Clase 2: Algunos modelos de evaluación con datos limitados

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https://luisacubillos.github.io/curso_sibecorp_evastock_datlim/index.html

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)

ICES WKDLSSLS https://www.ices.dk/community/groups/Pages/WKDLSSLS.aspx
Ver además 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_{∞}	$L_{95\%}/L_{\infty}$	> 0.8
$L_{max5\%}$	L_{∞}	$L_{max5\%}/L_{\infty}$	> 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}	~ 1
L_{maxy}	L_{opt}	L_{maxy}/L_{opt}	~ 1
L_{mean}	$L_{F=M}$	$L_{mean}/L_{F=M}$	≥ 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 $M/K = 1.5$:

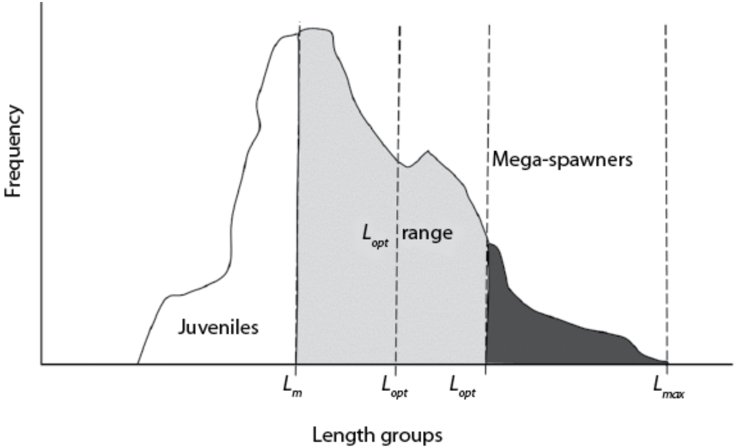
$$L_{opt} = 2/3L_\infty$$

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

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 Lmax5% 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

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

- Parámetros de historia de vida

FishLife

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/

Codigo: ICES-tools-dev/LBIndicator_shiny

Otras: ICES-tools-dev/ICES_MSY

Aplicación

https://scott.shinyapps.io/LBIndicator_shiny/

LBIndicator Application | Instructions | Upload data | Plot length frequency data | Length based indicator - plots | Length based indicator - table | Downloads

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 seperate 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

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

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

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

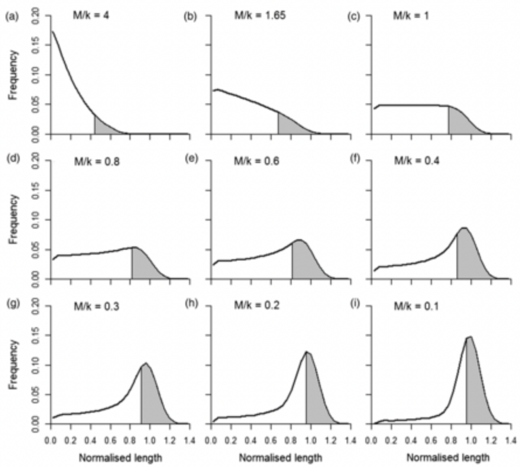
L_x: longitud esperada (estandarizada) a la edad x.

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

LBSPR Application | Instructions | Upload Data | Plot Data and Fit Model | Examine Results

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 seperate 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

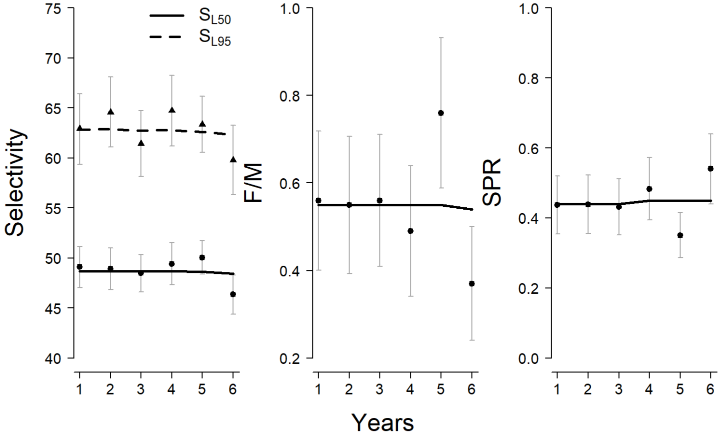
Enter the life history parameters for your species, and check that the length frequency distribution looks correct. If everything is correct, run the LBSPR model.

Use the example life history parameters for the example data files

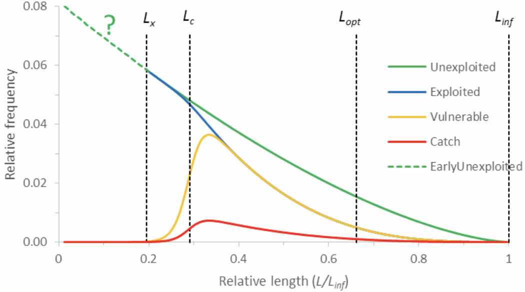
Examine Results

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



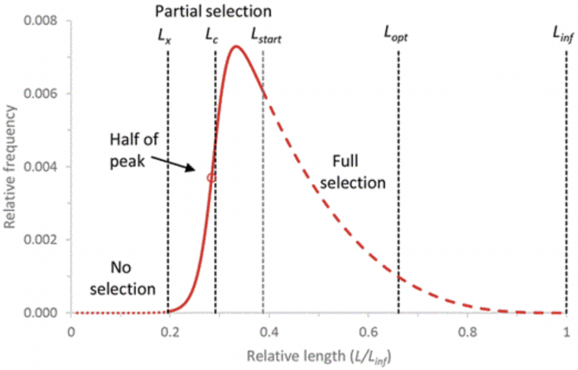
Length-Based Bayesian Biomass estimator



Froese, R., Winker, H., Coro, G., Demirel, N., Tsikliras, A.C., Dimarchopoulou, D., Scarcella, 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



GEOMAR https://oceanrep.geomar.de/43182/

https://github.com/SISTA16/LBB

LBB (cont.)

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

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 $L_\infty, L_c, M/K, F/K = (F/K)/(M/K)$.

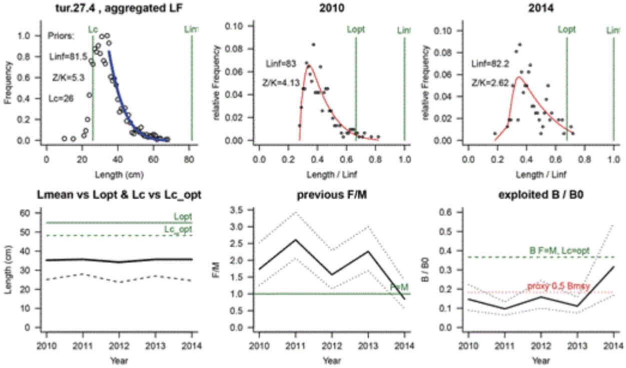
LBB (cont.)

- 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.)



tur.27.4 , aggregated LF
Priors:
Linf=81.5
Z/K=5.3
Lc=26
Lc
Linf
Frequency
Length (cm)
2010
Linf=83
Z/K=4.13
Lopt
Linf
relative Frequency
Length / Linf
2014
Linf=82.2
Z/K=2.62
Lopt
Linf
relative Frequency
Length / Linf
Lmean vs Lopt & Lc vs Lc_opt
Lopt
Lc_opt
Length (cm)
Year
previous F/M
F=M
F/M
Year
exploited B / B0
B F=M, Lc=opt
proxy 0.5 Bmsy
B / B0
Year

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.

Modelos basados sólo en capturas

- Clasificación de estatus:
  - Clasificación de estatus (Froese et al., 2012; Anderson et al., 20)
  - Enfoque ORCS mejorado (Free et al., 2017)
- Modelos de producción, p.e.:
  - CMSY (Martell y Froese, 2013)
  - OCOM (Zhou et al., 2017)

Clasificación de estatus

Criterios utilizados para asignar estados a datos de captura (Y) relativos a la máxima captura registrada (Y_{max}), capturas relativas al RMS, y biomasa relativa al B_{RMS}.

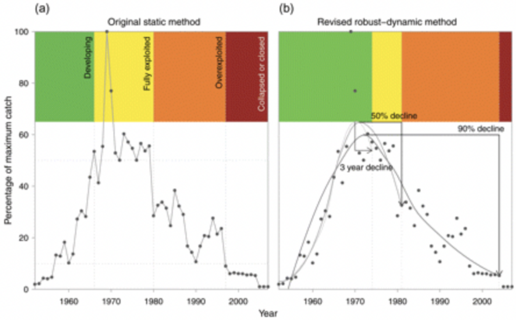
Indicador	Año	Y/Y_{max}	Y/RMS	B/B_{RMS}
Subdesarrollada	Antes de $Y \geq Y_{max}$	< 0.1	<0.1	
En desarrollo	-	0.1 a 0.5	0.2 a 0.75	> 1.5
Explotación plena	Después de $Y \geq Y_{max}$	> 0.5	> 0.75	≤ 0.5
Sobreexplotación	-	0.1 a 0.5	0.2 a 0.75	< 0.5
Colapso	-	< 0.1	< 0.2	<0.1

Recuperación: Año entre el colapso y el primer año subsecuente de explotación plena.

Froese, R., Zeller, D., Kleisner, K., & Pauly, D. (2012). What catch data can tell us about the status of global fisheries. Marine Biology, 159(6), 1283–1292. doi:10.1007/s00227-012-1909-6

Dynamic catch-based method

- El problema de máximos atípicos



Anderson, S. C., Branch, T. A., Ricard, D., and Lotze, H. K. 2012. Assessing global marine fishery status with a revised dynamic catch-based method and stock-assessment reference points. – ICES Journal of Marine Science, 69:1491-1500

Modelo de biomasa dinámica

$$B_{t+1} = B_t + rB_t(1 - B_t/k) - C_t$$

Encontrar la mejor combinación entre r y k que minimize la diferencia entre la biomasa observada y estimada.

$B = CPUE/q$

Métodos

- **Catch-MSY**: Catch-Based MSY estimation (Martell y Froese, 2013)
- **CMSY**: Catch Maximum Sustainable Yield 2 (Froese et al., 2017)
- **BSM**: Bayesian State-Space Surplus Production (Froese et al., 2017)
- **OCOM**: Optimized Catch-Only Model (Zhou et al., 2017)
- **SSCOM**: State-Space Catch Only Model (Thorson et al., 2013)
- **zBRT**: Boosted Regression Tree (Zhou et al., 2017)

Parámetros de historia de vida

$$r = 2F_{RMS} \sim 2M \sim 3K \sim 2/3M \sim 9/t_{max} \sim 3.3/t_{gen}$$

- Relaciones utilizadas para predecir r en FISHBASE
- Resiliencia qualitativa (Very Low, Low, Medium, High) y rangos para r están disponibles e FISHBASE.
- Ante ausencia de índices de abundancia, r puede ser obtenido de rasgos de historia de vida y un rango para k de la captura máxima.

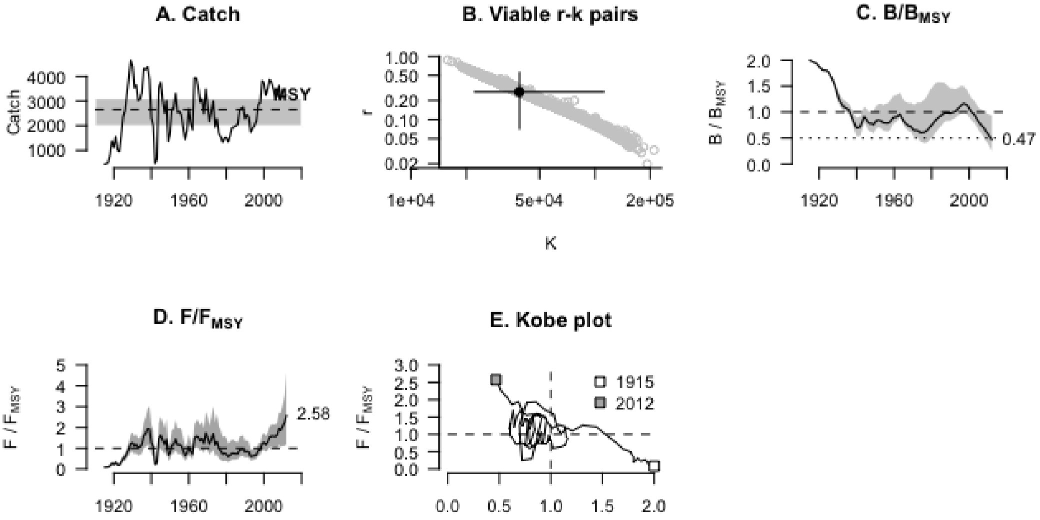
Casos especiales

Las capturas son series de tiempo, influenciadas por múltiples factores distintos que la pesca, por ejemplo:

- Cambios de régimen
- Incremento monótono
- Disminución monótona

Ejemplo: OCOM

Zhou, S., Punt, A. E., Smith, A. D. M., Ye, Y., Haddon, M., Dichmont, C. M., & Smith, D. C. (2017a). An optimized catch-only assessment method for data poor fisheries. ICES Journal of Marine Science, 75(3), 964–976. doi:10.1093/icesjms/fsx226



Indices de abundancia

- Data-Moderada:
  - Solo datos de índices de abundancia
    - AMSY - Froese et al. (2019)
  - Capturas + Indice de abundancia
    - ASPIC - Prager (1994), Prager et al. (1996)
    - SPiCT - Pedersen y Berg (2017)
    - JABBA - Winker et al. (2018)
    - JABBA-Select - Winker et al. (2020)
  - Productivity regimes, or gradual varying productivity
    - seaprodTVP - Mildenbeger et al. 2020
    - Ejemplos en https://github.com/tokami/spict/tree/seaprodTVP

Pausa y Café