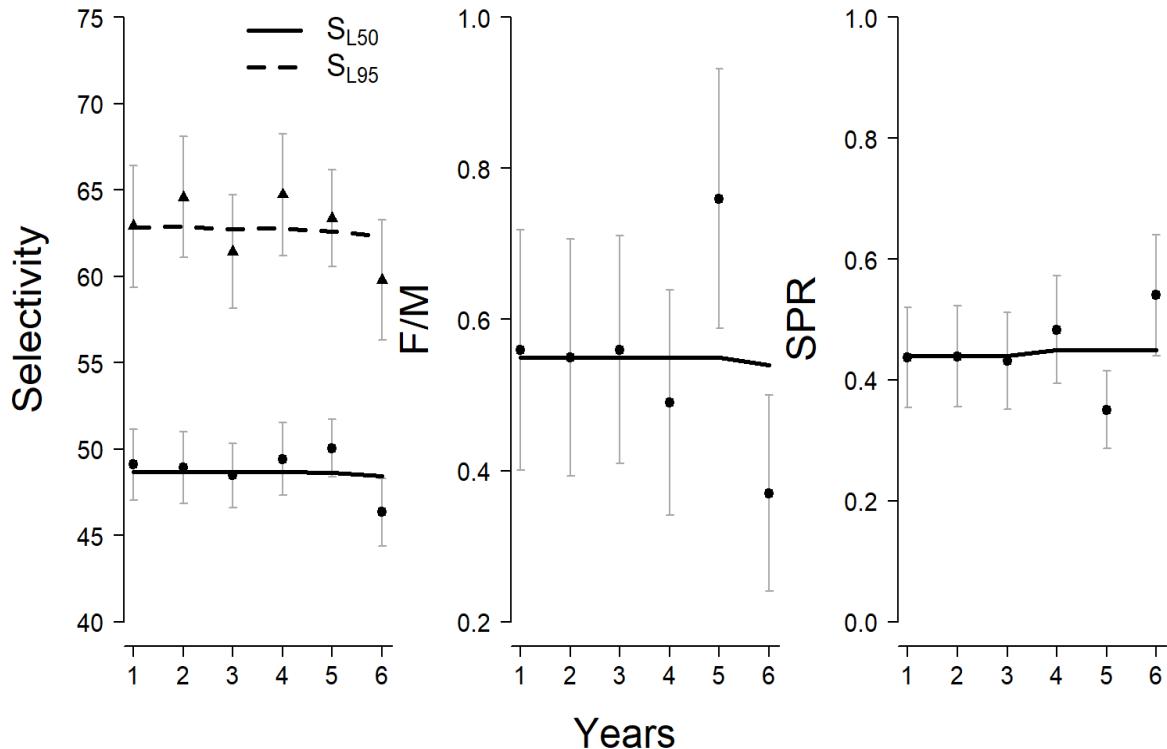
Enter the life history parameters for your species, and check that the length frequency distribution looks correct. If everything is correct, run the LBSPR model.

Use the example life history parameters for the example data files

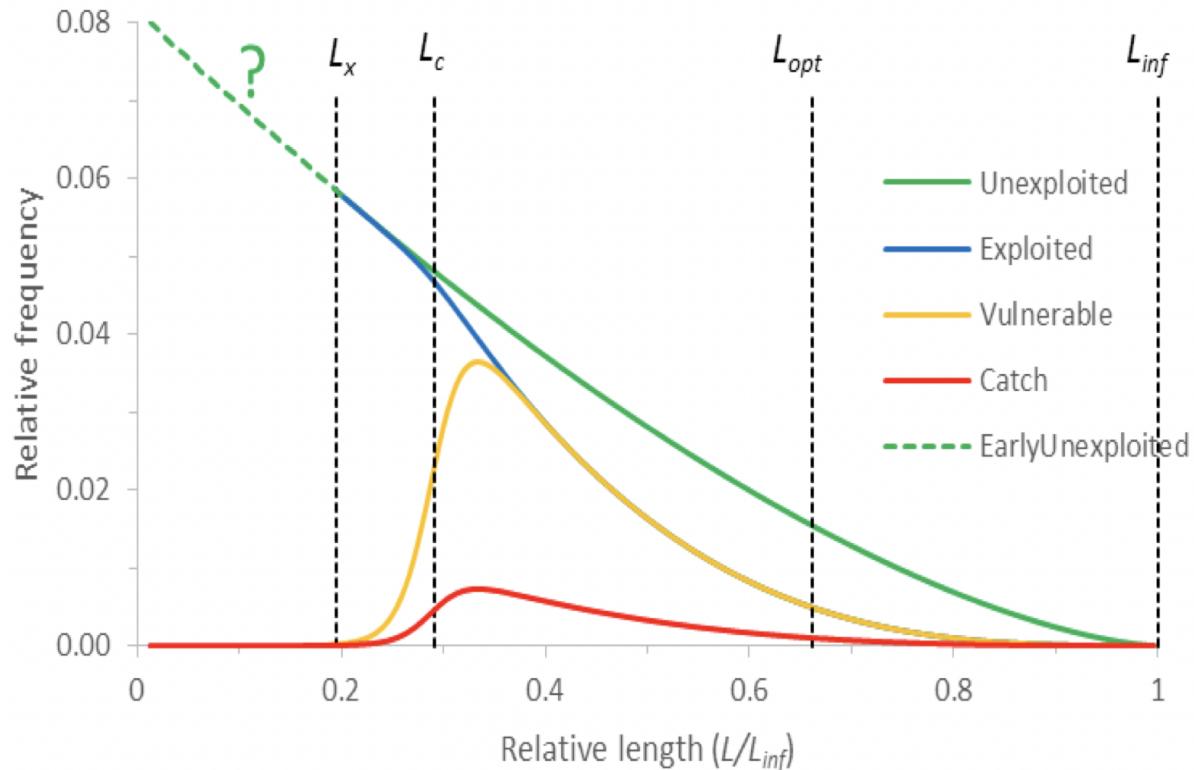
#### Examine Results

The estimated parameters of the LBSPR model in tabular and graphical format. All figures can be downloaded. The estimated parameters can be downloaded in CSV format.

# Interpretación



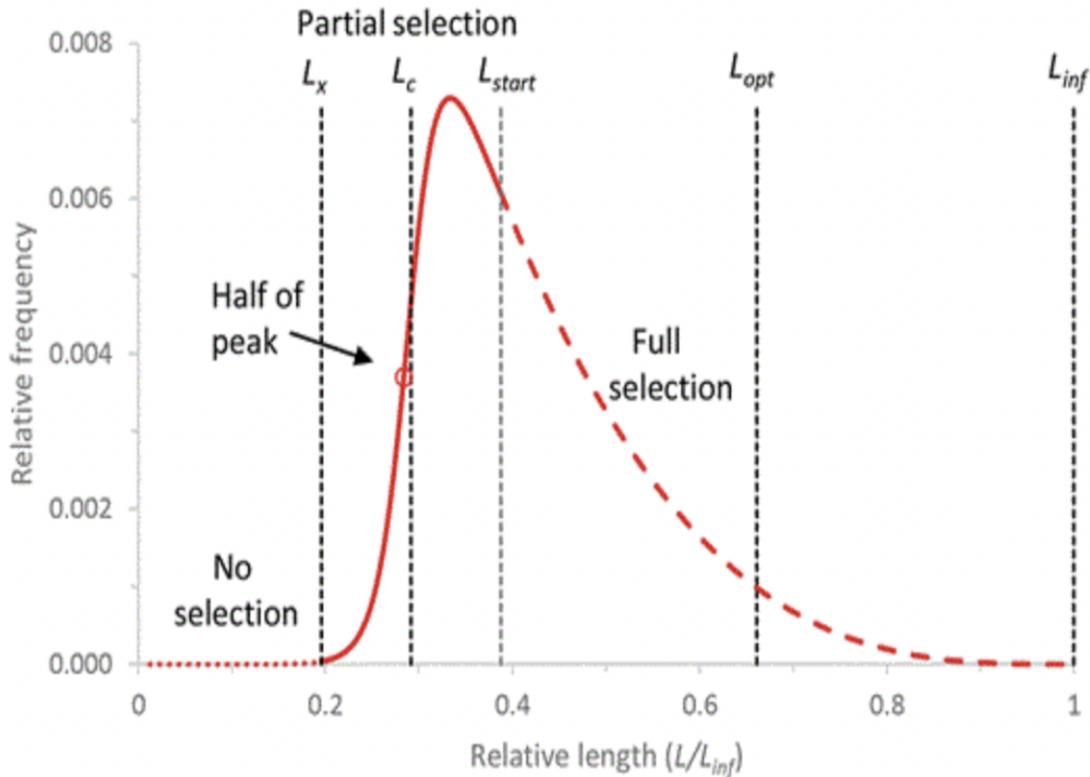
# Length-Based Bayesian Biomass estimator



Froese, R., Winker, H., Coro, G., Demirel, N., Tsikliras, A.C., Dimarchopoulou, D., Scarella, G., Probst, W.N., Dureuil, M. and Pauly, D., 2018. A new approach for estimating stock status from length frequency data. ICES Journal of Marine Science, 75(6), 2004-2015.

# LBB (Cont.)

- Datos: Captura a la talla



# LBB (cont.)

$$N_{L_i} = N_{L_{i-1}} S_{L_i} F((L_\infty - L_i)/(L_\infty - L_{i-1}))^{M/K+F/K S_{L_i}}$$

$F$  se cancela al dividir ambos lados por la suma.

Enfoque Bayesian, con priors obtenidos de datos previos o agregados de frecuencia de tallas, y estimación simultánea de  $L_\infty, L_c, M/K, F/K = (F/K)/(M/K)$ .

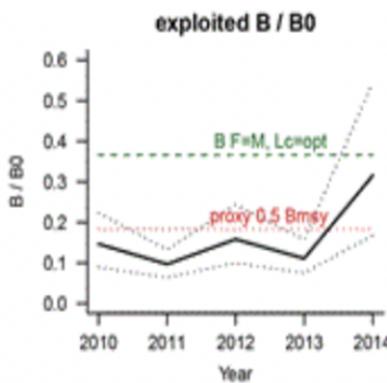
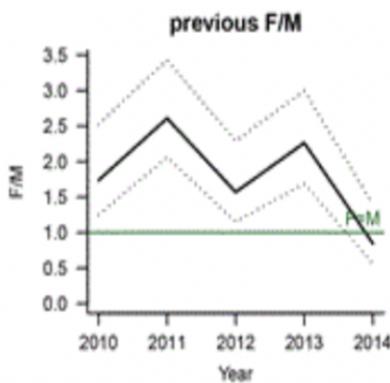
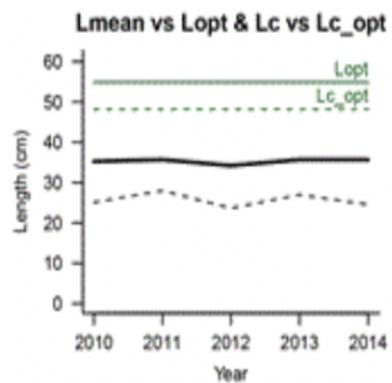
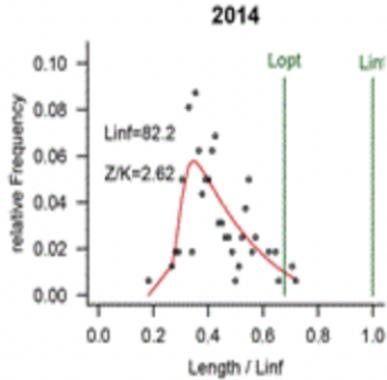
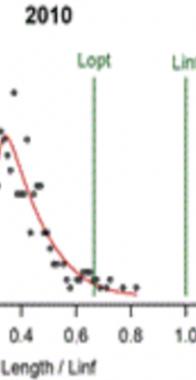
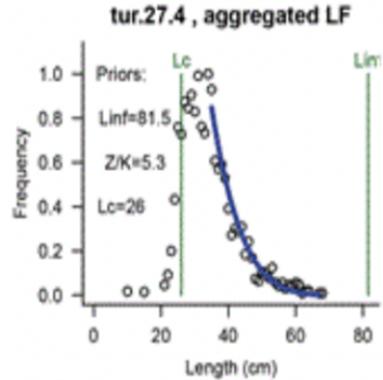
# LBB (cont.)

- Proxy de  $B_{RMS}$ , cuando  $L_c = L_{opt}$  y  $F/M = 1$ , i.e.,

$$\frac{B}{B_0} = \frac{CPUE'/R}{B'_0 > L_c/R}$$

$CPUE'/R$  y  $B'_0/R$  son indices por recluta.

# LBB (cont.)



# LIME

LIME: Length-based Integrated Mixed Effects

- Requiere un solo año de datos de talla e información biológica básica.
- Puede ajustarse a varios años de datos de talla con múltiples flotas (y capturas y un índice de abundancia si están disponibles).
- LIME evita la necesidad de hacer suposiciones de equilibrio, y mejora las evaluaciones data-poor.
- [Aplicación Shiny](#)

Rudd, M.B., Thorson, J.M. 2018. Accounting for variable recruitment and fishing mortality in length-based stock assessments for data-limited fisheries. Canadian Journal of Fisheries and Aquatic Sciences. 75(7): 1019-1035.